



Invited Talk



SINGLE CROSS HYBRID TECHNOLOGY FOR MANAGING ABIOTIC STRESSES IN MAIZE

Sain Dass and Ishwar Singh

Directorate of Maize Research, Pusa Campus, New Delhi 110012

Maize (*Zea mays* L.) is the most widely cultivated crop of the world being grown in tropics, sub-tropics and temperate regions under irrigated to semi-arid conditions. It is crop of more than 150 countries. The major maize growing countries are USA, China, Brazil, Mexico, France and India. It is third most important cereal crop in India after rice and wheat that occupies about 8.12 million hectares having production of 19.3 million tones with average productivity of 2.37 tonnes/ ha during 2007-08. It is an important crop that holds a unique position in world agriculture, for food (25%), animal feed (12%), and poultry feed (49%), starch (12%), brewery (1%) and seed 1%. Apart from normal maize it has many other types *viz.* quality protein maize (QPM), sweet corn, baby corn, pop corn, waxy corn, high oil, etc. It generates employment for many million people in the world.

Single cross hybrids (SCH) are most productive among the other types of hybrids and composite varieties of maize. Productive inbred lines are the strength of hybrid development programme. As many as 44 single cross hybrids of different maturity have been developed in a short span of period for different agro-ecological conditions. Because of their high yield potential, uniformity and resistant to various abiotic and abiotic stresses single cross hybrids are most acceptable to the farmers. The adoption of this technology has made maize a global productive crop. The cultivation of high yielding, stress resistant/tolerant single cross hybrids offers viable, sustainable and profitable option for Indian farmers. The impact of single cross hybrid adoption has already been witnessed in USA, China and many other countries of world. Even in India by hardly covering 20% area under single cross hybrids. The crop growth rate with respect to production and productivity of maize has increased significantly in many states of the country, which is probably highest among food crops.

This technology is certainly going to provide solution to the climate change that is rising temperature in eastern and some part of central India, lowering water table in rice dominated area and weed menace in wheat belt *etc.*, because of high productivity of single cross hybrids. Therefore it is a potential technology in achieving the nutritional and food security of the nation. With the change in global climatic scenario, maize has emerged as an alternative for diversification of rice-wheat cropping system. Temperate germplasm, being highly productive, has been introgressed for desirable gene(s) into promising tropical/sub-tropical genetic backgrounds to develop productive inbreds suitable for different agro-climatic conditions of the country. Winter maize is gaining popularity in north and eastern India. Hence, late maturing productive hybrids have been developed by using temperate as well as late maturing tropical and sub-tropical inbred lines. With the lowering of water table, rice- area from different states in various seasons has been shifted/likely to be shift more to maize. For these areas productive hybrids have been recommended for sustainability of the agriculture. More than 80% area of maize grown in India is rainfed and is subjected to the vagaries of monsoon. Cultivation of early maturing single cross hybrids has helped in reducing the yield loss on farmer field in the current century's severe drought year.



SCREENING TECHNIQUE FOR DEVELOPMENT OF IDEOTYPES IN COTTON (*G. HIRSUTUM*) UNDER RAINFED CONDITIONS

B.S. Janagoudar

Dean and Professor of Crop Physiology, College of Forestry, Sirsi University of Agricultural Sciences,
Dharwad 580 005, Karnataka
bjanagoudar56@gmail.com

Since water is a limiting resource under dry land conditions, cotton crop improvement and research activities are therefore, compelled to develop or screen high yielding genotypes with low leaf area and higher total biomass under rainfed conditions rather than those producing higher leaf area and higher biomass. This necessitates the identification and breeding of cotton genotypes with low leaf area and higher total biomass for obtaining higher yield. It would be helpful in identifying the cotton genotypes with higher photosynthetic rate thereby improving the yield potential of cotton genotypes under limited water conditions.

One of the possible approaches is to search for cotton ideotypes with specific and distinct characters or combination of characters that are known to influence the photosynthesis, growth and production of economically important plant parts, as are expected to perform better under adverse environmental conditions. Development or identification of such cotton ideotype is possible either by regular breeding programme or by screening from the existing cotton germplasm under rainfed conditions. In broad sense, an ideotype is a biological model which is expected to perform or behave in a predictable manner in a defined environment.

For the identification of ideotype in cotton, a wide range of cotton cultivars with a genetic diversity for various traits is required (Blixt and Vose, 1984). Application of ideotype concept in cotton with higher photosynthetic rate, higher yield, pest and disease resistance and better fibre character lies in the extent of understanding about plant growth and morpho-physiological characters in enhancing yield including the nature of interrelationships between different characters. Seed cotton yield is stagnated for the last 10 years and India's productivity (338 kg/ha) is very low as compared to the world average (478 kg/ha). It appears that, the frequent occurrence of natural vagaries of various kinds of stress, lack of scientific crop production technology and the low yielding nature of present genotypes except hybrid cottons resulted in lower productivity in India.

In this direction, efforts need to be made in elucidating the principal factors limiting seasonal yield under rainfed conditions. To meet the challenges of productivity, *Gossypium hirsutum* sp. offers better scope for genetic improvement among the four cultivated species of cotton. Majority of cotton produced by *G. hirsutum* sp. is medium and long staple and it has very high adoptability with rich diversity for yield and yield related characters.

Initially 228 genotypes were evaluated under rainfed conditions for only yield and morpho-physiological characters. Based on this preliminary investigation results in the successive years totally 62 *G. hirsutum* L. genotypes were evaluated in detail for morpho-physiological, biophysical and biochemical parameters apart from growth, yield and yield attributing characters, to identify desirable plant characters for ideotype under rainfed condition. Among the genotypes, Aleppo x Rex, DS-44, DRC-264, IC-376, NA-1269, DRC-19 and CPD-4-4-5 produced significantly higher yield as compared to the checks Abadhita and Sharada. The increase in yield was to the extent of 45 to 70 per cent. Among the high yielding genotypes, DS-44 and IC-376 were categorized as low LA types, because of low LA/TDM ratio's. These genotypes also had high NAR, SLW and TDM/LAD ratio as compared to other genotypes and both the checks. In addition, these genotypes had higher chlorophyll content at all the growth stages indicating better photosynthetic capacity of the leaves which might have resulted in higher dry matter accumulation per unit leaf area. The higher yield obtained in the above mentioned genotypes was ascribed to accumulation of higher total biomass and greater partitioning into



reproductive parts as evidenced by the higher degree of association with TDM ($r=0.629^*$) and harvest index ($r=0.460^*$). In addition, the higher yield obtained in these genotypes was associated with higher boll number ($r=0.832^{**}$), Bartlett's index ($r=0.278^*$), LAR at 60 DAS ($r=0.317^{**}$), SLW at 90 DAS ($r=0.289^*$), RGR ($r=0.268^*$) and NAR ($r=0.282^*$) between 60-90 DAS and the negative association with LAI at 60 DAS ($r=-0.312^*$) and stomatal conductance at 120 DAS ($r=-0.368^*$). All the fibre properties studied in these genotypes were on par with checks Abadhita and Sharada.

Based on the above investigations, it could be concluded that the desirable plant characters for ideotype of plant under rainfed conditions are with low leaf area between 12-18 dm² / plant at peak growth stage, NAR of 0.04 to 0.07 g/dm²/plant between 60-90 DAS, CGR of 2.0 to 3.0 g/dm²/day at 90 DAS, lower stomatal conductance (3 to 4 cm/sec), lower transpiration rate (45 to 50 $\mu\text{g H}_2\text{O/cm}^2/\text{sec}$) and higher NAR to stomatal conductance ratio (0.0645 to 0.0812) during peak growth period, higher photosynthetic rate (Low LA/ TDM ratio), higher productivity per day, higher yield per unit functional LA, total biomass of 90 to 130 g/plant at harvest, higher HI of 22-35 percent, and more number of good bolls per plant (6-8) and with medium maturity (160-165 days) and the resultant genotypes identified based on these characters as ideotype cottons are DS-44, IC-376 and CPD-4-4-5.

From the field studies conducted at Dharwad for many seasons the following cotton ideotype characters have been proposed under rainfed conditions.

1. Short compact plant structure with open canopy.
2. Smaller leaves well inclined to intercept maximum light and showing heliotropic movements.
3. Short multinodal sympodia (2 to 4 nodes).
4. Moderate deep root system.
5. Semi dwarf stature reaching not more than a meter with amenability to close spacing.
6. Leaf anatomy with thick palisade than spongy parenchyma and thinner epidermal layers.
7. Crop duration around 130 -150 days.
8. Balanced growth, high fruiting coefficient and economic utilization of observed nutrients.
9. High photosynthetic efficiency and higher specific leaf weight.
10. Low transpiration with higher turgidity of leaves



BIOPHYSICAL CHARACTERIZATION OF WATER STATUS IN PLANT TISSUES AND ITS RELEVANCE IN PLANT PHYSIOLOGY

Shantha Nagarajan

Principal Scientist, Nuclear Research Laboratory, IARI, New Delhi-110 012

Characterization of water status and its availability in plant tissues assumes importance in studies where water becomes limiting. Among the conventional parameters for measuring plant water status, water potential describes water status in terms of its availability for plant processes. Solute potential, which is an essential component of water potential, reflects plant water retentivity as a function of solute concentration. Lowering of solute potential allows maintenance of turgor at low water potential. Modification in water status as a result of drought, as measured by water potential and turgor potential has been related to metabolic, hormonal and functional variations in plant response to water stress.

Water plays an important role in all physiological processes in the plant and its deficit has long been known to affect almost all aspects of plant growth and metabolism. The biological processes are closely related to the structural organization of water at cellular level and a small change in the 'state of water' can drastically alter the properties and functions of macromolecules and subcellular components. Pulse NMR measurements of longitudinal relaxation time T_1 and transverse relaxation time T_2 have been used to study water status and its interactions in biological systems as they directly relate to translational and rotational mobility of water molecules. NMR offers a non-invasive and non-destructive determination of internal water availability, its physiological compartmentation, its states and their variations under stress. Some examples of the application of NMR and allied physiological traits in elucidating the stress tolerance in crop plants will be discussed.

Temperature and moisture play a significant and fundamental role in determining the seed viability status during storage. Biophysical properties of seed water determine the reaction kinetics of seed deterioration. The relationship between seed deterioration and dependence of the biophysical properties of seed water namely water potential, water activity, differential enthalpy, entropy, free energy, nuclear magnetic relaxation time reviewed in this study indicates that the changes in these biophysical properties of seed water reflect the seed deterioration. In seed research, the major emphasis is given to characterisation of large number of samples for various chemical constituents and physical properties in relation to seed viability status. Inferences on the quality of seeds are made based on many standard seed tests. Different biophysical techniques have been used to characterise the seed water status. The non-destructive Nuclear Magnetic Resonance (NMR) spectroscopic techniques can be effective in characterising the seed status. The pattern of changes in NMR spin-spin relaxation time (T_2) of seeds during ageing suggests that loss of viability due to high temperature and high moisture content is closely linked to the irreversible loss of membrane integrity and cellular machinery. The results from the various biophysical properties of seed water shows the interaction of seed water status on seed deterioration. This demonstrates that biophysical characterisation of seed water status provide tools to describe the combined effects of temperature and water content on the kinetics of seed viability loss during storage.

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POTENTIAL APPROACHES FOR IMPROVING RUBISCO EFFICIENCY UNDER DIFFERENT ENVIRONMENT

M.C. Ghildiyal, Poonam Sharma-Natu and Rakesh Pandey

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Rubisco catalyses the entry of CO₂ into photosynthetic metabolism. Its slow catalytic rate, low affinity for atmospheric CO₂ and use of O₂ as an alternative substrate for the competitive process of photorespiration together makes Rubisco inefficient. It is widely accepted as the ultimate rate-limiting step in photosynthetic carbon fixation and is often viewed as a potential target for genetic manipulation to improve photosynthesis and yield. The photosynthesis of C₃ plants is limited by the supply of CO₂ at its present level in atmosphere, because Rubisco K_m (CO₂) is 10-25 μM, whereas, chloroplast stroma contains around 5 μM CO₂. High temperature and water stress under tropical climate further aggravate this limitation. Considering the projected rise in global temperature as a result of greenhouse effect, the situation may further worsen. Under high temperature solubility of CO₂ declines resulting in a reduction in availability of CO₂ in the vicinity of Rubisco. Drought leads to partial closure of stomata resulting in a decrease in CO₂ supply to Rubisco. Decreased availability of CO₂ on one hand decreases the catalytic efficiency of carboxylation and on other hand enhances oxygenation, consequently, the photorespiration. Efforts are therefore, being made to improve Rubisco efficiency through improving Rubisco specificity factor and by introducing C₄ type of photosynthesis in C₃ plants. C₄ cycle acts as a CO₂ concentration mechanism to provide high CO₂ concentration in the vicinity of Rubisco. Alteration in Rubisco specificity factor is being attempted by looking for natural variation in Rubisco catalytic properties. Rubiscos with higher specificity factor than what exist in C₃ plants have been discovered. Introduction of these Rubiscos into crop plants has potential to increase photosynthesis. In attempt to introduce C₄ characteristics in C₃ plants, maize genes for C₄ enzymes have been over expressed in rice leaves without any significant alteration of photosynthetic characteristics. It may possibly require not only the introduction of C₄ enzymes but also the Kranz leaf anatomy. However, recent discovery of single cell C₄ photosynthesis in terrestrial C₄ plants provide new possibilities in this regard.

Photosystem II has been considered to be especially sensitive to heat stress. However, it has now been shown that damage to PSII only occurs at high temperature often above 45°C. The decrease in photosynthesis under moderate heat stress could therefore, be through a decrease in CO₂ assimilation. The inhibition of CO₂ assimilation by high temperature has been observed under both photorespiratory and non-photorespiratory conditions, which indicated that reduced photosynthesis at elevated leaf temperature can only partially be explained by greater rate of photorespiration. Indeed, the decrease in photosynthesis under elevated temperature appeared to be due to a decrease in activation state of Rubisco catalysed by Rubisco activase. Identification and incorporation of thermotolerant Rubisco activase would therefore be required to improve thermotolerance of photosynthesis. The high CO₂ environment may, therefore, provide some ameliorative effect under such conditions of high temperature and drought. However, high CO₂ grown plants showed a down regulation of photosynthesis, through limitation imposed on Rubisco gene expression as a consequence of sugar accumulation in the leaves. It has been shown that, in those species where excess assimilates accumulate in the leaves as starch, there is no down regulation of photosynthesis and Rubisco gene expression. Effort may be made to utilize this trait for improved sustenance of photosynthesis. It is hoped that successful alteration to enhance the efficiency of Rubisco under different environment will be a reality in near future.



PLANTATIONS AS A CLIMATE CHANGE MITIGATION TOOL THE CASE OF NATURAL RUBBER

James Jacob

*Rubber Research Institute of India, Rubber Board, Ministry of Commerce and Industry, Government of India,
Kottayam 686 009, Kerala
james@rubberboard.org.in*

This article discusses the ecosystem services provided by the world's over 10 million ha of natural rubber plantations which are entirely in Non-Annex I countries and the need get these reflected in any new climate treaty. The most significant ecosystem service provided by the natural rubber plantations is their remarkably high rate of CO₂ sequestration which is in the range of roughly 29 to 40 t CO₂ per ha per year in the different countries that grow this plantation crop. Taking a mean rate of 25 t CO₂ sequestered per ha per year, the world's over 10.4 million hectare of rubber plantations fix as much as 260 million t CO₂ every year. This accounts for offsetting the current rate of build up of CO₂ in the atmosphere to the tune of 1.6% which is a significant ecosystem service provided by the world's natural rubber plantations. This is in addition to these plantations providing livelihood means for over 10 million growers and supporting a vital industry on which mankind depends so much.

Like natural rubber, the other plantation crops such as oil palm, cocoa, coffee etc. and commercial plantation forestry activities also provide excellent ecological services in terms of removing CO₂ from the atmosphere. All these plantation activities occur in the poor or developing populous countries in the tropics. Obtaining carbon credits for the ecosystem services provided by these plantations would help the poor rural peasants improve their livelihood. Will climate negotiations leading to Copenhagen 2009 take note of this?



CLIMATE CHANGE RESEARCH AND CROP SIMULATION MODELS

S. Naresh Kumar and P.K. Agarwaal

*Division of Environmental Sciences, Indian Agricultural Research Institute, New Delhi-110012
nareshkumar.soora@gmail.com*

Human activities caused increased concentration of greenhouse gases (GHGs) in the atmosphere resulting in to warming of the global climate system. IPCC projections indicate that temperature increase by the end of this century is likely to be in the range 1.8 to 4.0°C. The projections also indicate likely increase in frequency of intense tropical cyclones, increased events of high wind speeds, heavy precipitation, hot extremes, heat waves, cold waves, dry spells and droughts. Himalayan glaciers and snow cover are projected to contract. It is projected that by the end of the 21st century rainfall over India will increase by 15-40%, and the mean annual temperature will increase by 3°C to 6°C. The warming is more pronounced over land areas, with the maximum increase over northern India. The warming is also relatively greater in winter and post-monsoon seasons. All these projections in climate change and climatic variability will have profound influence on agriculture and thereby food security. Hence it is important to assess the impact of climate change on crops in order to i) quantify the magnitude of impact (loss or gains) of climate change or variability on target crop ii) quantify spatio-temporal variation in impacts, iii) derive/evaluate adaptation strategies to minimize the adverse impacts and to maximize the beneficial influences and iv) assess the impacts and adaptation at regional/ state/ national level to derive the vulnerability of the system to climate change and climatic variability. Quantification of impact of major climate change parameters such as increased temperature and CO₂ on crops is being studied using two approaches, viz., field or controlled environment experiments (OTC, FACE, FATE, TGT and Phytotron studies) and simulation approaches. Data generated from field experiments provide vital inputs to simulation studies. Simulation approach enables researchers to integrate influence of several factors, which can provide regional/ state/ national level information. Well validated simulation models are strong tools which provide opportunity to use various climate change scenarios in combination with different management strategies for analyzing the regional impacts and adaptation options. Other areas where crop growth simulation models are being used are in analysing the optimising resource use, increasing productivity, identifying yield gaps and reducing adverse environmental impacts apart from environmental characterization and agro-ecological zoning, defining research priorities, technology transfer, estimating potential production and strategic and anticipatory decision making.



IS RISING ATMOSPHERIC CO₂ IN CHANGING CLIMATE IS BENEFICIAL TO PLANTS?

Madan Pal Singh, Pramod Kumar and Sangeeta Khetarpal

Division of Plant Physiology, IARI, New Delhi-110012

madanpal@yahoo.com

The fourth assessment report of the IPCC (IPCC, 2007) has provided clear evidence of changes in climate due to human activities. These changes in climate are likely to have impacts on agricultural ecosystems and food security across the globe through their direct or indirect effects on crops. The impact of climate change would be particularly severe in the tropical areas, mainly in developing countries, including India. The concentration of greenhouse gases in the atmosphere has progressively increased over the last century or so. The CO₂ concentration has been increasing at the rate of 1.9 $\mu\text{mol mol}^{-1}$ per year and is expected to reach up to 570 $\mu\text{mol mol}^{-1}$ by the middle of this century. These changes in emission of CO₂ and other green house gases have resulted in about 0.6°C increases in global temperature over the last century. The climate models project that there will be even greater warming during the 21st century. The CO₂ concentration is projected to reach 405 to 460 $\mu\text{mol mol}^{-1}$ by 2025, 445 to 640 $\mu\text{mol mol}^{-1}$ by 2050 and 720 to 1020 $\mu\text{mol mol}^{-1}$ by 2100 under various scenarios. The projected global mean temperatures for those CO₂ stabilization scenarios are 0.4-1.1°C by 2025, 0.8-2.6°C by 2050 and 1.4-5.8°C by 2100 above values in 1990. The IPCC (2007) has projected that the global average atmospheric temperature would rise by 1.8 to 4.0°C by the end of this century. For Indian region (South Asia), rise in temperature has been projected 0.5 to 1.2°C by 2020, 0.88 to 3.16°C by 2050 and 1.56 to 5.44°C by 2080. The responses of plants to changing environmental conditions are complex and not well understood. Various reports have shown that increase in CO₂ concentration in the atmosphere may have a fertilization effect on C₃ crop species and will enhance their productivity in the absence of any biotic or abiotic stresses. The rising concentration of CO₂ in the atmosphere has important contribution in global warming. Therefore CO₂-induced increase in the atmospheric temperature may lead to lower grain yield through poor seed filling and may offset the beneficial effect of CO₂. High temperature is the most imminent threat from climate change and its effect on plant growth, development and yield has been widely studied. Higher temperature may affect development of crop plants through reduction in crop duration, alteration in rate of respiration and photosynthetic partitioning, increased evapotranspiration, hastening the nutrient mineralization in soil and reduction in fertilizer use efficiency due to increased gaseous losses.

Exposure of plants to high atmospheric CO₂ often results in increase in growth and productivity under favourable growth regimes (Kimball *et al*, 2002). Such changes in plant growth have been attributed to enhanced photosynthesis and improved transpiration efficiency. However, prolonged exposure to high CO₂ exhibit photosynthetic down regulation and inhibition of photosynthetic capacity, which has been attributed to various anatomical and biochemical adjustment by the plants. However, the response of photosynthesis to high CO₂ varies with the change in ambient temperature of air and temperature optima for photosynthesis. If the ambient temperature is below the optimum for photosynthesis, a small increase in temperature can result in photosynthetic enhancement. The converse may be there if the increase in temperature will be near the maximum for plant growth and development and may contribute to down regulation (Polley, 2002).

In most of the studies, high CO₂ exposure resulted in enhanced vegetative growth more than reproductive development. In natural environment plants are exposed to various biotic and abiotic stresses concomitantly, and role of CO₂ in stress tolerance can be assessed only when grown in multiple environments. Some reports suggest that elevated CO₂ is beneficial to plants and can impart them tolerance under drought and high temperature. On the other hand various crops show no beneficial response, when subjected to multiple stresses along with elevated CO₂. In studies with soybean, the effects of high temperature and UV-B either alone or in combination



were not alleviated by elevated CO₂. In peanuts, drought and high temperature reduce the yields more than either of the stresses alone. However, the extent of damage depends on the most stressful factor and its intensity (Reddy *et al*, 2000). Some studies report increase in tissue temperature under elevated CO₂ due to reduction in transpiration. Prasad *et al* (2005) have reviewed interactive effects of elevated CO₂ and temperature in various C₃ crops and reported that in most of C₃ crops, the higher photosynthetic rates and vegetative growth at elevated CO₂ showed no amelioration the negative effects of high temperature on reproductive processes and yield. Similarly, no positive interaction between elevated CO₂ and temperature has been reported in wheat, beans, rice and cowpea (Wheeler *et al*, 2000). Some studies suggest that elevated CO₂ can ameliorate the effect of 1-1.5 °C increase in temperature through supplying additional carbon to compensate the enhanced respiration under high temperature. Thus rising CO₂ may increase crop yield through enhanced photosynthesis and water use efficiency but the net gain will depend upon the magnitude of changes in air temperature. Higher CO₂ may be beneficial in areas where ambient temperature is optimum for growth but increase in temperature beyond optimum level will cause reduction in yield by decreasing carbon gain and accelerating rate of development.

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RISING ATMOSPHERIC CO₂ AND CROPS: AN INDIAN OVERVIEW

D.C. Uprety* and Ranjan Das**

*F.N.A.Sc., Emeritus Scientist, Division of Plant physiology, IARI, New Delhi-110012

** Department of Crop Physiology, AAU, Jorhat, Assam

Anthropogenic activities lead to the rise in the atmospheric concentration of greenhouse gases including water vapour, carbon dioxide, methane, nitrous oxide and chloro-fluro carbons resulting in global climate changes. The exponential rise in the atmospheric CO₂ is an important global climate change, which effectively influences the productivity of the crop plants. The rising concentration of CO₂ in the atmosphere has important contribution to the global warming. Man made activities such as fossil fuel burning and deforestation lead to the exponential rise in the concentration of atmospheric CO₂. Its concentration in the atmosphere was around 270 μ mol mol⁻¹ during pre industrial period (1850) and human activities have added more than 100 μ mol mol⁻¹ to reach to the current level of 372 μ mol mol⁻¹ with the rate of rise as 1.8 μ mol mol⁻¹ of CO₂ per year. With this exponential rise in CO₂, its concentration will be doubled by the middle of 21st century. The increase in the atmospheric CO₂ cause global warming by absorbing long wave heat radiations from the earth's surface and may also affect cloudiness and precipitation (climatic effect). Plants have been directly affected by rising atmospheric CO₂ because it serves as the key substrate to photosynthetic carbon assimilation. C₃ plants respond to elevated CO₂ because of the presence of Rubisco, the key enzyme for photosynthesis. On the other hand, C₄ plants show little response to the elevated CO₂ because C₄ pathway is not competitively inhibited by O₂ and is completely CO₂ saturated.

Agriculture plays an important role in mitigating the greenhouse gas emissions. It reduces CO₂ emissions by 32%. Its effective management can contribute to mitigation of the adverse effects of climate changes by combining appropriate land and crop management practices to increase crop production. Future studies on critical management practices will bring enhanced soil and plant management and the development of new technologies of increased crop production efficiency with minimum impact on environmental quality. Adaptations to climate change exist in some cropping systems to maintain or even increase crop yield under future changed climatic conditions compared to the current one. Analysis of local cropping system approach is useful. Farmers will be able to use these changes for choosing the most favorable crops, cultivars and cropping systems. A global search for genetic materials that are more responsive to CO₂ and tolerant to high temperature would help farmers and plant breeders. Innovative approaches, for conducting long-term experiments to study the responses of crop plants to the elevated CO₂, have been developed.

Open top chamber CO₂ enrichment technology was designed and developed for South Asian conditions to study the effect of elevated CO₂ in the crop plants. CO₂ enrichment research network of India, Bangladesh, Nepal, Pakistan and Sri Lanka for multi country, multi disciplinary experiments was coordinated by the National Fellow programme of the Indian Agricultural Research Institute, New Delhi (Uprety *et al.*, 2000). A PC based system of Free Air CO₂ enrichment (FACE) technology was established with the help of National Physical Laboratory, New Delhi, to generate realistic biological data on the crop responses to the higher CO₂ concentration. Addition of these facilities has brought India on the GCTE CO₂ Research Network which is active in tackling vulnerable issues and adaptation strategies for meeting the rise in global food demand in the face of global environmental changes.

Field experiments for studying the responses of crop plants to the elevated CO₂ using OTC and FACE facilities were conducted at IARI under a global change national programme. Following conclusions were drawn:



1. Elevated CO₂ was highly significant in mitigating the adverse moisture stress effect on plant processes in *Brassica* species.
2. There is a possibility of transferring CO₂ responsive characters from one parent i.e., *Brassica campestris* to the hybrid *Brassica oxycamp*.
3. Studies on rice and wheat cultivars demonstrated significant increase in their growth and productivity. These responses have been physiologically and bio chemically characterized.

This information is an important component for decision support system for strategic choice of crop cultivars to be promoted in agricultural area, vulnerable to global environmental changes to sustain the livelihood in affected resource-poor farmers.



INFLUENCE OF MOISTURE AND HIGH TEMPERATURE STRESS ON PHENOLOGY, BIOMASS PRODUCTION & YIELD AND YIELD COMPONENTS OF DIVERSE CHICKPEA GENOTYPES

P.S. Deshmukh Manish Kumar Singh*, S.R. Kushwaha and R.K. Sairam

Division of Plant Physiology, I.A.R.I, New Delhi-110 012

**kumar.manish21@yahoo.co.in*

The planting of chickpea has been delayed due to late harvest of many kharif crops. This has caused serious reduction in the productivity of the crop. Chickpea is grown popularly in north-west plain zone of the country because of its high water use efficiency and better adaptation to high temperature conditions. But the productivity level was found far below as compared to other countries when grown under normal and further reduced due to various abiotic stresses. An experiment has been laid out to understand the physiological causes of low productivity. The chickpea genotypes released between 1940 to 2006 were included in this study and where grown under irrigated, rainfed, early & late planting conditions. The observations were recorded on duration of different phenophages, membrane stability index at vegetative & reproductive phase, growth parameters, yield & yield components. There was shortening of duration of various phenophases due to both moisture and high temperature stress in all the genotypes. In early & late flowering genotypes there were significantly more reductions both in biomass & seed yield as compared to medium durations. These genotypes yielded better under stress environment. The reduction in seed yield was caused due to significant reduction in pod number per plant & seeds per pod, however the 100 seed weight was found relatively stable character. Relatively less reduction in phenophages of medium duration genotypes allowed better accumulation of biomass and further supported in terms of assimilate partitioning. The data has been discussed in relation to moisture & temperature stress causing imbalance in source & sink to enhance productivity of pulses in general under changing environment.



BAEL FRUIT DRINK – A DELICIOUS, NUTRITIOUS AND CURATIVE RTS BEVERAGE FOR GOOD HEALTH

R.K. Pal, Jagvir Singh and Manish Kumar Singh

^{1,2}Division of Post Harvest Technology, ³Division of Plant Physiology, IARI, New Delhi-110012

Among the indigenous fruits of India, the Bael (*Aegle marmelos*) occupies an important place. Bael is one of the oldest fruit known under cultivation in India from pre-historic times. It is also known as “Bengal Quince”. The bael fruit consists of moisture 61.5 percent, protein 1.8 percent, fat 0.3 per cent, minerals 1.7 percent, fiber 2.9 percent and carbohydrates 31.8 percent per 100 grams of edible portion. Its mineral and vitamin contents include calcium, phosphorous, iron, carotene, riboflavin, thiamin, niacin and vitamin C. Bael fruit is one important underutilized fruit in India having tremendous commercial potentialities. The ripe bael fruit is aromatic, astringent, coolant and laxative. Half ripe fruit is astringent, digestive, improves appetite and antiscorbutic (helps to fight scurvy) due to vitamin C deficiency. It cleans and tones up the gastro- intestinal tract. Its regular use for two three months helps evacuate even the old accumulated foecal matter from the bowels. Bael fruit is the most effective food remedy for chronic diarrhea and dysentery where there is no fever. For best results it should be taken in the form of drink which is prepared from the pulp of the ripe fruit.

The division of Post Harvest Technology at IARI, New Delhi has developed novel technique for value addition of bael fruit and has been engaged in production and sale of bael drinks under the brand name of Pusa Fruit Drinks with FPO license of Cottage Scale Production Unit. The process of production of bael drinks has been standardized in such a way that the final product is preserved using low cost thermal processing technology without addition of any synthetic colour, flavour and class-II preservatives at the same time the goodness of the drink is retained up to one year with all the nutraceutical properties. The bael drinks is highly acceptable to the consumers and posses a great demand.



SALINITY STRESS TOLERANCE IN CROP PLANTS

R.K. Sairam

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Excess amount of salts in soil adversely affects plant growth and development. Nearly 20 per cent of the world's cultivated area and nearly half of the world's irrigated lands are affected by salinity. In terms of area it threatens the agricultural productivity in 77 million hectare of agricultural land, of which 45 million hectare (20% of irrigated area) is irrigated and 32 million hectare (2.1 % of dry land) is unirrigated land. Salinization is further spreading in irrigated land due to improper management of irrigation and drainage. Rains, cyclones, and wind also add salts after salts into the coastal agricultural land. Soil salinity often leads to development of other problem soils such as soil sodicity and alkalinity. The USDA Salinity Laboratory defines a saline soil as a soil having electrical conductivity of the saturated paste extract (EC_s) of 4 deci Siemens per meter (dS m⁻¹) or more. High concentrations of soluble salts such as chlorides of sodium, calcium and magnesium contribute to the high electrical conductivity of saline soils. NaCl contributes to most of the soluble salts in saline soils. Plants are classified as glycophytes or halophytes according to their capacity to grow on high salt medium. Most plants are glycophytes and cannot tolerate salt stress. First high salt concentrations decrease the osmotic potential of the soil solution, thus creating a water stress in plant. Secondly, they cause severe ion toxicity since Na⁺ is not readily sequestered into vacuoles as in halophytes. Finally, the interactions of salts with mineral nutrition may result in nutrient imbalances and deficiencies. The consequence of all these can ultimately lead to plant demise as a result of growth arrest and molecular damage. Salt stress and dehydration stress show a high degree of similarity with respect to physiological, biochemical, molecular and genetical effects. This is possibly due to the fact that a sublethal salt stress condition is ultimately an osmotic effect, which is apparently similar to that brought by water deficit and to an extent by cold as well as heat stresses. Processes such as seed germination, seedling growth and vigour, vegetative growth, flowering, and fruit set are adversely affected by high salt concentration, ultimately causing diminished economic yield and also quality of produce. Development of salinity tolerant crops is the need of the hour to sustain agricultural production. To achieve salt tolerance, the foremost task is either to prevent or alleviate the damage, or to reestablish homeostatic conditions in the new stressful environment.

Crop plants and other species, which experience salinity in their normal habitats, have evolved a number of defence mechanisms, such as sodium exclusion and sequestration, osmotic adjustment in the form of osmolytes synthesis and accumulation, and antioxidant activity to ameliorate the oxidative stress.

The ability of the plants to combat environmental stresses is determined by the efficiency of the plant to sense the environmental stress and activate its defense machinery. One of the responses observed under salinity is the generation of oxidative stress or formation of reactive oxygen species (ROS) in the form of superoxide radicals (O₂⁻), hydrogen peroxide (H₂O₂) and hydroxyl radicals (OH·). Experiments conducted with tolerant and susceptible genotypes of maize [PEHM 3 (tolerant) Navjot (susceptible)] and wheat [Kharchia 65 and KRL 19 (tolerant) HD 2687 and HD 2009 (susceptible)] revealed increase in O₂⁻ and H₂O₂ contents, and lipid peroxidation with increase in salinity levels in all the genotypes, however, the tolerant genotypes of both the crops recorded lower ROS production and lipid peroxidation than the susceptible genotypes. Antioxidant activity in the form of ascorbic acid, and activities of superoxide dismutase, ascorbate peroxidase, catalase and glutathione reductase also increased under salinity, however, the increase was greater in tolerant genotypes of wheat and maize than the susceptible genotypes. It is thus clear that lower ROS in tolerant genotypes of both the crops is due to the stress induced increase in activity of antioxidant enzymes activity.

Since the salinity like drought also results in dehydration or osmotic stress, one of the adaptation



mechanisms is the synthesis of various osmolytes. Tolerant genotypes of maize and wheat showed much greater accumulation of osmolytes like total soluble sugars, proline, glycine-betaine and trehalose than the susceptible genotypes of both the crops. The increase in glycine-betaine and trehalose was observed to be due to increase in the mRNA expression of *betaine aldehyde dehydrogenase (BDH)* and *trehalose phosphate synthase (TPS)*. This proves that the tolerant genotype react to saline environment by actually increasing the expression of genes associated with synthesis of enzyme proteins involved in the synthesis of osmolytes, leading to osmotic adjustment.

Plants perceive salt stress as ionic and osmotic stress. Excess Na^+ and Cl^- induced conformational changes in protein structure, and membrane depolarization can lead to the perception of ion toxicity. Plasma membrane proteins, ion transporters, and/or Na^+ sensitive enzymes have been hypothesized as sensors of toxic Na^+ concentrations in extra cellular and intracellular sites. Regulations of ion (Na^+ and K^+) homeostasis involving SOS (salt overly sensitive) genes have recently been suggested by the SOS pathway. The input of SOS pathway is due to excessive intracellular or extra-cellular Na^+ , which triggers a cytoplasmic Ca^{2+} signal. The outputs are expression and activity changes of transporters for ions such as Na^+ , K^+ and H^+ . Wheat genotypes tolerant (Kharchia 65 and KRL 19) and susceptible (HD 2687 and HD 2009) to salinity were subjected to various levels of salinity stress. Salinity stress resulted in increase in sodium content and decrease in potassium and calcium contents. Tolerant genotypes showed less increase in sodium content, sodium/potassium and sodium/calcium ratios, and fewer declines in potassium and calcium contents. To examine the role of SOS pathway in imparting tolerance against salinity stress wheat genotypes were subjected to 24 h salinity and their RNA was harvested, followed by gene expression studies done by RT-PCR using gene specific primers for SOS1, plasma membrane Na^+/H^+ antiporter; SOS2, a serine/threonine type protein kinase, which activate SOS1 by its protein kinase function; tonoplast Na^+/H^+ antiporter and tonoplast H^+ -pyrophosphorylase, the last two have role in sequestering Na^+ in vacuole. Kharchia 65, which is highly tolerant to salinity stress, showed very high gene expression of SOS1, SOS2, tonoplast Na^+/H^+ antiporter and tonoplast H^+ - pyrophosphorylase, while lowest expression was observed in highly susceptible genotype HD 2687. From this we can conclude that lower sodium accumulation in Kharchia is a function of SOS pathway and tonoplast Na^+/H^+ antiporter and H^+ - pyrophosphorylase.

Salinity stress tolerance thus is a complex mechanism involving interactive actions of various independent pathways, such as scavenging of ROS by increasing the activity of antioxidant enzymes, osmoregulation, to combat salt induced osmotic stress by increasing the synthesis of various osmolytes, and exclusion and sequestering of Na^+ ions by the SOS pathway and tonoplast Na^+/H^+ antiporter and H^+ - pyrophosphorylase. The consequence of positive actions of all these mechanisms is reflected in tolerant wheat (Kharchia 65) and maize (PEHM 3) genotypes having higher RWC, membrane stability and chlorophyll content than the susceptible genotypes.



PHOTORESPIRATION: A NEW LOOK

Prikhshayat Singh

*Division of Biochemistry, Indian Agricultural Research Institute, New Delhi-110012
pss_bioc@iari.res.in. & psingh_bioc@rediffmail.com*

Illuminated leaves of C_3 plants release recently fixed CO_2 during photorespiration also known as glycolate oxidation pathway. The light reaction involves the formation of glyoxylate from phosphoglycolate, a product of photorespiration. Subsequent oxidative decarboxylation of glycolate is known to be the source of photorespiratory CO_2 . An alternative mechanism of CO_2 evolution from glycolate and glyoxylate has been suggested involving isocitrate lyase reaction. The presence of isocitrate lyase was shown associated with mitochondria in green leaf. However, the relative contribution of glyoxylate oxidation towards CO_2 generation in light in leaf is not known. Succinate during active photophosphorylation will accumulate within the mitochondria. Glyoxylate a product of photorespiration will also accumulate in the leaf cells. We suggest the possible formation of isocitrate by the condensation of succinate with glyoxylate via the reversal of the isocitrate lyase reaction. Further metabolism of isocitrate via the shortened citric acid cycle would generate CO_2 . This pathway could be significant as a supplement or substitute for the anaplerotic carboxylation reactions, required to replenish the keto-acids, which are rapidly consumed for the synthesis of amino acids in photosynthetic tissues. The pathway suggests a physiological function for photorespiration in the sense that glyoxylate could be a source of carbon for the generation of carbon skeletons via short circuiting the citric acid cycle in light.



SENESCENCE INDUCED LOSS IN PHOTOSYNTHESIS IS A SIGNAL FOR INDUCTION OF SENESCENCE ASSOCIATED GENES (SAGs) LINKED TO SUGAR METABOLISM: EXPRESSION OF *din2* GENE AND MODULATION OF THE ACTIVITY OF CELL WALL BOUND HYDROLASES

Basanti Biswal

Biochemistry and Molecular Biology Laboratory, School of Life Sciences, Sambalpur University, Jyotivihar-768019, Orissa

Leaf senescence is known to be associated with the expression of several genes. But the precise nature of signaling system associated with induction of the genes still remains unclear. The process in the leaves of *Arabidopsis thaliana* causes a decline in the efficiency of primary photochemical reactions and carbon dioxide fixation, which ultimately results in the loss in the level of endogenous sugar. The loss in sugar level is suggested to act as a signal for expression of several genes including *din2* gene that codes for β -glucosidase bound to cell wall. The gene is expressed late during senescence and the late expression is observed even in *hys 1* mutant exhibiting early senescence syndrome. The enzyme β -glucosidase, encoded by the gene is known to be weakly bound to cell wall and is responsible for breakdown of the polysaccharides associated with the wall. The participation of β -glucosidase in the senescence program is supported by the senescence induced increase in its activity. The enzyme has been purified and characterized in our laboratory. In addition to β -glucosidase, another hydrolyzing enzyme namely, β -glucanase bound to cell wall has been examined. The activity of β -glucanase like β -glucosidase is also found to be enhanced in the background of loss of photosynthesis during senescence. A significant correlation is established between the loss of photosynthesis and enhancement in the activity of cell wall bound enzymes. Since cell wall remains intact till the last stage of senescence, it could be the final target of these hydrolytic enzymes, which break down the cell wall polysaccharides to provide respiratory sugars as the possible energy source to execute and complete the senescence program and for sugar remobilization. Our data on the activity of both these enzymes possibly explains the physiological significance of late expression of *din2* gene.



MICROPROPAGATION IN SUGARCANE: APPLICATIONS OF NON-PURINE CYTOKININS AND POLYAMINES

Ashok K. Dhawan*

*Centre for Plant Biotechnology, CCS HAU New Campus, Hisar-125004, Haryana
dhawanashok@hotmail.com*

Micropropagation is of immense application in sugarcane for fast multiplication of newly released varieties, multiplication of germplasm for testing at research centres, storage of germplasm, international exchange of materials and elimination of systemic pathogens that build up due to transmission during vegetative propagation. Several purine type synthetic and naturally occurring cytokinins such as BAP, kinetin, zeatin and isopentenyladenine are commonly employed in plant tissue cultures. In recent years, some non-purine compounds, notably, 4-CPPU [N-(2-chloro-4-pyridyl) N-phenylurea] and thidiazuron [TDZ; N-phenyl-N'-(1,2,3-thiadiazol-5-yl) urea] have been reported to simulate cytokinin activity in some responses. It is pertinent to mention that with the exception of BAP, purine type cytokinins are chemically unstable, whereas these non-purine types are generally stable and hence have the obvious advantage in procedures that involve heat sterilization. Further, polyamines like putrescine, spermidine and benzyl aminopurine have been reported to affect the growth and proliferation of culture *in vitro*. Importance of micropropagation in sugarcane and the work carried out in our laboratory on the applications of these non-purine cytokinins and polyamines in the process shall form the subject matter of the lecture.



GENETIC TRANSFORMATION OF CHICKPEAS (*Cicer arietinum* L.) TO CONFER RESISTANCE AGAINST WEEVILS AND POD BORERS

B.K. Sarmah

Professor, Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat – 785 013
bidyutsarmah@yahoo.co.in

Chickpea (*Cicer arietinum*) is the most important pulse crop of India and is one of the major sources of protein for the vegetarian population. Two very serious insect pests of chickpeas are weevils (*Callosobruchus* sp) and pod borers (*Helicoverpa armigera*). There is little or no natural resistance to these insects in the cultivated varieties, which hinders the development of resistant chickpeas using conventional breeding methods. With the development of gene technology it is now possible to incorporate insect resistance genes from unrelated sources into this important grain legume.

In collaboration with CSIRO Plant Industry, Canberra, we transformed chickpeas using a bean α -amylase inhibitor (α ?ai) gene to confer resistance against the stored grain pests in the *Callosobruchus* group. Transgenic lines were found to express the gene in mature seeds and protect the seeds from attack of the pest when compared to control seeds. These lines can now be incorporated into an introgression breeding programme in order to transfer the gene into other important desi and kabuli type chickpea cultivars for various regions of India. We have also transformed chickpeas using two different Bt genes (*Cry1Ac* and *Cry2Aa*) to confer resistance against pod borers (*Helicoverpa armigera*). The coding sequences for two Bt genes were obtained from NRCPB, IARI, New Delhi. Considerable effort was devoted to obtaining chickpeas with different versions of the Bt proteins that have already been approved for release in several countries. For reconstruction of Bt genes we used a twin binary vector which will facilitate the removal of selection marker gene from the segregating progeny. We first transformed chickpea with a chimeric *Cry2Aa* gene. Molecular analyses of the transgenic events and their progeny confirmed presence and expression of transgene. Insect bioassays using the progeny of selected lines showed differential resistance to pod borer (*Helicoverpa armigera*) larvae, depending upon the level of expression of the Bt protein. A high expressing line was found to confer near complete protection against the pod borer. We have also noted that some of our lines showed reduced plant vigour. Further research is needed to determine whether this can be overcome by backcrossing to advanced breeding lines. Currently we have transferred two of our high expressing lines and one medium expressing line to a private seed company “Mahyco” in India through a non exclusive license signed under the banner of Indo-Swiss Collaboration in Biotechnology programme for further evaluation and product development.

Currently we are transferring a *Cry1Ac* gene to the chickpeas. Several transgenic lines have already been generated. We are selecting an agronomically acceptable *Cry1Ac* line. In the longer term we propose to cross the best *Cry 1Ac* line with the best *Cry 2Aa* line in order to pyramid both these genes in a single plant.



COMPACT PANICLE ARCHITECTURE IS RESPONSIBLE FOR MORE ETHYLENE PRODUCTION AND LESS GRAIN FILLING IN RICE

P.K. Mohapatra

School of Life Science, Sambalpur University, Jyoti vihar, Sambalpur 768019

Change of plant type in rice resulting in increased compactness of panicle structure provides space for accommodation of a larger numbers of spikelets, but grain yield does not increase proportionately because of physiological limitations in grain filling. The objective is to identify the potential causes of poor grain filling in compact paniced rice, OR-1920-7 by comparing it with loose paniced cultivar Lalat. The physiological processes influencing source and sink activities of the cultivars were assessed by growing the cultivars in open field conditions during the dry season of 2007. Panicle grain number of compact paniced cultivar was significantly higher than that of the loose paniced cultivar, but average grain weight of the former declined severely in the spikelets located at different positions of the panicle axis compared to the latter. Compact paniced rice produced more ethylene in the boot of the flag leaf sheath during the pre-anthesis period. Ethylene evolution rate correlated negatively with growth and cell division rates of the juvenile endosperm. Because grain filling was slow in the compact paniced rice, unused assimilates accumulated in the endosperm. High ethylene also slackened photosynthetic activity of the flag leaf. It is concluded that grain filling is slow in the compact paniced rice because of high ethylene production at the sensitive stage of grain filling. High ethylene concentration is also detrimental to grain filling of spikelets located on secondary branches and base of panicle.



EFFECT OF NANO IRON OXIDE ON LEUTIN AND β CAROTENE CONTENT OF GREEN LEAFY VEGETABLE

P. Sudhakar, T.N.K.V. Prasad, P. Latha, M.Balakrishna, Y. Sreenivasulu and K. Raja Reddy
Plant Physiology, Regional Agricultural Research Station, Tirupati, Andhra Pradesh
sudakarp@yahoo.com

Nano materials are third generation bio materials predicted to revolutionise biological activity. Nano based nutrients owing to their smaller size (1-100 nm), there is every possibility of breaking barriers and to improve productivity and nutritional values. Carotenoids are fat soluble pigments comprising of carotenes (α and β carotene) and xanthophylls (leutin, zeaxanthin and β Cryptoxanthin). Green leafy vegetables (GLV) are rich in leutin and β carotene, which offer benefit to human health in general and in particular to eye health. Nano based iron oxide were synthesized using chemical method at this centre. These nano iron oxide of 20 nm size sprayed on *Rumex vesicarius* L. (chukka kura) at grand growth stage. Leutin and β carotene quantities in leaves were determined by reverse phase high performance liquid chromatography. The results of the study showed increased leutin and β carotene by 25% and 68% respectively compared to unsprayed check. This is the first report of effect of nano materials on carotenoid pigment of GLV.



POST-HARVEST PHYSIOLOGY OF CURED BETEL LEAF (*Piper betle* L.)

Prof. P. Guha

Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur-721 302 WB
pguha@agfe.iitkgp.ernet.in

Edible green leaves of *Piper betle* vines are known as *Paan* in many Asian countries where it is an important cash crop from the time immemorial. There are about 100 varieties of betel vine in the world, of which about 40 are found in India and 30 in West Bengal. The leaf is consumed by a large portion of population in many Asian countries on a regular basis in its natural, fresh and raw condition along with lime, areca nut, catechu, aniseed, coriander seed, cardamom, clove, etc mainly for the purpose of attaining digestive, stimulating and mouth freshening effects. Over 20 million people in India alone are associated with its production, processing, handling, transportation, marketing and consumption. This leaf contributes about Rs. 6000-7000 million every year to the Indian National Income and the railways earn about Rs. 100 million every year by transporting betel leaves from West Bengal to different parts of the country. Further, leaves worth about Rs 30-40 million are exported to different countries of the world.

Betel leaf is a very perishable commodity and therefore, always subject to wastage by quick spoilage due to dehydration, microbial infection, dechlorophyllation etc. This may cause post-harvest losses ranging from 10 to 70% during transport and storage amounting over Rs 900 million every year in monetary terms in the country. So much is the wastage that the surplus leaves are fed to the cattle and also buried in the ground. In view of such alarming losses, attempts have been made to minimize the wastage by adopting some post-harvest processing techniques like extracting essential oil, drying of the leaves, depetiolation, chemical treatments, manipulation of storage temperature, adopting better packaging materials and methods besides curing/bleaching of the leaves.

Curing process was invented to face the challenges of the continuously rising demand for fresh betel leaves, when a need was felt for improving its post-harvest qualities such as taste, mouth feel, leaf-colour etc besides prolonging shelf life of the product. However, the physiological changes associated with such attempt have not yet been studied well. Therefore, investigation was carried at IIT, Kharagpur to find out the physiological parameters and quantify their changes associated with improvement in organoleptic qualities of betel leaves due to curing treatments. The physiological parameters studied in the experiments included: pH, Electrical Conductivity (EC); Nutrients (N, P, K), Protein, Chlorophyll, Fibre and Carbohydrate contents while the organoleptic qualities of the cured leaves were examined through leaf-colour, taste and mouth feel. The results of the study indicate that there was substantial improvement in organoleptic qualities of betel leaves due to curing compared to the fresh ones. All the physiological parameters except fibre content were associated in different degrees with improvement in organoleptic qualities of betel leaves due to curing. The pH values showed an increasing trend while all other physiological parameters revealed a decreasing trend during curing except fiber content which remained unchanged.



POST HARVEST PHYSIOLOGY OF FRUITS, VEGETABLES AND FLOWERS

G.C. Srivastava

India is the second largest producer of fruits and vegetables in the world after China. Fresh fruits nuts and vegetables play a very significant role in human nutrition especially as source of vitamins, minerals and dietary fibre. Considerable loss of fruits and vegetables takes place in our country ranging from 20 to 40 per cent and sometimes exceeding 50 per cent. In some commodities, particularly papaya, loss goes further to the extent of 70 per cent or even more. Compared to fruits, post harvest loss in vegetable is less since many fruits are juicy and have more moisture content thus are liable to get rotted soon. There is immediate need to reduce the post harvest losses of the fruits, vegetable and flowers and all efforts either physiological, or physical like proper handling low temperature storage etc must be taken up to extend the shelf life of the harvested materials and maintain the nutritive value of the commodities. In India climacteric fruits are harvested when fruits start ripening and no well established scientific marker is available for the proper harvesting time. Thus fruits once harvested goes under ripening process and may have short shelf life and low in vitamins, minerals etc. Therefore, there is need to identify the proper harvesting time for each and every crop and variety which may help in better shelf life alongwith rich in nutrients etc.

In India in general, people do not follow post harvest treatments of fruits, vegetables or flowers except in case of rich farmers who have the facilities for preconditioning and good packaging facilities. Majority of the farmers send the harvested commodities for sale in the market by road. Indian roads are in poor condition which does not allow long distance transport fast and the commodities carrying vans are forced to take longer time. In the transit fruits, vegetables or flowers are likely to get spoiled due to higher temperature. India does not have sufficient refrigerated vans for transport of perishables and besides, the refrigerated van are expensive and beyond the reach of poor farmers. Under these circumstances, it would be very much desirable to look for some approach to delay the ripening and senescence process without losing the nutritive value of fruits.

Freshly harvested fruits, vegetable and flowers are live materials and respire fast. To extend the shelf life of fruits and vegetables and vase life of flowers the most important process i.e. respiration needs to be regulated. How to reduce the respiration in this live material without affecting the quality of the produce is a challenge. Several methods have been followed such as lowering the temperature of the storage, wrapping or waxing fruits with polythene paper or edible wax, treating fruits with some chemicals or irradiating the fruits with α -radiation etc.

Increase in respiration during ripening of climacteric fruits leads to many changes such as rise in the level of organic acid and cyanide resistant respiration. The cyanide resistant respiration results in rise in the temperature inside the fruits which favours the activity of hydrolyzing enzymes like PG and PME. Along with this, there is increase in the level of ethylene which switches on many genes of the ripening. Some chemicals like 1-MCP (1-methyl cyclopropene) and its related compounds have been tried to block the action of ethylene, however, these methods are not very much in practice. It is rather high time that this chemical should be tried and the concentration and duration of treatment need to be standardized for each and every variety of fruits separately. Another very useful method has been reported is the treatment of fruits particularly tomato fruit with ethanol vapour which delays the ripening of tomato fruit for considerable number of days. The whole technology of this treatment also needs to be worked out so that this can be recommended for commercial use. Treatment of fruits and vegetables with α -radiation in our country is not there. In western and other developed countries, the radiation of fresh meat product is mandatory to control the growth of micro-organism. Some approach has also been made to radiate the fruits with α -radiation to regulate the ripening process but this is just in infancy stage. There is need to make considerable effort to find the optimum dose and duration of treatment of fruits. Besides, some more innovative research is required to enhance the shelf life of fruits and vegetables and vase life of cut flowers and to achieve this, horticulturists, physiologists and molecular biologists have to work together.



SUSTAINABLE AGRICULTURE AND SEED PRIMING

Prof. (Mrs) Bandana Bose

*Dept. of Plant Physiology, Institute of Agricultural Sci., Banaras Hindu University, Varanasi – 221005, UP
bandana_bose2000@yahoo.com*

Agriculture has been changed dramatically since the end of IInd world war. Food and fiber productivity soared due to new technologies, mechanisation, increased chemical use and government policies favoured maximizing production. Although these changes have had many positive effects which reduced risks in farming, but at significant costs. Thus, today Agriculture in the developing countries is facing a number of problems such as top soil depletion, ground water contamination, increased incidences of soil salinity/acidity/water logging, imbalance status of nutrients in soil, resurgence of pest and diseases, increasing environmental pollution, increasing cost of production and disintegration of economic and social conditions in rural communities. To eradicate these environmental as well as social problems, a number of practices have come into existence. However, this emerged with a concept of Sustainable Agriculture which reflects the idea that 'The sustainable agriculture is that form of farming which produces sufficient food to meet out the need of present generation without eradicating the ecological assets and productivity of life supporting systems for future generation'. It can also be defined as a term that encompasses a range of strategies to address the problems of agriculture, hence it integrates three main goals: (1) Environmental health (2) Economic profitability & (3) Social and Economic equality. These require a series of small and realistic steps to sustain the environmental conditions in the era of fast growing population over exploitation of arable lands, increasing industrialization and loss in biodiversity causing global warming and climate change. However, in the last one hundred years temperature has increased in a range of 0.5 to 0.7°C. It has been predicted that a rise in temperature in range of 1 to 2°C may reduce 50% productions in rain fed agriculture. Last half of the past century disproportionate growth of population and agriculture, urbanization process, livelihood security particularly of urban and rural poor, unsustainable cropping system, heavy use of pesticides and fertilizers although have increased agriculture production 2.25% per capita but since 1990 it consistently started to decline in developing countries. In 20th century 75% of food biodiversity has been lost and only 12 industrial crops are used in supplying 80% of world's dietary energy. Thus, the challenges of sustainable growth of agricultural production and productivity with the mainstay of quality of life need the conservation and efficient utilization of biodiversity, use of biotechnological tools to produce stress resistance new plant types and to develop various technologies those are economical, eco-friendly, easy to handle and also enable to enhance crop production in adverse situations of environmental conditions.

Seed, the primary means of dissemination, is a ripe, fertilized ovule and a living link between parents and progeny. The internal organization of the seed is not homogeneous and it represents very sophisticated anatomical and physiological status in which the later present in a very concentrated form. In seeds all the plant hormones are present in bound and inactive form, except abscisic acid which gives it dormancy. With commencement of favourable conditions the germination of seeds starts, represents the first dynamic phase of plant's life. Germination is the resumption of metabolic activity and growth of the tissues in seeds which starts with the imbibition of water and ends with the protrusion of embryonic roots. The initial step of germination is adsorption of water, involving imbibition (a physical process) followed by osmosis (a biological process), resulted hydration of sub-cellular organelles leading towards diverse enzyme activities and hydrolyzed the storage reserves; the breakdown products of storage foods, like soluble sugars, amino acids and fatty acids are utilized by growing embryonic axis and to act as the substrates for energy generating process in aerobic condition. Hence, the germination has 3 major phases: (a) Imbibition: ϕ_w (water potential) of seed environment is much more higher than that in the seed, causing water molecule to flow through the seed epidermis to the embryo, and then leads to (b) the activation phases; in this stored bound hormones get free and enzymes stimulate physiological



development resulting to (c) growth and protrusion of radical from seed coat, completing the process of germination.

By nature seed is much harder than any plant part to sustain in hostile environments like fire, freezing, flooding even animal ingestion and seed is easy to handle in comparison to once grown plant; hence the seed represents a very important experimental tool for the researchers to produce more efficient plant / crop. However, during the process of germination if the ambient conditions are adverse then unsynchronized seedling emergence in the field takes place. Major constraints of seed germination are 1. Excess or low soil water content, 2. Absence of Oxygen, 3. Unfavourable temperature, 4. Presence of biota (fungus, insects etc. in soil), 5. Dormancy of seeds, 6. Late sowing of seeds due to unavailability of properly prepared land and 7. Late coming of monsoon (often occurs). All these drawbacks result in poor germination performance of crop followed by reduced yield despite of using breeder's seed with proper management practices. To overcome these situations plant scientists start to improve the quality of seeds in such a way that they can resist in adverse ambient conditions by fast and synchronized germination coupled with vigorous seedling stand which may have more input utilizing efficiency with increased production potential. The technique is broadly termed as **Seed Enhancement**. Scientifically and commercially it is a technique performed on the seed after harvesting and conditioning includes priming, pelleting and pre-germination seed treatments for crop protection. Among these **seed priming** is one of the major technique which helps to overcome most of the criteria related to the constraints of germination. It includes treatment of seeds with inorganic and organic chemicals /PGR's, hydration –dehydration (hardening), heat and chilling treatments, fumigation etc for improving germination , vigor and seedling stand under less optimum field conditions i.e. salinity, high and low temperature and soil moisture content hence performed better allometry of growing plant. It also induces various metabolic events like carbohydrate and nitrogen metabolism as well as antioxidant metabolism. It has also been observed to enhance yield potential in tested crops. Seed priming technology has been categorized as (a) hydropriming ,(b) osmopriming ,(c) hydrohardening ,(d) osmohardening and (e) solid matrix priming. The chemicals/PGRs frequently used for seed priming are NaCl ,CaCl₂ ,KH₂PO₄,K₃PO₄,KCl,KNO₃,MgSO₄,GA₃,BA,Ca(NO₃)₂,Mg(NO₃)₂,IAA etc. These chemicals are used in minute quantities during seed priming hence the treatment is very ecofriendly in nature. The solution/solutions of these chemicals ,having low water potential when used in form of pre-sowing soaking /hardening treatments are found to modulate/improve a series of physiological functions starting from germination to vegetative growth followed by reproductive growth and yield. This includes an improvement in germination ,seedling emergence and its vigor ,plant growth parameters like RGR,CGR,LA,LAI and NAR, water harvesting capacity, nitrogen utilizing efficiency(nitrate reductase activity/nitrogen content/ protein content),proline content ,activity of scavenging enzymes (SOD, peroxidase, catalase etc),chlorophyll and carotenoid contents,yield and yield attributes. During seed priming it has been experienced that nitrate containing salts when used in form of osmohardening responded better and showed an ability in amelioration of the bad effects of abiotic stresses related to crop growth and it has been tested in wheat ,mustard and rice . However on the basis of above it is to be urged that this type of simple economic and ecofriendly technology should be transferred to the farmers after proper on farm training. This will help to improve the socio-economic conditions of the farmers and to sustain the agriculture as well as the environmental assets for future generation in the era of evergreen revolution.



MONITORING FOREST PRODUCTIVITY AND SUSTAINABILITY USING BIOCHEMICAL MARKERS OF WOOD AND FOLIAGE

Rakesh Minocha^{1*}, Subhash Minocha² and Stephanie Long¹

¹USDA Forest Service, Northern Research Station, 271 Mast Road, Durham, NH 03824, USA.

²Department of Biological Sciences, University of New Hampshire, Durham, NH 03824, USA

The adverse effects of changing climate and increasing pollution on forests are of major concern to forest land managers because such processes may impact forest health leading to loss of productivity over large areas. In recent years, one of the major causes of forest ecosystem declines has been the increase in acidic deposition due to multiple anthropogenic factors including fossil fuel combustion and agricultural practices. The lowering of soil pH, and excess N and Al are additional factors; all attributable to acidic deposition and lead to Ca depletion in forest soils. Our objective is to identify biochemical markers which may be useful in predicting tree health and in turn forest sustainability in response to a variety of stress factors caused by environmental pollution (e.g. acid precipitation, high ozone, and heavy metals) and biotic factors (pathogens and invasive species). We studied several metabolites including **polyamines, amino acids, phytochelatins along with inorganic ion nutrition** in several tree species growing at various locations across US that were exposed to different levels of environmental stress. Our primary goal is to relate these biochemical markers to long term forest productivity. A strong correlation between various forms of abiotic stress, Ca and diamine putrescine was observed in most cases suggesting that **putrescine could be used as a reliable biochemical marker of abiotic stress in the foliage and/or wood of visually asymptomatic forest trees**. Ca plays a key role as a signal molecule in regulating the cellular metabolism. There is evidence to suggest that under stress polyamines can store excess nitrogen and substitute for some functions of calcium.



DEVELOPMENT OF TRANSGENIC *BRASSICA* FOR APHID RESISTANCE

K.R. Koundal, Rekha Kansal, Akhilesh Kumar, Ila Mukul Tiwari and Rashmi Singh

National Research Center on Plant Biotechnology, IARI, New Delhi-110012

Brassica juncea (Indian mustard) is an important source of edible oil cultivated in many countries across the globe. After groundnut *Brassica* (rapeseed-mustard) is the second most important edible oilseed crop in India and accounts for nearly 30% of the total oilseeds produced in the country. The productivity of *Brassica* is considerably hindered by its susceptibility to biotic and abiotic stresses and the limited variability for these traits available within the species. Pest infestation leading to massive crop damage is the most serious limiting factor in crop productivity. A major constraint on productivity is an aphid species, *Lipaphis erysimi* which causes yield losses from 35.4 to 91.3% with the average loss around 56.2%. The damage is mostly caused by nymphs and adult aphids, which suck away the plant sap, often covering the entire surface of the shoots, floral buds and pods. Also, aphids act as vectors for many disease causing viruses and pathogens, which further contribute to the yield loss and intensive farming practices have also increased the severity of aphids attack. It is necessary to develop a more environmentally friendly agricultural, which will have decreased inputs in energy and chemicals. In recent years, advances in plant genetic engineering have opened new avenues for crop improvement as it offers the possibility of introducing resistance genes from foreign crops into crop plants with novel agronomic traits. A large number of insecticidal proteins effective against insects have been reported. In last few decades several insecticidal genes both from microbial and plant sources have been introduced into the crop plants to make them resistant to insect pests. Plant lectins, the highly specific carbohydrate binding proteins, are reported to have insecticidal proteins. Various plant lectins have shown entomotoxic effects when fed to insects from coleoptera, homoptera and lepidoptera orders. Their possible toxic effects include binding of the lectins to glycosylated digestive enzymes. This agglutination properties makes them useful for the development of transgenic crops especially against sap sucking insects like aphids, whiteflies, leaf and plant hoppers, with no effect on human had it.

Realizing their importance, encoding lectins genes have been isolated and characterized in our laboratory from various legume plant species e.g. Chickpea (*Cicer arietinum*), Lentil (*Lens culinaris*), Pigeonpea (*Cajanus cajan*) and Mungbean (*Vigna radiata*). These isolated lectin genes have been sequenced and indexed in NCBI gene database. Chickpea lectin gene construct with single 35S CaMV promoter was made in pBINAR binary vector at Sma I and Pst I sites. T2 transgenic line has been raised so far with this construct and aphid bioassay has also been performed of T0 and T1 generation. For better aphid resistance we aimed for higher lectin expression in transgenic *Brassica*, for that purpose lentil lectin gene construct was made with duplicated 35S CaMV promoter by using pJIT117 vector, which was further cloned in pCAMBIA2301 binary vector at Kpn I site. To extend our investigation we have also used rolC Phloem specific promoter from *Agrobacterium rhizogenes*, which has dual advantage i.e. stronger than sucrose synthase promoter and silent in seed tissues, which is used for oil extraction. Lentil lectin gene construct with rolC promoter was made in pBI121 binary vector by using Bam HI and Hind III restriction sites.

These lectin gene constructs have been mobilized into *Agrobacterium tumefaciens* GV3101 strain by freeze-thaw method for genetic transformation. The protocols have been standardized for *Agrobacterium tumefaciens* mediated genetic transformation and regeneration of *Brassica juncea*, c.v. Varuna and Pusa Jaikisan. The molecular analysis of transformants with chickpea lectin was done by nptII, lectin gene specific PCR, southern hybridization and RT-PCR for stable integration and expression of gene of interest. Successful stable integration of transgene was confirmed by PCR, RT-PCR and southern hybridization in about 3.8% of putative transformants. Preliminary investigations have showed encouraging result. Efforts are underway to further analyze the transformants for other phenotypic characters and selecting the best events for development of good tailored transgenic mustard. The development of such transgenic crop variety will be very useful for higher productivity in sustainable agriculture system.



Session 01

Moisture Stress



01-01

PHYSIOLOGICAL ASPECTS OF WATER STRESS IN COTTON (*Gossypium* spp.) GENOTYPES

H. Vijayaraghavan P.S. Arjun Kumar and S. Vincent

*Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-3
vijayaraghavanprof@yahoo.co.in*

One of the most important yield limiting factors in cotton is the moisture stress which necessitates identification of drought tolerant genotypes. Glass house experiments were conducted to screen the cotton genotypes for drought tolerance based on growth, physiological and biochemical traits and also the yield. There was a significant reduction in plant height, LA, SLW, TDMP and RGR due to drought stress and its impact was more pronounced at flowering stage than at any other stages. The genotype JKC701 has shown least variation for reduction in growth as against susceptible variety Surabhi. The tolerant genotype, JKC701 has shown the lowest transpiration rate and susceptible genotype Surabhi had lower Stomatal Diffusive Resistance. Studies on ABA profiles indicated that water stress conditions induce more ABA content especially in JKC701 than Surabhi. These results suggest that JKC701 could be designated as a drought tolerant genotype and Surabhi as a susceptible one. Root anatomy sections of JKC701 and Surabhi were taken to view whether any variation exists between drought tolerant and susceptible ones. It was evident that the size of the ground tissue (i.e. cortex) showed enlargement due to water stress and this parameter was noticed maximum in the case of JKC701 when compared to Surabhi. Hence, the relative roles of endodermis and cortex of cotton roots under drought condition require further clarification. Moisture stress drastically reduced number of flowers and bolls and other yield components. The tolerant genotype JKC701 maintained higher yield, yield components, fibre quality and Harvest Index than Surabhi under stress. The genotype JKC701 and Surabhi have been forwarded to be used as a donor for drought tolerance in resistance breeding programme for abiotic stress tolerance and further evaluated for molecular mapping and genome sequencing.

01-02

BIOCHEMICAL TRAITS ASSOCIATED WITH DROUGHT TOLERANCE IN RICE (*Oryza sativa* L.)

Anuradha Singh, A.K. Singh, Alok Singh, V.N. Singh and P.K. Singh

*Center of Advanced Studies in Plant Physiology, N.D. University of Agriculture & Technology, Kumarganj,
Faizabad, Kumarganj, Faizabad*

An experiments were conducted to study the phenotypic and genotypic responses to flowering stage drought tolerance in rice (*Oryza sativa* L.) in relation to physiological, genetical and molecular approaches. Experiments were conducted during two successive wet season of year 2005 and 2006 at Instructional farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.), India. Experiment comprised (i) irrigated control and, (ii) in Rainout shelter (with holding irrigation one week before flowering) managed stress study the physiological basis of genetic variation in tolerance to drought. Variation in soluble sugar is considered to be measure determinant of leaf water potential, other compatible solute like proline content did not show linear relationship in present investigation. Although, significant variability regarding proline accumulation was observed among cultivars. Linear increase in SOD activity was observed among genotypes. Maximum increase in SOD activity was observed at 3rd day after rewatering of the plant. In over all consideration, soluble sugar upper root and starch at rewatering in control condition and starch in leaf, starch at rewatering and chl a in stress condition emerged as most important direct yield components owing to their high order positive direct effects at phenotypic as well as genotypic level. The genotype x environment interactions played very important role in the expression of all the characters except plant height and test weight. The linear component G x E interaction assumed significance in case of all the characters except plant height and fertile grains per panicle.



The non-linear component of G x E interaction assumed significance for all the characters except plant height, fertile grains per panicle, harvest-index, test weight, total biomass at flowering, total biomass at maturity, SOD at 0 days, soluble sugar at flowering, starch at flowering, soluble sugar at rewatering, soluble sugar in leaf, starch in leaf, soluble sugar in lower root and starch lower root. Assimilate accumulate prior to flowering are of paramount importance when plant experience drought stress at flowering stage. Present study indicated that translocated soluble sugar for grain growth is supported by apparent contribution rate (ACR) and apparent translocation rate (ATR) was higher in stress plants. Grain yield was significantly correlated with ACR ($r = 0.78$) and ATR ($r = 0.76$). In case of biochemical traits, none of the characters exhibited significant phenotypic or high order genotypic correlations in either positive or negative direction in control conditions. In contrast, soluble sugar at flowering stage, nitrate reductase, chl b and starch at maturity recorded strong positive association at both levels with high order positive genotypic correlations with grain yield in stress condition. In over all consideration, soluble sugar upper root and starch at rewatering in control condition and starch in leaf, starch at rewatering and chl a in stress condition emerged as most important direct yield components owing to their high order positive direct effects at phenotypic as well as genotypic level

01-03

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN RICE ECOTYPES TO BE GROWN UNDER AEROBIC SITUATION

B. Haloi, P.C. Dey*

*Department of Crop Physiology, FA, AAU, Jorhat, *RARS, Titabor, Jorhat*

In an investigation to physiologically characterize certain rice ecotypes to be grown under aerobic situation during 'ahu' season at Regional Agricultural Research Station, Titabor under Assam Agricultural University, eight ecotypes exhibited prominence to perform better under aerobic situation compared to irrigated one (5 cm of continuous water depth up to 50% flowering stage). The better performance under aerobic situation was attributed to physiological efficiency in terms of root volume, root length, improved leaf tissue water status and improved chlorophyll content. The ecotypes like IET 17509, Bandana and Govind have been identified as the potent ones to realize their yield potential more than 3 t. ha⁻¹ under aerobic situation during 'ahu' season. Selection of physiological traits for aerobic rice may help in enhancing water use efficiency sustaining the rice productivity.

01-04

RESPONSE OF POTASSIUM ON YIELD PARAMETERS OF UPLAND RICE EXPOSED TO WATER DEFICIT AT VEGETATIVE STAGE

Roopam Mishra, Prashant Vikram*, Arti and S.P. Singh

Dept. of Crop Physiology, N.D. Univ. of Agril. & Technology, Kumarganj-224229, Faizabad (U.P.)

**Department of Genetics and Plant Breeding, T.D.P.G. College Jaunpur (U.P.)*

The present investigation was conducted in earthen pots to assess the effect of potassium on yield components of upland rice at the experimental site of Department of Crop Physiology during Kharif season of 2006. The experiment was laid out in complete randomized block design (CRD) involving one rice variety (NDR-97) and four potassium (muriate of potash) levels viz., 0, 30, 60 and 90 kg K₂O ha⁻¹. The seeds were direct seeded in pots. Thirty days old seedlings were subjected to water deficit by withholding irrigation for a period of ten days (soil water potential ranged between 80-100 K kPa). The monitoring of drought was done by installing tensiometers. The plants subjected to water deficit were rewatered after completion of drought treatment.



A control set of all treatments was also maintained which was irrigated normally. In general, water deficit at vegetative stage caused a significant reduction in number of panicles per plant, number of grains per panicle, grains yield per plant and sterility percentage. Among above parameters, reduction in grain yield per plant was maximum (55%) due to water deficit which was brought to level of 38% by application of 60 KgK₂O ha⁻¹. Reduction in other yield parameters ranged from 24 to 36% which was improved considerably by potassium application. The effect of 60 Kg K₂O ha⁻¹ being at par with 90 KgK₂O ha⁻¹ was superior over other potassium treatments. So, from this experiment it is deduced that 60 KgK₂O ha⁻¹ is optimum dose which can be applied for ameliorating the adverse effect of vegetative stage water deficit in rice.

01-05

EFFECT OF DROUGHT STRESS ON PROTEIN AND PROLINE METABOLISM IN SEVEN RICE GENOTYPES

J. Chutia* and S.P. Borah**

*Department of Botany, Darrang College, Tezpur-784001, Assam

**Department of Botany, Gauhati University, Guwahati-781014, Assam
cjnan@rediffmail.com

Abiotic stresses can directly or indirectly affect the physiological status of an organism by altering its metabolism, growth, and development. Many plant species naturally accumulate proline and protein as major organic osmolytes when subjected to different abiotic stresses. These compounds are thought to play adaptive roles in mediating osmotic adjustment and protecting sub cellular structures in stressed plants. Different approaches have been contemplated to increase the concentrations of proline like compounds in plants grown under stress conditions to increase their stress tolerance. Seven different traditional rice varieties of Assam were evaluated for their response to osmolyte production under physiological drought condition through simulation at three levels of osmotic stress of 0.15 bar, 0.25 bar and 0.56 bar of physiological drought initiated by polyethylene glycol (PEG 6000). Along with the evaluation for Osmolyte response the different components of genotypic variation for six different drought-sustaining characters in the seven rice varieties were also substantiated. The results indicated that plant height and seed number have significant genotypic coefficient of variability (GCV) and heritability. Varieties like *Laodubi*, *Leserihali*, *Beriabhanga* and *Borah* were screened out as the best drought sustaining variety.

01-06

STUDY ON FLOWERING STAGE DROUGHT TOLERANCE TRAITS IN UPLAND RICES OF EASTERN UTTAR PRADESH

Alok Kumar Singh, A.K. Singh, P.K. Singh and G.S. Chaturvedi

Centre of Advanced Studies in Plant Physiology, Deptt. of Crop Physiology, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.)

Eighteen genotypes of upland rice of E. UP were evaluated for physiological traits and grain yield. Results of two years indicated that high estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed for sterile grain per panicle followed by root dry wt., root volume, root length and fertile grains per panicle under normal irrigated condition. In case of drought condition, high values of PCV and GCV were observed in root volume followed by root dry wt., root length, fertile grains per panicle, apparent translocation rate (ATR), sterile grains per panicle, grain yield, apparent contribution rate (ACR), water potential, straw yield and total biomass. The existence of high PCV and GCV estimates for both



condition indicated greater possibility of their improvement through selection in respective environments. High estimates of heritability and genetic advance were recorded for water potential, fertile grain per panicle, sterile grains per panicle, straw yield, total biomass at flowering, total biomass at maturity, ACR, root length, root volume and grain yield under normal irrigated condition and water potential, panicle length, fertile grains per panicle, sterile grains per panicle, ACR, membrane thermo stability, root length, root volume, root dry wt and grain yield under drought condition. The result also revealed that the estimates. GCV, PCV, heritability and genetic advance were higher in drought condition as compared to normal irrigated condition for majority of physiological traits. Apparent translocation rate and apparent contribution rate seems to easiest that to evaluate upland rices for flowering stage drought tolerance. This indicates that carbohydrate and dry matter accumulation before flowerings sustain better grain growth under drought at flowering stage.

01-07

MORPHO-PHYSIOLOGICAL CHARACTERS AND YIELD PERFORMANCE OF GROUNDNUT UNDER RAINFED CONDITION

I.J. Singh* and M.A. Khan**

*Asstt. Professor, C.S. Azad University of Agriculture & Technology, Kanpur

**Professor & Head Crop Physiology C.S. Azad University of Agriculture and Technology, Kanpur
ijsingh_cp@indiatimes.com

Ten genotypes of groundnut namely Amber, Kausal, TG37 A, tag-24, M13, M33, KGS-1, AVK-2006-1, CSMG 2015 and HNG 10, were tested under field conditions for their relatively tolerance to heat tolerance under soil moisture stress conditions. All the varieties significantly differed in their growth and physiological parameters under soil moisture stress conditions. Genotype TAG-24 produced maximum seed yield under high temperature stress due to maximum stability of chlorophyll content at flowering stage which also maintained high biological yield, pods per plant, total pods weight/plant and seeds per plant but this genotypes did not enable to maintained higher shelling percentage. Genotypes TG 37 A able to maintained higher shelling percentage but could not able to produce higher seed yield per plant due to lower pod setting per plant. AVK-2006 I was found best for relative water content and M 13 was more superior for thousand seed weight and shelling percentage. Among the tested genotypes Kaushal was more inferior in regard to seeds production this may be due to lower relative water content and yield attributing characters in spite of higher chlorophyll content at pod formation stages under soil moisture conditions. It is revealed that genotype M-13 have grater source & sink relationship followed by TAG 24 & TG 37A. As regards Heat tolerance, genotype M13, followed by TAG-24 & TG-37 A were gave better performance at 30°C. On the whole genotype TAG-24, TG-37 A and M 335 were identified as heat tolerant under soil moisture stress conditions.

01-08

ETHYLENE EVOLUTION AND ANTIOXIDANT DEFENSE MECHANISM IN *Cajanus cajan* L. NODULES UNDER DROUGHT

A.S. Nandwal, M. Jain, S. Sheokand, N. Kumar, B. Kumar and S. Devi

Department of Botany and Plant Physiology, CCS Haryana Agricultural University, Hisar-125004
nandwal@hau.ernet.in

To study drought induced ethylene evolution and its effect on pigeonpea (*Cajanus cajan* L. Mill sp.) cv. H-77-216 nodule functioning in relation to changes in the plant water status at vegetative stage i.e. 40-45 days after sowing, the plant were exposed to different levels of drought stress, designated as moderate (SMC% =



7.26±0.50) and severe stress (SMC% = 4.29±1.0) as compared to control (SMC% = 11.15±0.50). Revival experiments were done 2 days after reirrigation of stressed plants. Drought led to a tremendous increase in ethylene evolution through significant increase in ACC content (31-73%) and ACC oxidase activity (93%) in nodules. Upon revival a decline in ethylene evolution was seen which was parallel to the decrease in the activity of ACC oxidase and ACC content. N₂-ase activity (ARA) of nodules declined sharply from 34-69%. A close parallelism was observed between ARA and leghemoglobin content in nodules under different levels of drought stress. A sharp decline (57-85%) in Lb content of nodules was observed. The decline in osmotic potential (Øs) was due to the accumulation of proline and total soluble carbohydrates. The accumulation of H₂O₂ in nodules was related to the damage of Lb. Lb content showed slight recovery during revival, whereas reverse trend was noticed for H₂O₂ content. In nodules, the defense mechanism was activated by increased activity of catalase, peroxidase, ascorbate peroxidase and glutathione reductase, however, the activity of superoxide dismutase and glutathione-S-transferase decreased under drought. The rate of accumulation of H₂O₂ was much faster than the increase in enzyme activities. The ascorbic acid content also got decreased in nodules (83-98%). It is suggested that under drought, the functional efficiency of nodules decreases mainly due to overproduction of ethylene along with decline in ARA, Lb content and increase in H₂O₂ content and lipid peroxidation.

01-09

IMPROVING ABIOTIC STRESS TOLERANCE IN MAIZE

Ishwar Singh*, Sain Dass, R.P. Singh, S.K. Singh

Directorate of Maize Research, Indian Agricultural Research Institute, New Delhi-110012

*isingh.dmr@gmail.com

Maize (*Zea mays* L.) is an important food, feed and industrial crop in India. However, the productivity of maize in India is quite low (< 2.5 t/ha) as compared to other major maize growing countries like U.S.A and China. Low yield level in India inspite of high potential of productivity of maize is due to a number of biotic and abiotic stresses. Among the abiotic stresses drought waterlogging and extreme of temperatures (ow and high) the most prevalent one. Soil salinization major factor of soil degradation has reached 19.5 % of the irrigated land and 2.1 % of the dry-land agriculture existing on the globe herefore, salt stress tolerant maize will be of major focus in near future.

01-10

EARLY MOISTURE STRESS CAUSES MORE DAMAGE THAN LATE MOISTURE STRESS IN SUNFLOWER HYBRIDS

B. Mohan Raju, M. Senthil Kumar, M.S. Sheshshayee, T.G. Prasad, M. Udaya Kumar and R. Uma Shaanker

Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore

mohanbraju@indiatimes.com

The effect of early and late moisture stress on growth and yield of sunflower hybrids was evaluated by sowing them in randomized complete block design with three replications in field condition. In order to study whether or not the early or late moisture stress causes more damage on growth and productivity of sunflower hybrids, moisture stress was imposed to one set of plants at active vegetative phase by withholding irrigation between 40-60 DAS (early moisture stress). Similarly, to another set of plants, moisture stress was imposed by withholding irrigation between 60 and 80 DAS which coincided with reproductive phase (late moisture stress). All together, 3 treatments namely, control, early moisture stress and late moisture stress were imposed in the field condition. Before and after stress period, some of the growth parameters were recorded. Similarly, chlorophyll



stability and extent of membrane damage as a measure of stress tolerance was also measured in plants of all the treatments. The results of the experiment indicated that, moisture stress caused significant reduction in growth and productivity of sunflower. Between early and late moisture stress, the extent of yield reduction was significantly more under early moisture stress compared to late moisture stress. Accordingly, as against 17.70% reduction under late stress, early moisture stress has resulted in 32.20% reduction in seed yield over control. This reduced seed yield is as a consequence of both seed number and test weight where under early moisture stress, both of them were significantly lower compared to late moisture stress. In fact, our results contradicts the results of a few other workers where they have shown that late moisture stress coincided with reproductive phase resulted in greater loss compared to early moisture stress. In the present study, plant height and leaf area recovery after alleviation of stress was significantly lower in early than in late moisture stress treatment. In addition, under early stress, the plants retained less chlorophyll in their leaves with greater percentage of membrane damage compared to the plants exposed to late moisture stress treatment. Therefore, decreased leaf area coupled with less chlorophyll and more membrane damage under early moisture stress could appear to be the main reason for reduced seed yield in sunflower. This is valid because, whenever leaf area is reduced, it reduces radiation use efficiency and photosynthetic activities of plants resulting in lower assimilate synthesis and hence reduced head diameter and seed yield. Although seed yield was reduced under stress, some hybrids did produce relatively good seed yield and based on the seed number and test weight, some of the promising hybrids tolerant to early moisture stress as well as late moisture stress have been identified.

01-11

DIFFERENTIAL RESPONSE OF NIGER CULTIVARS (*Guizotia abyssinica* Cass.) TO PEG INDUCED WATER STRESS IN RELATION TO GROWTH AND OSMOTIC ADJUSTMENT

S.G. Ghane, P.P. Patil and T.D. Nikam*

Department of Botany, University of Pune, Pune-411 007
tdnikam@unipune.ernet.in

Niger (*Guizotia abyssinica* Cass.) belonging to family Asteraceae is an important oilseed crop cultivated in India, and other parts of the world for its edible oil content up to 40%. Meager information is available on physiological and biochemical behavior of this plant under abiotic stress conditions. Therefore, in the present investigation the efforts have been made on differential responses of four certified cultivars of niger (IGP 76, NO 71, GA 10 and IGPN 2004) to water deficit condition replicated using various concentrations (5 to 20%) of PEG-8000 at seedling stage. The germination percentage, growth parameters (fresh and dry weight, root and shoot length) and biochemical analyses were carried out after 7 d exposure to PEG stress. The germination percentage was severely affected at higher levels of PEG as compared to control in all the cultivars of niger. In general, lower concentrations of PEG improve the shoot growth of the seedlings except cv No. 71. The cvs IGPN 2004 and GA10 revealed increased, however cvs No. 71 and IGP 76 showed reduction in root length at all the concentrations of PEG as compared to control. The osmotic adjustment in all the cultivars was carried out through the accumulation of osmolytes, proline, glycine betaine and total soluble sugars. Among all the cultivars, IGPN 2004 revealed significantly the highest accumulation of proline at all the concentrations of PEG as compared to control, whereas GA10 showed the least. Similarly, the lesser content of glycine betaine accumulation was observed in GA10 under PEG stress as compared to other cultivars. The accumulation of total soluble sugar (TSS) was also the highest in cv IGPN 2004, whereas cv No. 71 revealed lower content of TSS. The results revealed that, cv IGPN 2004 showed higher tolerance as against cv GA10 which showed sensitivity to PEG, however, cvs No. 71 and IGP76 showed moderate tolerance to drought stress. Thus, the lower levels of PEG are helpful to improve the growth of the niger cultivars under drought stress, wherein the osmotic adjustment was associated with the differential accumulation of various osmolytes.



01-12

**DETECTION OF STARCH MOLECULES ACCUMULATION AND REMOBILIZATION AT
FLOWERING STAGE DROUGHT IN UPLAND RICE GENOTYPES**

Brajesh Kumar Mishra^{1*} and G.S. Chaturvedi

*Centre of Advance Studies in Plant Physiology, N.D. University of Agriculture and Technology,
Narendranagar (Kumargang) Faizabad-224229, U.P.*

**Department of Plant Physiology, Institute of Agricultural Sciences, BHU, Varanasi 221 005*

**brajeshmishraphd@gmail.com*

Rice (*Oryza sativa* L.) remains the most important staple food on the planet since it feeds roughly half the population on a daily basis. Approximately, 750 million on the world's poorest people depend on it to survive. According to FAO; the global rice requirement in 2025 will be of the order of 800 million tonnes. The current production is less than 600 million tonnes. The additional 200 million tonnes needed will be produced by increasing productivity per hectare. In India drought occurs once in three years. Understanding the mechanism of drought tolerance plays a major role in developing plant type and also to screen genotypes for drought resistance. Rice yield is most susceptible to yield reduction by drought at flowering stage due to water deficit. Grain growth is largely dependent on the reserved food material, mainly accumulated carbohydrate in culm / stem before stress and the actual amount of its remobilization during stress and recovery. Quantitative analysis of starch is the most reliable method of determining carbohydrate but it consumes a lot of time and is difficult for estimation by breeders. Accumulation and remobilization of starch analysis in different parts of rice provides an alternative method to know the level of carbohydrate mainly starch qualitatively in shortest time and selection criteria for screening of large number of genotype in breeding programme of rice crop plant to drought prone environment. Mechanism of drought tolerance / resistance at the vegetative stage is different from those at flowering stage. There is little information regarding the factors responsible for drought at reproductive stage. In the varieties popularly grown in Eastern Uttar Pradesh. Thus drought treatment (80 Kpa±) at flowering stage was given to six upland rice genotypes (3 improved N-22, Ashoka- 228, NDR-97 and three traditional Bagri, Nankawa, Bakaiya) was studied with this specific objective, to determine variation in intensity of starch in culm, leaf sheath, leaf blade and root by the histochemical and colorimetric method. Drought tolerance improved upland variety N-22 had higher intensity of starch staining before stress and faster remobilization during stress than the traditional and other improved varieties. Accumulation of carbohydrates in vegetative tissue and translocation of carbohydrates from vegetative tissue to grain filling are independent processes. Many varieties accumulate carbohydrate in the culm and leaf sheath but do not remobilize carbohydrate to panicles. There may be an internal signal from the sink or other regulatory system needed for carbohydrate remobilization. Alternatively carbohydrate under stress conditions may depend on genotypic ability to maintain internal water stress to move soluble sugars. Total soluble carbohydrate, starch and grain yield was higher in all improved genotypes. Under drought conditions culm, leaf sheath, leaf blade and root of N-22 had relatively less starch and soluble carbohydrate content in recovery suggesting faster translocation ability. Among all improved and traditional upland rice varieties studied in our experiment N-22 emerged as most drought tolerant to flowering stage drought with a better yield than others. N-22 was found a good drought donor parent and could be used in breeding rice for drought prone environment.



01-13

INFLUENCE OF PRODUCTION ENVIRONMENT ON PHYSIOLOGICAL AND BIOCHEMICAL ATTRIBUTES OF SEED QUALITY IN DROUGHT TOLERANT AEROBIC RICE (*Oryza sativa* L.)

Pavithra Vani, B.V¹., Rame Gowda¹, K. Aparna² and H.E. Shashidhar²

¹Department of Seed Science & Technology, ²Department of Genetics & Plant Breeding, University of Agricultural Sciences, Bangalore 560065
pavi_bv@rediffmail.com

Rice has one of the largest germplasm collections in the World. Direct seeding is becoming an attractive alternative to transplanting of rice in order to save precious water. It is high yielding rice grown in non-puddled, but aerobic soils with protective irrigation like any other field crops and is considered to be eco friendly. Freshly harvested seeds obtained from aerobic and puddled cultivation were subjected to seed quality evaluation. Both genotypes and methods of cultivation differed significantly for seed quality attributes. Higher germination and seedling vigour index (98.7 % and 3183, respectively) were recorded in BI 43 under aerobic condition. While, BI 33 recorded lower EC (66.63 dSm⁻¹ and 59 dSm⁻¹) values under both the conditions. Total soluble seed protein was recorded higher under aerobic condition in cv. BI 33 (5.52 %) and lowest in cv. IRRI 49 (4.33 %) in the seeds of puddle condition. Higher amount of iron and zinc content was noticed in cultivars BI 27 (114.33 ppm) and IRRI 259 (101.65 ppm), respectively under puddle condition. IRRI 259 recorded higher total dehydrogenase activity (0.55) in puddle condition. BI 43 recorded higher amylase activity (32 enzyme unit) in aerobic condition. Similarly, peroxidase activity was also found to be significantly higher in IRRI 23 (0.32 enzyme unit) in the seeds produced under aerobic condition. Significantly higher field emergence was noticed in BI 43 (88 %) under aerobic condition. Accelerated ageing of freshly harvested seeds lead to break down of dormancy and higher germination per cent was noticed in IRRI 14 (90.15 %), IRRI 23 (92.26 %) and IRRI 49 (69.40 %). Further seed germination was positively and significantly correlated with various physiological parameters such as amylase activity, total dehydrogenase activity. Thus the study suggested that the performance of seeds grown under aerobic cultivation was on par and equally good with seeds of puddled cultivation and therefore, quality seed production can also be taken up even under aerobic condition which is cost effective and eco-friendly.

01-14

**EVALUATION OF MAIZE INBRED LINES FOR DROUGHT TOLERANCE IN MAIZE
COMPARATIVE PERFORMANCE OF SINGLE CROSS HYBRIDS FOR DROUGHT TOLERANCE
IN MAIZE (*Zea mays* L.)**

S.K. Singh, Sain Dass, D.K. Singh and Ishwar Singh*

Directorate of Maize Research, Indian Agricultural Research Institute, New Delhi-110012
*isingh.dmr@gmail.com

Drought stress at critical crop growth stages is a major limiting factor for production and productivity of maize in India. About 80% of the maize area during the rainy season (*Kharif*) is rainfed, and dry spells can occur any time during the crop season. Flowering and grain filling are the most sensitive crop stages to drought stress. These stages also coincide with the vagaries of the monsoon. Drought stress at these crop stages also results in a decline in photosynthesis per plant. Ability to protect cellular membranes and enzymes from water deficit will enhance the crop's capacity to survive and produce grains. Plants ability to capture water even from drying soils through deeper root system would stabilize and increase the flow of assimilates to the developing grains. Early maturing single cross hybrids (SCH) have been found more suitable under drought stress as compared to open pollinated varieties (OPVs). Therefore, a field experiment was conducted with five promising single



cross hybrids (HQPM-1, HQPM-5, HM-4, HM-5 and HM-7) under managed stress (rain-out shelter) and drought was imposed during flowering stage. Although all hybrids produced grains under drought stress but reduction in grain yield was relatively less in HQPM 1, the roots of which penetrated deep in soil (37 cm from soil surface) for extracting moisture and had higher root biomass. The hybrids HQPM-1 and HQPM-5 recorded higher proline accumulation, total soluble proteins, and chlorophyll content in leaves and had higher leaf area index under moisture stress as compared to others. Therefore, Hybrids HQPM-1 and HQPM-5 may be suitable for cultivation in drought prone areas and rain fed condition.

01-15

EFFECT OF EARLY STAGE DROUGHT ON PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN RICE VARIETIES

P. Swain, M.J. Baig and P. Lenka

Central Rice Research Institute, Cuttack-753006

swainp_crri@yahoo.com

Seedlings of five rice varieties viz. Vandana, Browngora, N 22, Kalakeri and IR 20 were subjected to early vegetative stage drought for consecutive five days (D1 - D5). The results on morpho-physiological and biochemical changes revealed that the variety like N-22 maintains high turgidity on the 5th day of stress showing 73.86% RWC value followed by Browngora (69.55%) indicating their tolerant characters towards moisture stress. Higher photosynthetic rate was recorded in N-22 ($15.9 \mu \text{mol m}^{-2} \text{s}^{-1}$) followed by Kalakeri ($15.4 \mu \text{mol m}^{-2} \text{s}^{-1}$) on the 1st day on imposing stress. The value decreased gradually as the intensity of stress increased from D1 to D5 recording the minimum value of PN on D5 with a lowest value of $4.5 \mu \text{mol m}^{-2} \text{s}^{-1}$ in IR-20 showing its susceptible characters towards moisture stress. The lowest decrease in photosynthetic rate under the maximum stress (D5) was recorded in Browngora and keeping its fast recovering efficiency on re-irrigating the crop, considered to be the tolerant variety to moisture stress. A strong correlation was found between photosynthetic rate and stomatal conductance ($r = 0.740^{**}$). Under extreme stress i.e. at the D5 maximum accumulation of photosynthetic pigment in terms of chlorophyll 'a', 'b' and total chlorophyll was recorded in Browngora followed by N-22 and Kalakeri. Under moisture stress the activity of catalase and super oxide dismutase (SOD) increased and maximum increase over control for catalase was recorded in N-22 followed by Browngora and for SOD in Vandana followed by Browngora. Increasing in proline was parallel to decrease in RWC and higher accumulation of proline with lower RWC was recorded in N-22 and Browngora which are considered to be the most tolerant varieties among the five varieties tested for early moisture stress.

01-16

A BIRD'S EYE VIEW OF PHYSIOLOGICAL OBSERVATIONS IN ADVANCED VARIETAL TRIAL -NWPZ (TIMELY SOWN) ON WHEAT UNDER EXTREME WATER DEFICIT CONDITIONS

C.S. Gupta, S.L. Gartan and Vipin Kalia

Hill Agricultural Research and Extension Centre, CSK Himachal Krishi Vishvavidyalaya,

District Sirmour, Himachal Pradesh

Rabi season 2008-09 was a drought year in the true sense due to complete failure of rains coupled with rainfed status of the field and intense interest was generated to study the behaviour of Breeder's lines under such harsh conditions. Variety PBW -613 invested three times more biomass in roots than shoots whereas other varieties UP-2744 and WH-1081 2 times, all other varieties in a pattern of 1:1. Significantly higher tiller survival was noticeable in variety PBW -613, imply thereby that more investment in roots has paid off the rich dividends.



01-17

SCREENING OF COTTON GENOTYPES FOR MOISTURE STRESS USING DROUGHT STRESS INDICES

V. Kumar and Kirti Bardhan*

Main Cotton Research Station, Navsari Agricultural University, Athwa farm, Surat (Gujarat) 395007

*kirti_vardhan@indiatimes.com

Twenty entries / genotypes of *G. hirsutum* were evaluated under stress (rainfed) and normal (irrigated) condition in split plot design. The plant height, stomatal conductance, transpiration rate, RWC, biomass, boll weight, number of bolls and yield significantly reduced due to stress. Usual significant differences amongst genotypes were observed in these traits except stomatal conductance and RWC. Genotypes can be categorized into different groups based on their performance in stress and non stress environment, some genotypes express uniform performance in both conditions, some perform favorably only in non stress while others in stress. Bihani 161, GTHV-0/35, GTHV-02/45, KH-155, GJHV-374 and CPD-824 produced more biomass under stress and or exhibited a minimum reduction in the same. Bihani 161, GJHV-374, GTHV 0/35, ADB -102 and KH-155 performed better under stress and gave maximum yield stability (> 90) under stress. Different stress indices were computed and their correlation matrix was calculated with yield under stress. Yield under stress showed positive significant correlation with plant height stability index (PHSI), dry matter stability index (DMSI) and Yield stability while negative correlation with susceptibility index. RAHH-231, CPD-817, GSHV 152 and H 1236 showed highest susceptibility index and recorded less than average yield under stress. These results indicated that these drought indices are helpful for screening of cotton genotypes for moisture stress.

01-18

INFLUENCE OF MOISTURE AND HIGH TEMPERATURE STRESS ON PHENOLOGY, BIOMASS PRODUCTION AND YIELD AND YIELD COMPONENTS OF DIVERSE CHICKPEA GENOTYPES

Manish Kumar Singh*, S.R. Kushwaha, P.S. Deshmukh and R.K. Sairam

Division of Plant Physiology, I.A.R.I, New Delhi-110 012

kumar.manish21@yahoo.co.in

The planting of chickpea has been delayed due to late harvest of many kharif crops. This has caused serious reduction in the productivity of the crop. Chickpea is grown popularly in north-west plain zone of the country because of its high water use efficiency and better adaptation to high temperature conditions. But the productivity level was found far below as compared to other countries when grown under normal and further reduced due to various abiotic stresses. An experiment has been laid out to understand the physiological causes of low productivity. The chickpea genotypes released between 1940 to 2006 were included in this study and were grown under irrigated, rainfed, early & late planting conditions. The observations were recorded on duration of different phenophases, membrane stability index at vegetative & reproductive phase, growth parameters, yield & yield components. There was shortening of duration of various phenophases due to both moisture and high temperature stress in all the genotypes. In early & late flowering genotypes there were significantly more reductions both in biomass & seed yield as compared to medium durations. These genotypes yielded better under stress environment. The reduction in seed yield was caused due to significant reduction in pod number per plant & seeds per pod, however the 100 seed weight was found relatively stable character. Relatively less reduction in phenophases of medium duration genotypes allowed better accumulation of biomass and further supported in terms of assimilate partitioning. The data has been discussed in relation to moisture & temperature stress causing imbalance in source & sink to enhance productivity of pulses in general under changing environment.



01-19

SCREENING OF PEARL MILLET GENOTYPES FOR DROUGHT TOLERANCE BY CELL MEMBRANE STABILITY INDEX

N.K. Gupta, Ramavtar Sharma and Govind Singh

*Plant Biotechnology Centre, Rajasthan Agricultural University, Bikaner
nkgupta69@yahoo.co.in*

The response of pearl millet genotypes for drought stress was investigated under laboratory conditions. Surface sterilised seeds of 32 genotypes of pearl millet were transferred aseptically into sterilised test tubes containing filter paper bridge whose lower half was dipped in 1/4 MS liquid media supplemented with auxin and cytokinins. Water stress treatment was created by applying polyethylene glycol (6000) 15 per cent after seven day of sowing. Membrane injury was observed in leaves after three day of water stress treatment. Result showed that there was variation in the membrane injury among genotypes taken for study. The tolerant genotypes exhibited higher membrane stability index (low injury) as compared to susceptible genotypes. Out of 32 genotypes 19 were found tolerant, 8 moderately tolerant and 5 susceptible to PEG induced water stress conditions. The data were in general, comparable with other parameter taken under laboratory and field conditions. It is reby that more investment in roots has paid off the rich dividends.

01-20

BIOPHYSICAL CHARACTERIZATION OF MAGNETIC FIELD INDUCED ENHANCEMENT IN CHICKPEA (*Cicer arietinum* L.) SEEDS IN RELATION TO SOIL MOISTURE STRESS

Nilimesh Mridha, Shantha Nagarajan and Anjali Anand

Nuclear Research laboratory, Indian Agricultural Research Institute, New Delhi-110012

A pot culture experiment was conducted to study the effect of pre-sowing seed exposure to static magnetic field on two chickpea varieties with a view to understand their mechanism of action in terms of growth, water relations and yield. A *desi* variety, Pusa 256 and on a *kabuli* variety, Pusa 1053 were selected for this study. Seeds of both varieties exposed to 100 mT static magnetic field for 1 h, standardized by preliminary experiments were used as planting material. Physiological traits (leaf photosynthesis, stomatal conductance, transpiration, leaf water potential, osmotic potential, turgour potential) measured in plants grown under soil moisture potentials of -0.1 MPa and -0.2 MPa reduced significantly from flowering to podding stage and with soil moisture stress. However, irrespective of soil water potentials, in plants from magnetically exposed seeds, these traits showed significant improvement over the plants from unexposed controls. Growth parameters such as leaf area, specific leaf weight, root and shoot weight and root parameters like total root length, root surface area and root volume increased from flowering to podding and decreased with soil moisture stress. In plants from treated seeds, adverse effect of stress was ameliorated as they maintained relatively higher photosynthesis and leaf water status through osmotic adjustment and greater root length and root surface area. In both varieties, RUE and WUE decreased sharply under stress conditions. Magnetic field exposure has improved RUE and WUE over the unexposed controls except for Pusa 1053 at -0.1 MPa potential. At harvest irrespective of magnetic treatment, drastic reduction in grain weight of stressed plants was observed but in well watered condition, plants from magnetically treated seeds produced more biomass, pod number and grain weight than untreated controls. It may be concluded that exposure to static magnetic field of 100 mT for 1h improved root system which coupled with superior leaf water status led to increased photosynthesis in mature plants and produced greater biomass and grain weight. Also, when these plants were subjected to severe water stress (-0.2 MPa), the adverse effect was ameliorated partially by magnetic field treatment.



01-21

WATER STRESS AND ANTI-OXIDATIVE RESPONSE TO NICKEL EXCESS IN CLUSTER BEAN

Rajeev Gopal* and **Nirmala Nautiyal**

Department of Botany, University of Lucknow, Lucknow-226007

Cluster bean (*Cyamopsis tetragonoloba* Tau.) cv Pusa Nav Bahar plants exposed to excess nickel (0.1 to 400 μ M) under controlled glass house conditions were quantified for selected parameters of oxidative stress and water deficit. Supply of excess nickel for 48h induced chlorosis of young leaves, the effect being most pronounced at 400 μ M Ni supply. Excess supply of nickel showed decreased concentrations of chlorophyll and carotenoids along with a marked increase in the activities of superoxide dismutase, ascorbate peroxidase and peroxidase. The decrease activity of catalase may suggest interference of excess nickel in iron metabolism of plants. The effect on the enzyme activities varied with the level and duration of nickel supply. Leaves of plants supplied excess nickel showed decrease in relative water content and an increase in proline. The appearance of metal specific toxicity is likely result of damages predominantly due to enhanced reactive oxygen species (ROS) generation at higher, 300-400 μ M nickel supply. Results observed indicate that excess supply of nickel interferes with plant water relations and induces oxidative stress.

01-22

STRESS SIGNAL HYDROGEN PEROXIDE IMPROVING SALT TOLERANCE IN FENUGREEK SEEDLINGS

K.A. Varshney, Shipra Varshney, B.K. Verma and Anuraag Mohan

*Plant Physiology and Biochemistry Section, P.G. Dept. of Botany, Bareilly College, Bareilly-243122
nkvarshney87@rediffmail.com*

Increased salinity is a stringent problem to crop production. Present investigation is an effort to evaluate hydrogen peroxide pretreatment of seeds leading to metabolic changes vis – a – vis improved salt tolerance in fenugreek (*Trigonella foenum – graecum* L.). Soaking of seeds in 1, 50 and 100mM H₂O₂ caused low penetration, reaching maximum at 5 hrs (2.283 mMg⁻¹ fresh seeds at 100mM) and decreasing thereafter to the level of control (water) by 8 hrs. This showed an activation of antioxidants and hydrogen scavenging in seeds after 5 hrs. Seeds treated with 1 – 100mM H₂O₂ for 8 hrs germinated in saline (4mS cm⁻¹ of NaCl) medium faster curtailing the mean germination time even less than control (water). The levels of H₂O₂ in seedlings arising from treated seeds nurtured under salinity were found low than salinized controls. Moreover, H₂O₂ treatment was found to improve leaf osmotic potential. It may therefore be suggested that H₂O₂ signals the activation of antioxidants in seeds which maintains in the seedlings. This leads into the improved physiological and biochemical attributes supporting the seedling growth under saline conditions.

01-23

STUDIES ON GAS EXCHANGE AND ROOT CHARACTERISTICS OF BANANA GENOTYPES SHOWING DIFFERENCES IN MOISTURE STRESS TOLERANCE

R.H. Laxman, K.V. Ravishankar, A. Rekha and G. Savita

*Indian Institute of Horticultural Research, Hesaraghatta, Bangalore-560 089
laxman@ihr.ernet.in*

Banana requires uniformly warm and moist conditions for optimum growth and yield. The genetic yield potential of banana is rarely attained due to limitations imposed by water availability and the productivity gets



drastically reduced when availability of irrigation water is severely constrained. Growing banana successfully under water limiting conditions requires better understanding of the traits imparting moisture stress tolerance. Hence, this study was conducted with three genotypes, *Musa acuminata* ssp *burmannicoides* (Calcutta-4) (AA), Bee hee kela (BB) wild *Musa balbisiana* collection from North East and Kach Kela (ABB), differing in moisture stress tolerance for gas exchange and root characteristics. Under well watered conditions, Bee hee kela recorded highest photosynthesis rate ($12.03 \mu\text{mol m}^{-2} \text{s}^{-1}$) followed by Kach kela (11.7) and Calcutta-4 recorded the least (8.76). With ten day water stress there was a reduction and Bee hee kela, showed better performance with photosynthesis rate of $7.7 \mu\text{mol m}^{-2} \text{s}^{-1}$ followed by Kach kela (4.93) and Calcutta-4 (4.75). The transpiration rate ranged from 11.97 to $12.67 \text{ mol m}^{-2} \text{s}^{-1}$ in all the three genotypes under control conditions. But, under stress conditions Calcutta-4 recorded lowest $8.35 \text{ mol m}^{-2} \text{s}^{-1}$ compared to Bee hee kela and Kach kela, 9.55 and $8.8 \text{ mol m}^{-2} \text{s}^{-1}$, respectively. The stomatal conductance also showed the same trend. Among the three genotypes, Calcutta-4 had higher shoot to root ratio (19.02 g shoot mass over a gram of root mass) compared to Bee hee kela (12.28) and Kach kela (12.42). Indicating a higher root mass over shoot mass in these genotypes. The average number of roots per plant, root dry weight and total root length were lowest in Calcutta-4 as compared to Bee hee kela and Kach kela. The results show that the genotypes with BB genome have higher photosynthesis rate, root mass relative to the shoot mass and also with higher number of roots per plant are better adopted for withstanding water stress conditions.

01-24

CORRELATION COEFFICIENT STUDIES BETWEEN MEMBRANE STABILITY INDEX (MSI) AND YIELD OF WHEAT UNDER HIGH TEMPERATURE CONDITIONS

S.R. Kushwaha*, P.S. Deshmukh, R.K. Sairam, D.V. Singh and Manish Kumar Singh

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

**sr_kushwahapp@rediffmail.com*

A field experiment was conducted to evaluate the performance of different wheat genotypes under high temperature (late planting) conditions. Twenty five genotypes were grown under normal and late planting conditions. Observations were recorded on chlorophyll content, membrane stability index at anthesis, 8 days after anthesis, 22 days after anthesis (DAA), yield attributes and total biological and seed yield were recorded. A significant variation in membrane stability index, chlorophyll content, yield attributes and seed yield were observed. The genotypes i.e. PBW-503, PBW-498, PBW-502, Raj-4014, NW-2036 and K-2008 recorded maximum membrane stability index and also yielded higher. These genotypes possessed higher chlorophyll content at anthesis stage. Correlation coefficient studies between MSI and yield attributes revealed that the MSI had significant and positive association with number of ears per plant (0.424), number of grains per ear (0.604), total biological yield (0.758), seed yield (0.567) and harvest index (0.393). The seed yield was also positively associated with number of ears (0.663), number of grains per ear (0.513), biological yield (0.703) and harvest index (0.631). Regression studies revealed that biological yield increased significantly with increasing membrane stability index at 22 DAA ($y = 33.183 + 0.0249 X$ ($r = 0.458^{**}$)). Similarly, seed yield increased ($y = 13.873 + 0.1216 X$) with increase in membrane stability index at 22 DAA. This study confirms that MSI is a suitable parameter for screening of large number of genotypes. On the basis of physiological traits the genotypes were grouped into tolerant and susceptible.



01-25

EFFECT OF NUTRIENT MANAGEMENT IN NURSERY FOR IMPROVING SUBMERGENCE TOLERANCE AND PRODUCTIVITY OF RAINFED LOW LAND RICE

A.H. Khan¹, P.N. Singh¹, P.C. Ram¹, Basant Ram¹ and A. Ismial²

¹Centre of Advanced Studies, Dept. of Plant Physiology, N. D. University of Agriculture & Technology, Kumarganj, 224229, Faizabad, U.P

²International Rice Research Institute, Philippines

Early flooding that persists for several days usually reduces plant survival and productivity of rice in South and South East Asia. The productivity of rice under rainfed lowland condition is about 2 t/ha due to non availability of submergence tolerant rice varieties and management options. The experiment was conducted with four genotypes viz. NDR-9930116, NDR-9730018, Mahsuri, IR-42 and three treatments viz. (i) control, (ii) N60+P40+Zn20 kg/ha (iii) and N60 + P40 + Zn20 + FYM kg/ha + 10 t/ha were applied in the nursery as basal dose before seeding. Thirty days old seedlings were transplanted in the field. Fields were completely submerged at 15 days after transplanting for 15 days. At the end of submergence period water was drained out leaving only 10 cm water in the field. Survival of plants was recorded after 10 days after the removal of water from the field. Nursery nutrient management with N60 + P40 + Zn20 + FYM kg/ha + 10 t/ha was found most effective in improving seedling vigour which improved survival during submergence condition. Survival range was recorded 23 - 74% in all the genotypes while genotypes with lower elongation had maximum survival. Grain yield advantage was obtained about 20-25% with nutrient management in nursery relative to control which was due to high survival during submergence. The response was more apparent in submergence intolerant varieties Mahsuri and IR-42. This technology was found most suitable of rice cultivation under flood prone ecosystem for successful cultivation of rice.

01-26

MORPHO-PHYSIOLOGICAL, BIOCHEMICAL AND MOLECULAR MECHANISMS OF WATER STRESS TOLERANCE IN RICE (*Oryza sativa* L.)

S. Maibangsa* and M. Thangaraj

Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore- 641 003

*Senior Scientist (Crop Physiology), Regional Agril.Res. Station, North Lakhimpur-787 032

smaibangsa@yahoo.co.in

Forty nine genotypes were screened in PEG-6000 mediated water stress. The same genotypes was evaluated for water stress tolerance under field condition. Finally, three drought tolerant genotypes viz. Banglami, Sivapukulipidichan, TKM-9 and a susceptible check CO-37 were studied for mechanisms of water stress tolerance. Germination stress index showed significant positive correlation with grain yield under water stress and thus can effectively be used as an index for screening. Upland adapted genotypes recorded higher diffusive resistance during the stress period which might have allowed them to avoid dehydration. Thus, higher RWC in the tolerant genotypes was due to low transpiration during water stress. Mean yield reduction due to water stress during reproductive (54-82 DAS) stage and vegetative (26-54 DAS) stage recorded were 38.7 per cent and 27.8 per cent respectively. This was associated with reduced filled grain percentage, number of spikelets panicle⁻¹ and number of panicles m⁻². Most rapid decline in mid-day leaf water potential and RWC was observed in CO-37. Reduced water potential led to increased accumulation of sugars while starch accumulation was reduced. Soluble protein content was reduced under water stress up to 74.8 per cent in CO-37 at the end of stress period and was associated with reduced NRase activity. Reduction in leaf water potential resulted in increased AAO activity



particularly in susceptible variety CO-37. AOS scavenging enzymes viz. catalase, peroxidase and SOD were over expressed in stressed leaves. However, with further decline in leaf water potential, the activity of these enzymes started declining. This decline started much earlier and more rapidly in the susceptible genotype CO-37. On the other hand Sivapukulidichan and TKM-9 maintained higher AOS enzymes activity even at the terminal stage of water stress. A native protein band ($R_m + 0.36$) was specific to tolerant genotypes. Further, studies with SDS-PAGE protein profile revealed drought tolerant specific 109.6 kDa and 106.7 kDa putative proteins. Water stress also induced two polypeptide bands with molecular weight of 97.0 kDa and 28.4 kDa in tolerant genotypes. These proteins could belong to LEA protein family and might served as molecular marker for drought tolerance. Two SOD isoforms viz. SOD 19 and AOD 52 were expressed specifically in all the three drought tolerant genotypes. These isoforms of SOD could be potent molecular marker for drought tolerance in rice.

01-27

EFFECT OF MOISTURE STRESS ON SOME SELECTED UPLAND RICE CULTIVARS OF ASSAM

Nirupa Roy Baruah

*Dhudhnoi College, Goalpara
nirupa.roybaruah@gmail.com*

A laboratory trial was conducted with three locally cultivated rice cultivars viz. Dubai Senga, Kopuguni and Maibee and higher yielding varieties viz. Kolong, Luit and IR-50 under different moisture regimes; 0 bar - 2 bar, -6 bar and -8 bars to assess the moisture tolerance ability among the cultivars. The stress conditions were maintained by using PEG 6000. Moisture deficit resulted in lowering of seed germination percentage and seedling vigour in all the cultivar. The cultivars were found to differ wildly in their germination percentage, vigour index, chlorophyll content, dry matter of seedlings and root volume. The higher value of this parameter was recorded in Maibee cultivar followed by Dubai senga. Similar results were observed in Relative water content (RWC) and chlorophyll stability index (CSI) also where Maibee showed higher value followed by Kolong. From the observations, it can be concluded that the local cultivars are having better adaptive characters under moisture deficit situation due to possession of better morpho-physiological characters.

01-28

PUTRESCINE POTENTIAL TO AMELIORATE MULTIPLE STRESS IN *B. juncea*

S.N. Mishra, Pushpa C. Tomar* Nita Lakra

Faculty of Life Sciences, M.D. University Rohtak 124001

** Department of Biotechnology, Manav Rachana University, Faridabad*

Putrescine, precursor of polyamines, a new class of growth regulators was evaluated for growth promotion potential in *Brassica juncea* cv RH-30 seedlings under salinity and metal stress. The putrescine increased significantly the biomass in stressed seedlings of Indian mustard. The biomass accumulation was attributed to increased photosynthetic pigments, total soluble proteins, total organic nitrogen, Nitrate reductase activity, homeostasis in Na^+ and K^+ , proline and anti oxidative system consequently reduced free radicals and IAA oxidase elevated under stress conditions. Putrescine modified the metal load in stressed plants. The SDS – PAGE analysis revealed qualitative change in proteins in leaf and root tissues of stressed seedlings might be involved in modifying physiological processes needed for growth promotion. The pleiotrophic effect of Putrescine could be thus an indicator of plant growth promotion potential.



01-29

EFFECTIVE IN VITRO REGENERATION PROTOCOL THROUGH SEED AND SEEDLING EXPLANTS IN DROUGHT TOLERANT GENOTYPE BGD72 OF CHICKPEA (*Cicer arietinum*)- A RECALCITRANT CROP

Anuradha Yadav

Department of Botany, Maitreyi College, University of Delhi, New Delhi-110021

Chickpea, commonly known as gram is extensively cultivated as one of the most important winter crop throughout India, especially in northern states. Unfortunately, its productivity has been severely hampered due to several constraint like its cultivation on marginal lands, impacts of biotic and abiotic stresses, and low research and management efforts. In vitro plantlet regeneration protocol has been developed employing seed and seedling explants for improving the crop through biotechnological manipulations. The three explants – seed, embryonal axis and nodal segment (excised from 30-d-old seedling) were cultured on Murashige and Skoog's basal medium supplemented with various growth regulators, i.e. N6 – benzladenine (BA), kinetin (Kn), α -naphthalene acetic acid (NAA), indole-3- butyric acid (IBA) and indole-3-acetic acid (IAA) alone or in combinations. Of the three explants tried, the seed explants elicited best morphogenic response in terms of multiple shoots production. BA at 5 μ M proved optimum for eliciting an average of 3.59 ± 1.18 shoots in 50% cultures in seeds whereas for embryonal axis 100% cultures induced an average of 3.09 ± 0.19 shoots on the same level in 30 d. However for nodal explants, 2.5 μ M BA showed better response and an average of 3.25 ± 0.38 shoots per explants was induced in 91.7% cultures. For induction of roots, MS (1/2) + IBA proved best where 72.5% shoots developed an average of 18.10 ± 1.37 roots within 20 d. The plantlets have been hardened and transferred to soil. Thus, BGD72 which is drought tolerant has proved most competent for producing optimum and recurrent shoots and can be employed for further genetic manipulations.

01-30

WATER DEFICIT STRESS REGULATED FLOWERING IN NAGPUR MANDARIN (*Citrus reticulata* Blanco)

A.D. Huchche, A. K. Srivastava and P. Panigrahi

*National Research Centre for Citrus, P.B. No. 464, Amravati Road, Nagpur-440 010
ambadas_huchche@yahoo.co.in*

Studies were carried out during 2004-2007 with two sets of five orchards each for *Mrig* flush and the *Ambia* flush in the age group of 12–15 years located in Nagpur district (Sawandri, Chargaon, Fetri, Kalmeshwar and NRCC orchard Nagpur). Observations on the duration and quantum of water stress, protein profiles, flowering, fruit set and fruit yield were recorded. The peak water stress in terms of leaf water potential ranged from -3.2 to -3.7 MPa. After resumption of irrigation in *Ambia* flush after 30 days of withholding of water, the leaf water potential values ranged from -1.5 to -1.9 MPa ten days after alleviation of stress indicating optimum availability of soil moisture. Similar observations were recorded in *Mrig* flush after 40 days of water stress. The intensity of flowering was observed more in the orchards where optimum stress was recorded. Leaf nitrogen and zinc contents showed significant differences in *Ambia* and *Mrig* orchards. Optimum leaf-N content (2.08-2.23 %) coupled with Zn content above 22 ppm (22.3 to 28.2 ppm) ensured good flowering intensity (108.71 to 124.83 flowers/meter shoot length) in *Ambia* flush. The fruit set differed significantly but it did not indicate any relationship with the quantum of stress. Two orchards where irrigation was resumed by 10th Jan. recorded a yield of 21.35 and 23.54 t/ha. Orchards where irrigation was resumed by the end of January recorded poor yields (14.91, 10.51 and 9.00 t/ha). Hence the date of alleviation of stress seemed to have a definite relationship with final fruit retention.



Session 02

Photosynthesis and Global Climate Change



02-01

INFLUENCE OF TEMPERATURE ON PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF CHICKPEA (*Cicer arietinum*) CULTIVARS

Sangeeta Khetarpal^a, Madan Pal Singh^a and Sneh Lata^b

^aIndian Agricultural Research Institute, PUSA, New Delhi 110012

^bMMH College, Ghaziabad-201002, U.P.

The impact of climate change has received significant attention during the past decade due to increased awareness about global warming. These changes in climate can have significant effect on productivity and quality of foods in general and pulse crop in particular. Chickpea is the third most pulse crop in the world after dry beans and dry peas. In the present study, two cultivars of chickpeas (Pusa 1108 and Pusa 1053) were grown under four different environmental conditions: 1. ambient temperature, 2. elevated temperature throughout entire growth period, 3. elevated temperature only during flowering stage, and 4. elevated temperature only during pod filling stage. Influence of elevated temperature on growth, yield, photosynthesis, membrane stability, relative water content (RWC), proline concentration, protein, and four mineral nutrients (Fe, Zn, Mg, and Mn) was investigated. The results showed that the leaf area and the shoot biomass increased at elevated temperature in both the cultivars with maximum impact during the vegetative stage. Rate of photosynthesis increased in Pusa 1108 under elevated temperature and no significant effect occurred in Pusa 1053. Elevated temperature grown plants of both the cultivars showed significant increase in membrane stability index during the flowering stage and no significant changes were observed in RWC. Proline concentration was higher at podding stage in both the cultivars under elevated temperature and no significant changes occurred in leaf and stem protein content. Yield attributes increased significantly in Pusa 1053 plants exposed to elevated temperature during flowering stage while no significant changes occurred in Pusa 1108. Fe, Mg and Mn content increased significantly in seeds of both the cultivars under elevated temperature while Zn content decreased in chickpea plants exposed to elevated temperature during podding stage.

02-02

GREENNESS AND PHOTOSYNTHETIC RATES IN MUNGBEAN

Vijaylaxmi* and A. Bhattacharya**

Division of Crop Physiology, Biochemistry and Microbiology, IIPR, Kanpur-208024

*vijaylaxmi01@yahoo.com, **dra_bhattacharya@yahoo.com

The portable chlorophyll meter (SPAD-502) has been successfully used for rapid and direct estimation of total chlorophyll content in leaves of some annual as well perennial crops. A linear correlation was shown between SPAD-502 and photosynthetic rates. Leaf photosynthesis is a complex process and need a lot of precision as well time, particularly on field crops for different genotypes. Field experiments were conducted during the *kharif* seasons in 2006 and 2007 at the Indian Institute of Pulses Research, Kanpur involving 16 mungbean genotypes, to quantify the relationships between leaf photosynthetic rate and leaf characteristics *viz.*, greenness, area, specific weight in mungbean [*Vigna radiata* (L.) Wilczek.] during various stages of crop ontogeny, in order to identify means for indirect estimation of leaf photosynthetic rate in mungbean genotypes. Leaf greenness, was measured non-destructively by hand portable chlorophyll meter. SPAD-502 of Konica, Minolta, Sensing, Inc, Japan. Leaf area of genotypes was measured by Ä-T Area Meter MK-2, UK. The results showed that SPAD values had linear positive correlation with leaf photosynthetic rates at all the crop growth stages (vegetative, flowering and post flowering). Relationships between photosynthesis and leaf area or specific leaf weight were studied and these relationships were also found to be positive and linear. These results suggest that chlorophyll readings are quick, reliable, and repeatable indicators of photosynthetic rate that can be used for screening mungbean genotypes as well as for other field crops.



02-03

**PHOTOSYNTHETIC PERFORMANCE OF WATERMELON UNDER BIODRAINAGE
VEGETATION (*Casuarina equisetifolia*) IN COASTAL ORISSA**

**S. Roy Chowdhury*, Ashwani Kumar, P.S.B. Anand, S. Ghosh, S.K. Jena, Rajeeb Mohanty N. Sahoo
and G.C. Panda**

Directorate of Water Management (Formerly Water Technology Center for Eastern Region (ICAR),
Chandrasekharpur, P.O: SE Railway Project Complex, Bhubaneswar-751023
sornath_rc@yahoo.com

The rise of water table situation which causes water logging in agricultural field can be controlled with biological drainage in addition to usual engineering drainage measures. The process uses the transpiration properties of trees. The biodrainage species, also known as “Phaeatophytes” is able to draw water directly from the ground water table or from the capillary fringe above it and eventually transpiring it to atmosphere. This causes decline in water table beneath the vegetation bringing waterlogged field to cultivable condition. Under such scenario in post monsoon season water melon was cultivated in a biodrained field under *Casuarina equisetifolia*. plantation. Comparative photosynthesis performance of water melon under Casuarinas and in field without biodrainage vegetation was evaluated. The objective was to physiologically evaluate productivity of inter crops like watermelon under biodrainage vegetation. And development of understanding of tree-crop interaction in reclaimed field. The *Casuarina* plantation on average caused 21-34% reduction in incident PAR over watermelon crop in comparison to control, i.e., watermelon crop without plantation. The photosynthesis rate in two cultivars ‘Mokasa’ and local ‘Sugar baby’ was 24.63 and 19.43 $\mu\text{mol m}^{-2}\text{s}^{-1}$ compared to 21.80 and 18.93 $\mu\text{mol m}^{-2}\text{s}^{-1}$ in control respectively. The excess soil water in root zone in control field caused reduction in photosynthesis, stomatal conductance as well as yield, in both cultivar. However, as intercrop inside biodrainage vegetation photosynthesis, stomatal conductance and yield of both cultivars were better. However Mokassa was superior than local ‘sugar baby’ both in photosynthetic performance and yield. Hence, Mokasaa is more suitable cultivar of watermelon for use as a intercrop inside *Casuarina* biodrainage vegetation.

02-04

STOMATAL CHARACTERS AS SUITABLE TRAITS FOR SELECTION OF APRICOT (*Prunus armeniaca* L.) GENOTYPES TO BE GROWN IN ELEVATED TEMPERATURE CONDITION

A.K. Trivedi*, R.R. Arya and K.S. Negi

National Bureau of Plant Genetic Resources, Regional Station-Bhowali-263132, District-Nainital
ajayakumartrivedi@gmail.com

Global warming is having a significant impact on plant species around the world but the most dramatic effects may not be felt for decades. Geographical range of numerous species had shifted poleward or moved to a higher elevation indicating that some plants are occupying areas that were previously too cold for survival. Fruit-trees survive these conditions either because they avoid such stress due to morphological or physiological modifications that enable them to avoid or postpone the effects. Stomata, the small pores on the surfaces of leaves and stalks, regulate the flow of gases in and out of leaves and thus plants as a whole. They adapt to local and global changes on all timescales from minutes to millennia. Stomatal morphology, distribution and behaviour respond to a spectrum of signals, from intracellular signaling to global climatic change. In the present study stomatal frequency, size and conductance of sixteen apricot genotypes were compared. The leaf stomatal frequency significantly varied among the apricot genotypes. The highest stomatal frequency was found in IC-360686 (343 stomata/ mm^2) and lowest in IC-360702 (177 stomata/ mm^2). Stomata size varied from 65 μm (in IC-360692) to



102 μm (in IC-360697). Stomatal conductance was lowest in IC-360699 ($86 \text{ mmol.m}^{-2}.\text{s}^{-1}$) and highest in IC-360701 ($261 \text{ m.mol}^{-2}.\text{s}^{-1}$). Difference in leaf stomatal characters viz., frequency, size and conductance found among different apricot genotypes can be taken in to consideration as suitable traits for apricot to be grown in elevated temperature conditions. An understanding of relationship between stomatal features and environmental factors will be of considerable importance for the better fruit tree growth on warming globe.

02-05

GENOTYPIC VARIABILITY OF PIGEONPEA IN PHOTOSYNTHESIS, P UPTAKE AND YIELD UNDER VARIED P SUPPLY

Sunita Sheokand, Jai Dayal, Ramdahri Vashisht*, S.S Dudeja** and K. Swaraj

Deptt of Botany & Plant Physiology

*Pulses Section Deptt of Plant Breeding, **Deptt of Microbiology,

CCS Haryana Agricultural University, Hisar-125004

This study compared the growth, photosynthetic responses and P content to changes in supply of soil P nutrition. Fifteen pigeon pea genotypes were raised in sand culture under pot culture house conditions. Three P levels were maintained in the nutrient solution (100%P, 60% P and 20% P). Low P conditions resulted in reduced plant height, plant biomass, number of leaves, branches and reproductive parts (buds, flowers and pods) and yield/plant. H02-60, H04-26 and H03-41 showed comparatively less reduction in shoot length under low P conditions. H02-60, H04-26, H03-41 and Paras also performed well in terms of plant biomass at low P conditions. Highest assimilation rate and chlorophyll content was observed in HDM04-1 at all the P levels. The other genotypes which performed well at low P conditions were Paras, H01-22, ICPL and H03-41 in terms of assimilation rate and Paras, H01-4, H01-22, H01-37, H04-20, H04-24 and H04-26 in terms of total chlorophyll content. Chl a fluorescence measurements also gave important correlations with P content. Chlorophyll a fluorescence decreased with decreasing P levels. The genotypes which performed well in terms of chl fluorescence at low P conditions were H03-41, H04-26, H04-24 and H02-60. The density of the reaction centres (RC/CS_m and TR_0/CS_0) also decreased with decreasing P levels and the genotypes which performed well at low P conditions were H04-26, H03-29, H04-24, H03-41 and H02-60. These genotypes also maintained high P levels in different plant parts as compared to other genotypes at low P conditions. H04-26 and H03-41 performed well in terms of yield/plant at low P conditions.

02-06

EFFECT OF LIGHT INTENSITY ON THE PHYSIOLOGICAL TRAITS, GROWTH AND YIELD OF FINGER MILLET (*Eleusine coracana* L. Gaertn.)

Y.A. Nanja Reddy, E.G. Ashok and B.N. Dhananjaya

Project Coordinating Unit (Small Millets), GKVK, UAS, Bangalore - 560 065

In recent years, area under finger millet is decreasing, however area under dry land horticulture especially mango has been increasing in southern Karnataka. Finger millet being a staple food crop of the region, possibilities of enhancing finger millet cultivation in mango orchards has to be exploited. Therefore an experiment was conducted at GKVK Farm, UAS, Bangalore during 2007-08 to study the effect of low light intensity on the physiological traits, growth and yield of finger millet. A preliminary study revealed that light intensity decreased with age of the tree due to increase in canopy coverage. However, in pure crop of finger millet, where 100, 75, 50 and 25 per cent of normal light were imposed on 30 days after sowing, decreased light intensity resulted in more plant height and delayed flowering. The DM/LA (assimilation rate) was significantly lowest in 25 per cent



light intensity as compared to higher light intensities suggesting that finger millet (C_4) is photosynthetically efficient. The leaf area and dry matter at flowering were decreased significantly at 50 and 25 per cent light intensity. As the light intensity decreased, the TDM at harvest, grain yield and harvest index were decreased significantly. Reduction in light intensity by 25, 50 and 75 per cent from the normal, reduced the yield by 16.4, 34.8 and 55.6 per cent, respectively. Among the varieties, short and medium duration varieties showed less reduction in yield and were a better choice as compared to the long duration.

02-07

**GROWTH, BIOMASS PRODUCTION AND CANOPY PHOTOSYNTHESIS OF *Cenchrus ciliaris*
AND *Stylosanthes hamata* UNDER ELEVATED CO_2**

R.K. Bhatt, M.J. Baig* and H.S. Tiwari

Indian Grassland and Fodder Research Institute Jhansi-284 003

**Central Rice Research Institute, Cuttack (Orissa)*

Since in the mid 1800's, the increasing human activities have contributed to atmospheric CO_2 which has increased from roughly 250 to present day 380 ppm and further doubling within the next century. This increasing CO_2 level has caused us to reevaluate our knowledge of plant responses to increasing CO_2 . Large numbers of studies have been carried out under controlled environment but there is need to evaluate the response of crop species to elevated CO_2 in the natural field conditions. *Cenchrus ciliaris* (C_4) and *Stylosanthes hamata* (C_3) in the intercropping systems has been studied as a response to elevated CO_2 (600 ± 50 ppm) on their growth and biomass production in the Open Top Chambers in semi arid tropics. In *C. ciliaris* and *S. hamata* the plant height increased by 65% and 78% inside open top chambers (OTCs) with elevated CO_2 (600 ± 50 ppm) over the open grown field crops. The leaf area index of *C. ciliaris* + *S. hamata* increased to 1.6 fold as the crops grown under elevated CO_2 over the control (8.60). The leaf area index increased due to increase in leaf length and leaf width and the total number of leaf production per plant. *C. ciliaris* + *S. hamata* produced 106% higher fresh biomass and 141% dry biomass under elevated CO_2 over open grown crops in intercropping systems. The accumulation of photosynthetic pigments such as chlorophyll a, chlorophyll b and chlorophyll a+b were also estimated higher in the leaves of these crop species as grown in OTC with elevated CO_2 . Rate of photosynthesis and photosynthetic water use efficiency (PN/TR) increased in these crop species as grown under elevated CO_2 over the control. The canopy photosynthesis (PN X LAI) increased significantly in *C. ciliaris* and *S. hamata* under elevated CO_2 over the open grown crops. The increase in canopy photosynthesis may be due to increase in the rate of photosynthesis and leaf area index. The higher accumulation of chlorophyll and canopy photosynthesis under elevated CO_2 has maximized the CO_2 assimilation which intern the increased growth and biomass production and therefore, these two crop species should be promoted for higher biomass production and carbon sequestration system in the semi arid tropical environment.

02-08

**AVAILABILITY OF INCIDENT LIGHT DETERMINES THE LEAF MICROCLIMATIC RESPONSES
IN GREEN GRAM (*Vigna radiata* L.) IN A SEMI-ARID CLIMATE OF CENTRAL INDIA**

Badre Alam*, Rashmi Singh, Ram Newaj and Munna Ram

National Research Centre for Agroforestry, Gwalior Road, Jhansi-284003, U.P.

badrealam@gmail.com

We have conducted experiments to decipher the leaf microclimatic responses at varying intensity of incident light providing different regimes of shade in green gram (*Vigna radiata* L. var. PDM-54) plants at



National Research Centre for Agroforestry, Jhansi located in a semi-arid zone of Central India. The crop was grown in field under three different categories of shades (33%, 50% and 75 %) in separate net houses or without shade (open). Conspicuous effects of varying incident light on the plants were observed. There was unambiguous impact of varying intensity of shades on different microclimatic variables mainly incident photosynthetic photon flux density (PPFD), air temperature and relative humidity. Resultant effects of all these microclimatic variables due to shades were reflected in the leaf physiological responses of the plants comparing to the plants grown in open conditions. Major physiological functioning which was largely influenced by such shade-induced changes in microclimate was stomatal conductance (Gs). There was clear indication of light-limiting response of stomatal activity in the plants grown in shade. There was decreasing trend of Gs with increasing intensity of shade. Rates of stomatal conductance in open grown plants were higher than the plants grown in shades. However, decrease in Gs in the plants grown in 33% shade was marginal in comparison to the open grown plants. Similar decreasing trend with increasing shade was noted in the rates of transpiration (E). This corroborates the dependence of E on Gs which are modulated by availability of incident light and microclimate. Gs and E showed significant linear correlations with incident PPFD. This strong linear correlation between Gs and E with PPFD provides ample scope for using these biophysical responses in predicting impacts of various degrees of shade and microclimate on the crop in the context of climate change.

02-09

IN VIVO QUALITY CONTROL OF PS II TO SUSTAIN PLANT PERFORMANCE: PHOTOINHIBITION AND ITS RESTORATION

Munna Singh

Botany Department, University of Lucknow, Lucknow-226 007 (UP)
drmunnasingh@yahoo.com

Cyanobacteria, green algae and vascular plants respond to the changes in the light environment in which they grow. The photosynthesis and related plant productivity aspects of plants and cyanobacteria depend upon the functioning of photosystem 2 (PS II), associated with D₁ and D₂ heterodimer reaction centre core proteins. The irradiances affect chloroplast development along with its composition, structure and functioning of the photosynthetic apparatus. The excess irradiance, higher than that needed to saturate photosynthesis during plant growth, causes photoinhibition or impairs radiant energy transformation, followed by CO₂ assimilation that reduces plant growth and productivity eventually. The target of such kind of irradiation – dependent damage lies in the D₁ reaction centre core protein of PS II. The D₁ protein accounts for even less than 1% of the total thylakoid membrane protein content, but its rate of turnover is very much comparable to LSU of RUBISCO, most abundantly (~ 55%) present in the green tissue. *In vivo* quality control of PS II was revealed by subjecting intact cells of *Synechocystis* PCC 6803 under photoinhibitory irradiance in combination with temperatures (20-40°C). The loss in the chlorophyll fluorescence variable yield per maximum yield (Fv/Fmax) and degradation of D₁ protein occurred not only under high light exposure but also continued when these cells were subjected under dark restoration process, after high light exposure. However, neither any loss in Fv/Fmax nor D₁ degradation did occur during recovery under growth / low light, because, it helped in re-synthesis of new D₁ protein, essential to sustain quality control of PS II. The up-regulation of protease pool seems to be involved in inducing proteolysis of photodamaged D₁ protein to extend PSII functioning in association with over – expression of a membrane bound Ftsh protease to sustain quality control of PS II.



02-10

PESTICIDE INDUCED CHANGES IN THE PRIMARY PHOTOCHEMICAL REACTIONS OF THYLAKOID MEMBRANE OF *Nostoc Carneum* AND *Anabaena torulosa*

Shantanu Bhattacharyya, Snigdha Behera, Binata Nayak, Basanti Biswal

School of Life Sciences, Sambalpur University, Jyoti Vihar, Sambalpur, Orissa

basanti_b@hotmail.com, bioshantanu@gmail.com

Cyanobacteria are the photoautotrophic ancient life forms and have adapted to a variety of extreme environments, including exposure to pesticides. The present investigation intends to determine the comparative tolerance studies of two locally isolated cyanobacteria *Nostoc carneum* and *Anabaena torulosa*, which grow profusely in rice field and treated with two commercial grade organophosphate insecticides such as Monodhan and Quinalphos. The organisms were cultured in temperature and humidity controlled culture room at 26 ± 0.5 °C. The response of the Cyanobacteria with respect to growth, total protein, pigment (Chl and Car) content, photosynthetic efficiency (Fv/Fm) and initial fluorescence (F_0) was examined in control and pesticide (organophosphate) treated conditions. *Anabaena* can tolerate up to 10 ppm Quinalphos and 100 ppm of Monodhan, whereas tolerance capacity of *Nostoc* for both the pesticides is up to 20 and 150 ppm respectively. Decrease in growth, pigment and protein content and photosynthetic efficiency was observed in both the cyanobacteria with increase in concentration and time of exposure to both the pesticides. Out of the two organisms *N. carneum* shows relatively higher tolerance capacity to both the pesticides than *A. torulosa* and Quinalphos showed more damaging effect on both the cyanobacteria compared to Monodhan.

02-11

PHOTOSYNTHETIC EFFICIENCY, CARBOHYDRATE PARTITIONING AND GRAIN YIELD IN RICE HYBRIDS UNDER DIFFERENT IRRADIANCE LEVEL

M.J. Baig, P. Swain and R.N. Rao

Central Rice Research Institute, Cuttack-753 006, Orissa

mjbaigcrrri@gmail.com

Three rice hybrids (Rajlaxmi, Ajay and PHB 71) were grown under four irradiances i.e. 100 (I_{100} , as control), 75 (I_{75}), 50 (I_{50}) and 25 (I_{25}) % of full sunlight. Photosynthetic efficiency and carbohydrate partitioning in different plant parts were studied. With the increase in irradiance from 25 to 100% of full sunlight the maximum net photosynthesis increased in all the hybrids. At full sunlight Ajay had a high capacity of photosynthesis while at low irradiance levels it maintained relatively higher values as compared to other two hybrids. The grain yield and the harvest index decreased in all the rice hybrids with the decrease in irradiance, which might be linked with lower photosynthesis at lower irradiance than at higher. Under 100% solar radiation the grain yield was recorded as 8.79, 9.15 and 8.35 t/ha in PHB-71, Rajlaxmi and Ajay respectively. By decreasing light intensity there was a decrease in grain yield in all the hybrids. However, the extent of decrease is not proportional to the decreasing light intensity. PHB-71 showed a yield decrease of 23.77%, 35.15%, 45.05%, Rajlaxmi showed 29.18%, 39.78%, 50.60% and Ajay records the yield loss of 20.84%, 34.13% and 42.87% over control when grown under 75, 50 and 25% light intensities respectively. Among the three hybrids Ajay showed a minimum yield loss when light intensity decreased from 100 to 25% in comparison to other two hybrids. Internal CO₂ concentration increased with the decreasing light intensity. Higher internal CO₂ concentration under low irradiance level indicates the scope for more CO₂ fixation and high photosynthetic rate leading to higher productivity. Carbohydrate partitioning in different plant parts showed that at vegetative stage maximum carbohydrate was translocated to stem, however during grain filling stage maximum translocation occurred to the grain in all the hybrids tested.



02-12

EFFECT OF PROJECTED CLIMATE CHANGE ON FEW PHYSIOLOGICAL PARAMETERS OF RICE GROWN IN INDO-GANGETIC PLAINS OF BIHAR

R. Elanchezhian and A.A. Haris

ICAR Research Complex for Eastern Region, ICAR Parisar, Patna, 80014, Bihar

The global change in climate would have a direct bearing on production of food crops like rice. Rice is the major cereal along with wheat in the Indo-gangetic plains of India. This study was aimed to analyze the impact of climate change on physiological parameters of rice varieties viz. Saket 4 (SDV), Sita (MDV) and Radha (LDV) using simulation model INFOCROP. These varieties were grown at ICAR RCER, research farm during kharif 2007 and 2008 and crop growth and physiological parameters were recorded as per standard procedures. These data were used for model simulation and validation in INFOCROP model. Thereafter the crop growth and yield data ranging from 1997 to 2003 were taken into consideration as observed data and used for projecting the performance of rice varieties at future scenarios of 2020, 2050 and 2080. The yield trend was similar in Saket 4 and Sita upto 2050 and maximum being in 2050 and declined thereafter in 2080. In Radha, maximum yield was projected at 2020. It was observed that SDV performed better than MDV/LDV under scenarios for 2020, 2050 and 2080. Filled grain and harvest index decreased at 2050 in all varieties. These results suggest that SDVs can be better proposition under future climate change scenarios for growing in Indo-gangetic plains of Bihar.

02-13

PHYSIOLOGICAL RESPONSE OF WHEAT AND CHICKPEA CROP TO ELEVATED CARBON DIOXIDE (CO₂) AND TEMPERATURE

Bidisha Chakrabarti, S.D. Singh, Bhupinder Singh, R.C. Harit and Vinod Kumar

Division of Environmental Sciences, IARI, New Delhi 110 012

Climate change is one of the most important challenges affecting world food production. To understand the effect of this anticipated change field experiment was conducted during the rabi season in 2008-09, with wheat and chickpea as target crop. Crops were grown inside FACE (Free Air CO₂ Enrichment) rings to study the impact of elevated carbon dioxide (CO₂) on crops. In order to expose the crops to varying temperatures, both wheat and chickpea crop was grown inside temperature gradient tunnels (TGT). Inside the TGT temperature gradient of 0-1.8°C was maintained, whereas elevated CO₂ level of 550 ppm was maintained inside the FACE rings for 8 hours daily. Results showed that increased CO₂ had no significant effect on crop phenology. But higher temperature caused early flowering in chickpea and wheat crop. Temperature rise by 1.8°C hastened flag leaf initiation by 3 days and anthesis by 5 days in wheat crop. Under elevated CO₂ condition both the crops showed higher photosynthesis rate in different growth stages. Higher photosynthesis rate resulted in better growth which was reflected in higher leaf area index (LAI) of the crops. But stomatal conductance got reduced with in CO₂ treatment. In TGTs both the crops showed increased rate of photosynthesis with increase in temperature. This might be attributed to the fact that both wheat and chickpea are grown in the winter months, when air temperature is lower, especially in northern India. So, increase in temperature by 0.5°-1.8°C proved to be beneficial for the crops in terms of its response to photosynthesis rate. This suggests that elevated CO₂ and temperature in future climate change scenarios will affect duration of crop growth stages as well as physiological processes of crops.



02-14

PHOTOSYNTHESIS VIS-AVIS RICE PRODUCTIVITY IN RESPONSE TO MOISTURE STRESS CONDITION

S.K. Mohanty, P. Sethy and M. Kar

*Department of Plant Physiology, College of Agriculture, O.U.A.T, Bhubaneswar
saroj_mohanty2001@yahoo.co.uk*

A pot culture experiment was carried out in the Department of Plant Physiology, College of Agriculture, OUAT, Bhubaneswar during *rabi* season of 2008-2009 to study the effect of moisture stress on photosynthesis, morphophysiological traits and productivity of early duration rice genotypes popularly grown in Orissa. The experiment was laid out in a factorial CRD with three stress treatments and three replications and twelve varieties of rice having 95-100 days duration. The study revealed a significant variations among the rice varieties in respect of various morpho-physiological and biochemical characters recorded at different growth stages. Explicitly speaking, the varieties like Khandagiri, Udayagiri, Nilgiri and Ghanteswari excelled over others in most of the characters studied contributing to yield and yield attributes. The characters like Pn, Gs, E, RWC, CSI, Panicle length, grain weight, grain number were positively correlated to grain yield of rice under moisture deficit conditions. Photosynthesis (Pn), stomatal conductance (Gs) and Transpiration ratio (E) among the varieties exhibited a variation by a margin of 29 to 56, 5.2 to 43 and 15 to 47.2 % respectively. On the basis of the above characters vis-à-vis grain yield, the aforementioned 04 varieties contemplated to possess drought resistant mechanisms grown under present agro climatic conditions. Stress at reproductive stages was found to be more critical in all the varieties for which there was significant reduction in panicle length and its weight, effective grain number with concomitant increase in chaff percent. The decrease in productivity due to moisture stress varied by a margin of 16-19 percent compared to control (non-stress). Extrapolation of drought index (DI) made to implicit the varying response of the varieties to drought prone environments.

02-15

INTERACTIVE EFFECT OF ELEVATED CO₂ AND TEMPERATURE ON GRAIN QUALITY TRAITS OF RICE GENOTYPES

Jyoti Jha, Divya Shah, Madan Pal Singh, Sangeeta Khetarpal, Anjali Anand and Shantha Nagarajan
Indian Agricultural Research Institute, New Delhi-110012

An experiment was conducted in open top chambers (OTCs) at IARI farm, New Delhi to evaluate the effect of elevated CO₂ and high temperature on grain quality parameters of the first aromatic hybrid rice variety PRH 10 and its parental lines PRR 78 (male line) an PUSA 6B (female line). Plants were raised in normal soil in large drums of 18" diameter inside OTCs maintained with normal (380 μmol mol⁻¹) and elevated levels (600 μmol mol⁻¹) of CO₂. At panicle initiation stage (50-55 days after transplanting) and flowering stage (90-95 days after transplanting), part of the plants were exposed to elevated temperature of about 3^o above ambient for 10 days. There were four replicated drums per genotype and treatment and two OTC chambers. At maturity, plants were harvested and the grains were subjected to various quality analysis. Test weight of grains reduced under elevated CO₂ in the hybrid and female parent and remained unchanged in male parent. Similar trend was observed in the proportion of high density grains. Increased grain yield observed under elevated CO₂ was due to increased tiller number/plant and not due to bolder and denser grains in these genotypes. Milling percentage was not affected by either elevated CO₂ levels or elevated temperature, but head rice recovery significantly reduced due to high temperature in hybrid PRH 10. Percent chalky grains increased by exposure to high temperature, but the effect was partly ameliorated by increased CO₂ levels. Most important quality parameters for basmati rice are



the slenderness of the grain, elongation of the grain after cooking and aroma of cooked rice. The length / breadth ratio was not affected by any of the above treatments, but the elongation ratio of the cooked grain improved in the male parent PRR 78, declined in the female parent PUSA 6B and remain unchanged in the hybrid PRH 10. Aroma improved in the grain harvested from plants of all the genotypes exposed to higher levels of CO₂. Alkali spreading value in general increased and hence the gelatinization temperature decreased when the plants were heat stressed for a short period of 10 days. Germination characteristics like seed leachate conductivity, percent germination, seedling vigour as determined by seedling length and seedling weight did not show any specific response to either elevated CO₂ or elevated temperature. It may be concluded that elevated CO₂ combined with moderately high temperature for 10 days panicle initiation and flowering adversely affected only few of the grain and quality traits and hybrid and parental lines responded differentially.

02-16

PHOTOSYNTHESIS AND ANTIOXIDANT METABOLISM IN BLACK GRAM (*Vigna mungo* L.) IN RESPONSE TO MOISTURE DEFICIT CONDITIONS

M. Kar, B. Hota, R.K. Mishra and B. Pattnaik

Department of Plant Physiology, College of Agriculture, O.U.A.T, Bhubaneswar

The present investigation was carried out in the Deptt. of Plant Physiology, College of Agriculture, Orissa University of Agriculture & Technology, Bhubaneswar during April to June-2008 to study "Photosynthesis and antioxidant metabolism in blackgram (*Vigna mungo* L.) in response to moisture deficit conditions." The experiment was conducted in a completely factorial randomized design (CRD) with twelve treatment combinations including one control (So) and stress induction at nodulation (S1) and flowering stages (S2) of the crop having four replications. The results revealed that stress at nodulation stage had significant uninnocuous effect on plant height, leaf area, chlorophyll content, chlorophyll stability index and leghaemoglobin content. While stress at flowering stage had affected thousand seed weight, seeds per pod, number of pods per plant, seed yield per plant and seed protein content. Proline accumulation increased manifold under the stress treatments. A significant increase in catalase activity was observed under both the stages when stress was imposed at nodulation and flowering stages. Ascorbate accumulated in stress plants. Increase in activity of catalase and ascorbate content is related to antioxidative defense system of the cultivars. In the present study water stress had tremendous effect on photosynthetic rate (Pn), photosynthetic active radiation (PAR), stomatal conductance (Gs), and transpiration rate (E) as measured by CIRAS-2 PP system. The study envisaged that cv TU 94-2 is relatively more drought tolerant followed by cv.T 9 and cv Ujalla was found to be susceptible. Among the two stages the flowering stage was more critical than the nodulation stage when subjected to water limited conditions.

02-17

CARBON MONITORING PROGRAMMES: CONTEMPORARY STIPULATION WITH SPECIAL REFERENCE TO HIMALAYAN ALPINE SOIL CONSTANCY

Neelam Rawat*, B. P. Nautiyal and M.C. Nautiyal**

neelrawat08@gmail.com/mcnautiyal@gmail.com*

Himalayan alpine soils basically are acidic in nature, receive direct solar radiations which mainly have large proportion of UV and infra red radiations, have high albedo ratio, faces short growing periods which changes their nutrient status and productivity in short periods and remain under snow for a period of six to seven months. These characters along with other environmental, topographical, geomorphological and anthropogenic characters make the unique type of the soil in Indian alpine. In attendance primary requirement with allusion to alpine soil stability is to engineer a better Himalayan alpine scenario by increasing productivity and rural employment while shielding the environment. With reference to high altitude expanses of the globe, vegetation shift, vegetation change and upward migration of plant species has become a universal menace. Owing the massive significance of these very sensitive ecological indicators, different carbon monitoring programmes still



needs to be intended including an accurate estimate of atmospheric CO₂ concentration, proportion of carbon in aboveground and belowground vegetation compartments, shares which are contributed by standing and decomposed phytomass, carbon sink and source analysis of different channels, response and stability of the weathered rock particles along with the organic matter. Global summits with developed and developing nations need to be premeditated so that acceptance, objections and rejections to these issues could be summarized.

02-18

EFFECT OF ELEVATED CO₂ AND TEMPERATURE ON ANTIOXIDATIVE CAPACITY GROWTH AND YIELD OF RICE GENOTYPES

Sunil Kumar Pandey, Jyoti Jha, Divya Shah, Madan Pal Singh, Anjali Anand, Sangeeta Khetarpal and Shantha Nagarajan

Indian Agricultural Research Institute, New Delhi-110012

The increase in atmospheric CO₂ concentration and global air temperature has stimulated interest to study their impacts on future food security and sustainable productivity of rice crop. This study was conducted to determine the impact of elevated CO₂, temperature and CO₂-temperature interaction on hybrid aromatic PRH 10 and its parental rice genotypes PRR 78 (male parent) and PUSA 6B (female parent). Seedlings of all genotypes were exposed to ambient (380 μmol mol⁻¹) and elevated (600 μmol mol⁻¹) CO₂ in open top chambers. The plants were subjected to high temperatures of 3.6 °C for 10 days at panicle initiation and anthesis stage at both the CO₂ levels. After high temperature treatments the pots were shifted back to their respective OTCs. Rate of photosynthesis increased in all three genotypes due to exposure to elevated CO₂ at both PI and anthesis stage. PRH-10 showed higher increase in rate of photosynthesis in plants exposed to high CO₂ and temperature but in PUSA 6B it increased under CO₂ and declined in high temperature exposed plants. In PRR 78 rate of photosynthesis increased under high CO₂ and temperature during PI stage but at anthesis declined in high temperature exposed plants. Sugar concentration increased in all three genotypes under high temperature during PI stage. No significant effect on sugars was observed in PRR 78 and PUSA 6B at anthesis stage due to exposure to high temperature but decreased in PRH 10. Spikelet fertility decreased due to exposure of plants to high temperature at anthesis stage and more reduction in fertility was observed under high CO₂ and temperature. Grain yield increased under high CO₂ in all the three genotypes. Exposure to high temperature resulted in reduction in grain yield at normal CO₂ but under high CO₂ and temperature the reduction in yield was less. High CO₂ enhanced total plant dry weight and highest response of CO₂ was recorded in PRH 10. Antioxidant enzymes (Asc.POX, POX, CAT and SOD) activity increased in all the genotypes under high temperature stress. PRH 10 and PUSA 6B showed similar trend of increase in enzyme activity at PI stage. On the other hand PRR 78 showed increased activity of the enzyme at anthesis stage. Enhanced enzyme activity under temperature stress could help in scavenging the free radicals produced under stress. This study concludes that rising CO₂ may enhance rice plant biomass and grain yield but simultaneous increase in temperature may negate this positive response of high CO₂.

02-19

GROWTH AND YIELD RESPONSE OF DIFFERENT CROPS TO ELEVATED TEMPERATURE AND CO₂

S. Singh, B. Chakravorty, R.C. Harit, V. Kumar and V.K. Singh

Division of Environmental Sciences, IARI, New Delhi - 110012

Four important crops viz., greengram, pigeonpea, chickpea and wheat grown in temperature gradient tunnel showed early flowering and maturity with marked reduction in leaf area index (LAI) by gradual increase in air temperature, which in turn manifested gradual reduction in biomass and economic yield of the crops. The reduction in yield was mainly attributed to marked reduction in both the number of sinks per plant and 1000 seed/grain weight. Among the crops, wheat and greengram showed higher degree of reduction in grain yield by increasing temperature (thermal sensitivity) as compared to pigeonpea and chickpea. Reproductive growth



showed greater thermo-sensitivity as compared to vegetative growth in almost all the crops. These crops, when exposed to high CO₂ level (560 ppm) under FACE, recorded higher leaf area index (LAI) throughout the crop growth season, while failed to show any phenological response to elevated CO₂. Both wheat and chickpea grown under elevated CO₂ condition recorded higher photosynthesis rate and lower stomatal conductance throughout the crop growth period. Elevated CO₂ enhanced the biomass and yield of greengram, pigeonpea, chickpea and wheat substantially (11-22%). Among the crops, chickpea showed greater degree of increase in yield followed by wheat and greengram, while biomass was increased to maximum extent in wheat as compared to other crops. Enhancement in crop yield was attributed to marked increase in number of sinks and seeds/grains per sink. Harvest index was however least affected by CO₂ fertilization in almost all the tested crops. Uptake of nitrogen, phosphorus and potassium decreased with increase in temperature, while increased under elevated CO₂ condition.

02-20

GAS EXCHANGE AND CHLOROPHYLL FLUORESCENCE PARAMETERS UNDER SIMULATED SUBMERGENCE STRESS IN RICE

R. Elanchezian, A.A. Haris and M.K. Meena

*ICAR Research Complex for Eastern region, B.V. College P.O., 800014, Patna
elanrc@gmail.com*

Four rice varieties viz. Sita, IR64, FR-13A and Bharani were reared in simulated tanks and subjected to submergence stress at seedling and active tillering stages. The effect of submergence stress on gas exchange and chlorophyll fluorescence parameters were measured. Photosynthesis rate declined in plants subjected to stress under both the stages. Varieties FR-13A and IR 64 recorded maximum photosynthetic rate than Bharani and Sita. Stomatal conductance was also observed to be declining in all four varieties with stress. However, Sita showed lesser decline in conductance with stress than other varieties. Chlorophyll fluorescence parameters viz. maximum quantum yield of PSII, electron transport rate, photochemical quenching and non-photochemical quenching were recorded in all four varieties. All the parameter except non photochemical quenching declined with stress at panicle initiation and flowering stage. The decline in yield of PSII, electron transfer rate and photochemical quenching was less in FR 13A followed by Bharani and IR 64. Non-photochemical quenching was higher when stress was imposed among varieties and maximum quenching was observed in Sita. Higher photosynthesis rate coupled with lesser decline in yield of PSII, electron transfer rate and photochemical quenching might have increased the tolerance of variety like FR13 A towards submergence stress.

02-21

EFFECT OF ROOT FLOODING ON CHLOROPHYLL FLUORESCENCE, LEAF GAS EXCHANGE AND GROWTH RESPONSES IN *Jatropha curcas* (L.)

Krishan K. Verma and Munna Singh

*Botany Department, University of Lucknow, Lucknow-226 007 (UP), India
drmunnasingsh@yahoo.com*

Severe soil drainage constraints are estimated to adversely affect ca. 10% of the global land area, may also acquire ca. 20% for specific regions (FAO, 2002). Flooding is a major environmental stress and adversely affects the developmental and metabolic processes alongwith plant biomass (Bailey-Serres and Voesenek, 2008; Jackson, 2008). The field grown *Jatropha curcas* seedlings (45 days old) were subjected to soil flooding stress for a period of four weeks under open environmental variables (mid June – mid July, 2007). The height of



plants, total area of leaves, number of leaves, chlorophyll content, quantum efficiency of PS II based on chlorophyll fluorescence yield i.e., Fv/Fm and Fv/Fo values, photosynthetic CO₂ assimilation, stomatal conductance and harvest index were monitored. The significant reduction in stem elongation, leaf area and harvest index was observed as a result of soil flooding. The photosynthetic performance of PS II as diagnosed through Fv/Fm and Fv/Fo ratios was found to be down regulated along with loss in chlorophyll content, stomatal conductance and CO₂ assimilation. The ultrastructural studies related with chloroplast and mitochondria were also found to be altered. The electrolyte leakage was found more in roots compared to leaves during soil flooding. The anatomical structures of root, stem and leaves revealed an adaptation towards soil flooding. The SODs seem to be up-regulated to protect affected seedlings from the soil flooding. An overall impact of soil flooding has been discussed in detail in relation to establishment and cultivation of *Jatropha curcas* plantation for seed yield to promote and sustain the proposed biodiesel extraction in India.

02-22

ANALYZING THE RESPONSE OF WHEAT CROP TO GLOBAL WARMING AND ATMOSPHERIC CARBON-DIOXIDE RISE

K. Byjesh, R.C. Harit, S. Naresh Kumar and P.K. Aggarwal

Division of Environmental Science, IARI, New Delhi -110012

The Intergovernmental Panel on Climate Change (IPCC) has predicted an increase in atmospheric temperature and carbon dioxide (CO₂) concentration in the coming years. Climate change due to the enhanced greenhouse effect is expected to affect global agricultural productivity especially Indian agriculture. Wheat, important cereal crop of the country, it is important to analyze its impact due global warming and CO₂ rise. Wheat response to increasing atmospheric temperature (1-4°C) and CO₂ (380-Current, 450, 550, 650) was analyzed using a generic crop growth model - InfoCrop-wheat. Well calibrated and validated model were used for the study. Validated model was run for 4 different important Indian wheat production sites (Pantnagar, Ludhiana, Karnal, Lucknow) by using past 25 years of weather data for current and changed scenarios. Site specific data (Soil and weather) and current crop management details (Variety, fertilizer, Irrigation) were input in the model. In all the studied sites CO₂ increase has benefitted the crop of about 4-5 % at 450 6-8% at 550 and 10-12 at 650 ppm, as wheat is a C₃ crop. In all the sites an average reduction of 7-10%, 14-17%, 23-24, 29-10% at 1, 2, 3, 4°C increase in maximum and minimum temperature. Preliminary analysis confirmed that the benefits of CO₂ rise will nullified by the initial increase in atmospheric temperature. Future research should be oriented towards identifying potential adaptation strategies to reduce the impact and to quantify the net vulnerability of wheat productivity to the anticipated climate change.

02-23

PHYSIOLOGICAL EVALUATION OF RICE GENOTYPES UNDER CHANGING CLIMATIC SCENARIO

Devendra Singh, M. S. Gill and Vipin Kumar

Project Directorate for Cropping Systems Research, Modipuram, Meerut (U.P.) - 250 110

dsingh@pdcsr.ernet.in

A field experiment was conducted during *kharif* 2008 to evaluate 20 genotypes of rice for their phenological growth in relation to climatic conditions and to monitor different morpho-physiological parameters in relation to productivity. Twenty five days old seedlings of rice were transplanted in the field on July 02 2008. Observations were recorded on various phenophases and morpho-physiological parameters of growth and productivity. Phenological variations were observed in panicle emergence (PE), 50 % PE and maturity in different



rice genotypes. Early panicle emergence (42-47 days after transplanting, DAT), 50 % PE (50-55 DAT) and maturity (87-90 DAT) were observed in Ananda and Poornima than the fine basmati types (PB 1, PB1460, PS 4, PS 5, Pant Sugandha 15, Basmati 370 and Tarawadi Basmati) which were 10-30 days late in maturity. Saket 4, PD-10, PD-12, PS 4 and PS 5 behaved relatively early in terms of 50 % PE (58-62 DAT) than other genotypes and matured in about 90-100 DAT. Linear increase in LAI was observed in all the genotypes up to 9th week after transplanting (ATP) except in Poornima, Ananda, Pant dhan 10, Basmati 370 and Saket 4, where maximum LAI reached at 6th week ATP, and Pant Sugandha 15, where it was linearly increased up to 12th week ATP. On the other hand, biomass was linearly increased up to maturity in all the genotypes. Tillers number m⁻² were linearly increased up to 50 DAT in all the genotypes, except in basmati 370, PB 1, PB 1460 and PS 4, where highest tiller numbers reached at 40 DAT. Foliage growth (LAI) was relatively low (1.6-3.0) but the photosynthesis (μ mole CO₂ m⁻² s⁻¹) was higher in early types (17-22) than late types (14.87). Grain yield was, however, higher (5.0-6.0 t ha⁻¹) in early (90-100 DAT) and medium (100-110 DAT) maturing genotypes than late maturing () group of genotypes (4.1 t ha⁻¹). High grain yield in early genotypes was largely due to high HI (35-40 %) as compared to late maturing group of genotypes (28 % HI). Total heat unit requirement i.e. growing degree days (GDD) was relatively low in the early type genotypes (1250-1400 °C) than the late maturing genotypes (1450-1600 °C). Heat use efficiency (HUE, kg/GDD), on the other hand, was more in early genotypes (4.0) than the late maturing genotypes (2.72).

02-24

FERTILIZER MANAGEMENT AS GREEN HOUSE GAS EMISSION MITIGATION OPTION FROM ACID SOILS OF NORTH EAST INDIA

Boby Gogoi¹ and K.K. Baruah²

¹Department of Horticulture, Assam Agricultural University, Jorhat, 785013, Assam

²Department of Environmental Science, Tezpur University, Tezpur, 784028, Assam

Global warming induced by increasing nitrous oxide concentration in the atmosphere is a matter of great environmental concern. Its concentration was estimated from wheat growing field at north bank plain agroclimatic zone of Assam. Seeds of wheat variety HUW 234 were sown on 27th December 2007, with nine different fertilizer treatments viz., T₁: Urea, SSP, MOP @ 60:45:42 kg/ha, T₂: Urea, SSP, MOP @ 65:48:43 kg/ha, T₃: Urea, SSP, MOP @ 55:42:41 kg/ha, T₄: DAP, SSP, MOP @ 60:45:42 kg/ha, T₅: DAP, SSP, MOP @ 65:48:43 kg/ha, T₆: DAP, SSP, MOP @ 55:42:41 kg/ha, T₇: Organic manure + Urea, SSP, MOP @ 60:45:42 kg/ha, T₈: Organic manure + Urea, SSP, MOP @ 65:48:43 kg/ha and T₉: Organic manure + Urea, SSP, MOP @ 55:42:41 kg/ha respectively. Gas samples were collected at weekly interval and nitrous oxide concentration in the gas samples were analysed by using a gas chromatograph (PerkinElmer Clarus, 500 GC) equipped with an electron capture detector (ECD) and packed column (porapak Q). Plant and soil samples were also collected for analysis along with the gas samples. Seasonal integrated nitrous oxide emission (E_{sif}) recorded from wheat variety HUW 234 treated with various fertilizer treatments were – T₁(383.60 mg N₂O-N m⁻²), T₂(384.16 mg N₂O-N m⁻²), T₃(380.18 mg N₂O-N m⁻²), T₄(390.32 mg N₂O-N m⁻²), T₅(393.06 mg N₂O-N m⁻²), T₆(386.73 mg N₂O-N m⁻²), T₇(397.09 mg N₂O-N m⁻²), T₈(399.28 mg N₂O-N m⁻²) and T₉(396.03 mg N₂O-N m⁻²). Emission peaks were recorded at 31, 52 and 87 days after sowing. Nitrous oxide emission showed significant positive correlations with soil organic carbon, soil nitrate-N, and soil temperature. Seasonal integrated flux was highest in T₈ where comparatively higher dose of Urea, SSP and MOP was applied along with organic matter. T₃ (Urea, SSP, MOP @ 55:42:41 kg/ha) showed lowest seasonal integrated nitrous oxide emission flux and recorded an average yield of 30.68 q/ha. Urea, SSP, MOP @ 55:42:41 kg/ha (T₃) can be suitably use in wheat field for reducing green house (N₂O) emission and for higher productivity.



02-25

EFFECT OF WATER STRESS ON LEAF PHOTOSYNTHESIS AND CHLOROPHYLL FLUORESCENCE CHARACTERISTICS IN AVENA SPECIES

Harish C. Pandey, M.J. Baig* and R.K. Bhatt

Indian Grassland and Fodder Research Institute, Jhansi-284003, India

*Central Rice Research Institute, Cuttack (Orissa)

Oat (*Avena sativa* L) is the most important cereal fodder crop grown in the winter season in the north-western, central India and now extending to the eastern region. Seven species of genus *Avena* viz., *Avena sativa*, *Avena strigosa*, *Avena brevis*, *Avena vaviloviana*, *Avena abyssinica*, *Avena marocana* and *Avena sterilis* were studied for important physiological trait under drought condition. Rate of photosynthesis (P_N) ranged between 9.42 to 13.71 $\mu\text{molesm}^{-2}\text{s}^{-1}$ at vegetative and 10.69 to 16.37 $\mu\text{molesm}^{-2}\text{s}^{-1}$ at flowering stage in different species. The minimum decrease in P_N was recorded in *A. brevis* followed by *A. strigosa* and *A. sativa*. However, at flowering stage minimum decrease was recorded in *A. abyssinica* followed by *A. sativa* and *A. strigosa*. The stomatal conductance (g_s) also showed same trend as per P_N with minimum decrease in *A. brevis* followed by *A. marocana* and *A. strigosa* at vegetative stage but at flowering stage the minimum decrease was recorded in *A. Marocana* which is having at par value with *A. brevis*. The stomatal resistance (R_s) and internal CO_2 concentration (C_i) increased under stressed environment. Maximum increase in the R_s was recorded in *A. sativa* at both the stages. However at vegetative stage *A. sativa* was followed by *A. vaviloviana* and *A. abyssinica* and at flowering *A. sativa* is followed by *A. strigosa* and *A. marocana*. Under limited water environment minimum increase in C_i was recorded in *A. strigosa* followed by *A. abyssinica* and *A. sativa* at vegetative stage. However, at flowering stage *A. abyssinica* recorded minimum increase followed by *A. marocana* and *A. vaviloviana*, which showed at par with each other in the well watered environment. In our experiment the photosynthesis is governed by stomatal limitations as there is strong positive correlation between photosynthesis and stomatal conductance, whereas stomatal resistance is negatively correlated to photosynthesis at both the stages of the crop. The species showing their vegetative stage drought tolerance in terms of chlorophyll fluorescence, the minimum decrease in F_v/F_m recorded in *A. abyssinica* followed by *A. sativa* and *A. sterilis* and the flowering stage drought tolerance was showed by *A. sterilis* followed by *A. marocana* and *A. brevis*. The fluorescence parameter F_v/F_m can also be used as selection criteria for screening large number of germplasm for drought tolerant.

02-26

ATP-SULFURYLASE ACTIVITY, PHOTOSYNTHESIS, AND SHOOT DRY MASS OF MUSTARD (*Brassica juncea* L.) CULTIVARS DIFFERING IN SULFUR ACCUMULATION CAPACITY

R. Nazar and N.A. Khan

Department of Botany, Aligarh Muslim University, Aligarh – 202 002, India

khan_rahatnazar@rediffmail.com

Sulfur (S) is an essential nutrient element required in a large quantity by mustard. S regulates photosynthesis and plant growth through improving nitrogen (N) acquisition. Mustard cultivars Alankar, Varuna, Pusa Jai Kisan, and SS2 differing in S accumulation capacity calculated as sulfate transport index (STI) were tested for ATP-sulfurylase activity, S and N accumulation, photosynthesis, and shoot dry mass (DM) at 30 and 60 d after sowing (DAS). The activity of ATP-sulfurylase, shoot N content, net photosynthetic rate (P_N), leaf area, and shoot DM of the cultivars were in the order: Pusa Jai Kisan > Alankar > Varuna > SS2. ATP-sulfurylase activity was strongly and positively correlated with P_N and shoot DM in all the cultivars. Hence ATP-sulfurylase activity may be used as a physiological trait for augmenting photosynthesis and shoot DM.



02-27

**ADAPTATION STRATEGIES OF *Brassica* TO HIGHER LEVEL OF ELEVATED CO₂ UNDER
MOISTURE STRESS CONDITION: A CASE STUDY**

Ranjan Das* and **D.C. Uprety****

* Department of Crop Physiology, AAU, Jorhat, ** Division of Plant, Physiology IARI New Delhi

The response of two *Brassica* cultivars namely *B. campestris* cv. 'Pusa Gold' and *B. juncea*, cv. 'RH-30' to the interaction of elevated CO₂ and moisture stress, was studied using Free Air Enrichment Technology (FACE) to simulate doubling CO₂ concentration. Moisture stress treatment was given by restricting irrigation at different stages of growth. It was observed that the gas exchange system was stimulated under elevated CO₂ due to increase in the rate of photosynthesis in both the cultivars. The continuous high rate of photosynthesis throughout the growth period was attributed to the increased generation of additional foliage, reproductive organs and enhancement of stem and root growth. Elevated CO₂ with additional vegetative and reproductive growth might possibly result by the continued high rates in photosynthesis to sustain the growth of the new sinks. The moisture stress treatment, which could increase the stomatal resistance and reduce the intercellular CO₂ concentration and chlorophyll content, caused reduction in photosynthesis. The elevated CO₂ compensated the intercellular CO₂ depletion. Further, the decline in respiration under drought condition was greater at ambient CO₂ compared to elevated CO₂ condition. This indicated the CO₂ induced compensatory mechanism of carbon balance under stress condition in *Brassica* species. Elevated CO₂ brought about significant increase total crop growth period. The increase in vegetative period resulted in the complete development of CO₂ induced new branches and leaves. These newly developed leaves and branches act as temporary sinks for the photo assimilates produced due to CO₂ enrichment. Increase in reproductive period lead to the development of more number of siliquae per branch synchronizing the production of the photo assimilates. Seed filling period for both early and late initiating siliquae increased to develop high density grains and increasing the grain weight and grain yield. CO₂ enrichment not only increased the sink size but also its capacity to give additional benefit to plants to combat the adverse effect of moisture stress on yield components. The elevated CO₂ prolonged physiological activities by maintaining the water status in plants under moisture stress condition. This was promoted by root proliferation and increased exploitation of deep soil moisture reserves, thus delaying the onset of stress. Besides the maintenance of water status, physiological adjustments such as. stomatal closure, osmotic adjustment, changes in tissue elasticity and resistance to xylem embolism shown to be important tolerance and adaptive mechanisms in *Brassica* cultivars that helped in survival and recovery from stress. The increased leaf area in response to elevated CO₂ brought about an early development of full canopy, where the reduced transpiration due to decreased stomatal conductance in leaves further slowed down the soil moisture depletion. Another possible mechanism demonstrated in this study was the enhanced osmotic adjustment by accumulating non-structural carbohydrates, fructans and sugars etc. under moisture stress condition. The increased accumulation of starch, other non-structural carbohydrates, proline, free amino acids, and free fatty acids served as strong osmolites to regulate the osmotic balance in cell under stress condition. This mechanism would decrease leaf osmotic potential while maintaining both higher water and turgor potentials delaying the onset of stress. The elevated CO₂ increased the superoxide dismutase, ascorbate peroxidase, catalase and glutathione reductase activity under moisture stress and ameliorated the oxidative stress effect to the level of unstressed plant by detoxifying the O₂⁻. It was revealed that the senescence intensity in CO₂ enriched plants was significantly lower. The delayed senescence was due the decreased level of MDA and H₂O₂ in the leaves of CO₂ enriched plant. The delay in senescence was one of the most important consequences of increasing leaf area duration and seed filling period. Increased leaf area duration coupled with more photosynthetic rate during seed filling resulted in increased productivity of plant. Moisture stress enhanced the senescence and reduced the seed filling period but stress induced enhancement of this senescence was suppressed by elevated CO₂ and increased seed filling period. Longer seed filling period



was recorded in 'RH-30' cultivar. The anatomical study on the phloem showed that protophloem sieve imported solute for structural development and metaphloem helped for the transfer of photosynthate for inducing new sink development. Improvement of xylem structural organization helped plants to regulate maximum residual water under stress condition to maintain water status for active physiological process by delaying the onset of moisture stress. This database on *Brassica* species has helped to understand various strategies developed by the plants due to elevated CO₂ to adjust and acclimate under moisture stress condition.

02-28

PHOTOSYNTHESIS, GROWTH AND ANTIOXIDANT METABOLISM IN MUSTARD (*Brassica juncea* L.) CULTIVARS DIFFERING IN CADMIUM TOLERANCE

Noushina Iqbal* and Nafees A Khan

Department of Botany, Aligarh Muslim University, Aligarh 202002, UP
naushinaiqbal@gmail.com

Two mustard (*Brassica juncea* L. Czern and Coss) cultivars differing in cadmium (Cd) tolerance were treated with 0, 25 and 50 μ M Cd to study physiological processes forming basis of difference in Cd tolerance. Cultivar SS2 (Cd sensitive) accumulated greater Cd in leaves than the cultivar Pusa Jai Kisan (Cd tolerant). Further, SS2 exhibited higher contents of thiobarbituric acid reactive substances (TBARS) and H₂O₂ and electrolyte leakage than Pusa Jai Kisan. The activity of antioxidant enzymes catalase (CAT), ascorbate peroxidase (APX), glutathione reductase (GR), dehydroascorbate reductase (DHAR) was higher in Pusa Jai Kisan than SS2. Treatment of 25 μ M Cd induced maximum activity of enzymes. However, the activity of GR increased upto 50 μ M Cd in both the cultivars. Contrarily, the activity of superoxide dismutase (SOD) was higher in SS2 than Pusa Jai Kisan and maximum at 25 μ M Cd. The non-enzymatic antioxidants ascorbate (AsA) and glutathione (GSH) were higher in Pusa Jai Kisan than SS2, whereas dehydroascorbate (DHA) and oxidized glutathione (GSSG) were higher in SS2. Photosynthesis and growth were adversely and maximally affected by 50 μ M Cd treatments in both the cultivars, but SS2 exhibited greater reductions. The lesser reduction in photosynthesis and growth in Pusa Jai Kisan were associated with its capacity to accumulate lesser Cd in leaves, low level of TBARS and H₂O₂ and electrolyte leakage and higher antioxidant metabolism.

02-29

METHANE EMISSION ASSOCIATED WITH MORPHO-PHYSIOLOGY OF TWO IMPROVED SALI RICE (*Oryza sativa* L.) CULTIVARS

Kaushik Das and K.K. Baruah*

Department of Crop Physiology Assam Agricultural University, Jorhat, Assam- 785 013
*Department of Environmental Science, Tezpur University, Tezpur, Assam-784 028

Rice fields serve as an important anthropogenic source of atmospheric methane. Experiments with two improved rice cultivars viz. 'Bahadur' and 'Piolee', over two consecutive years during *Sali* rice-growing season evaluated the effects of morpho-physiological characteristics of rice (*Oryza sativa* L.) plants on methane emission. Higher methane flux was recorded in 'Bahadur' compared to 'Piolee' at different stages of crop growth. Higher photosynthetic rate was recorded in 'Bahadur', resulted in profuse vegetative growth in terms of leaf number and area, root volume and length and tiller number. In both the years, a higher soil organic carbon content was recorded in plots of 'Bahadur'. Our results suggest that in 'Bahadur', enhanced diversion of photosynthate to roots resulted in more substrate being available for methanogenesis in the rhizosphere. Additionally, the more extensive vegetative growth of this cultivar may enhance methane transport from the soil to the above ground atmosphere.



02-30

PHOTOSYNTHETIC AND YIELD CHARACTERISTICS OF RICE (*Oryza sativa* L.) PLANT ASSOCIATED WITH METHANE EMISSION

Kaushik Das and K. K. Baruah*

Department of Crop Physiology Assam Agricultural University, Jorhat, Assam- 785 013

**Department of Environmental Science, Tezpur University, Tezpur, Assam-784 028*

A field experiment was conducted during *Sali* rice growing season in order to elucidate the relationships of intervarietal difference in CH₄ flux with photosynthetic characteristics of rice plant (*Oryza sativa* L.). Ten (five traditional and five improved high yielding) rice cultivars were grown in the field under rainfed condition. Wide variation in CH₄ flux was noticed among the rice genotypes. Seasonal integrated CH₄ flux (Esif) ranged from 8.74 g m⁻² to 12.46 g m⁻² among the cultivars. We classified the cultivars into three groups *viz.* low, medium and high CH₄ emitting based on their seasonal CH₄ emission. High and medium CH₄ emitting cultivars recorded higher rate of photosynthesis during vegetative growth period, whereas low CH₄ emitting cultivars recorded higher photosynthetic rate after panicle initiation. Significant variation in photosynthate partitioning among different rice genotypes influencing CH₄ emission was demonstrated.

02-31

IDENTIFICATION OF CHICKPEA GENOTYPES FOR HIGH TEMPERATURE TOLERANCE

Divya Shah, Madan Pal Singh, Sangeeta Khetarpal, Sunil Kumar Pandey and Jyoti Jha

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

Chickpea is an important pulse crop of India. Rising temperature under climate change scenario may affect the productivity of pulse crops particularly chickpea. A field study was thus conducted to identify high temperature tolerant chickpea genotypes. Thirty-four chickpea genotypes of both *desi* and *kabuli* types, were grown in the field under timely (November 25, 2008) and delayed (December 27, 2008) sowing. Observations were recorded on membrane stability index (MSI) during flowering and podding stage, dry matter production, yield and its components and daily mean, maximum and minimum temperature. The daily mean temperature during flowering of normal sown crop was 18°C, while at pod filling stage it ranged 20-22°C. On the other hand for late sown crop, the daily mean temperature during flowering was calculated to be 20°C and at pod filling it was more than 25°C, while the maximum daily temperature was recorded up to 28-30°C at similar stages. The yield data showed reduction in yield parameters in most of *desi* and *kabuli* type chickpea cultivars, and some genotypes showed marked reductions in yield due to delayed sowing of the crop. The changes in number of pods per plant were less compared to seed yield, which suggests that high temperature during podding stage in late sown crop was detrimental for grain filling. MSI also decreased in late sown chickpea genotypes and no clear trend in the magnitude of changes in MSI and yield reduction was recorded. Further studies are suggested alongwith large number of genotypes (including the above) to confirm these findings.



02-31

PHOTOSYNTHETIC CHARACTERS OF RICE CULTIVARS, ADT 43 AND ADT45

V. Suganya*, S. Vincent, H. Vijayarahavan and C. Vijayalakshmi

Department of Crop Physiology, Tamil Nadu Agriculture University, Coimbatore – 3

**agrisugan@yahoo.co.in, nivitnau@yahoo.co.in*

Experiment was conducted in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during Kuruvai season 2009 (May-June) to study the Photosynthetic characters of two rice genotypes, ADT 43 and ADT 45. Three foliar spray treatments were given at active tillering stage along with control. Observations were recorded at this stage on photosynthetic characters *viz.*, photosynthetic rate, stomatal conductance and transpiration rate by using Photosynthetic system (Li-cor 6400) and SPAD values by using SPAD chlorophyll meter (SPAD-502- Minolta). The results revealed that foliar application of cyclic compounds (Allwin Top) 0.2% recorded a higher photosynthetic rate (13.47, 11.61 $\mu\text{molCO}_2\text{cm}^{-2}\text{s}^{-1}$), transpiration rate (10.3, 11.93 $\mu\text{g of H}_2\text{O cm}^{-2}\text{s}^{-1}$), low stomatal conductance (0.339, 0.491 cm^{-1}) which were the conformity with the results of SPAD values recorded higher chlorophyll content of 41.07 and 42.63 in the varieties respectively.



Session 03

Water Logging, Salinity and Other Stresses



03-01

**CHANGES IN ANTIOXIDATIVE SYSTEM DUE TO MERCURY AND OSMOTIC STRESSES IN
*Trigonella – foenum – graecum L.***

Pranab Kumar Bandopadhyay¹, Nilima Karmakar² and Arunabha Chakravarty²

¹Department of Plant Physiology, ²Department of Agricultural Biochemistry, Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur, Nadia, W.B., 741252

The induction of different types of stresses on a particular crop showed a range of biochemical and physiological variations from which it is very much clear that heavy metal and draught may adopt its own mechanism of resistance and plant responded in different ways to combat the detrimental effects of stresses. In the present study two types of stresses such as heavy metal (HgCl_2 10 ppm) and osmotic stress (PEG-1-bar) were applied on 6 days old fenugreek (*Trigonella-foenum-graecum L.*) seedlings and maximum abnormality in respect of root and shoot has been depicted by heavy metal compared to osmotic stress. Heavy metal mercury showed maximum catalase (CAT) and minimum peroxidase (POD) activities along with fairly high lipid peroxidation reaction. PEG treatment showed maximum super oxide dismutase (SOD) activity compared to CAT and POD. The efficacy of total Antioxidative activity with the help of a free radical DPPH were studied, it was observed that PEG treatment revealed better Antioxidative system to scavenge the free radical than that of heavy metal treatment. From the comparative studies it might conclude that all stresses had substantial damaging effect over trigonella sp. In respect of Antioxidative enzyme analysis, where toxicity damages more expressed in metal than that of osmotic stress.

03-02

**EFFECT OF SALT STRESS ON FRUIT GROWTH AND CARBOHYDRATE ACCUMULATION IN
DIFFERENT BANANA CULTIVARS**

I. Ravi*, M. Mayil Vaganan, R. Kalaivani and M.M. Mustaffa

National Research Centre for Banana, Thogamalai Road, Thayanur Post, Tiruchirapalli-620102

In India, banana is an important commercial crop with a total production of 23.4 million tonnes annually from 0.64 million hectares, grown in varying agro-climatic conditions and soil types. Banana is cultivated in more than 30% of the area adverse soil condition with $\text{pH} > 8.5$, $\text{ECe} > 4 \text{dSm}^{-1}$ and $\text{ESP} > 15$. In such saline-sodic soils, banana suffers from salt injury with external symptoms of marginal chlorosis of leaves, less photosynthetic activities leading to yield loss and less finger weight. The present investigation was aimed at studying the effect of salt stress on banana fruit growth and sugars and starch accumulation in peel and pulp in different banana cultivars. Robusta, Nendran, Saba and Ney Poovan banana cultivars were grown in salt affected field ($\text{EC}_{1:2.5} = 3.34 \text{dSm}^{-1}$ $\text{pH} 8.1$.) with standard management practices and data on the following parameters were recorded after flowering. There was significant increase of fruit volume, pulp/peel ratio between 30 and 60 days after flowering (DAF) in Saba and Ney Poovan, compared to Nendran and Robusta. Saba accumulated lesser total sugar content than all other cultivars in pulp and peel during fruit development. Accumulation of total sugars was more in peel than pulp till 60 DAF in all the cultivars, but the trend was reversed in Saba and Ney Poovan from 90 DAF, whereas in Robusta and Nendran total sugars recorded significantly higher in peel than pulp throughout fruit development. Starch content was higher in pulp than peel in all cultivars. However, in Robusta and Nendran bananas the starch content did not increase after 30 DAF compared to Saba and Ney Poovan. Based on fruit growth and carbohydrate accumulation data, it was found that Saba and Ney Poovan are tolerant to salt stress and accumulated more sugars and starch in pulp than peel, whereas in Robusta and Nendran (susceptible cultivars), peel accumulates more sugars and starch. The results are presented and discussed.



03-03

AMINO ACIDS METABOLISM IN BERSEEM CULTIVARS DURING SALINITY STRESS

Deepak Kumar and Deepika

Department of Botany, Dhampur Degree College, Dhampur-246761, Bijnor, U.P.

dr.deepak_kumar@yahoo.co.in

Salt tolerant (Wardan) and salt susceptible (BL-10) cultivars of berseem were evaluated for amino acids in relation to imposed salinity stress. The results in the present study revealed that total amino acids decreased significantly with increasing levels of salinity except proline and glycine. Wardan had a higher concentration of glycine, cystine, leucine, lysine, glutamic acid and proline in comparison to BL-10. The content of arginine, threonine, cystine, leucine, lysine and glutamic acid decreased progressively with increasing levels of salinity but increased with advancement of plant age. Greater accumulation of arginine and threonine is registered in BL-10 as compared to Wardan.

03-04

CARBON EXCHANGE RATE, MINERAL NUTRIENT UPTAKE AND PARTITIONING IN PIGEONPEA [*CAJANUS CAJAN* (L.) MILLSP.] UNDER WATERLOGGING

Vinay Pratap Singh, J.P. Srivastava* and Ruchi Bansal

Department of Plant Physiology, Institute of Agricultural Sciences, BHU, Varanasi, 221005

jpsbhu25@yahoo.co.in

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important legume crop of rainfed agriculture. Productivity of pigeonpea in India is low due to various biotic and abiotic stresses. Waterlogging poses a serious problem to pigeonpea production. Under waterlogged condition, hypoxia followed by anoxia in rhizosphere and decreased soil redox potential, shifts plant's metabolism from aerobic to anaerobic, resulting in derangement in plants processes. In the present investigation, an attempt was made to investigate changes in photosynthetic and mineral nutritional parameters during waterlogging in pigeonpea. Three pigeonpea genotypes, differing in their waterlogging resistance, i.e., ICPL-84023 (resistant), PTH-1 (moderately resistant) and MAL-18 (susceptible), were selected. Plants were grown in plastic pots containing 2 kg soil. After 20 days of growth under normal condition, half set of the pots of each genotype were subjected to waterlogging stress by placing pots in cemented tanks and maintaining water level 3 cm above the soil surface in pots through out. Photosynthetic parameters, mineral nutrient status as well as their partitioning were investigated in normal as well as waterlogged plants. Waterlogging decreased carbon exchange rate and stomatal conductance significantly, and the reduction in photosynthetic rate was more than the reduction in leaf conductance. In studied genotypes, waterlogging led to significant decrease in total plant N and K contents, but increase in Fe content. Under waterlogging leaf N content decreased significantly, but remained unchanged in roots and stem. In leaves, K content also decreased significantly under waterlogging, but in root and stem, it showed variable trend. Unlike N and K, Fe content increased in root and stem tissues, but decreased in leaves under waterlogging. No significantly significant differences were recorded in the contents of P, Ca, Mg, Zn, Mn and Cu in normal and waterlogged plants. Results are discussed in the light of differential performances of genotypes under waterlogged condition.



03-05

EFFECT OF POST ANTHESIS HIGH TEMPERATURE TOLERANCE ON MORPHO- PHYSIOLOGICAL CHARACTERISTICS IN CONTRASTING WHEAT GENOTYPES

Sunita Gupta and N.K. Gupta

*Plant Biotechnology Centre, Rajasthan Agricultural University, Bikaner-334006
nkgupta69@yahoo.co.in*

A pot experiment was conducted to study post anthesis high temperature tolerance in four wheat genotypes namely Raj-3765 and Raj-3777 (tolerant to high temperature) and Raj-3077 and PBW-343 (heat susceptible). All these genotypes were sown on three dates i.e. 5th November (normal sowing), 20th November (late sowing I) and 5th December (late sowing II). Observations on different growth and physio-biochemical parameters were recorded at 0, 10 and 20 days after anthesis. Result showed that late sowing decreased the rate of photosynthesis, chlorophyll content, relative water content and membrane stability index, but increased leaf stomatal conductance and transpiration rate. The trend was almost similar at 0, 10 and 20 days after anthesis. The genotypic variations pertaining to these parameters were found significant. The tolerant genotypes showed lesser reduction than susceptible genotypes, particularly under late sown conditions. The grain yield decreased significantly under late sown condition. The reduction was higher in susceptible genotypes as compared to tolerant genotypes.

03-06

GENETIC VARIABILITY IN ANTIOXIDANTS ASSOCIATED WITH SUBMERGENCE TOLERANCE OF LOWLAND RICE

A.K. Srivastava, P.N. Singh and P.C. Ram

*Centre of Advanced Studies in Plant Physiology, Department of Crop Physiology, N.D. University of
Agriculture & Technology, Kumarganj, Faizabad 224229, India
ashish-2005@india.com*

Submergence of rice (*Oryza sativa* L.) by flash floods is a major constraint limiting rice production in South and South East Asia. Rice cultivars though possess the ability to tolerate complete submergence but if prolonged, may cause partial to complete failure. Two important factors influencing rice plant survival during submergence are the limited gas diffusion under water and reduced irradiance that impair the processes of photosynthesis and efficient energy production and utilization. During flash floods, a third factor which adversely affects plant survival is the production of free radicals of oxygen during post submergence phase when flood water recedes. In a controlled pot experiment, 21 days old plants of six rice genotypes differing in submergence tolerance were subjected to 10 days complete submergence. Under water shoot elongation, plant survival (recorded 7 days after de-submergence), antioxidants like total ascorbate and reduced glutathione, along with membrane damage as malondialdehyde production were measured prior to submergence and just after de-submergence in order to assess the possible beneficial effects of antioxidants in newly developed lowland rice varieties/ genotypes. Submergence tolerant varieties Swarna Sub1 (Improved Swarna), FR 13A, NDR9730018 and NDR9930111 depicted lower shoot elongation during 10 d submergence, consequently had higher plant survival. Strong negative correlation ($r^2= 0.91$) was observed between underwater shoot elongation and plant survival. Total ascorbate being an important antioxidant associated with the protection of plant membranes by the removal of hydrogen peroxide produced during post submergence oxidative stress was measured over a time course between 0-24 hours after de-submergence. Total ascorbate content prior to submergence was almost at par in all the genotypes, but increased just after de-submergence. Tolerant genotypes showed higher increase, whereas, susceptible genotypes showed lower increase. A time course study indicated initially negative correlation with



the survival per cent ($r^2=0.20$) but further correlation with survival per cent improved ($r^2=0.69$ to 0.87 from 2nd to 24th hr after de-submergence) clearly depicted the direct relationship between survival and total ascorbate content just after de-submergence. Glutathione is another metabolite in addition to ascorbate, which regulates the level of ROS during oxidative stress. Tolerant genotypes had higher reduced glutathione content prior to submergence than susceptible genotypes. During post submergence phase, however, glutathione content decreased, showing maximum reduction of 87.7% in susceptible genotype IR 42 which had the lowest survival of 44%. Strong negative correlation ($r^2=0.81$) was observed between reduction in glutathione and plant survival during submergence. Malondialdehyde a by-product of lipid peroxidation showing membrane disintegration on sudden entry of oxygen, was almost at par in all the genotypes prior to submergence but increased just after de-submergence. Maximum increase in malondialdehyde content was observed in susceptible genotype IR 42 (541.7 %) followed by Swarna (277.7%) which showed pronounced negative effect on plant survival ($r^2=0.91$). It is, thus, concluded that antioxidants like ascorbate and glutathione had strong positive role to play in scavenging the toxic free- radicals of oxygen in plants, exposed to oxidative stress after a brief period of submergence, possibly by regulating the Asada-Halliwell pathway for antioxidant regeneration. These traits can be the possible markers for developing submergence tolerant rice varieties.

03-07

EFFECT OF WATER LOGGING ON GAS EXCHANGE PARAMETERS, OXIDATIVE ENZYMES, YIELD AND QUALITY OF FLUE-CURED TOBACCO

M. Anuradha, K. Sivaraju and V. Krishnamurthy

Central Tobacco Research Institute, Rajahmundry – 533105

An experiment was conducted with different periods of water-logging (24, 48, 72 and 96 h along with the control) to study its effect on gas exchange parameters, activity of oxidative enzymes, yield and quality of flue-cured tobacco. Tobacco seedlings were grown in 150 kg capacity pots filled with light soil using recommended package of practices. The tobacco plants were subjected to water logging for different periods when the plants attained the flower bud initiation stage. Then plants were topped and suckers were controlled using a suckercide (decanol). Harvested leaves were cured in an electric barn. Cured leaf samples collected at X, L and T positions were analyzed for quality constituents *viz* nicotine and reducing sugars. Results showed that the gas exchange parameters *viz.*, photosynthetic rate, stomatal conductance and transpiration rate were decreased with increase in water logging period. The total soluble protein content of leaf decreased with increase in period of water logging. With increase in period of water logging yield and quality were reduced drastically. The reduction in yield due to water logging for a period of 24, 48, 72 and 96 h were 23, 43, 76 and 82% respectively. Nicotine and reducing sugars were decreased with increase in the period of water-logging at all plant positions. Under water logging condition, plants synthesized the new isozymes of peroxidase, poly phenol oxidase and catalase to protect from peroxide radicals generated due to water logging. Due to water logging the superoxide dismutase activity enhanced. This shows that even though tobacco plants tried to counteract the ill effects of water-logging by synthesizing the isozymes of oxidative enzymes and enhancing the activity of superoxide dismutase there was reduction in yield.



03-08

GROUPING OF RICE (*Oryza sativa* L.) VARIETIES FOR SALINITY TOLERANCE BASED UPON Na: K RATIO AND IT'S COMPONENT PARTS OF FRESH AND DRY WEIGHT

S.R. Patel, H.S. Thakare, D.P. Patel, A.M. Patel, J.D. Awadaria, and R.G. Patil

National Agriculture Research Project and Soil – Water Management Research Unit NAU, Navsari–396 450
lspsrp_1951@yahoo.in, harish_0503@yahoo.co.in

The laboratory study was undertaken with a view to know the effect of different levels of water salinity (*i.e.* rain water, tube well water, EC 2, 4, 6 and 8 dSm⁻¹) on Na:K ratio of different cultivars such as Masuri, Jaya, GR -4, GR -7, NAUR -1, Gurjari, GR -11, GR -104, IR -28, IR -22, Dandi, SLR 51214 in FCRD with 3 replication at SWMRU, NAU, Navsari, during 2009. Fresh weight and dry weight, total fresh weight and Na:K ratio of shoot and root recorded after 12 days of superimpose of the treatments of different levels of water salinity. Significantly the highest value of fresh weight and dry weight of shoot and root recorded with 3 cultivars *viz.* NAUR-1, Jaya and Dandi and the lowest with IR-22, IR-28 and GR-7. Total Fresh weight and Na:K ratio recorded significantly the highest value with NAUR-1 and Jaya. It was also recorded that the tube well water (EC 0.08 dSm⁻¹) produces significantly the highest values of fresh weight and dry weight, total fresh weight and Na:K ratio of shoot and root of different cultivars followed by EC 2 & 4 dSm⁻¹. Significantly the highest and lowest fresh weight and dry weight, total fresh weight and Na:K ratio of shoot and root was recorded in the treatments of rain water and EC levels of 6 and 8 dSm⁻¹. From this it can be inferred that, *cv.* NAUR-1, Jaya, Dandi, Gurjari, Masuri and SLR 51214 were more tolerant to water salinity and having highest Na: K ratio and fresh and dry weight as compared to remaining cultivars.

03-09

PHYSIOLOGICAL TRAITS TO SCREEN *Phaseolus vulgaris* GENOTYPES FOR DROUGHT AND HIGH TEMPERATURE STRESS IN A SUBTROPICAL ENVIRONMENT

Ashok Kumar

Department of Agronomy, CCS Haryana Agricultural University, Hisar

Snap bean (*Phaseolus vulgaris*) was introduced in the subtropical islands of Okinawa aimed at to supply fresh green vegetables round the year especially during the summer season. However, the yields are drastically reduced as a result of high temperature combined with water deficits induced infertility by malfunctioning of reproductive organs, senescence and abscission of flowers and young pods and decreased growth rates of pods. One of the most important strategies to overcome the harmful effects of these stresses is to grow tolerant cultivars. Therefore, elucidation of physiological mechanisms of stress tolerance and their use to identify and develop heat-tolerant cultivars for sustaining productivity of snap bean is very important. Experiments conducted in controlled and field conditions in snap bean at Ishigaki Islands, Okinawa, Japan revealed that the maintenance of high leaf relative water content (\hat{i}) with decreasing leaf water potential (\emptyset) varied with the level of temperature and the sensitivity of cultivars. The reduction in \hat{i} with \emptyset became faster with the increase in high temperature, and it was larger in the heat-sensitive than in heat-tolerant cultivar. The effect of temperature and water stress was more pronounced during the reproductive than the vegetative growth period. Heat-tolerant cultivar showed reduction in dry matter partitioning to vegetative parts after shift from normal temperature (27/23 °C, day/night), while no such trend was found in heat-sensitive cultivar indicating a wider temperature adaptability of the former than the latter cultivar. Relationship between the midday drop of \hat{i} and reproductive responses showed that the cultivars with a smaller reduction in midday \hat{i} over morning displayed a higher pod setting ratio, and produced larger number of pods per plant and consequently higher yield as compared with the plants with a larger midday drop of \hat{i} . Therefore, leaf water content is an important physiological trait for improved productivity, and it can be used as a physiological indicator heat and drought tolerance in snap bean.



03-10

ASSESSMENT OF BIODEGRADABILITY OF ON-FARM WASTE

Praveen Kumar and Uday Burman

Central Arid Zone Research Institute, Jodhpur 342 003, Rajasthan

praveen_kumar@cazri.res.in

Climate change is threatening our food security. Though industry is largely blamed for the emission of green house gases but a significant part also originates from agricultural activity such as emission of NO_x from N fertilizers, CO₂ from decomposing residues or degradation of soil organic carbon or methane from paddy fields. Recycling the agricultural waste is an important field approach to reduce emission of greenhouse gases from agricultural activities. However, the waste must decompose for recycling that in turn depends on its chemical composition. Though chemical methods such as assessment of quantity of soluble C or cellulose or lignin or their ratios viz. C:N, lignin to N or polyphenol plus lignin to N have been studied earlier to define decomposability of on-farm waste, but they do not consider the availability of C compound for microbial growth and have consequently failed to be a reliable predictor of decomposition. Also being farm specific activity, on site estimation of decomposition by individual farmers may not be possible with these methods due to the instrumentation involved. Thus, a field diagnostic and user friendly method based on conversion of 2,3,5-tetrazolium chloride to triphenyl formazan by microorganisms growing on feedstock was developed wherein differences in the decomposability could be assessed on the basis of time taken for the development of red color. On this basis, common on-farm residues were classified in the three groups i.e. residues which developed dark red color within 4 hour-highly decomposable (e.g. pearl millet and clusterbean), between 4 to 8 hour-moderately decomposable and >8 hour-slowly decomposable (e.g. sesame and amarnath). The method was able to predict decomposability even in metal/pesticide polluted residues and can thus be used as field diagnostic kit.

03-11

HIGH TEMPERATURE INDUCED ABCISSION OF REPRODUCTIVE ORGANS IN CAPSICUM IN RELATION TO CHANGES IN POLYAMINES, ETHYLENE BIOSYNTHESIS, INDOLE ACETIC ACID AND HEAT SHOCK PROTEINS

K.K. Upreti, N.K. Srinivasa Rao and H.L. Jayaram

Indian Institute of Horticultural Research, Hessaraghatta lake PO Bangalore-560 089

kku@ihr.ernet.in

Incidences of high temperature at reproductive stage limit the productivity in capsicum by inducing abscission of reproductive organs. In order understand the mechanism underlying the high temperature induced abscission of reproductive organs, investigations were carried out on polyamines, indole acetic acid (IAA), ethylene biosynthesis and heat shock proteins (Hsps) in the two capsicum varieties, namely, Arka Gaurav and Arka Mohini exhibiting differences in the flower bud and flower abscission. The experiment was carried out under growth chamber conditions by keeping plants at temperatures 35/25 and 25/20°C (day/night) at reproductive phase. The abscission pattern of the reproductive organs at high temperature revealed Arka Gaurav as the low abscising and Arka Mohini high abscising varieties. The contents of free polyamines, putrescine, spermidine and spermine increased in the flower buds and flowers of plants grown at high temperature, with pattern of polyamine changes being differential in the cultivars. While putrescine increase was greater under high temperature in the flower buds and flowers of high abscising cv. Arka Mohini, the increase in spermidine and spermine dominated both in flower buds and flowers in the low abscising cv. Arka Gaurav. At 35/25°C, the IAA content declined and ethylene production, ACC content and ACC-oxidase activity increased both in flower



buds and flowers as compared to 25/20°C; the effect being more drastic in high abscising cv. Arka Mohini. Also at high temperature, the flowers recorded low IAA but high ACC content and the flower buds higher ethylene production and ACC-oxidase activity in both the cultivars. The soluble proteins in the flowers registered a decline, with high abscising Arka Mohini showing greater decline than the low abscising Arka Gaurav. The high temperature exposure also led to induction of Hsps 60, 70 and 90 in the flowers of both cultivars, with the induction Hsps, 70 and 90 KDa being prominent in the low abscising cv. Arka Gaurav. These results implicate that the abscission of reproductive organs in capsicum under high temperature is associated with increased biosynthesis of ethylene and putrescine accumulation concomitant with decline in IAA. It is also evident that the induction of Hsps, 70 and 90 KDa contributed in down regulating the abscission of reproductive organs under high temperature.

03-12

IMPLICATION OF ANTIOXIDANT REGULATION IN FLOODING TOLERANCE RESPONSES OF RICE (*Oryza sativa* L.) CULTIVARS

R.K. Upadhyay* and S.K. Panda

Department of Life Science, School of Life Sciences, Assam Central University, Silchar-788 011

**rishik.upadhyay@rediffmail.com*

Flooding/Submergence stress is one of the most adverse factors on growth and productivity of rice plants. The physiological and biochemical responses of two rice cultivars were investigated under flooding stress for different duration. A uniform decrease in chlorophyll and carotenoid content was recorded in both the genotypes. The increase in activity of enzymic antioxidants involved in detoxification of the superoxide radical increased on re-aeration. Both the non-enzymic antioxidants, i.e., ascorbate and glutathione increased with increasing stress duration, acts as antioxidant substrates in the O₂⁻ detoxification systems on re-aeration.

03-13

SALTS AND ABA INDUCED PHYSIOLOGICAL CHANGES IN RICE VARIETIES AT VEGETATIVE AND FLOWERING STAGE

K.A. Kalariya and R.R. Shah

Department of Plant Biotechnology, Navsari Agricultural University, Navsari-396 450

Low water availability, which is considered main environmental factor limiting photosynthesis and consequently, plant growth and yield worldwide, is caused mainly by drought and salinity. Nearly 20% of the world's cultivated area and nearly half of the world's irrigated lands are affected by salinity (Zhu, J. K., 2001). Exogenous application of ABA can potentially protect crops from environmental stresses such as drought, chilling, salt, and heat (Abrams *et al.*, 1997). We evaluated various physiological parameters in three rice varieties for salt tolerance at different salinity levels in combination with or without foliar application of 0.1 mM ABA at vegetative and flowering stage. Salt treatment of 300 mM NaCl for 72 hours adversely affected photosynthesis, stomatal conductance, transpiration and RWC. All the rice varieties responded to ABA treatment in the way similar to salt stress for the photosynthetic rate, stomatal conductance and transpiration rate at both the stages. The adverse effect of salt was highest in variety Masuri at both the growth stage. 0.1 mM ABA spray had its highest influence on physiological parameters when incorporated with the highest salinity level.



03-14

EFFECT OF SEEDLING HEALTH AND PRE- TRANSPLANTING SEEDLING HANDLING FOR IMPROVEMENT OF SUBMERGENCE TOLERANCE AND YIELD OF LOWLAND RICE

P.N. Singh¹, A.H. Khan¹, S.P. Singh¹, O.P. Verma¹, R.K. Yadav¹, N. Singh¹, P.C. Ram¹, Basant Ram¹ and A. Ismial²

¹Centre of Advanced Studies, Dept. of Plant Physiology, N. D. University of Agriculture & Technology, Kumarganj, 224229, Faizabad, U.P.

²International Rice Research Institute, Philippines

Rainfed lowland is the second most important ecosystem after irrigated rice in India. Out of total rice area of 2.6 m ha in Eastern U.P., approximately 1.4 m ha is rainfed lowlands which are prone to submergence causing huge economic loss. The main reasons for low productivity in rice is the unfavorable and uncertain weather conditions even water depth generally ranges from 20-60 cm., but some time it reaches around 1m. The productivity of rainfed lowland rice is low an average around 1.0-1.5 t/ha which is higher than upland and deep water rice but much lower than that of irrigated eco-system. The experiment was conducted with three genotypes viz., NDR-9730018, NDR-9830099 and Mahsuri. Nursery was raised with low seed density (50g/m²) and high density (100g/m²) as per farmers practice. Nursery was uprooted at 30 DAS and transplanted at (1) Just after uprooting (2) 24 hr. of staking. Fifteen days after transplanting, plants were completely submerged for 15 days. Maximum survival of plants was recorded in NDR-9830099 (79.7%) and NDR-9730018 (63.7%) while lowest in Mahsuri (16.3%) in low seed density, transplanting just after uprooting as compared to 100g/m² which showed 66.5, 59.1 and 13.9% in NDR-9830099, NDR-9730018 and Mahsuri, respectively. On the other hand seedlings (seed density 50g/m²) transplanted after 24 hr staking survival per cent was maximum in NDR-9830099 (75%) followed by NDR-9730018 (56.4%) while minimum in Mahsuri (10.0%) as compared to 100g/m² possessing maximum in NDR-9830099 (62.7%) followed by NDR-9730018 (51.6%) and in Mahsuri (9.8%). Higher survival percent in 50g/m² seedling might be due to high biomass at the time of transplanting of seedling. Tolerant genotypes have lower elongation percent as compared to intolerant variety Mahsuri. Shoot biomass was noted after de-submergence in all the genotypes and maximum reduction was observed in Mahsuri while minimum in NDR-9730018. Seeding density of 50g/m² in nursery produced healthy seedlings which showed better establishment on planting and survival during submergence. Yield improvement of 15-20% was observed under 10-15 days of complete submergence.

03-15

STUDY ON EFFECT OF SALINITY ON IN VITRO GROWTH AND SOME PHYSIOLOGICAL PARAMETERS OF VARIOUS RICE (*Oryza Sativa* L.) CULTIVARS

Minal Wani, Snehal Pande and Ujjwal Fultambkar

Dr. D.Y. Patil Biotechnology and Bioinformatics Institute, Akurdi, Pune, Maharashtra
minal1412@gmail.com

Varieties of rice differ in their resistance to sodium chloride salinity. Comparative studies of salt tolerance in four cultivated varieties of *Oryza sativa* L. have been carried out. Rice cultivars Pawana, Indryani, Phule sumrudhi and Basmati were evaluated through in vitro germination study experiments. Germination study was done by arranging the seeds in petridishes in a medium supplemented with various concentrations of Sodium chloride i.e. 25, 50, 75 and 100 (mmol /lit) with five replications. Seeds in distilled water were treated as control. Germination percentage and traits including plumule length and radical length were measured. Five days grown seedlings were transferred to M. S. medium containing five salinity levels for further growth studies. Various physiological parameters like shoot length, root length, length of leaves and Number of leaves were



measured. Germination percentage was observed to be declining in cultivars Pawana and Indrayani as the salt concentration increases, where as Basmati 370 showed a decline followed by slight increase. Optimum germination percentage along with maximum length of plumule and radical was shown by Phule samrudhi even in higher salt concentrations used. Of the four cultivars studied cultivar Phule samrudhi exhibited highest shoot length, root length, length of leaves and number of leaves with increasing salt concentration. The present evaluation showed that rice cultivar Phule samrudhi exhibited highest salt tolerance during their early growth stages which was followed by Indrayani, Basmati 370 and Pawana respectively.

03-16

NITRIC OXIDE COUNTERACTS THE INHIBITORY EFFECTS OF SALINITY IN CHICKPEA LEAVES

Anita Kumari, Sunita Sheokand and Sukham Madaan

Dept. of Botany and Plant Physiology, CCS HAU, Hisar, Haryana

Nitric oxide (NO) is a bioactive molecule which in plants has been found to function as peroxidant as well as an antioxidant. In this work, we evaluated the protective effect of NO donor sodium nitroprusside (SNP, 500 μM) on salinity (6 dSm^{-1}) induced toxicity in HC-3 leaves. Salt stress resulted in oxidative stress as was evident from increased reactive oxygen species (ROS) and hydrogen peroxide (H_2O_2) content. A substantial increase in membrane injury and lipid peroxidation was also observed with salt treatments. SNP supplementation to salt stress treated plants decreased ROS, H_2O_2 content, membrane injury and lipid peroxidation and this was confirmed by using NO scavenger (c-PTIO). Salt stress induced the antioxidant defence system by increasing the activities of antioxidant enzymes, Ascorbate peroxidase (APX), Superoxide dismutase (SOD), Catalase (CAT), Peroxidase (POX), Glutathione reductase (GR), Dehydroascorbate reductase (DHAR) and Monodehydroascorbate reductase (MDHAR). SNP treatments further increased the activity. The ascorbate redox ratio (ASC/DHA) decreased with salt stress. SNP exerted a positive effect by increasing the total ascorbate content and the ascorbate redox (ASC/DHA) ratio. The same trend was observed with glutathione under salt and salt + SNP treatments. NO scavenger (c-PTIO) treatments reversed the effects of SNP treatments. Salt stress adversely affected the DW of all plant parts at maturity and significantly decreased the seed yield. NO partially alleviated the adverse effect of salinity on seed yield. Thus, it can be concluded that NO acts as an antioxidant under salt stress. The positive effect of SNP on plant biomass and seed yield under Cd and salt stress could be attributed to the fact that NO acts as a growth regulator. The fourth experiment constituted of pot culture house studies on the effect of salinity (6 dSm^{-1}) on chickpea leaves and the adaptive responses induced by NO (SNP, 500 μM). Thus, it can be concluded that NO acts as an antioxidant under both salt and heavy metal stress. The positive effect of SNP on plant biomass and seed yield under Cd and salt stress could be attributed to the fact that NO acts as a growth regulator.

03-17

CHOLINE AND BETAINES ACCUMULATION IN SOME LEGUMINOUS PLANTS DURING FIELD SALINITY STRESS

K.A.Varshney, Gaurav Shukla and V.K. Gupta

*Plant Physiology and Biochemistry Section, P.G. Department of Botany, Bareilly College, Bareilly – 243005
nkvarshney87@rediffmail.com*

This study examined the synthesis and accumulation of quaternary ammonium compounds like choline and betaine in certain leguminous plants in relation to field salinity stress. It was observed that both the aforesaid organic metabolites compared their accumulation fairly well under salinity stress. The choline showed its



accumulation in ascending order as berseem < groundnut < soybean < cowpea < lentil < chickpea < garden pea while betaine demonstrated more or less identical trend as berseem < lentil < chickpea < cowpea < groundnut < soybean < garden pea. The maximum choline and betaine concentrations (26.4 and $54.0 \mu\text{gg}^{-1}$ dry wt.), attained by garden pea leaves, were twice that recorded in berseem leaves. These results are consistent with an adaptive response for choline and betaine accumulation in leguminous plants during salinity episodes.

03-18

EFFECT OF SODIUM CHLORIDE SALINITY ON PHOTOSYNTHESIS, STOMATAL MOVEMENT AND ANTIOXIDANTS IN YOUNG SAPLINGS OF BER (*Ziziphus mauritiana* L.)

A.K. Purohit, Ritu Agrawal and N.K. Gupta

Academic Staff College, Rajasthan Agricultural University, Bikaner-334006
contactarvind1649@rediffmail.com

An experiment was conducted to study the effect of saline water (ECe 0. 4.0, 8.0, 12.0 and 16.0 as NaCl) on gas exchange, transpiration, stomatal conductance, oxidative injury and activities of anti-oxidative enzymes in young sapling of ber (cv. Gola and Umran) at 60, 10 and 180 days after budding. Results showed that there was a linear reduction in gas exchange, transpiration and stomatal conductance with increasing level of salinity. The deleterious effect was more pronounced after 12dSm^{-1} salinity in both the cultivars. Enhancement in hydrogen peroxide activity accumulation and lipid peroxidation (MDA content) with salinity was observed, particularly after 12dSm^{-1} salinity. Activities of antioxidants viz. superoxide dismutase, peroxidase and catalase were increased significantly under saline conditions. It seems that at cellular level, the *Ziziphus mauritiana* can tolerate the toxic effect of superoxide radicals and hydrogen peroxide by enhancing the antioxidant system.

03-19

TOLERANCE LIMIT OF *Spirulina Platensis* IN LINEAR ALKYL BENZENE SULFONATE POLLUTED WASTE WATER

Ajay, Javeed Ahmad Lone, J. K. Saha, S. Kundu and A. Subba Rao

Indian Institute of Soil Science, Bhopal, M.P.
ajay@iiss.ernet.in

Domestic detergents, carried by the urban wastewater, normally accumulates in the surface water bodies in most of the cities. One of the major chemical components of these detergents is Linear Alkyl Benzene Sulfonate (LAS) and accumulation of this chemical in water bodies may become toxic to aquatic flora and fauna. In the present study, the growth of a cyanobacterium *Spirulina platensis*, generally used as nutraceutical source of protein, was studied in CFTRI medium spiked with 5 levels of LAS (0,2,4,6,8 and 10 ppm). The growth of *Spirulina* was not affected upto 6 ppm of LAS rather there was gradual improvement in growth upto 6 ppm of LAS. Beyond 6ppm level of LAS, there was gradual decline in growth and reached minimum at 10 ppm level. At 6 ppm level of LAS, maximum biomass yield ($109.5 \text{ mg}/50\text{ml}$), protein ($587.5 \text{ mg}/\text{ml}$) and nitrate reductase activity ($79.2 \text{ NR MNO}_2 \text{ hr}^{-1}\text{g}^{-1}\text{FW}$) were observed. Maximum content of Carotenoid ($0.446 \text{ mg}/\text{g}$ FW) and Chlorophyll-a were observed at 2 and 4 ppm length of LAS. The result thus, showed that *Spirulina Platensis* is able to tolerate upto 6ppm of LAS in wastewater bodies.



03-20

EFFECT OF ENVIRONMENTAL STRESS ON SEED GERMINATION AND SEEDLING GROWTH OF RICE (*Oryza sativa* L.) WITH PARTICULAR REFERENCE TO BRPL EFFLUENT

Ranu Roy* and Champak Lal Boissya**

*Botany Department, Birjhora Mahavidyalaya, Bongaigaon- 783380, Assam

**Retd. Professor of Botany Department, Gauhati University, Assam
ranuroy_bng@rediffmail.com

Bongaigaon Refinery and Petrochemicals Limited (BRPL) is one of the largest Refinery in Assam. Its effluent possessed intensive oil pollution and thereby caused deleterious effect on soil and water qualities of the adjoining rice field of Dhaligaon area. An attempt was therefore made on 2002 to determine the effect of BRPL effluent on seed germination and seedling growth of rice plant. Effluent was collected from the source. Bora variety of rice (*Oryza sativa* L.) was selected to grow in this effluent. Physico-chemical parameters such as pH, temperature, DO, BOD, COD, conductivity, turbidity, TDS, TSS, Ca⁺⁺, Mg⁺⁺, nitrate nitrogen and oil and grease of the effluent were analyzed. Rice seeds were grown in different dilution of effluents. The investigation clearly revealed that BRPL effluent attributed to the delay, retard and decline rice seed germination. It was due to high pH, reduction of DO and increase of BOD and COD values in the effluent. Presence of large quantities of Ca⁺⁺, Mg⁺⁺, nitrate nitrogen and high oxygen demanding chemicals cause bio-toxicity to the germinating seeds. Seedling raised from seed grown up to 40% effluent exhibited greater shoot and root growth. Sufficient concentration higher than 40% retarded the growth of the seedlings. This differential raise in rice seedling growth might be due to the presence of nutrients viz. nitrogen, K⁺⁺, Ca⁺⁺, Mg⁺⁺ etc. in diluted (up to 40%) effluent in such concentrations which promoted the growth, while at higher concentrations, the nutrients impaired toxic effect resulting in inhibition of root and shoot growth.

03-21

GENETIC VARIABILITY FOR HEAT TOLERANCE IN CHICKPEA

Neeraj Kumar, A.S. Nandwal¹, Satish Kumar, V.S. Lather and R.S. Waldia

Pulses Section, Department of Plant Breeding, ¹Department of Botany and Plant Physiology, CCS Haryana Agricultural University, Hisar-125 004, Haryana
neeraj-k@hau.ernet.in

High temperature particularly during pod filling stage is a major factor affecting plant growth, development and productivity of chickpea in northern-western region of the country. High temperature (<35 °C) coupled with low humidity under late sown conditions proved detrimental to seed filling and with this objective an experiment was conducted with 115 chickpea genotypes for screening against high temperature tolerance by studying various morpho-physiological traits and seed yield attributes. High temperature stress was given by manipulation of sowing dates i.e under normal (November) and late (December) sown conditions. Observations for days to flowering, maturity, pod setting above 35 °C, canopy temperature depression (CTD), the difference between air and canopy temperature), seed yield attributes were recorded. CTD exhibited significant differences under both the environments. Under normal sown conditions, CTD values ranged from -2.9 to -7.2 °C in RSG-2 and GNG-146, respectively. Under late sown conditions, the CTD value was -1.8 °C in Vaibhava and was -4.8 °C in H-208. Genotypes namely GNG 663, Pusa 244, IPC 98 -12, CSG-8962, KWR-108, M2, JG-218, DCP 92-3, GNG 146, GCP-101, CSJD 844, RSG 973, Pusa 329, Dohad yellow, BGD 75, H04-57, BG 276, ICCV 4958 were identified thermo-insensitive and showed the maximum tolerance against heat stress with least variation for seed yield and heat susceptibility index (HSI) values less than 0.5. Genotypes namely, ICC 4958, HK 94-134 (HK-2) and Vaibhava showed higher seed yield and biological yield than their respective general mean under both the environments. Genotype, H03-56 showed early physiological maturity. Genotypes IPC 2000-45, Pusa-1053, IPC 92-39, JGG-1, C-235, GL 769, JG 74, SAKI-9516, GCP-105, Pusa-240 were identified as thermo-sensitive against heat stresses with HSI values more than 1.5.



03-22

ALLELOPATHIC STRESS OF ACACIA AURICULIFORMIS A. CUNN EX BENTH ON GERMINATION, SEEDLING GROWTH AND BIOMASS PRODUCTION OF THREE WEED SPECIES OF SURFACE VEGETATION

Karabi Goswami* and S.K. Sarma**

*Sl. Grade Lecturer, Cotton college, ** H.O.D of Botany, GU.

Acacia auriculiformis A.Cunn. ex Benth (Australian acacia-common name) is an exotic plant, used in social forestry for their vigorous growth, to reforest the continent and create an adequate supply of fuel and timber for rural communities under the augur of 'social forestry'. It seems to be completely unmindful that these fast growing exotic species which are used by Assam Social forestry Department can jeopardise the biological productivity, principally of arid regions, may be due to allelopathic properties. In this way, such plants have a deleterious effect on plant life of native understory vegetation, by restricting germination. Not only that it was observed that wild grasses are also not grow beneath social forestry plants, but some grasses can grow vigorously beneath other tree species. All effects of different leachates [different conc.] and possible phytotoxicity on germination, length of radicle, length of plumule and biomass production of *Axonopus compressus* (Sw) Beauv, *Cynodon dactylon* (Linnaeus) Persoon and *Paspalum conjugatum* were tested in the laboratory and their toxicity threshold levels were determined. Bioassays indicated that all effects were proportional to the concentration of leachates. The changes observed in biomass expression may indicate a biochemical alteration at the cellular level of the tested weeds. As air dried plant parts indicated the presence of the growth retarding factor that may be allelochemicals of great allelopathic implications, intensive kind of more research screening and survey for plantation of social forestry plants which are not deleterious for native understory vegetation species might be of great practical value.

03-23

HIGH TEMPERATURE INDUCED CHANGES IN ANTIOXIDANT, AMYLASE AND NITRATE REDUCTASE ENZYMES DURING GERMINATION IN INDIAN MUSTARD (*Brassica juncea* L.)

Maharaj Singh*, R. K. Gupta and J. S. Chauhan**

Directorate of Rapeseed-Mustard Research (formerly National Centre on Rapeseed-Mustard), Sewar,
Bharatpur-321303 (Rajasthan)
ms_nrcrm@yahoo.com

High temperature is the second most important stress next to drought, which can affect crop plants at any time and impose severe limitation on crop growth and development. The main adverse effects of this stress at the time of sowing are poor germination and seedling mortality resulting into poor crop stands and consequently seed yield. Of late, high temperature at the time of crop establishment has been increasingly becoming an important impediment in rapeseed-mustard cultivation. The problem is further aggravated in rainfed production system where monsoon cessation based early sowing is crucial for higher productivity. Anti oxidant enzymes provided possible defense mechanism to plants to protect cellular and sub cellular system from the antitoxic effects of heat induced active oxygen radicals. Information regarding possible role of anti-oxidant enzymes and other biochemical characters under high temperature stress in Indian mustard is scanty. Therefore, the present investigation was carried out under laboratory conditions during July-October 2008 with 10 genotypes of Indian mustard (*Brassica juncea*) to study the high temperature induced changes during germination in carbohydrates, activities of peroxidase, superoxide dismutase (SOD), amylase and nitrate reductase enzymes. The temperature regime significantly affected all the characters studied. The genotypes x temperature interaction effects were significant only for germination and peroxidase activity. Increased temperature promoted the SOD and peroxidase



but decreased nitrate reductase and amylase activities. Decline in the carbohydrates utilization in seeds limited by reduced amylase activity might have led to reduced germination. Germination exhibited positive and significant relationship with the activities of amylase ($r = 0.392^{**}$), nitrate reductase ($r = 0.265^*$) and peroxidase ($r = 0.506^{**}$) under high temperature regime. The regression analysis revealed that under high temperature regime, peroxidase and amylase enzyme activities were important contributors to germination accounting for 24.4% and 14.5%, respectively, of the total variability in seed germination.

03-24

BIOINDICATION OF ACID RAIN BY TERRICOLOUS MOSSES

Bhagawan Bharali¹ and J. Efferey W. Bates²

Division of Biological Sciences, Imperial College of Science, Technology and Medicine, Silwood Park
Campus, London SL5 7PY, UK

¹b.bharali33@rocketmail.com, ²j.bates@imperial.ac.uk

Present address of the corresponding author: SRS, Buralikson Assam Agricultural University, Baruah
Bamungaon, Golaghat-785618 Assam

The bio-indication of acid rain was studied with net photosynthesis (P^n) of two terricolous mosses (*Pleurozium scheriberi* and (*Rhytidiadelphus triquetru*), collected from acid and calcareous habitats respectively. Simulated acid rains (pH 3.0, 2.5, 2.0) were employed for 30 minutes to incubate the moss shoots, which were isolated from their native substratum. The over all depression of the P^n was directly proportional to the acidity of the rain solution for both the species. The hypothesis was that the metal ions absorbed by mosses from the underlying sub-stratum, may ameliorate the adverse effects of acid rain on the terricolous mosses *P. scheriberi* and *R. triquetru* were also cultivated on artificial substrata (calcareous, acid-mineral and organic acid) with weekly spraying of simulated acid rain solutions of pH 3.0 for 50 d. The substratum type showed significant effects on cation distribution in the cellular locations of the mosses, and the absorbed cations nullified the effects of acid rain on P^n . Calcium ions were found more in both the moss species grown on calcareous substratum, while iron was increased significantly in the tissues of the mosses growing on acid-mineral substratum. The influences of these cations on possible buffering of rain acidity and photosynthetic sensitivity to simulated acid rain, have been interpreted here.

03-25

SEEDLING GROWTH OF ASSAM RICE UNDER LOW TEMPERATURE STRESS

D. Dutta, S. Baishya, K. K. Sharma and P. K. Pathak*

*Principal Scientist, Department of Plant Breeding and Genetics, AAU, Jorhat 785013, Assam
pathakpk_aau@yahoo.co.in

Low temperature induced injury, slow growth and prolongation of duration are some of the serious problems of *boro* rice cultivation in Assam and other eastern states of India. Stunted seedling growth makes transplanting of rice during the *boro* season a difficult task. Therefore, any variety to be ideally fitted to the *boro* rice season must have desired degree of cold tolerance, particularly, in terms of vigorous seedling growth. In the present study, a set of rice varieties, randomly drawn from the rice germplasm stock of about 2000 varieties conserved in Assam Agricultural University, was evaluated for their seedling growth under low temperature stress. Several varieties, both modern and traditional, distributed across different classes and sub-classes of the Assam rice germplasm, exhibited desired degree of tolerance to low temperature stress measured in terms of seedling growth. In the study, the traditional *boro* rice varieties recorded better seedling growth compared to those belonging to the other classes and sub-classes barring a very few exceptions like Sial Sali, Hati Sali etc. Both genotypic and phenotypic coefficients of variation were relatively low for the seedling growth parameters but the estimates of heritability and genetic advance were generally high for the parameters.



03-26

SELECTION OF RICE GENOTYPES FOR WATER LOGGED SITUATION OF ASSAM

T. Ahmed, A. Roy, P.C. Dey, B. Haloi and S.K. Chetia

Regional Agricultural Research Station, Titabar-785 630

Rainfed low land rice is generally affected by flash flood or water logging in Assam. Generally, water stagnates in relatively low lying areas from the time of transplanting of rice crop. The area affected due to water stagnation is to the tune of more than one lakh hectare in Assam. Farmers of such areas generally cultivate traditional varieties, the productivity of which are very low. To develop high yielding rice varieties tolerant to water logged situation, a hybridization programme was initiated. From this programme, forty advanced breeding lines were developed at RARS, Titabar from the crosses IET 6987 X Aki Sali, IET 6987 X Mugi Sali, Kmj 1-19-1 X Mugi Sali, Kmj 1-17-2 X Aki Sali, Kmj 1-17-2 X IET 10016, Kmj 1-19-1 X IET 10016, Kmj 1-17-2 X Herapoasali were evaluated with a view to select the promising lines having physiologically efficient traits. An experiment was carried out with the breeding lines during *Kharif* 2005 to 2007 for selection of high yielding genotypes for water logged situation. Selection of the genotype was done on the basis of important traits. Eight genotypes *viz.*, TTB 303-2-23, TTB 303-1-25, TTB 303-14, TTB 303-1-20, TTB 303-1-42, TTB 303-1-26, TTB 303-18-3, and TTB 303-5-9 were found promising on the basis of experimental results. The study revealed existence of considerable genetic variability for all the characters studied *viz.*, seedling height, mortality percentage, tillers/plant, plant height, days to flower, grain type, grains/panicle, sterility percentage, grain yield and harvest index. The On-Farm evaluation in the farmer's field as mother and baby trials had also being conducted during 2008 to confirm the results.

03-27

PHYSIO-GENETIC TOLERANCE POTENTIAL OF RICE GENOTYPES TO LOW TEMPERATURE STRESS

B.N. Medhi* and H.Borah

Professor, Deptt. of Plant Breeding and Genetics, BN College of Agriculture, Biswanath Chariali - 784176

Rice production and productivity have often been constrained by various environmental stresses. Low temperature stress causing cold injury of rice plant have, thus, been a major yield constraint of economic importance world wide-needing a matching solution by optimizing genotype-meteorological interaction in relation to cold stress. By nature of its evolutionary origin, rice is commercially grown in the tropical region. However, continuous production drive to meet the increasing demand for cereal food grains has compulsively pushed the rice cultivation across a wide latitudinal range, varying day lengths and seasonal temperature regimes. In some of the subtropical as well as the temperate countries of the Asiatic rice ecosystem weakly photo insensitive to photoperiod sensitive rice varieties have been cultivated wherein the length of the growing season is mainly limited by low temperature in early spring or late autumn. Physiological manifestation cold injury of 14 rice genotypes were assessed by parameters like failure in germination, slow seedling growth, prolonged life cycle, abnormality of meiosis and resultant grain sterility. Observed field sterility percentage and the microscopically assessed cytological abnormalities like abnormality of meiosis, pollen sterility and resultant grain sterility were observed to occur below the critical temperature from 16 to 20^o C with initiation of flower primordia to booting as the most susceptible stage. Promising rice genotypes *viz.* Tupaboro, Jungliboro, Begun velchi, BR-9 and Joymati displayed a fair degree of tolerance to cold injury indicating their genetic potential as promising breeding stocks for genetic upgradation of rice varieties with tolerance to cold stress.



Session 04

Physiological Basis of Plant Productivity, Crop Modeling and Sustainable Agriculture



04-01

CROP-WEED COMPETITION ON PHYTOTOXICITY RATING, WEED BIOMASS, YIELD AND YIELD COMPONENTS AND ECONOMICS IN CABBAGE

L. Jagadish, B.B. Channappagoudar, M.B. Chetti and Sanket Mane

Department of Crop physiology, University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted during *rabi* season to study the weed control efficiency in cabbage (*Brassica oleracea* var *Capitata*) under irrigated condition on Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The soil of the experiment site was a vertisol and clay in nature. The pre-emergent herbicides viz., alachlor, butachlor, metolachlor, pendimethalin, oxyfluorfen, oxadiargyl, trifluralin, clomozone were sprayed uniformly with high volume sprayer to the plot next day of transplanting. In the present study it was observed that the treatments with clomozone @ 0.75 kg ai ha⁻¹ registered significantly higher phytotoxicity effect as compared to other herbicides and the less phytotoxicity was found with the herbicides pendimethalin @ 1.0 kg ai ha⁻¹ and thus indicated that pendimethalin possesses less phytotoxicity ratings and is well suited for weed control in cabbage. The number of monocot weeds, dicot weeds and total number of weeds were found to be maximum in unweeded control and the herbicide treatment pendimethalin @ 1.0 kg ai ha⁻¹ and trifluralin @ 1.5 kg ai ha⁻¹ decreased these parameters to a greater extent. Among the various herbicides tried, pendimethalin @ 1.0 kg ai ha⁻¹ recorded the lowest dry matter followed by trifluralin @ 1.5 kg ai ha⁻¹ at all the stages of crop growth while, clomozone @ 0.75 kg ai ha⁻¹ was found least effective. The present study indicated that the yield determining component such as inner leaves per head, diameter of head and weight of the head was found to be lower in unweeded control. Among the herbicides, the application of pendimethalin @ 1.0 kg ai ha⁻¹ was found to be superior followed by trifluralin @ 1.5 kg ai ha⁻¹. The application of pendimethalin @ 1.0 kg ai ha⁻¹ resulted the lower values of weed index (4.83 %) compared to other treatments with maximum yield of 55.09 t/ha. This treatment also recorded the highest benefit: cost ratio (13.67).

04-02

GENOTYPIC VARIATION FOR MORPHOLOGICAL TRAITS AND DRY MATTER PARTITIONING IN RELATION TO SEED YIELD IN GREENGRAM (*Vigna radiata* L. WILCZEK)

Ratna Kinkor Goswami*¹, S.M. Hiremath², M.B. Chetti³, R.V. Koti⁴ and P.M. Salimath⁵

¹Associate Prof., Deptt. of Crop Physiology, BN College of Agriculture, Biswanath Chariali, Assam

²Prof., ³Prof. & Head, ⁴Prof., Depart. of Crop Physiology, Univ. of Agricultural Sci., Dharwad

⁵Prof. & Head, Deptt. of Genetics & Plant Breeding, University of Agricultural Sciences, Dharwad

A field experiment was conducted during *kharif* season with 20 greengram genotypes belonging to varying yield potentials under rainfed condition on vertisols of University of Agricultural Sciences, Dharwad, Karnataka. The genotypes selected for the study comprised of 6 high yielding genotypes, viz. M-446, M-100, M-1, TARM-18, Pusa-9071 and Co. 2-1; 6 medium yielding genotypes, viz. LM-421, Varsha, ML-4, LM-590, ML-3 and M-42; 6 low yielding genotypes, viz. M-123, LM 5-12, LM-641, Colco. LM-5, LM-87 and Anjugan along with 2 checks, viz. China mung and Pusa baisakhi. The experiment was laid out in a randomized block design with three replications. The crops were grown following the recommended package of practices and timely plant protection measures were also adopted. Significant variations were observed among the genotypes with respect to the morphological traits, phenological parameters, dry matter production and partitioning pattern, yield components and seed yield. Among the morphological traits, number of primary branches, green leaves per plant and dry weight of root nodules were found significantly higher in high yielding genotypes, indicating



clearly the importance of these parameters in achieving higher productivity in greengram. The high yielding genotypes were found to possess higher leaf dry weight and total dry weight as compared to medium yielding, low yielding genotypes and checks. Among the genotypes, M-446 and M-100 were identified as morpho-physiologically superior genotypes, capable of producing more dry matter and its proper partitioning and coupled with higher productivity. These genotypes may be used as a genetic source for improvement of yield potential in greengram.

04-03

INFLUENCE OF SEEDLING AGE AND PLANTING TIME ON GROWTH AND FRUIT YIELD OF TOMATO CV. GUJ.TOMATO -1

A.D. Patel, B.N. Satodiya, B.R. Patel, S.B. Patel and Amarjeet Singh

Main Vegetables Research station Anand Agricultural University Anand, Gujarat

Tomato is an important vegetable crop grown through out the country next to potato. There is a wide gap exist between potential yield and actual yield in tomato crop. Therefore an experiment was carried out to study the influence of seedling age and planting time on growth and fruit yield of tomato. Total 12 treatment combinations comprised with three levels of seedling age (15th days, 21th days and 27th days old seedling) and four levels of transplanting time (i.e. 30th August, 15th Sept, 30th Sept, and 15th Octo.) in FRBD replicated thrice during *kharif* 2008 at M.V.R.S., Anand Agril. University, Anand. Differences among the various seedling age and transplanting time treatments were revealed significant for various parameters i.e. pl.ht., Branches/pl, fruit/pl. fruit weight and yield/pl etc. The maximum fruit yield was registered by the S1 (i.e. 15th day seedling age, 196.4 q/ha) and T1 (i.e. 30th August, 169.14 q/ha) respectively. However, interaction effect of S1xT1 recorded significantly the highest fruit yield of 210.08 q/ha, which remained at par with S1x T3 (207.41q/ha) and S1 xT2 (195.47q/ha). This might be due to synergist effect of seedling age and environment, which helped in enhancement of growth and yield of the tomato.

04-04

CALIBRATION AND VALIDATION OF CROP GROW-SOYBEAN MODEL FOR SIMULATION OF GROWTH, DEVELOPMENT AND YIELD OF SOYBEAN IN THE NORTH BANK PLAIN ZONE OF ASSAM

Prasanta Neog, J. Bhuyan, Bipul Deka, K.K. Singh* and A.K. Baxla*

BN College of Agriculture, AAU, Biswanath Chariali- 784176, Sonitpur, Assam

**National Centre for Medium Range weather Forecasting, Mausam Bhavan Complex, Lodi Road, New Delhi-110003*

Field experiment was conducted on sandy loam soils of farm area of BN College of Agriculture, AAU, Assam with two varieties *viz.* JS -97-52 and Bragg for two consecutive *kharif* seasons (2005 and 2006) with three dates of sowing of Soybean following recommended agronomic practices. The number of days took to attain different phenological events *viz.*-First flower appearance, Physiological maturity' etc as well as seed yield and total above ground biomass at maturity of both the varieties grown at different seasons and sowing dates were recorded. Attempt was made to calibrate the CROPGROW-Soybean model with four data sets of the crop data generated during all three sowings during first crop season and the first sowing during second crop season. The calibrated model was validated with two data sets generated during second and third sowings during the second crop season for both the cultivars. The deviation of observed and predicted days to different phenological events as well as biomass and seed yield was within the acceptable limit of $\pm 10\%$.



04-05

BIODEGRADATION OF SUBSTRATES DURING MUSHROOM GROWTH AND POSSIBILITY OF ITS RECYCLING

A. J. Bora, A. M. Baruah* and S. Baishya*

Department of Agricultural Biotechnology, *Department of Agricultural Biochemistry

Popularity of oyster mushroom is increasing for its ease of cultivation, high yield potential, high nutritional value and its ability to grow and fructify on cheap organic wastes. For making the mushroom industry an environmental friendly undertaking, the spent mushroom substrate (SMS) is to be properly recycled. In this investigation, *Pleurotus sajor-caju* (Fr.) Singer was grown on two different substrates individually and in their blended forms, viz., rice straw (RS), Bamboo waste (BW), RS+BW @50:50, RS+BW @75:25 and RS+BW @25:75 to see the efficiency of the substrates and cellulolytic and lignolytic activity of the mushroom. The yield and biological efficiency of the mushroom was found highest in mushroom grown on RS+BW @75:25 while total soluble protein was highest in RS alone. The C:N ratio of the substrates was found reducing considerably and the cellulolytic and lignolytic activities of the mushroom was found varying with substrates. The SMS having C:N ratio in the range of 25-30 were found suitable as organic fertilizer for French bean indicating the efficiency of the SMS for recycling.

04-06

BIOCHEMICAL CHANGES WITH SPECIAL REFERENCE TO ANTIOXIDANT PROPERTIES IN DIFFERENT GROWTH STAGES OF MANGO FRUITS

V.K. Singh and A.K. Srivastava

Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow

The mango (*Mangifera indica* L.) is the largest subtropical fruit crop in India because of its attractive colour, delicious taste and excellent nutritional properties. Fruits of five commercial cultivars of mango viz. Amrapali, Chausa, Langra, Dashehari and Mallika were evaluated for total antioxidant activity, total phenolics (TSP), total tocopherol, carotenoid and flavonoids at various fruit development stages. Ferric reducing ability of plasma (FRAP) and 1,1 diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity assay were used to determine the total antioxidant activity. The FRAP value ranged from 4.07 to 8.83 mg AEAC/g fresh wt in different cultivars being maximum (8.83 mg AEAC/g fresh wt.) in Langra at fruit maturity. DPPH value showed similar trend at all stages of fruit development. Total phenolic, total tocopherol, carotenoids and flavonoids ranged from 0.94 to 11.17mg/g fresh wt, 41.02 to 236.82 µg/g fresh wt., 0.06 to 67.23 µg/g fresh wt. and 0.01 to 2.90 mg/g fresh wt., respectively among different cultivars. All the cultivar exhibited higher carotenoids value at maturity stage. But at early stage of fruit growth and development these showed negligible amount of carotenoids. However, higher carotenoid content at maturity stage did not show significant correlation ($r^2=0.29$) with total antioxidant value. On the other hand total antioxidant activity of fruits showed a strong correlation with total phenols ($r^2=0.5$) and least correlation with flavonoids ($r^2=0.1-0.8$). Narrower the difference between FRAP and other contributory compounds at maturity stage clearly depicted the higher antioxidative value of pulp.



04-07

**IMPACT OF ORGANIC FERTILIZERS ON QUALITY TRAITS OF AROMATIC RICE
GEETANJALI**

Sanjukta Das, S.G. Sharma, P. Bhattacharyya and A. Das

Central Rice Research Institute, Cuttack-6 (Orissa)

sanjuktacri@yahoo.com

A field experiment was conducted during Kh.08 with the long slender scented basmati rice Geetanjali to explore the possibility of improving the grain quality parameters through different organic manures. The organic treatments consisted of FYM, GM, FYM + GM, FYM + Azolla, crop residue (5 t/ha) + GM, Azolla + GM and crop residue (2.5 t/ha). The organic nutrients used in this study provided 60 kg N/ha. The treatments were compared with untreated control ($N_0P_0K_0$) and the recommended dose of chemical fertilizers ($N_{60}P_{40}K_{40}$). Rice grain analysis for quality traits showed a significant enhancement over control due to application of different organic fertilizers. The treatment FYM + Azolla gave highest head rice recovery (HRR %) percent (60%) followed by FYM and GM (58.5%) compared to chemical control (56.25%). Water uptake (WU) value considerably increased (145 ml/100gm) with the application of FYM + Azolla followed by FYM (140 ml/100gm) compared to control (110 ml/100gm). Alkali value was not affected by the treatments. Highest elongation ratio was observed in the treatment FYM + azolla. Amylose content was intermediate (24.49-25.31%) in all the treatments except chemical treatment, where it was slightly higher (26.48%). The amylopectin was highest (53.02%) in the treatment FYM. The starch content was significantly different among the treatments, highest starch content (77.80) was found in the treatment crop residue (2.5 t/ha) + GM. There was no adverse effect of treatments on grain aroma. The study revealed that the application of organic nutrients viz., FYM, and FYM + Azolla could improve the grain quality of organically grown long slender scented rice Geetanjali.

04-08

**DETERMINATION OF OPTIMUM HARVEST INDEX BASED ON PHYSICO-CHEMICAL
PROPERTIES OF PINK FLESHED PUMMELO FRUIT (*Citrus grandis* LINN.)**

J. Sharma, L. Saikia and P Mahanta

Department of Horticulture, Assam Agricultural University, Jorhat-13

An investigation was carried out in the Laboratory of food and Vegetable Processing Unit, Department of Horticulture, Assam Agricultural University, Jorhat to determine the optimum harvest index of pummelo fruit (pink flesh) (*Citrus grandis* Linn.). The fruits of pummelo (pink flesh) were analysed at 20 days interval, starting from 60 days after fruit set to 220 days for their physico-chemical properties. The results of the study revealed that physical parameters like fruit weight, fruit volume, fruit length, fruit diameter and volume of juice were increased significantly till 200 days. Rind thickness decreases till 200 days after fruit set and no specific trend were observed in seed number per fruit. However the biochemical constituents such as total soluble solids (TSS), reducing sugars, non-reducing sugars and the total sugars were increased significantly with the development of the fruit till 200 days after fruit set and declined thereafter. Highest TSS (11.10%), reducing sugar (3.38%), total sugar (6.67%), non-reducing sugar (3.29%) were obtained at 200 days after fruit set. From the results it can be concluded that pummelo (pink flesh) can be harvested at 200 days after fruit set when it develops good yellow colour, optimum nutritional and sensory qualities.



04-09

**PHYSIOLOGICAL ANALYSIS OF GROWTH AND YIELD VARIATION IN SUMMER
GROUNDNUT (*Arachis hypogaea* L.)**

S.N. Mate, Pallavi Jagtap and D.V. Deshmukh

Department of Agricultural Botany, MPKV, Rahuri-413 722, Dist.: Ahmednagar (M.S.)

Eighteen groundnut genotypes were evaluated for physiological analysis of growth and yield variation during summer 2008 at Cotton Improvement Project, M.P.K.V., Rahuri with two replications. The observations on dry matter production and its distribution in component parts of plants, growth parameters, vegetative growth and source, generative growth and sink capacity, physiological parameters and some chemical studies were recorded. It was observed that all the genotypes exhibited significant difference for dry matter of stem, pods, roots and total dry matter production per plant. AGR, RGR, NAR and LAR showed no definite trend of growth for all the genotypes. The values of these growth parameters increased between 60 and 80 DAS and declined thereafter towards maturity. Among the morphological characters such as plant height, number of branches and number of leaves were increased rapidly up to 100 DAS and declined thereafter. Leaf area and leaf area index (LAI) played an important role in maintaining high photosynthetic activity and ultimately productivity of the plant. The leaf area and LAI showed increasing trend up to 100 DAS and decreased thereafter. The genotypes, RHRGS-06083, RHRGS-06080 and JL-501 recorded highest pod yield was mainly due to favourable yield contributing characters like number of pods per plant, pod yield per plant, 100 kernel weight and harvest index. The genotype AK-159 recorded highest oil content while genotype JL-24 recorded highest protein content. The genotypes JL-24 and ICR-48 had maximum total chlorophyll and produced moderate pod yield.

04-10

**PHYSIOLOGICAL EFFICIENCY FOR GROWTH AND YIELD IN COWPEA (*Vigna unguiculata*
(L.) Walp.)**

S.N. Mate, Shubhangi Chavan and D.V. Deshmukh

Department of Agricultural Botany, MPKV, Rahuri-413 722, Dist.: Ahmednagar (M.S.)

Twelve cowpea genotypes were evaluated for physiological efficiency for growth and yield during *kharif* 2008 at Pulses Improvement Project, M.P.K.V., Rahuri, Dist. Ahmednagar (MS) with three replications. The observations on dry matter production and its distribution in component parts of plants, growth parameters, vegetative growth and source, generative growth and sink capacity, physiological parameters and some chemical studies were recorded. Partitioning of total dry matter and its distribution in vegetative and reproductive plant parts played an important role in yield determining processes. Studies on leaf area revealed that it is good for increasing photosynthetic efficiency of plant. The photosynthetic, transpiration rate and stomatal conductance were highest at 50 % flowering and decreases after 15 days of 50 % flowering. Whereas, water use efficiency increased from 50 % flowering to 15 days after 50 % flowering. The genotypes differed significantly for seed yield per plant. The highest yield was recorded by the genotypes, GC-3 (1514 kg/ha), C-152 (1500 kg/ha), PCP-0207-24 (1361 kg/ha) and Phule Pandhari (1277 kg/ha). The yield attributes namely, pod number per plant, grain number per pod and 100 grain weight appeared to be the most important characters to determine sink capacity. The highest protein content (24.50%) and vitamin 'C' (13.82mg/100 g) was maintained by the genotype Phule Pandhari and PCP-05010, respectively. Therefore, it concluded that the genotypes, GC-3, C-152, PCP-0207-24, Phule Pandhari and PCP-05010 may be considered as important sources for boosting up the breeding programme for yield improvement as well as protein and vitamin 'C' content.



04-11

MANAGEMENT OF LATE TRANSPLANTED SALI RICE UNDER LOWLAND SITUATION

K. Thakuria, S.S. Ashem and K. Kurmi

Department of Agronomy, Assam Agricultural University, Jorhat-785 013

A field experiment was conducted at the Instructional cum Research farm of Assam Agricultural University, Jorhat during *khariif* season of 2007 to study the effects of planting time, spacing and type of seedling on the growth and yield of late transplanted *khariif* (*Sali*) rice. The treatments comprised of three times of planting of rice variety Gitesh (10 September, 20 September and 30 September), two planting spacings (15 cm X 10 cm and 20 cm X 10 cm) and two types of seedlings (60 days nursery seedlings and 60 (30 + 30) days double planted seedlings). The experiment was laid out in split-plot design replicated thrice, keeping time of planting in main plot and combination of spacing and type of seedlings in sub-plot. The soil of the experimental site was sandy-loam in texture with acidic in reaction (pH 5.4), medium in organic carbon (0.64 %), and low in available N (269.69 kg/ha), available P (8.83 kg/ha) and available K (78.08 kg/ha). A uniform dose of fertilizers @ 40 – 20 - 20 kg N, P₂O₅ and K₂O /ha was applied 10 days after each transplanting date in the main field. The rainfall received during the period of experimentation was 937.2 mm distributed in 68 days. Results of the experiment revealed that grain and straw yields were significantly influenced by planting time, spacing and types of seedling. Among different planting times, planting on 10 September without significant difference with 20 September recorded the highest grain and straw yields of 29.13 and 66.28 q/ha, respectively. Delaying the planting date from 10 September to 30 September caused 29.2 per cent reduction in grain yield. All the yield attributing characters also recorded higher values on 10 September planting and decreased with delay in planting time. The closer spacing of 15 cm X 10 cm recorded higher yields as compared to wider spacing of 20 cm X 10 cm. The 60 days (30+ 30 days) double planted seedlings produced significantly higher grain and straw yields over 60 days nursery raised seedlings. The net return and benefit – cost ratio were found to be highest on 10 September planting with 60 days (30+ 30 days) double planted seedlings at 15 cm X 10 cm spacing.

04-12

INFLUENCE OF HERBICIDES ON PHYSIOLOGICAL AND BIOCHEMICAL PARAMETER IN BRINJAL

Sanket Mane, B.B. Channappagoudar, M.B. Chetti and Lalit Meena

Department of Crop Physiology, University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted at University of Agricultural Sciences, Dharwad during summer season under irrigated condition to know the influence of herbicides on weed control efficiency and to know the influence of herbicides on growth, yield, bio-physical and biochemical parameters in brinjal. The experiment was laid out in a randomized block design (RBD) with 12 treatments and 3 replications. The treatments comprised of 4 pre-emergence herbicides via Alachlor, Butachlor, Pendimethalin and Pretilachlor each at two concentrations and were compared with weed free check and unweeded control. The soil of the experimental plot was medium black. All the herbicides were applied immediately after the transplanting of brinjal. All the herbicides significantly reduced the weed biomass. Among the herbicides Pendimethalin @ 1.0 kg a.i./ha and Alachlor @ 1.0 kg a.i./ha were found more effective and recorded highest weed control efficiency without any phytotoxic effect on main crop. Morpho-physiological observations were recorded at 30, 60 days after transplanting and at harvest and the biophysical observations were recorded at 50 DAT. The highest plant height, number of leaves, leaf area index, canopy spread, numbers of branches, numbers of fruits per plant, fruit diameter and fruit weight per plant were recorded in weed free check followed by Pendimethalin @ 1.0 kg a.i./ha and Alachlor@1.0 kg a.i./ha. The



higher photosynthetic rate was recorded in Pendimethalin treatment (23.5 $\mu\text{mol}/\text{m}^2/\text{sec}$). The chlorophyll content and NARase activity was also noticed higher in weed free check, Pendimethalin @ 1.0 kg a.i./ha and Alachlor 1.0 kg a.i./ha. Highest yield of brinjal was recorded in weed free check (manual weeding) followed by Pendimethalin application @ 1.0 kg a.i. / ha.

04-13

REARING PERFORMANCE OF MUGA SILKWORM (*Antheraea assamensis*, Helfer) ACCESSIONS UNDER VARIED CLIMATIC CONDITIONS

Kartik Neog, R.K. Saha, B.N. Choudhury, D. Goswami, Sarat Saikia and R.K. Rajan

Central Muga Eri Research & Training Institute, Central Silk Board, Lahdoigarh, Jorhat-785700
kartik_neog@rediffmail.com

Twelve domesticated accessions of muga silkworm (*Antheraea assamensis*, Helfer) accessions collected from different locations of northeastern India were evaluated for their rearing performance under agro-climatic conditions of Jorhat, India. Two best performers were put into multi-locational trial at Lakhimpur and Mangaldoi areas of Assam, Tura in Meghalaya, Coochbehar and Kalimpong areas of West Bengal and their rearing performance recorded.

04-14

EVALUATION OF CHICKPEA (*CICER ARIETINUM* L.) GENOTYPES FOR PHENOPHASES, GROWTH, YIELD AND YIELD TRAITS UNDER NATURAL CONDITIONS

T.P. Singh¹, P.S. Deshmukh², Mohar Singh³, S.K. Sharma⁴, S.K. Mishra⁵ and Ranjan Das⁶

^{1,3,4,5} National Bureau of Plant Genetic Resources, Pusa New Delhi 110 012

² Division of Plant Physiology, IARI New Delhi 110 012

⁶ Crop Physiology, AAU Jorhat, Assam

More than 85% of chickpea is grown as rainfed crop mostly on the residual soil moisture after harvest of *kharif* crops. The crop is preferred under rainfed conditions because of its inbuilt capacity of higher yields and greater economic profitability. Environmental stresses represent the most limiting factors for agricultural productivity. Nowadays, a big concern is the water deficit, extremes in temperature and low atmospheric humidity leading to drought which is one of the most limiting factors for better performance and higher crop yield. In such conditions resistance to abiotic stress is becoming one of the most desired trait of crops. One of the prerequisites for successful breeding for drought tolerance is availability of reliable methods for screening of desirable genotypes. The aim of present study to screen the genotypes for higher drought and temperature tolerance. A field experiment was conducted during 2006-2007 at IARI, Research Farm with twelve diverse chickpea genotypes. The observations were recorded for various traits on the basis of data recorded the range of days to first flowering was 59 days (ICCV 88506) to 80 days (BGD-72), days to 50% flowering varies from 68 days (ICCV 88506) to 104 days (BGD72), days to first pod formation ranged from 84 days (ICCV 88506) to 120 days (BGD 112), days to physiological maturity ranged from 140 days (ICCV 88506 and Pusa 372) to 146 days (F6-51 and Pusa 1103), plant height varies from 42 cm (Pusa 372) to 82cm (Pusa 1108), number of primary branches ranged from 3 (BGD-112, F6-46) Pusa 1108 and Pusa 372) to 5 (F6 – 36 and Pusa 362), number of pods per plant 45 (F6-51) to 210 (Pusa 362), pod weight per plant 11.5 gm (F6-51) to 52 gm (Pusa 362), test weight varies from 10.2 gm (Pusa 372) to 29.8 gm (Pusa 1108), biomass per plant 25 gm (F6-51) to 92.5 gm (Pusa 362), seed yield per plant 8.7 gm (F6-51) to 38.5 gm (Pusa 362), harvest index 27.5% (F6-36) to 41.6% (Pusa 362), cold tolerance index varies from 1 (F6-36 and BGD-72) to 3 (BGD112, F6-46 and Pusa



1103), canopy temperature varies from 23.7 °C (ICCV 88506) to 26.6°C (F6-36), CATD varies from 1.7°C (F6-36) to 4.8°C (Pusa 1108). Further, it was concluded that ICCV 88506 and Pusa 372 genotypes were early maturing type and BGD-72, F6-51, F6-36, F6-46, Pusa 1103 and Pusa 1108 were late maturing genotypes. For most of the growth and yield traits, Pusa 362 was better than other genotypes studied and F6-51 had lower performance. Under resource limited conditions Pusa 362 was better than others. Genotype Pusa 362 can be used by farmers for enhancing the yield potential of chickpea. Furthermore, this genotype can be used in future crop breeding programme under changing environment.

04-15

RELATION BETWEEN HARVEST INDEX, GRAIN YIELD AND YIELD ATTRIBUTING CHARACTERS IN MUNGBEAN [*Vigna radiata* L. (WILCZEK)]

Pradeep Kumar, S. Singh and A.K. Singh

*Department of Crop Physiology, N.D. University of Agriculture and Technology, Kumarganj,
Faizabad-224229, UP*

Mungbean [*Vigna radiata* L. (Wilczek)] is one of the important pulse crop in India. It is excellent source of high quality protein. Its harvest index is very low due to poor fertilization, fruit setting and flower dropping. Therefore, keeping in view to find out the relation between harvest index, grain yield and yield attributing characters in different cultivars of mungbean. The present study was carried out during kharif season-2006 at experimental pot house of department of plant physiology, C.S.A. University of Agriculture and Technology, Kanpur. Results clearly indicated that maximum harvest index of 35.55 was obtained from variety K-851 followed by PDM-54 (32.81), Narendra Mung-1 (32.03), BDYR-1 (28.99), Pant Mung-1 (24.75) and Type-44 (22.30). All the yield parameters and yield were positively correlated with harvest index except the number of seeds per pod and 1000 seeds weight which were negatively correlated with harvest index. Significant positive correlations were noticed between harvest index, number of pods/plant, number of seeds/plant and seed yield/plant. However negative correlations were observed between harvest index and total dry matter.

04-16

RURAL WOMAN EMPOWERMENT THROUGH SELF HELP GROUPS IN UDAIPUR DISTRICT OF RAJASTHAN

M. Chargotra and Manish Kanwat

Deptt. of Agriculture Extension Education in MPUAT Rajasthan

Woman, who are the most potential human infrastructure of the countryside, are still invisible when country is being counted among the flourishing economies. Still a false view is prevailing that “everything has been done by men”. So the concept of empowerment comes into arena. Empowerment is a multifaceted process. It is simply gaining the power to make one’s choices heard to contribute to plans and decisions that affect one to use one’s expertise at the work to improve one’s performance and with it the performance of whole organization. Keeping this in mind the present investigation was carried out in the Udaipur District of Rajasthan with the objective to study the socio-economic and psychological profile of selected respondents, group formation and its development and the group performances in relation to decision making procedure. The findings exhibited that maximum respondents i.e. 60.34% were of middle age and 55.32% were illiterate besides, maximum number were labour (30.23%). Radio and the local head were the main source of information. Many of the households possess pig in small number. It was noticed that only those women who were affiliated with some SHGs were independent in nature on decision making. 68.32% respondents were found to have medium level decision



making ability. Widows and where husband's cooperation was negligible in house hold affairs were taking independent decisions. Further it was been found that majority (68.47%) of the respondents have fairly good reach to resources and they have the very high level of aspiration (78.91%) to increase their life style. Among the SHGs, about 62.32 % groups were in grade B groups and high level of group cohesion and confidence (54.28%) was also observed among group members. Therefore it can be concluded that only government can't be held responsible for empowerment and back position. Illiteracy is the major hindrance in the empowerment of women.

04-17

POPULATION TREND OF SCARAB BEETLES IN RELATION TO WEATHER PARAMETERS

Badal Bhattacharyya, Utpal Bhuyan, D. Pujari, A.A.L.H. Baruah, R.K. Saud and Jogesh Goswami
*AINP on White grubs and other soil arthropods, Department of Entomology, Assam Agricultural University,
Jorhat-785013, Assam*

The light trap study conducted in the Instructional Cum Research Farm, Assam Agricultural University, Jorhat during 2007 & 2008 revealed the presence of a wide array of scarab beetles. The light trap (pest-o-flush) was operated daily during the peak activity seasons of the beetles (March-September) and the number of beetles trapped was recorded. In both the years, the first appearance of the beetles was observed during the month of March and thereafter, their population increased gradually and the maximum numbers of beetles was trapped during July. However, the population was decreased from August onwards and the lowest population was recorded in the month of September. The correlation study between different weather parameters and the mean monthly population of scarab beetles showed a significant positive correlation with maximum and minimum temperature, evening relative humidity, total rainfall, numbers of rainy days and wind speed while negative significant correlation was observed with morning relative humidity and bright sun shine hours.

04-18

INCIDENCE OF *LEPIDIOTA MANSUETA* (BURMEISTER) IN RELATION TO SOIL CHARACTERISTICS OF MAJULI

Badal Bhattacharyya, M.C. Talukdar, Utpal Bhuyan, D. Pujari, A.A.L.H. Baruah, and R.K. Saud
*AINP on White grubs and other Soil Arthropods, Department of Entomology, Assam Agricultural University,
Jorhat-785013, Assam*

Lepidiota mansueta, a white grub species has been identified from Majuli, Assam as a severe key pest of potato, sugarcane, colocasia and many other field crops. Preliminary investigations showed that this species lean towards biennial life cycle which may be the first of its kind from North East India. Considering the severity of the problem, an attempt was made to investigate the incidence of this insect in relation to the soil characteristics of endemic villages of Majuli. Experimental results indicated that grub population of *L. mansueta* showed a positive significant correlation with silt content, organic carbon, P^H CEC, available Nitrogen, exchangeable Ca and Mg, whereas negative significant correlation was observed with sand content and bulk density of the soil. Furthermore, it was also observed that organic carbon content of soil and the thatch zone (dead grass stems and other organic debris) influenced the incidence of the grubs.



04-19

HOST PLANTS OF SCARAB BEETLES IN ASSAM

Utpal Bhuyan, Badal Bhattacharyya, D. Pujari, A.A.L.H. Baruah, R.K. Saud and Jogesh Goswami
*AINP on White grubs and other soil arthropods, Department of Entomology, Assam Agricultural University,
Jorhat-785013, Assam*

The term white grub is applied to the immature stage of scarab beetles which feed on the roots of many seedlings and older plants, reducing draught tolerance and thereby affecting final yield. The adult stages of white grubs are popularly known as cockchafers, leaf chafers or scarab beetles which generally come out of the soil during March-April (during premonsoon season) and immediately after their emergence they settled down in some specific host plants for feeding and reproduction. Therefore, a survey was conducted in the Instructional Cum Research Farm and Orchard of Assam Agricultural University, Jorhat during the peak activity seasons to study the host ranges of adult scarab beetles. The study revealed the presence of nine numbers of host plants viz., *Hibiscus mutabilis* (an important foraging plant of apiary), *Aquilaria malaccensis* (Agar tree), Ber (*Zyziphus jujuba*), Guava (*Psidium guajava*), *Terminalia chebula* (Silikha), Green gram (*Vigna mungo*), Jute (*Corchorus* sp), Rose (*Rosa chinensis*) and Soalu (*Litchea polyantha*). Out of all, *Hibiscus mutabilis*, *Rosa chinensis* and *Aquilaria malaccensis* were found to be the most proffered host plants. However, the detail study on morphological and biochemical analysis of the leaves of these plants will clarify the possible reasons of attraction of scarab beetles towards these plants.

04-20

STUDIES ON INTERCROPPING OF GREENGRAM (*Vigna radiata* L.) WITH UPLAND RICE (*Oryza sativa* L.) UNDER RAINFED CONDITION OF NAGALAND

H. Lwarence and T. Gohain

School of Agricultural Sciences & Rural Development (SASRD), Nagaland University, Medziphema-797106

An experiment was conducted during kharif season of 2007 at the research farm of School of Agricultural Sciences & Rural Development (SASRD), Nagaland University, Medziphema to evaluate performance of greengram (*Vigna radiata* L) with upland rice (*Oryza sativa* L) under rainfed condition of Nagaland. The experiment was conducted in RBD, replicated three times with seven treatments-T1-Pure rice, T2- Pure greengram, T3- Rice (100%) + Greengram (25%), T4- Rice (75%) + Greengram (25%), T5- Rice (50%) + Greengram (50%), T6- Rice (25%) + Greengram (75%), and T7- Rice (25%) + Greengram (100%) . Different growth and yield parameters were recorded to see the treatments effect. The results revealed that the plant height was not significantly increased with different treatment combinations of intercropping for both the crops. However, pure crop rice recorded maximum plant height (140cm) at 60 days after sowing. In case of greengram also highest plant height (58cm) was recorded in pure greengram plots. Numbers of tillers and number of effective tillers at maturity also recorded significantly higher in pure rice crop in compare to intercrop treatments. Similarly other factors such as number of panicle per running meter (54), length of panicle (43cm), number of grains per panicle (197), filled grains percentage (92) and finally grain yield (17q/ha) also recorded significantly higher in pure rice plots in compared to intercrop with greengram under different plant population . Whereas in case of greengram intercropping with rice recorded higher number of branches (2), number of pods/plant (4), length of pod (8cm), number of grains per pod (8) in compared to pure greengram plots. The findings of rice + greengram intercropping clearly visualized that rice greengram (4:1) seems to be appropriate planting geometry giving highest rice equivalent yield and land equivalent ratio. From economic point of view rice+greengram at 4:1 ratio was found to be superior as compared to other treatments and it gave maximum gross return (Rs.21200/-) and net return (Rs.15000/-).



04-21

EVALUATION OF BIO-EFFICACY OF UPH 707 AGAINST THE COMPLEX WEED FLORA IN GRAPES

S. D. Ramteke, Sandhya K. Dherange, Arun Suryavanshi, R. G. Somkuwar and P. G. Adsule

National Research Centre for Grapes (ICAR), P.B. No. 3, Manjri Farm P.O., Solapur Road, Pune - 412 307
sdramteke@yahoo.com, nrcgrape.mah@nic.in

A field experiment was conducted to evaluate the bio-efficacy of UPH 707 against the complex weed flora in grapes at research farm, NRC for Grapes, Pune during 2008-09. The experiment was laid out in analysed block design with six treatments replicated four times. The treatments included test chemical UPH-707 at 250, 500 and 750 g a.i. /ha dosages along with std check of paraquate dichloride at 500 g a.i. /ha. These were compared with weedy check and manually weeded check. The treatments were applied as post emergence directed inter-row spray at 2-3 leaf stage (22 days after pruning) of weeds in the vineyard. All the treatments significantly reduced the total number of weeds recorded at 15 and 30 days after treatment over untreated weedy check. The manually weeded plot recorded the minimum number of weeds per sq m (3.5, 4.5) and followed by the treatment of UPH 707 @ 750 g a.i. /ha (41.5, 29.0), which was found at par with the treatment of UPH 707 at 500 g a.i./ha (48.5, 44.0) and it was found more effective than std. Check of paraquat dichloride @ 500 g.a.i./ha (89.5, 89.0) at 15 and 30 days after application. No phytotoxic signs or symptoms viz. leaf tip/surface injury, wilting, vein clearing, necrosis, epinasty and/or hyponasty were observed at 1, 3, 7 and 15 days after treatment with test herbicide (UPH -707) at all the dosages including the higher dose of UPH 707 @ 1000 g a.i./ha.

04-22

PHENOLOGY, GROWING DEGREE DAYS AND REGRESSION MODEL OF WHEAT (*Triticum aestivum* L.) UNDER RICE (*Oryza sativa*) WHEAT CROPPING SYSTEM IN PUNJAB

D.S. Gill, Amandeep Kaur and Tilak Raj

Punjab Agricultural University, Ludhiana 141004, Punjab

Field experiment was conducted during the *rabi* season at Punjab Agricultural University, Ludhiana to study the relationship between phenology, thermal unit requirement (GDD) and to generate phenological growth model in wheat cultivars. The five wheat varieties namely PBW-502, PBW-343, WH-542, PBW-509 and Raj-3765 were sown at five dates at weekly intervals starting from 7th November. The crop sown on 7th November took more number of days from sowing to maturity (162 days) and the duration consistently reduced with subsequently delay in sowing. Late sowing reduced the duration of vegetative and reproductive growth phases by 20 days. The thermal units (GDD) accumulated to reach the physiological maturity from sowing ranged from 1918.2 to 1745.2 degree Celsius day and its maximum value recorded in earlier sowing i.e. 7 th November. A decreasing trend in accumulated growing degree-days (thermal units) with delay in sowing was noticed. Based on the phenological data for five date sowing dates and five wheat cultivars, the regression model was prepared indicating the relationship between grain yield, growth duration and growing degree -days accumulated during different phenophases. The model also indicated that growing degree-days (GDD) is the best index for screening thermo tolerance in wheat under late sown condition in Punjab.



04-23

**PHYSIOLOGICAL TRAITS FOR SCREENING THERMO TOLERANCE UNDER LATE SOWN
CONDITION IN WHEAT (*Triticum aestivum* L.) CULTIVARS**

D.S. Gill, Amandeep Kaur and Tilak Raj

Punjab Agricultural University, Ludhiana 141004 Punjab

Field experiment was conducted during the *rabi* season at Punjab Agricultural University, Ludhiana to find out suitable physiological traits for screening thermo tolerance in wheat varieties PBW-343, PBW-502, Raj-3765, WH-542, and PBW-509 were sown at different dates at weekly intervals starting from 1st week of November. The cv. PBW-343 had higher grain yield (51.44q/ha) due to its higher dry partitioning to spike at anthesis stage (0.31g), crop growth rate (CGR) after anthesis (6.75mg cm⁻² day⁻¹), number of spikes m⁻² (523.60), 1000-grain weight (33.01g) and chlorophyll content at milky stage (0.967mg g⁻¹ FW) followed by cv. WH-542. The path coefficient analysis showed significant positive co relationship between grain yield and physiological traits i.e. 1000-grain weight ($r = 0.9304$), partitioning to spikes at anthesis ($r = 0.8948$), biological yield ($r = 0.8922$), number of grains per spike ($r = 0.8351$) and number of effective tillers m⁻² ($r = 0.8323$). These results indicated that physiological traits like effective tillers, pre-anthesis dry matter production, partitioning to spike at anthesis, crop growth rate, number of grains per spike and chlorophyll content at milky stage can be used as an index for screening thermo tolerance in wheat cultivars.

04-24

PHYSIOLOGICAL AND YIELD EFFECTS OF ZERO BUDGET NATURAL FARMING

T.V. Shadakshari and Ramkrishna Muley

Sri Sri Institute of Agricultural sciences & Technology Trust, Art of Living International Ashram, Bangalore

Changes in agriculture policies started around 1960 in world during the green revolution, inducing farmers to be fully dependent on chemical fertilizers, Chemical pesticide and fungicide for crop production. The system of zero budget natural farming is eminently suited to the farmers particularly small and marginal farmers because of its simplicity, adoptability and drastic cut in cost of cultivation of crops. Zero budget natural farming techniques are not harmful to the environment since herbicides, insecticides, and fungicides, which may cause permanent damage to the earth, are not used. The appeal to the farming community lies in the fact that maintaining optimum levels of production and keeping the cost of cultivation to the bare minimum will substantially enlarge the profit margin. All the sample farmers acknowledged it as farmer friendly and financially viable. Natural farming rice retained proportionately more tillers and had a higher proportion of mature seeds than conventionally grown rice. Moreover, farmers claim that vegetables taste sweeter, are crispier and have shinier skins than conventionally grown vegetables, more bird species were found. However during the initial period of transition to new system, the results will not be encouraging because of the lingering effects of chemical farming. The results will become evident only after adequate mulching and restoration of biological activity in the soil. Hence, patience and perseverance are required on the part of farmers.



04-25

PRELIMINARY STUDIES ON THE PHYSIOLOGICAL EFFECT OF HOMA FARMING ON THE YIELD

T.V. Shadakshari and Ramkrishna Muley

Sri Sri Institute of Agricultural sciences & Technology Trust, Art of Living International Ashram, Bangalore

Agnihotra is a gift to humanity from ancient most Vedic sciences of bioenergy, medicine, agriculture and climate engineering. Agnihotra is the basic healing fire of Homa Therapy. Agnihotra is the process of purification of the atmosphere through the agency of fire prepared in a copper pyramid tuned to the biorhythm of sunrise/sunset. It is a method that can neutralize the effects of pollution on plants, animals and humans. All the spheres of life on this planet come into Harmony. The byproduct of homa farming called Agnihotra ash is obtained by burning dry cow dung, cow ghee and unbroken raw rice in an inverted copper pyramid plate at the time of sunrise and sunset with chanting specific Vedic mantras. It was believed that adoption of homa farming in agricultural field completely sterilized the environment and cleared the field from pathogens. Hence, an experiment was conducted to study the effect of foliar spraying of Agnihotra ash (500 gram of Agnihotra ash in 2.5 liter desi cow urine kept for three days for fermentation and dissolved in 25 liter of water). The treatments comprised of spraying of Agnihotra ash 5 times at 10 days interval, The fruits, vegetables and grains grown by this method are qualitatively better in texture, taste and size as compared to controlled farms where regular use of pesticides and fertilizers is done. Agnihotra atmosphere induces rapid seed germination. Agnihotra ash is an effective fertilizer.

04-26

EFFECT OF WEED MANAGEMENT ON GROWTH TRAITS AND PERFORMANCE OF SUNFLOWER

N.S. Renukaswamy and V.P. Chimmad

Department of Crop Physiology, University of Agricultural Sciences, Dharwad-580005, Karnataka

The early growth period is the most critical stage at which stress of any kind can affect the physiological growth parameters and in turn the economic yields of the crop. In sunflower, weed competition is one such important stress during this period. In this regard, a field trial was conducted during *kharif* season at main research station experimental farm, University of Agricultural Sciences, Dharwad. The experiment consisted of four pre-emergent herbicides such as Alachlor (2.0 l ha⁻¹), Metolachlor (1.50 l ha⁻¹), Clomazone (1.0 l ha⁻¹) and Pendimethalin (1.50 l ha⁻¹) and mixture of these herbicides with half of their concentrations. In addition, weed free check and un-weeded check were also included for comparison. The result revealed that among the herbicide treatments maximum increase in LA, LAI, LAD, AGR, CGR, RGR and NAR was observed in the Alachlor (1.0 l ha⁻¹) and Metolachlor (0.75 l ha⁻¹) combination during all the crop growth stages with lowest weed biomass of 106.90 kg ha⁻¹ and a weed index of 3.18% with highest weed control efficiency of 78.20%. The seed yield of sunflower was significantly higher (1277 kg ha⁻¹) with application of these herbicide combinations which was on-par with the seed yield of weed free check (1319 kg ha⁻¹). In unweeded check the weed biomass was 489.40 kg ha⁻¹ and weed index was 33.51 % which were significantly higher compared to herbicides treatment and the application of herbicides significantly increased the sunflower seed yield as compared to unweeded check (877 kg ha⁻¹).



04-27

DATE OF EMERGENCE: CRUCIAL FOR DOMINANCE AND GRAIN YIELD OF RICE TILLERS

Ekamber Kariali, Suprava Sahu, Padmini Pradhan and Pravat Kumar Mohapatra
School of Life Sciences, Sambalpur University, Jyotivihar, Sambalpur, 768019, Orissa

A large number of later-initiated tillers of semi-dwarf rice cultivars become either less- or un-productive at maturity. Rice cultivar Lalat was grown in pot in the botanical garden of the School of Life Sciences, Sambalpur University and also in the field at Regional Research and Technology Transfer Station, Chiplima during the wet season of 2004. The phenological and morphological development, assimilate contents and grain yield of the panicle of different categories of tillers were assessed in order to find out the bias against development of the less productive tillers. The order of dominance of the tillers decreased acropetally in both the conditions. In contrast to the field, the plant tillered profusely in pots. The duration of vegetative and reproductive periods of the late-initiated tillers were short as events like tiller emergence, booting and anthesis were delayed in them, but maturity date was more or less synchronized. Among tillers, grain yields and assimilate concentration decreased with durations of vegetative and reproductive growth. The concentration of soluble sugars was highest at anthesis and differed among the classes of tillers with lower concentration in the late-initiated tiller compared with the early-initiated tillers. Absence of late-tillers in the field-grown plants increased dominance of early-tillers and prompted higher partitioning of assimilates to panicle at crucial stages like booting and anthesis for benefit of grain yield. In contrast, the tillers emerged on later date in the profusely tillering potted plants possessed poor sink organogenesis and failed to use assimilates partitioned in their favour leading to poor grain yield. It is concluded that, time of tiller emergence is crucial factor for determination of apical dominance and grain yield of individual tillers in high yielding rice.

04-28

HOST PARASITE INTERACTION OF THE HEMI PARASITE *HELICANTHUS ELASTICA*

T. Girija, V.C. Vijaya and C.T. Abraham
College of Horticulture, KAU, Vellanikkara

Helicanthus elastica is the most devastating hemi parasite of the plains attacking nearly 40 host species. It is a major parasite of the plantation crops like Cocoa, Rubber, Cashew, Nutmeg, Clove and fruit trees like Mango, Sapota and Guava. It is an aerial branching parasite belonging to Loranthaceae which attaches to the host plant by means of haustoria. The parasite has multiple visible haustorial connection with the host plant. These haustorial connections described as epicautical roots (ERS) or runners (Bell, 1991) are secondary roots since they arise after the root pole of the embryo has formed the initial haustorium termed as the primary haustorium. Anatomical studies conducted at the College of Horticulture, Vellanikkara indicated that the haustorium is connected to the xylem of the host plant. Analysis of the leaf samples revealed that the parasite contained 1.12 % Nitrogen, 0.08 % Phosphorus and 0.11 % Potassium indicating that it is absorbing the nutrients from the host plant by means of the haustorial connections. The parasite reduces growth and vigour of the host plant and severe infestation leads to the death of the tree. *H. elastica* is dispersed by birds which feed on its fruit with a sticky layer. This leads to fast spread of the parasite in orchards and plantations. Sanitation of the orchards and plantations by regular removal of the infested branches is the only control measure currently available.



04-29

PHYSIOLOGICAL PARADIGMS IN THE UTILIZATION OF PLANT GENETIC RESOURCES FOR FOOD SECURITY

Neeta Singh

*National Bureau of Plant Genetic Resources, New Delhi-110012
neetasingh@nbpgr.ernet.in*

In order to be able to respond to imminent rapid changes in the global climatic pattern, sources of genetic variation to tackle novel environmental challenges will be required. Abiotic stresses arising from extremes of climate and soil deficiencies are major contributors to food insecurity. With enhanced capacity for genetic dissection of complex traits, and ability to conduct multidisciplinary plant improvement programs in target environments, the role of plant genetic resources has never been greater. Most crop species show considerable genetic variation in tolerance to the major climatic and chemical stresses. Physiological evaluation and characterization of genetic resources conserved in the gene bank is now one of the most important activities and will help to identify the useful genotypes to assist in development of crop varieties more appropriate for altered climates anticipated in future. A better understanding of sensitivity of genetic resources currently in the gene banks to climatic variables will help in identifying trait-based collection. An estimated 37% of germplasm available with different sources has been evaluated for some abiotic stress. Screening for drought tolerance, raised temperatures, salinity, and physiological effects of CO₂ i.e., enhanced photosynthetic rates on water availability and on pest, diseases and their vectors and the critical tolerance ranges of crop with respect to climatic factors to identify those adapted to projected climates is needed. Wild and weedy relatives of crops have been exploited as sources of desirable physiological traits like tolerance to drought, salinity, frost, heat, and acid sulphate soil, high biomass and yield in crops like *Oryza*, *Cajanus*, *Phaseolus*, *Cicer*, lentil, sesame and tomato. Similarly traditional varieties and landraces have been utilised as donors of many physiological traits in rice, sorghum, and chickpea. Several new crops have been introduced for traits like salt, drought and alkalinity tolerance and high seed protein content. Exotic germplasm of rice, barley wheat, groundnut, *Brassica*, chickpea, lentil, pea, soybean and green gram have been introduced by the National Bureau of Plant Genetic Resources (NBPGR) for desirable physiological traits like frost, drought, salinity, sodicity, heat and submergence and aluminium and iron toxicity tolerance, floral malformation, photoperiod insensitivity, photo thermo insensitivity, crop duration, non shattering nature, low chilling, high seed protein and oil content and several others. Promising germplasm has been identified by NBPGR for physiological traits in rice, wheat, maize, chickpea, soybean, tomato, brinjal, chillies, apple and pecan. Germplasm have been registered for drought, salinity, sodicity, heat and submergence tolerance, floral malformation, photoperiod insensitivity, photo thermo insensitivity, stay green trait, crop duration, fast early growth, extended grain filling, high leaf area, high HI, high yield, high protein and oil content, high beta carotene, low lignin and GA₃ content. Stress tolerant cultivars of crops have been developed using indigenous germplasm in rice, barley, urd, mung, chickpea, mustard, safflower, sunflower, groundnut, castor and linseed.



04-30

EFFECT OF DIFFERENT SOURCES OF RADIATION ON GERMINATION, PLANT GROWTH, YIELD AND YIELD ATTRIBUTING CHARACTERS OF NEW WHEAT PLANT TYPE OF WHEAT UNDER FIELD CONDITION

Ompal Singh and M.S. Kaim

Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi-110012

A low dose of gamma radiation has successfully been used to increase the yield of cereal crop by altering different morpho- physiological characters and biochemical activities of the plants. However, high doses of gamma radiation has been used to reduce pathogenic bacteria, eliminate parasites, decrease post harvest losses and to extend the shelf life of fresh perishable foods. To improve yield, it is imperative to increase number of tillers per ear, leaf or photosynthetic area, leaf biomass, number of grain per ear, total vegetative biomass, plant vigour, stem thickness, and number of spikelet per spike etc. It is possible that radiation particularly gamma radiation has a role to play in increasing the yield by improving morpho-physiological characters. The new plant type DL 1266-5 is reported to have more efficient mobilizes of the assimilates to the developing grain sink. However, it produces less number of productive tillers per plant. This means that DL 1266-5 is also efficient reservoir of nutrient as they produce limited number of synchronous tillers with thick stem and compact long ear heads. In order to study the effect of different source of radiation on morpho-physiological characters of new wheat plant type DL 1266-5, an experiment was conducted in field giving low doses of gamma radiation i.e. 0.02. 0.04. 0.06. 0.08 and 0.10 kGy, low intensity magnetic field for 1 hr and 0.04 kGy along with 100 mT for 1 hr . The treated seeds were grown in the field adopting the recommended practices of cultivation. The results showed that 0.04 kGy dose of gamma radiation was found most effective in increasing the germination %, Ps activity, biomass and yield. The 0.06 kGy dose of gamma radiation was found more effective in increasing the tiller number, stem thickness, harvest index, yields attributing characters and protein % than other doses of gamma radiation. Low intensity magnetic field (100 mT for 1 hr) was found more effective in increasing the germination %, biomass, tiller number and yield as compared to all doses of gamma radiation.. However, the additive effect of low dose (0.04 kGy) of gamma radiation and low intensity magnetic field (100 mT) for 1 hrs was not found effective in increasing any of these characters. The improved harvest index also support the above postulation and indicate a superior assimilate reserve accumulation and its mobilization to the developing grain sink so that very high number and improved grain weight resulting in a significantly higher grain weight per ear. These results indicate that low doses (0.04 – 0.06 kGy) of gamma radiation is most effective in increasing the yield by increasing morph-physiological characters particularly more tiller number in this genotype.

04-31

HOST PLANT MANAGEMENT TOWARDS SUSTAINABLE DEVELOPMENT OF MUGA CULTURE IN NORTHEAST INDIA

Urmimala Hazarika and P.K. Handique

Central Muga Eri Research & Training Institute, Central Silk Board, Lahdoigarh, Jorhat-785 700, Assam

Muga silkworm, *Antheraea assamensis* Helfer is a semi domesticated multivoltine species endemic to northeastern region of India and the pride of Assam. It is cultivated in the length and breadth of Assam and few other states of North Eastern Region of India for production of the precious muga silk. Nearly 30,000 families of the region are engaged in production of 117 MT muga raw silk annually. Assam and Meghalaya contributes about 98.0 % of production of the country and remaining 2.0 % comes from the other states like Arunachal Pradesh, Manipur, Nagaland and West Bengal. Among the different contributing factors for higher productivity of silk, production and quality of host plants play a major role. Though polyphagous in habit, it feeds primarily



on the leaves of Som (*Persea bombycina* Kost) and Soalu (*Litsaea monopetala* Roxb.). Practice of muga culture with the age old traditional system and cultivation & management of muga host plants without definite package of practices were the major bottlenecks in muga silk industry till 1980, since quality leaf production is the only means to enhance cocoon production. In recent years, intervention of improved technologies have increased leaf production from 14 MT to 20 MT per hectare per year and raw silk production from 45 MT in 1979-80 to 117 MT in 2007-08. Hence, refinement of technologies in certain strategic issues is very crucial and need to be considered to address suitably for solving the specific problems and to achieve the targeted production.

04-32

EFFECT OF CLIMATIC FACTORS ON GROWTH AND DEVELOPMENT OF *Pestalotiopsis disseminata* CAUSING GREY BLIGHT DISEASE OF MUGA FOOD PLANT SOM (*Persea bombycina*)

Ranjana Das and D.K. Jha*

Central Muga Eri Research & Training Institute, Lahdoigarh –785700, Jorhat, Assam

*Dept. of Botany, Gauhati University, Guwahati, Assam

Som, the primary food plant of muga silkworm, grows abundantly in northeastern region, where the conditions are not only favourable for the luxurious growth of the plants but also congenial for the growth of various pathogens. Thus the food plant is prone to various diseases that affect the quality and quantity of leaves and ultimately affect on cocoon yield. Grey blight is one of the major foliar diseases of som plant caused by *Pestalotiopsis disseminata*. Temperature, relative humidity, incubation period and leaf age play significant role on spore germination and germ tube development of *P. disseminata*. The spores germinated only at temperature from 15 to 30°C. The maximum spore germination and highest germ tubes length were recorded at 25°C. However, 75% relative humidity was ideal for conidial germination and germ tube development. The spore germination and growth of germ tube started 8 hours after incubation and gradually increased up to 18 hours. The percentage of spore germination was higher on the first four leaves and it decreased gradually as the age of leaf increased

04-33

REPRODUCTIVE PHYSIOLOGY OF MUGA SILKWORM (*Antheraea assamensis* Helfer) DURING DIFFERENT CROP SEASONS

K. Das, Ranjana Das and M. Chutia

Central Muga Eri Research & Training Institute (CMER&TI), Central Silk Board, Lahdoigarh, Jorhat-785700

A study was undertaken to observe the reproductive physiology of muga silkworm (*Antheraea assamensis* Helfer) in different crop seasons in respects of microclimate environment. The moth emergence, mating aptitude, oviposition behavior etc were significantly different in different crop seasons. The over all moth emergences and healthy moths were significantly higher during November (99.7%) and May (99.4%) and comparatively less number of moths emerged during September (85.6%) and July (82.7%) with maximum number of cripple moths (12.58%). Good numbers natural couplings were recorded during May (35.8%) and November (35.2%) crops, however very poor number were recorded during September (2.0%). Mechanical couplings percentage were maximum during September (12.5%) and July (10.3%). Similarly, higher numbers of average eggs laying was recorded in November (184.2±8.6) and July (179± 11.6) whereas less number was obtained during January (123.2±9.15) and July (119.8±8.3). The egg size and hatching percentage were comparatively maximum during November (2.9 mm and 89%) and May (2.8 mm and 88%) against July (2.4mm; 36%) and September (2.2mm; 39%) respectively. The results revealed that temperature and Relative humidity (RH) were significant dependent factors on reproductive physiology of muga silkworm. Due to optimum range of temperature and RH (21-31°C and 72-90%) during May and November, better moth emergence, natural couplings, oviposition, egg size and hatching percentage were recorded.



04-34

FORAGING BEHAVIOUR OF HONEYBEES, *APIS CERANA* ON CUCUMBER AND ITS INFLUENCE IN YIELD

N. Islam and M.K. Deka

Entomology Department, Assam Agricultural University, Jorhat-785013

The study on foraging behaviour of *Apis cerana* and its effect on fruit set and yield of cucumber conducted at Horticulture Orchard, AAU, Jorhat during 2006-07 and 2007-08 showed that bee visited the flowers right from 0700 to 1600 hrs although the peak period of their foraging activity was in between 0900-1000 hrs with 10.50±1.85 per minute and foraging of flower visit was 62.73±1.85 per minute. The maximum pollen (7.50mg/ trip) was collected during 0800-0900 hrs. The maximum fruit set was in Bee pollination 3 (BP3) treatments (18.35%) followed by BP2(17.80%). Similarly, BP3 treatment gave highest yield (74.10t/ha) followed by 71.79t/ ha in BP2 as compared to significant lowest yield (23.88t/ha) in Without Bee Pollination (WBP) treatment.

04-35

SCREENING OF WHEAT GERMPLASM FOR SPECIFIC PHYSIOLOGICAL TRAITS UNDER NATURAL ENVIRONMENTAL CONDITIONS

T.P. Singh¹, Pramod Kumar², S.K. Mishra³, Mohar Singh⁴, S.K. Sharma⁵, P.S. Deshmukh⁶ & Ranjan Das⁷

^{1,3,4,5}Germplasm Evaluation Division, NBPGR, New Delhi-110012

^{2,6}Division of Plant Physiology, IARI, New Delhi-110012

⁷Crop Physiology, Assam Agricultural University, Jorhat, Assam

Drought and temperature are the major abiotic stresses causing adverse effects on crop productivity and quality. Continual heat stress is a problem in about 7 mha, while terminal heat stress is a problem in about 40% of the irrigated wheat growing areas of the world in wheat. Physiological traits like membrane stability index, relative water content and chlorophyll content have also been suggested as simple selection criteria for stress tolerance in germplasm characterization and evaluation and future breeding programme. Keeping in mind the above constraints screening of wheat genotypes is useful to identifying heat tolerant genotypes. A field experiment was conducted at IARI, Research farm with 22 diverse wheat genotypes. The observations were recorded for membrane stability index, relative water content and chlorophyll content at flowering and anthesis stage. On the basis of data recorded the range of MSI was 33.95% (Lal Bhadur) to 58.94% (HD-1913) at flowering stage and 27.36% (Lal Bhadur) to 54.24% (HD-2913) at anthesis stage; relative water content ranged from 69.79% and 62.22% (K. Sona) to 90.24% and 79.79% (HD-2866) at flowering and anthesis stage. Total chlorophyll content ranged from 2.303 mg/g Fr.wt. (C-306) to 4.344 mg/g Fr.wt (Lal Bhadur) at flowering stage and 2.578 mg/g Fr.wt. (HD-2866) to 4.367 mg/g Fr.wt. (Lal Bhadur) at anthesis stage. The above results clearly indicated a wide range of variation in physiological traits under study. It was concluded that wheat genotypes HD-2913, HD-2866 and Lal Bhadur are least affected by heat and drought than other genotypes. Such genotypes can be used in wheat breeding programme for enhancing the yield potential and tolerance to heat under changing climate.



04-36

PHYSIOLOGICAL BASIS OF YIELD VARIATION OF RABI SORGHUM GENOTYPES UNDER MEDIUM AND SHALLOW SOIL

R. W. Bharud* and Vijaya P. Sonawane**

Department of Agricultural Botany, MPKV, Rahuri, Dist. Ahmednagar (M.S.) 413 722

**Professor of Plant Physiology and Cotton Breeder, ** M. Sc. (Agri.) Student*

The present investigation entitled “Physiological basis of yield variation of rabi sorghum genotypes under medium and shallow soil” were carried out at Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, dist. Ahmednagar (Maharashtra) during rabi, 2003-04. The experiment was laid out in randomized block design (RBD) on separate plots under medium and shallow soil with three replications involving eleven genotypes viz., CRS-1, CRS-4, CRS-6, PVR-57, PVR-577, PVR-578, RSP-1, RSP-2, RSLG-383, RSLG-241, IS-2312 alongwith three check variables viz., Phule Maulee, M-35-1 and CSV-216. The study revealed that the varieties differed significantly in respect of plant height, number of leaves, leaf area, leaf area index, dry matter production, grain yield per plant (g/plant), net plot yield (kg), and grain yield (q/ha), fodder yield per plant (g), per plot and per hectare (q/ha), total biomass (q/ha) and harvest index. The genotype RSLG-383 recorded higher grain yield on medium (14.75 q/ha) and shallow soil (11.41 q/ha) mainly due to lower stomatal frequency and chlorophyll stability index and higher relative leaf water content (RLWC). The genotype CSV-216 and RSLG-383 recorded higher heat unit efficiency for dry matter production and partitioning efficiency, number of grain per panicle, 1000 grain weight and harvest index. Therefore, it can be broadly concluded that there is large variability among the different genotypes of rabi sorghum for morpho-physiological and yield contributing characters. The genotypes RSLG-383 was found to be promising followed by PVR-577, RSP-1 and RSP-2 in the respect of morpho-physiological traits viz., leaf area, leaf area index, relative leaf water content, chlorophyll content, total dry matter production and its partitioning and major yield contributing characters especially number of grains per panicle, 1000 grain weight and harvest index. These genotypes can be further exploited in rabi sorghum crop improvement programme.

04-37

COMPETITIVE ABILITY AND ALLELOPATHIC POTENTIAL OF FIVE RICE CULTIVARS AGAINST WEEDS

S.K. Guru, Pratibha Singh and Alok Shukla

Department of Plant Physiology, G.B. Pant University of Agriculture and Technology, Pantnagar

skguru123@yahoo.com

The present study was conducted with an objective to evaluate the competitive ability of five rice cultivars against weeds. Field experiments were conducted during the rainy seasons of 2007 and 2008 at the Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar with five rice cultivars viz. Pant Dhan 18, Govind, Pusa 44, Pant Sugandha Dhan 15 and Pant Sugandha Dhan 17. The experiment was laid out in a split-plot design comprising of three replications with weed control methods as the main plot and cultivars as the sub-plot treatments. Among the five cultivars, Pant Dhan 18, Govind and Pusa 44 were found to be more competitive against weeds than the rest two cultivars. Vegetative vigour and biomass production at the early stages were found to be correlated with competitiveness whereas physiological growth parameters such as RGR, NAR, RLGR and RLAGR were poorly correlated with competitiveness. Estimation of phenolic acids through HPLC was done to estimate the allelopathic potential of the cultivars. Hydroquinone, *p*-hydroxy benzoic acid, vanillic acid, syringic acid and gallic acid were found to be the major phenolics present in rice roots which determine the allelopathic potential of the rice cultivars.



04-38

CHARACTERIZATION OF POTENTIAL EVAPOTRANSPIRATION IN ASSAM FOR PROPER PLANNING OF CROP

P. Gogoi Khanikar and K.K. Nath

*Department of Agrometeorology, Assam Agricultural University, Jorhat-785013, Assam
pgkhanikar@yahoo.co.in*

Potential evapotranspiration (PET) is the basic data for calculating crop water requirements which is a very important parameter for irrigation planning and management. From the long term climatological data of 22 years throughout Assam, potential evapotranspiration was calculated by modified Penman's method as given by Doorenbos and Pruitt. Monthly and seasonal distribution maps of this parameter were drawn throughout Assam. PET is the highest (130-150 mm) during the month of May and lowest (60 mm) in the month of December. In winter season PET lies in the range of 190-220 mm over the Brahmaputra Valley, while in the Barak Valley it ranges between 240-250 mm. The pre-monsoon PET varies between 340mm (lowest) from upper Assam to 450 mm (highest) in the Barak Valley. During monsoon season PET varies from a minimum value of 460 mm in the extreme NE part of the state to maximum of 530 mm in the central part of the state. Orography influences the distribution pattern of monsoon PET to some extent because rainshadow area shows a higher PET than that of the higher rainfall area. During post monsoon season, the PET varies between 175 mm to 210 mm. Thus these maps will indicate the water need of crop at different location which gives idea about irrigation scheduling and hence planning of crop in a particular location.

04-39

RELATIONSHIP BETWEEN LEAF NUMBER AND FRUIT DEVELOPMENT IN DIFFERENT MANGO CULTIVARS

V.K. Singh and A.K. Srivastava

Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow-227107

Mangoes have very low orchard efficiency in terms of commercial fruit production and many commercial cultivars tend to be alternate bearing. The study of fruit growth and development in mango, have a great potential for all round promotion of quality and quantity of fruits. The fruit growth is depends upon the leaf number and their area for utilization of carbohydrate, either currently produced or stored as reserve. The optimum leaf number required for normal fruit growth in different cultivars of mango viz. Amrapali, Chausa, Dashehari and Langra were studied by isolating individual fruits with known number of supporting leaves by shoot girdling at the time of panicle emergence. The ungirdled shoot served as control. Results showed the significant differences in the leaf area (249.01-1817.10 cm²), fresh (7.00-46.60 g) and dry (3.70-27.0 g) weights of leaves having 30, 20, 10 and 5 leaves shoot⁻¹ as compared to control (15.00 g). The panicle length, flowering and fruit set were also affected in evaluated cultivars except Chausa and Langra with 5 and 10 leaves, which did not differ significantly. Decrease in fruit setting was manifold when leaf number (shoot⁻¹) was reduced to 5 from 30. There was heavy fruit drop in girdled shoot having 5, 10 and 20 leaves. Panicle growth was also found affected with varying number of leaves and its length reduced from 28.25 to 19.05 cm in cv. Chausa when supporting leaves number was maintained to only 5 shoot⁻¹, however, a minimum reduction of 2.4% in fruit weight in Amrapali and maximum of 18.3% was recorded in Chausa. The difference in photosynthetic rate in leaves with its varying number per shoot was non-significant in different cultivars except Amrapali, where it decreased significantly in the shoots having 5 leaves (14.89 m mol CO₂ m⁻²s⁻¹) as compared to 30 leaves (17.88 m mol CO₂ m⁻²s⁻¹) and control (18.50 m mol CO₂ m⁻²s⁻¹). The data on the rate of photosynthesis in different pool size of leaves and fruit growth in girdled and non girdled shoots clearly show that fruit development depends not only on the current assimilate but also to a great extent on reserves.



04-40

LOW COST MEDIA FOR MICROTUBERIZATION IN POTATO CV. *Kufri Himalini*: AN INITIAL APPROACH FOR SUSTAINABLE AGRICULTURE IN THE HILLS OF WESTERN HIMALAYA

Anoop Badoni* and J. S. Chauhan

*Seed Biotechnology Laboratory, Department of Seed Science and Technology
H. N. B. Garhwal Central University, Srinagar (Garhwal), Uttarakhand, India*

**annabadoni@yahoo.co.in or badonianna@gmail.com*

The present investigation was undertaken in four steps namely establishment and bulk proliferation of shoots, microtuber induction, minituber production and quantification of carbohydrate in micro and minitubers. The most important attempts during the whole investigation were taken to make *in vitro* propagation protocol, cost effective by using economically cheaper alternatives to MS salts, agar and sucrose. MS (Murashige and Skoog) and Low cost media with different hormonal combinations of Kn (0.04, 0.06 and 0.08 mg/l) and IAA (0.50 mg/l) were used for shoot and root proliferation, multiplication and tuberization. In low cost media, tapioca was used as substitute of agar and replacing sucrose with cane sugar, because of low cost and easy availability. Calcium ammonium nitrate (6.6 gm/l), Single super phosphate (1 gm/l), Muriate of potash (10.6 gm/l) and cane sugar (30 gm/l) were used as low cost media in place of MS salts. Amongst the two media used for proliferation, the shoot height (14.73 cm), number of nodes (23.7) and root length (14.3 cm) were significantly higher in LC media with 0.04 mg/l Kn and 0.50 mg/l IAA hormonal combination, as compared to MS media after 80 days of growth. For tuberization, the MS media drawn cultures were exposed to 10 mg/l BAP and the LC media drawn cultures were exposed to the varying concentration of BAP i.e. from 5 mg/l to 15 mg/l. The yield, number of microtuber harvested/ flask, number of eyes/microtuber, size of each microtuber, fresh and dry weight and percent biomass of each microtuber from LC drawn media were significantly higher than those were recorded from MS media. After microtuber production in both MS and LC media, the harvested microtubers have been transplanted to the soil for minituber production. The maximum number of minitubers (12.4) was produced from microtubers of LC media in comparison to *in vitro* plants of both MS and LC media. The maximum yield of minituber (439.1 gm) was produced through microtubers of LC media. The maximum percent biomass have observed in the minituber produced from *in vitro* plant of MS media (36.42%). The analysis of carbohydrate was done in micro and minitubers produced by *in vitro* plant and microtuber of MS and LC media using Mc Ready method. Yet, no earlier reports were found related to carbohydrates analysis in micro as well as in minituber of potato cultivar *Kufri Himalini*. It has been observed that higher carbohydrate content was found in the microtuber produced from LC media, than MS media. The minitubers produced by both *in vitro* plant and microtuber of MS and LC media showed almost no variation in the carbohydrate content. The results obtained from the present investigation indicate that LC media was consistently better for shoot proliferation and tuberization in cultivar *Kufri Himalini*. From the present investigation, it is concluded that through reduction of the cost on the techniques, the cost of the product also be reduced and farmers get benefited using low cost, disease free and clonal planting material with high production and saving land resources.

04-41

EFFECT OF PLANTING TIME ON YIELD OF PATCHOULI

J. Das, K.K. Das, B.P. Gautam and H.Choudhury

*B.N. College of Agril., Assam Agricultural University, Biswanath Chariali, Sonitpur, Assam-784176
hemenchou@rediffmail.com*

The yield performance of Indonesian type of Patchouli cultivars were studied during 2003-04 at the experimental plot of B N College of Agriculture, Assam Agricultural University, Biswanath Chariali, Assam to



find out the most suitable planting time for Assam condition. The experiment was carried out in a Randomized Block Designed with three replications with the individual plot size of 10 sq. m. The healthy patchouli cuttings of 25 days old age were planted at 60 cm X 45cm spacing at 15 days interval starting from 30th May, 2003 to 10th May, 2004 as such there were 24 planting times and 72 experimental units. During the study the highest 25.30 q/ha and 5.70 q/ha fresh and dry herbage yield of patchouli respectively were recorded with 10th May planting whereas the lowest 3.70 q/ha and 0.83q/ha fresh and dry herbage yield of patchouli respectively were produced with 24th February planting. Moreover, the present investigation also revealed that significantly higher yield could be harvested if patchouli were planted during April to June. Then there was a gradual decline in fresh and dry yield of patchouli after June planting and February planting produced the lowest yield. Therefore, April to June could be suggested as the most suitable planting time for better yield performance of patchouli in Assam condition.

04-42

INFLUENCE OF TRANSPLANTING DATES ON TEMPERATURE AND HUMIDITY OF DIFFERENT PHENOLOGICAL AND YIELD TRAITS OF RICE

Arti Guhey, K.C. Patel and Kavita Agrawal

*Department of Plant Physiology, IGKV, Raipur-492006 (C.G.)
agravalkavita.2007@rediffmail.com*

Eighteen promising rice cultivars involving tall and semi dwarf were grown in different transplanting dates to expose the crop at varying temperature and humidity range. Experiment was mainly aimed with the major objectives to examine the effect of temperature on physiological, growth and yield traits of different cultivars. In general thermal stress reduces the flag leaf area, leaf angle, canopy temperature, relative water content, membrane stability index, apparent translocation rate and chlorophyll content in grains to varying extent in all the cultivars. Among the yield determining traits, high temperature possess penalty through reduced panicle length, seed yield per plant. Among the cultivars tested MR-185, Nippon bare, Shennong-89366 showed greater stability in growth and yield attributes and eventually recorded higher grain yield than those of others under varying transplanting dates and could be classified relatively more temperature tolerant cultivars for high temperature regions.

04-43

FEASIBILITY OF DRIP IRRIGATION WITH MULCHING IN CASTOR

G.J. Patel, A.S. Patel, R.A. Patel, S.U. Zala and R.P. Kacha

*Agriculture Research Station (Irrigated Crops), Aann Agricultural University, Thasra, (Gujarat)
girish_agri2005@yahoo.co.in*

Castor is one of the important cash crops with less risk and cultivated with limited water resources. Drip irrigation is one of the most efficient systems in delivering water for the plant. For improving the efficiency of irrigation, further drip irrigation in conjunction of with mulching is advocated. Mulching accelerating the plant growth by increasing soil temperature and establishing the soil moisture. The present investigation was taken with the objective to study the techno-economical feasibility of drip irrigation with mulch on growth and yield of the castor crop during 2005-06 to 2007-08 at Agricultural Research Station (for irrigated crop) A.A.U., Thasra (Gujarat). The Experiment was taken up in split plot design with the main plot irrigation regimes (Irrigation at IW/CPE ratio of 0.4, 0.6, 0.8 with Drip depth of irrigation 20mm and 0.8 with surface flood irrigation with depth of irrigation 60 mm) and in the sub plot, no mulch, Bland plastic mulch (50µ) and Paddy straw mulch (5 t ha⁻¹). Castor variety GCH-5 was sown with the Pair row planting (60x180)x 60 cm (Drip irrigation) and 120 x



60 cm Spacing under flood irrigation. The drip system of irrigation should be laid out at a lateral distance to 2.40 m (in pair row) and dripper (4.0 lph) spacing 0.60 m. The system should be operated at 1.2 kg f/cm² pressure. Among the irrigation treatments (0.8 IW/CPE drip irrigation) recorded higher plant height (140.3 cm), length of main spike (66.89cm), number of capsule per main spike (65.06), number of spike per plant (5.07), 100 seeds test weight (30.55 g.) and yield (2018 Kg ha⁻¹). While Black Plastic mulch treatment recorded highest plant height (130.06 cm), length of main spike (64.25cm), number of Spike per plant (3.91) and yield (1768 kg ha), However, it was remained at par with Paddy straw. Higher yield and net return (8.60%) were obtained with drip system of irrigation (0.8 IW/CPE ratio) laid out at a lateral distance of 2.40 m in pair row, and dripper (4.0 lph) Spacing 0.60m at on interval of 7 days during the crop period and 29 to 30 percent higher net profit with paddy straw and black plastic mulch.

04-44

EFFECT OF SQUARE REMOVAL ON COTTON GROWTH, YIELD AND FIBER QUALITY

H.S. Thakare, V. Kumar and Kirti Bardhan

Department of Crop Physiology, N.M. College of Agriculture, N.A.U., Navsari. 396 450
harish_0503@yahoo.co.in

A plant type with a good morphoframe would sustain more boll load with synchronous boll development and boll burst. In Bt cotton the plant *morphoframe* doesn't develop fully due to retention of early stage squares. Thus an attempt to improve Bt plant *morphoframe* through removing the early square, a *field experiment* was carried out at the Main Cotton Research Station, Navsari Agricultural University, Surat during the *Kharif* season of year 2008-09. Twenty treatments, consisting of five hybrids of Cotton (*viz.* RCH 2 Bt, JKCH 99 Bt, NCEH 2R Bt, Mallika Bt and non Bt G.Cot.Hy.10) and two concentration of Ethylene (*i.e.* 30 and 45 ppm at square initiation) and one time hand removal of squares besides untreated control in FRBD with three replications. The results indicated that the plants irrespective of hybrids, following square removal by 45 ppm Ethylene attained significant increase in plant height, number of fruiting forms, number of sympodia, boll weight, seed cotton yield and biomass. Square removal by hand was also found effective and mostly at par to Ethylene treatments for many of parameters. However, in case of fiber quality parameters, square removal treatments had adverse effect on uniformity ratio and maturity coefficient, yet it met transcribed norms of fiber quality. Thus, application of square removal by 45 ppm Ethylene or by hand significantly improved various growth and yield of Bt cotton with impairing fiber quality.

04-45

INTEGRATED CROP MANAGEMENT AND SYSTEM OF RICE INTENSIFICATION FOR PRODUCTIVITY ENHANCEMENT OF LOWLAND RICE IN NORTH EASTERN REGION OF INDIA

Anup Das¹, D.P. Patel¹, G.C. Munda², P.K. Ghosh², S.V. Ngachan³ and Badahunlang Wahlang⁴

¹Senior Scientist, ²Principal Scientist, ³Director, ⁴M. Sc (Ag) Scholar
ICAR Research Complex for NEH Region, Umiam -793 103, Meghalaya
anup_icar@yahoo.com

System of rice intensification (SRI - 10 days seedling, 1 seedling/hill, 25 x 25 cm) and integrated crop management (ICM - 20 days seedling, 2 seedling/hill, 20 x 20 cm) have potential to save inputs, protect the environment and could improve productivity and soil health. Field experiments were conducted during *kharif* seasons of 2005 to 2008 at ICAR Research Complex for NEH Region, Umiam, Meghalaya to study the effect of crop establishment methods and nutrient management practices on lowland rice (*Oryza sativa*). Higher values



of yield attributes i.e., number of panicles/hill, grains/panicle, panicle weight and test weight etc. were recorded in SRI followed by ICM rice culture. The root volume and dry weight were also significantly higher with SRI and ICM compared to conventional rice culture (CRC). Whereas, maximum grain yield (4.54 and 5.45 t/ha in 2005 and 2008, respectively) was recorded with ICM followed by SRI (4.38 and 5.29 t/ha in 2005 and 2008, respectively). The higher grain yield in ICM was mainly due to higher number of panicles/sq metre compared to SRI method. However, the grain, straw and total biomass recorded with SRI and ICM were at par with each other but remained statistically superior to CRC. Lowest grain yield (4.0 and 4.99 t/ha in 2005 and 2008, respectively) and straw yield was recorded under CRC. This was mainly due to poor growth and yield attributes under CRC compared to other two practices. Further, the rice under SRI matured about a fortnight earlier to CRC and about a week earlier to ICM. Among the nutrient management practices, application of 100% NPK (80:60:40kg /ha) + FYM @5t/ha recorded significantly higher yield (4.78 and 5.65 t/ha in 2005 and 2008 respectively) closely followed by 50% NPK + FYM @10 t/ha and remained at par with each other. An observational experiment was also conducted to study the effect of plant population (spacing) and rice productivity under various rice cultures. The result indicated that young seedlings (SRI) recorded higher yield under 20 x 20 cm spacing compared to 25x 25cm and 20 x 15cm.

04-46

PROMOTION OF VARIETALS ADOPTION OF RICE THROUGH FRONTLINE DEMONSTRATIONS IN THE NALBARI DISTRICT OF ASSAM

Ramani Kanta Thakuria

Krishi Vigyan Kendra, Assam agricultural University, Sariahtali, Assam, Pin- 781 337

Frontline demonstrations (FLDs) were conducted on farmer's field from 2004 to 2008 with the objective to accelerate the adoption of some promising rice varieties in the Nalbari district of Assam. The new varieties tested under FLDs were- Bishnuprasad, Jyotiprasad, Joymati, Kanaklata, NBR-1, NBR-2, NBR-3, Luit, Disang, Lachit, Chilarai, Piyali, Gitesh and Prafulla. The tested varieties with its recommended technologies resulted increased yield over that of local varieties to the extend of 13.0 to 56.52 per cent during summer and 14.78 to 46.0 per cent during winter (*kharif*). The extension gap for summer season varieties ranged from 5.70 to 13.50 qha⁻¹ and from 3.90 to 13.50 qha⁻¹ for winter. Technology gap for varieties were found in the range of 1.18 to 50.50 qha⁻¹ during summer and 32.10 to 44.70 qha⁻¹ during winter. Similarly, technology index showed quite a high range from 1.82 to 48.89 per cent for varieties during summer and from 42.67 to 56.0 per cent during winter. Overall, the results indicated scope for maximizing rice production in the district. Economic analyses also resulted high average net return due to the new varieties adoption from Rs. 2098.00 to Rs. 12,686.00 ha⁻¹ against the reduced net return values from (-) Rs. 3085.00 to Rs10,031.00 ha⁻¹ from check varieties during summer. During winter, the values of net return ranged from Rs2165.00 to Rs. 9595.00 ha⁻¹ for new varieties while Rs. 1540.00 to Rs. 4170.00 ha⁻¹ for the check. Benefit: Cost also showed the similar pattern.

04-47

SCREENING OF WHEAT (*Triticum aestivum* L.) GENOTYPES AGAINST LODGING RESISTANCE

Kiran P. Bhagat, R.K. Sairam, P.S. Deshmukh and S.R. Kushwaha

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Lodging in wheat cause serious losses in productivity, grain quality and harvest efficiency in India. To understand the lodging pattern with respect to morpho-physiological parameters, a field experiment was conducted at in field conditions at Indian Agricultural Research Institute, New Delhi during *rabi*, 2005-06 and laid out in randomized block design (RBD) with three replications. Twenty four wheat genotypes obtained from Directorate



of Wheat Research (DWR), Karnal were used for screening of lodging resistance. Results indicated that morpho-physiological parameters, viz., plant height and leaf area were significantly higher in tall genotypes as compared with medium-tall and semi-dwarf genotypes. The investigations also revealed that the stem breaking strength of lodging tolerant genotypes was significantly higher due to thicker stem and lower second inter-nodal length compared to susceptible genotypes. The stem breaking strength was directly related to the lodging resistant factor index (LRFI) and higher stem breaking strength contributed significantly towards holding up of strong sink potential. Thus, lodging in wheat is greatly influenced by the stem strength and LRFI. These two parameters along with plant height are vital consideration to accomplish the objective of getting lodging tolerant genotypes, which will also increase productivity potential in senescence non-limited conditions. However, different strategy is required to be adapted under late planting conditions.

04-48

HERITABILITY AND GENETIC ADVANCE STUDIES FOR MORPHOLOGICAL, BIO-CHEMICAL, RHIZOME YIELD AND QUALITY TRAITS AMONG THE ELITE TURMERIC (*Curcuma longa* L.) GENOTYPES

R. Jagadeesan*, M. Rajavel and B. Arthi Rani**

**Dept. of Spices and Plantation Crops, **Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu
rajavel1980@gmail.com, arthiagrmet@gmail.com*

Evaluation of fifty turmeric genotypes based on the morphological, biochemical and molecular characterization on yield and quality traits was carried out during cropping seasons of 2004 – 2006. The variability for morphological traits was found to be highly significant. The characters such as rhizome yield and girth of primary and secondary rhizomes had exhibited high heritability and genetic advance suggesting the additive gene action, which can be further used for the selection programme. The association analysis for yield and yield contributing traits demonstrated that all the biochemical traits other than the quality parameters namely essential oil content, oleoresin content, curcumin content and rhizome core ratio were considered for further breeding programme.

04-49

AN ASSESSMENT OF PHYSIOLOGICAL EFFECTS OF THE SYSTEM OF RICE INTENSIFICATION (SRI) COMPARED WITH RECOMMENDED RICE CULTIVATION PRACTICES

A.K. Thakur, Sreelata Rath, R.K. Mohanty and Ashwani Kumar

*Directorate of Water Management, Bhubaneswar-751023, Orissa
amod_wtcer@yahoo.com*

An evaluation study was conducted in eastern India to compare the performance of System of Rice Intensification (SRI) methods with recommended management practices (RMP). The overall aim was to understand the benefits in terms of yield and other physiological parameters, if any, of SRI management practices compared to RMP. SRI practices out yielded RMP by 42% and higher yield was associated with various phenotypical alterations with significant changes measured in physiological processes and in plant characteristics: longer panicles, more grains, and better grain-filling. Decreased plant density in SRI compensated by increasing per-plant productivity. The study revealed that SRI hills had deeper and better-distributed root systems, higher root exudation rates, a more open plant architecture with more erect and larger leaves, and larger tiller number than did RMP hills. Due to the reduction in number of hills m⁻² in SRI plots, no significant difference was found



in root dry weight, leaf number, tillers or panicle number on an area basis for SRI compared to RMP. Nevertheless, in spite of fewer hills per unit area under SRI and lesser tiller number, leaf area index (LAI) was greater with SRI practices due to larger leaf size, which resulted in more light interception. At ripening stage, the higher exudation rate in SRI plant roots resulted in higher leaf chlorophyll content (delayed senescence) and greater fluorescence efficiency (Fv/Fm and $\hat{O}PS$ II). This contributed to more efficient utilization of light and to a higher rate of photosynthesis which was responsible for the observed grain filling and for increase in grain size compared to RMP plants. The higher photosynthesis rate coupled with lower transpiration in SRI plants indicated that they used water more efficiently. Under RMP, older seedlings transplanted with closer spacing created both below- and above-ground competition that limited access to nutrients and solar energy. During the later stages of vegetative growth, these plants were unable to express their full growth potential. This probably contributed to their observed shorter panicle length, lesser grain number, higher percent of unfilled grains, smaller-sized grains, and finally resulted into yield reduction. The constraints observed in RMP plants were counterbalanced by SRI cultivation practices as single young seedlings having wider spacing and growing under unflooded soil conditions were able to produce more grain.

04-50

MORPHOLOGICAL CHARACTERIZATION OF GROUNDNUT CULTIVARS

A.A. Jadhav, S.N. Mate and V.R. Shelar

Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri 413722 (MS)

An effort was made to characterize fifteen groundnut cultivars on the basis of morphological characterization. The cultivars selected were from Virginia bunch (B-95, ICGV-86564, RHRG-12, TMV-10), Virginia runner (M-13) and Spanish (AK-159, ICGS-11, JL-24, JL-286, TAG-24, TG-17, TG-26, TG-42, TKG-19A and TPG-41). The characterization was done on the basis of seed, seedling, plant and flower characteristics. The semi erect plant growth habit was observed in ICGV-86564, JL-24, RHRG-12, TMV-10 and TPG-41, whereas only M-13 showed prostrate growth habit. The leaflet size of cultivars *viz.*, B-95, ICGS-11, M-13 and TG-26 was small, whereas it was large in JL-24 and TG-17. The leaflet colour of cultivars *viz.*, AK-159 and TG-26 was light green, whereas it was green in cultivars *viz.*, JL-24, JL-286, and TG-17. The obovate leaf shape was observed in cultivars *viz.*, AK-159, JL-24 and TG-26, whereas lanceolate shape was observed in cultivars *viz.*, ICGS-11, M-13, TAG-24, TG-17 and TMV-10. Green stem pigmentation was observed in cultivars *viz.*, ICGS-11, JL-24, M-13, RHRG-12, TG-26, TKG-19A and TMV-10, whereas in remaining cultivars it was purple. The cultivars *viz.*, AK-159, JL-24, JL-286, TG-42 and TMV-10 had simple inflorescence whereas in remaining cultivars it was multiple. The alternate flowering pattern on side branches at 50% flowering was observed in two cultivars *viz.*, ICGV-86564 and RHRG-12 whereas it was irregular in M-13 and TMV-10. Remaining cultivars showed sequential pattern of flowering. The peg colour was light purple in cultivars *viz.*, AK-159, ICGS-11, JL-24, JL-286, TG-26 and TPG-41, whereas in remaining cultivars it was purple. The pod constriction was deep in cultivar TPG-41, while in cultivars *viz.*, AK-159, B-95, JL-286, TG-26 and TMV-10 it was shallow. The pod reticulation was absent in cultivars *viz.*, ICGS-11, JL-24 and TG-26, whereas it was prominent in cultivars M-13, TG-17, TKG-19A. The prominent beak pod was observed in cultivars *viz.*, ICGV-86564, JL-24, JL-286, M-13, TG-17 and TPG-41. The TMV-10 was the only cultivar showed variegated kernel colour whereas remaining cultivars showed monochrome colour. It was concluded that the above cultivars can be distinguished from each other on one or the other morphological characteristics.



04-51

**GROWTH ANALYSIS STUDIES AND THEIR POSSIBLE USE IN SELECTION WORK IN
SAFFLOWER (*CARTHAMUS TINCTORIUS* L.)**

P.K. Ghosh¹, M.K. Majumder and S.P. Banerjee

*University College of Agriculture, Department of Plant Breeding, Calcutta University, 35, Ballygunge
Circular Road, Calcutta-700019, West Bengal.*

¹*CSB, CSR&TI, Berhampore-742101, District-Murshidabad, West Bengal*

An intensive investigation showed that some physiological growth parameters were determined for efficient selection work at early stages of crop growth in safflower (*Carthamus tinctorius* L.). Plant samples were taken three times at 15 days interval starting from 38 days of seeding. Results revealed significant genotypic differences in respect of Crop Growth rate (CGR) and Leaf area Index (LAI) between 38 and 53 days of seeding, whereas Net Assimilation Rate (NAR), Relative Growth Rate (RGR) and Specific Leaf Weight (SLW) gained in importance in the interval between 53 and 68 days. The magnitude of total correlation among and of direct effects of most of these growth parameters on seed yield were low and insignificant suggesting that dry matter accumulation at earliest stages of crop growth (before anthesis) would have little impact on seed yield. The object of the present investigation was found that the growth analysis indicates that leaf area was more effective in dry matter accumulation at the earliest stage of crop development while in the later stage both leaf area and leaf mass (SLW) played significant role in crop growth.

04-52

**EFFECT OF HERBICIDE (GERMOXONE) ON POLLEN GERMINATION AND TUBE LENGTH
OF STORED POLLEN OF APOCYNACEAE – A CRITICAL REVIEW**

S.A. Salgare

*Salgare Research Foundation Pvt. Ltd., Prathamesh Society, Shivaji Chowk, Karjat-401 201 (Maharashtra)
drsalgare@refiffmail.com & drsalgare@sancharnet.in*

Pollen of successive flowers (viz. F, F-24, F-48, F-72 series i.e. open flowers and the flower buds which require 24, 48, 72 hours to open respectively) of 5 cultivars of Apocynaceae e.g. red, pink and white-flowered cultivars of *Nerium odorum* Soland and pink- and white-flowered cultivars of *Catharanthus roseus* (L.) G. Don. Were collected soon after the dehiscence of anthers in the open flowers and stored at room temperature (22-31.8°C) having RH 57% and in diffuse laboratory light at the Department of Botany, Govt. Institute of Science, Mumbai. Germination of stored pollen grains of successive flowers was made soon after the dehiscence of anthers and with 2 hours intervals for the first 10 hours in the optimum concentrations of sucrose (acts as control) as well as in the optimum concentrations of sucrose supplemented with the optimum concentrations of Gramoxone. Observations were recorded 24 hours after incubation. For each experiment a random count of 200 grains was made to determine the percentage of pollen germination. For measurement of length of pollen tubes, 50 tubes were selected randomly and measured at a magnification of 100x. Potentiality of pollen germinability was recorded in F series of all the 5 cultivars of the Apocynaceae studied. It was the pollen of F-24 series of red-flowered cultivar of *Nerium odorum* and both the cultivars of *Catharanthus roseus* found germinated in the optimum concentrations of sucrose. It should be pointed out that the pollen of F-48 and F-72 series of pink-flowered cultivar of *C. roseus* showed their germination in the optimum concentrations of sucrose. Thus the potentiality of pollen germinability in Apocynaceae was observed in 10 out of 20 series investigated. Even the lowest concentration (10^{-17} mg/ml) of gramoxone tried suppressed the germination of pollen of F-72 series of pink-flowered cultivar of *Catharanthus roseus*. The herbicide stimulated the germination of pollen as well as tube length of the stored pollen.



04-53

CONSUMPTION AND UTILIZATION OF FOOD PLANTS BY *Spilactia obliqua* (Walker) LARVAE

Anjumoni Devee and S.K. Dutta

Deptt. of Entomology, Assam Agricultural University, Jorhat, Assam

A study on consumption and utilization of five different food plants viz., green gram, French bean, sunflower castor and maize by *Spilactia obliqua* (Walker) revealed that consumption index (CI), growth rate (GR), Approximate digestibility (AD), Efficiency of conversion of ingested food (ECI) and Efficiency of conversion of digested food (ECD) for IV, V and VI instar larvae were higher on greengram. Maize appeared to be the poorest food plant in respect of these parameters and indicates the suitability of greengram to *S. obliqua* and can be used as a trap crop in future IPM of the pest. Moreover, the CI, GR, and AD values gradually decreased and the ECI and ECD values gradually increased with age, irrespective of their food.

04-54

VARIABILITY AND CORRELATION STUDIES IN SUGARCANE (*Saccharum officinarum* L) UNDER RAINFED CONDITION OF NORTH EASTERN INDIA

G.C. Bora¹, K. Chandra and P.K. Goswami

Sugarcane Research Station, AAU, Buralikson, Golaghat – 785 618

¹Deptt. of Horticulture, AAU, Jorhat – 785 013, Assam

An investigation was conducted at the Sugarcane Research Station, Buralikson during 2005-06 and 2006-07 for variability and correlation in thirty one early and mid-late Sugarcane (*Saccharum officinarum* L) varieties for yield, yield component and quality characters under the rainfed conditions of Assam. The studies revealed moderate to high range of variation for all the characters studied except cane diameter and quality characters. The characters showing high genotypic and phenotypic variance, GCV and PCV, heritability with high genetic advance were NMC, cane height and single cane weight. The characters showing high and significant correlation with cane yield were NMC, germination (%), shoot count, cane length and single cane weight. Hence, these characters must be given importance while selecting sugarcane varieties for yield improvement. The sugar recovery had high and significant correlation with field brix and sucrose (%). Hence these two characters must be given importance for sugar recovery improvement.

04-55

A NOTE ON GENOTYPIC DIFFERENCES FOR WOOLY APHID TOLERANCE IN SUGARCANE (*Saccharum officinarum* L)

G.C. Bora¹, B. Bhattacharyya² and B. Bordoloi

Sugarcane Research Station, AAU, Buralikson, Golaghat – 785 618

¹Deptt. of Horticulture, ²Deptt. of Entomology, AAU, Jorhat – 785 013, Assam

An investigation was conducted to study the genotypic differences for wooly aphid tolerance in sugarcane at the Sugarcane Research Station, Buralikson, Assam during 2005-06. The genotypes showed significant differences for wooly aphid incidence ranging from 22.3% to 58.4% in plant crop and 29.1% to 63.2% in ratoon crop. The ratoon crop showed higher incidence than the plant crop. The genotypes showing lower average incidence (<30%) were CoBln 90006, CoBln 03171 and CoBln 03173 indicating less susceptibility to wooly aphid. Other genotypes showed medium to higher incidence. However, to draw concrete conclusion about tolerance, further study on yield is essential.



04-56

NURSERY MANAGEMENT FOR BORO RICE

M.K. Sarmah, P.C. Dey, N.T. Rafique, A. Roy, S. Ali and K.K. Sharma

Regional Agricultural Research Station, AAU, Titabar

The effect of five nursery management treatments along with four sowing dates on seedling health and their subsequent effect on crop yield of *boro* rice (cv. Bishnuprasad) were studied in 2001-02 and 2002-03. Results revealed that the seedling height and dry weight were significantly affected by sowing dates and nursery management practice in both the years. There were an increasing trend of both the characters as the sowing was delayed from December 10-25 in 2001-02, while a reverse trend appeared with advancement of sowing dates (November 28-Dec 23) in 2002. In case of nursery management practices, the increase in seedling height under Plastic tunnel was recorded to the tune of 62.3% over the standard management practices. Use of fresh cowdung slurry after one week of sowing also increased seedling height (14.9%). The effect of sowing dates on number of panicles and grain yield was very marginal, while the nursery management practices had significant role on both the characters. The seedlings grown under polythene cover produced the maximum number of panicles (258-295/m²) and grain yield (40.64-41.44 q/ha) in both the years. From the results it was concluded that the use of LDPE film of 25 μ (100 gauge) for raising boro seedlings may overcome the problem of seedling height in boro season and thereby resulting in enhancement of the grain yield of the crop.

04-57

EMBRYONIC DEVELOPMENT OF MUSHROOM NEMATODE, *DITYLENCHUS MYCELIOPHAGUS*, GOODEY, 1958

Debanand Das and Harish K. Bajaj*

Department of Nematology, Assam Agricultural University, Jorhat -785 013

**CCS Haryana Agricultural University: Hisar – 125 004*

The mushroom nematode, *Ditylenchus myceliophagus* is an important nematode pest of commonly cultivated mushroom, *Agaricus bisporus* limiting the production and productivity of the crop. A detail study was conducted in laboratory condition to know the embryonic development of this nematode. The study revealed that embryonic development of *Ditylenchus myceliophagus* was completed in 75 h and 279 h at 25° C and 13° C, respectively. Hatching was assisted by the movement of juvenile inside the eggshell, stylet thrusting as well as the pressure exerted by the lip region on eggshell. Sexes could be differentiated after second moult with the position of germinal nucleus in the genital primordium. In juvenile destined to be female, germinal nucleus located anterior to epithelial nuclei, while for juvenile destined to become male, reverse the case noticed. At 5°C and at 35°C eggs of *D. myceliophagus* fails to develop and hatch.

04-58

MANAGEMENT OF PEARLMILLET-WHEAT CROPPING SYSTEM FOR SUSTAINABLE YIELD

S.K. Yadav, Pawan Kumar and Manoj Kumar

Department of Agronomy, CCS Haryana Agricultural University, Hisar-120 004, India

yadavask@hau.ernet.in

In recent years, the production level of several crops sown as sole crop or in cropping system have stagnated or even declined due to several factors. It has become a challenge for scientists, administrators and managers to sustain/enhance crop productivity. The use of FYM seems to be a component which may reverse



the trend of crop productivity decline and therefore, the present study was conducted using farmyard manure and higher seed rate along with chemical fertilizers during 2005-06 and 2006-07 at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar, India to get the sustainable yield in pearl millet-wheat cropping system. The experiment was laid out in four strips of 65 X 10m² each, consisting of four treatments viz. T₁ : recommended fertilizer and package for both crops, T₂ : T₁ + 10t FYM/ha to pearl millet T₃ : T₂ + 30% higher seed rate in both crops and T₄ : T₁ + intercropping of clusterbean in paired rows of pearl millet in place of sole crop of pearl millet. The replicated data were taken from five fixed spots from each strip. The incorporation of 10 tonnes/ha farm yard manure to pearl millet alongwith recommended fertilizers and 30% higher seed rate to both crops increased pearl millet and wheat yield significantly. Mean pearl millet and wheat grain yield were recorded 3403 kg ha⁻¹ and 4875 kg ha⁻¹ respectively, where 10t/ha FYM was incorporated in field before sowing of pearl millet along with recommended fertilizers as compared to recommended package and practices where yield of pearl millet and wheat was recorded 3201 kg ha⁻¹ and 4641 kg ha⁻¹, respectively. Incorporation of farmyard manure along with recommended dose of fertilizers increases soil/nitrogen, phosphorus, potassium, improves the physico-chemical properties of soil, promotes root and shoot growth and as a result increases crop yield.

04-59

ROOT STUDIES IN RABI SORGHUM GENOTYPES

R.S. Wagh, V.D. Deshmukh and J.V. Patil

Mahatma Phule Krishi Vidyapeeth, Rahuri – 413 722, Dist. Ahmednagar (M.S.)

Thirteen genotypes of *Rabi* sorghum were evaluated for root characteristics during *Rabi* 2008. The various physiological and root observations of rain fed and irrigated plots were recorded periodically. It is revealed that the genotypes were differed significantly for physiological and root characters. The genotype Phule Vasudha had produced significantly higher grain yield in both irrigated as well as rain fed conditions.

04-60

REGULATION OF SINK SIZE FOR SUCROSE ACCUMULATION AND RELATED METABOLITES WITH REFERENCE TO BIOMASS PRODUCTION IN SWEET SORGHUM (*Sorghum bicolor* (L.) Moench) GENOTYPES

S. Ramesh, T.Y. Madhulety*, A. Siva Sankar, R.Subhash Reddy¹ and N.A. Ansari²**

Dept. of Plant Physiology, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad-500030

**Principal Scientist (Plant Physiology), DBT, ARI, Rajendranagar, Hyderabad*

***Professor & Head, Department of Plant Physiology, CA, Rajendranagar, Hyderabad*

¹Professor & University Head, Department of Agricultural Microbiology & Bio-energy

²Associate Dean, Agricultural College, Aswaraopet, Khammam Dt.A.P.

Physiological and biochemical aspects of sweet sorghum (*Sorghum bicolor* (L.) Moench) genotypes (SSV-84, RSSV-9 and CSH-18) with four treatments (intact panicle, panicle removed, ethanol dipping and 2,4-D spray) were investigated during *Rabi* and *kharif*, 2005-2006 relevant to bio-ethanol production. The genotype SSV-84 exhibited higher leaf area at all the growth stages when compared to other genotypes. In *kharif*, the mean fresh weight of leaves and stalks was the highest for SSV-84 followed by RSSV-9 while CSH-18 showed lowest. Mean leaf area was highest at flag leaf (FL) stage for SSV-84 followed by RSSV-9 while CSH-18 showed lowest mean leaf area in *kharif*. Mean total sugars in leaves and stalks was the highest in the genotype SSV-84 followed by RSSV-9 while CSH-18 recorded the least in *rabi*. At milky (M) stage, SSV-84 showed highest leaf reducing sugars followed by RSSV-9 while, CSH-18 recorded the least while highest stalk reducing



sugars was noticed at panicle emergence (PE) stage in SSV-84 followed by RSSV-9 and CSH-18. The treatment involving removal of panicle by cutting (T_2 : de-heading) proved to be the best in accumulation of maximum reducing sugars in all the genotypes. Of all the treatments, the treatment involving removal of panicle by cutting (T_2) paved way for higher accumulation of stalk and leaf non-reducing sugars in all the genotypes studied. Among the genotypes, SSV-84 showed highest accumulation of protein content in leaves while CSH-18 showed highest accumulation of protein in the stalks. At milky stage, CSH-18 has got higher starch accumulation in leaves and stalks than SSV-84 and RSSV-9 but the differences were not much significant.

04-61

IMPACT OF REGULATION OF SINK SIZE ON DYNAMICS OF SPECIFIC ACTIVITIES OF SUCROSE SYNTHETASE, INVERTASE AND α -AMYLASE IN SWEET SORGHUM (*Sorghum bicolor* (L.) Moench) GENOTYPES

S. Ramesh, T.Y. Madhulety*, A. Siva Sankar **, R. Subhash Reddy ¹ and N.A. Ansari ²

Dept. of Plant Physiology, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad-500030

*Principal Scientist (Plant Physiology), DBT, ARI, Rajendranagar, Hyderabad

**Professor & Head, Department of Plant Physiology, CA, Rajendranagar, Hyderabad

¹Professor & University Head, Department of Agricultural Microbiology & Bio-energy

²Associate Dean, Agricultural College, Aswaraopet, Khammam Dt.A.P.

Field experiments were conducted with an objective of studying enzymatic aspects of sweet sorghum (*Sorghum bicolor* (L.) Moench) genotypes relevant to bio-ethanol production. during *Rabi* season, 2005 with three genotypes (SSV-84, RSSV-9 and CSH-18) and four treatments (intact panicle, panicle removed, ethanol dipping and 2, 4-D spray). Sucrose synthetase (SS) activity was highest at flag leaf stage and thereafter showed a continuous decrease up to maturity stage in all the genotypes. It remained more or less same up to physiological maturity stage which is a desirable trait in sweet sorghum for maintaining unabated flow of sucrose from leaves to storage 'sink' in the culms. The specific activity of sucrose synthetase was highest for SSV-84 followed by RSSV-9 and CSH-18 and the treatment, de-heading (T_2) proved best in showcasing the activity of the enzyme. At flag leaf (FL) stage, all the genotypes showed maximum acid invertase activity and at physiological maturity (PM) stage it was least. The reduction was very rapid between flag leaf (FL) and panicle emergence (PE) stages (75%), but it was only 3 per cent between panicle emergence (PE) and milky (M) stages. Of the treatments imposed, the treatment involving removal of panicle by cutting (T_2 : de-heading) recorded the highest acid invertase activity in all the genotypes when compared with the control (T_1). Maximum α -amylase activity was observed at flag leaf (FL) stage and then there was a continuous decline up to physiological maturity (PM) stage. SSV-84 showed highest mean α -amylase activity followed by RSSV-9 and CSH-18 at panicle initiation (PI) stage. For SSV-84, α -amylase activity values obtained by the mean of all the crop growth stages was the highest for de-heading treatment Similar was the trend noticed for RSSV-9 and CSH-18 genotypes with respect to α -amylase activity.

04-62

STRIPE DISEASE INDUCED CHANGES IN PHYSIOLOGICAL TRAITS OF BARLEY

Satish Kumar, S.S. Karwasra and Renu Munjal*

Dept. of Plant Pathology, *Wheat Section, Dept. of Plant Breeding, CCS HAU, Hisar (Haryana)

Barley is one of the first domesticated crop species in the world. It had been traditionally considered as poor man's crop because of low input requirement and better adaptability to harsh environment. But now in India, its cultivation is becoming more and more oriented towards industrial utilization. This crop suffers from



number of diseases such as stripe rust, leaf rust, covered smut, loose smut, net blotch, and leaf blight etc. which causes significant losses to crop yield. Most attempts for defining the disease physiology of stripe in Barley are indirect. Therefore in this investigation, an attempt was made to obtain a more comprehensive study of disease physiology. 10 healthy and infected leaves of Barley cultivar BH 393 were evaluated for measuring chlorophyll content, net photosynthesis, stomatal conductance, leaf area and transpiration rate at 50 days after sowing. Stripe disease induced reduction of chlorophyll content (70.1%), net photosynthesis (68.8%), stomatal conductance (71.8%), leaf area (38.2%) and transpiration rate (51.7%). Decrease in net photosynthesis concomitant with dramatic decrease in 1000 grain weight (44%), yield (29%) and no. of grains/ear (30%).

04-63

CHARACTERIZATION OF POP SORGHUM GENOTYPES FOR GROWTH PARAMETERS AND YIELD

H. Mahantha, D.I. Jirali, M.B. Chetti, and S.S. Angadi

Department of Crop Physiology, University of Agricultural Sciences, Dharwad – 580 005

A field experiment was conducted during rabi season 2007-08 At Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to evaluate twelve Pop Sorghum genotypes for growth parameters and yield. The genotypes differed significantly with respect to all the growth parameters. The results of various growth parameters viz., Leaf area index, Leaf area duration, Crop growth rate and Specific leaf area were maximum in genotypes Koppal-3, Telkar-2 and Byahatti-3 which were high yielders. Minimum values were obtained in low yielding genotypes Kannolli-3 and Saradagi. Further, LAI, LAD and CGR were found to be positively correlated with grain yield.

04-64

STUDIES ON YIELD COMPONENTS, YIELD AND QUALITY PARAMETERS IN POP SORGHUM GENOTYPES

H. Mamata, D.I. Jirali, M.B. Chetti, and S.S. Angadi

Department of Crop Physiology, University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted during *rabi* season 2007-08 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to evaluate twelve Pop Sorghum genotypes for yield, yield components and quality parameters. Among the genotypes, significant differences were observed with respect to yield, yield components and quality parameters. The genotype Koppal-3 had the maximum grain yield followed by Telkar-2 and Byahatti-3. The genotype Kannolli-3 recorded lowest yield followed by Saradagi. It was also observed that the grain yield had positive significant association with number of grains and harvest index. The genotypes also showed significant differences with respect to quality parameters viz., popping yield, expansion ratio and flake size.



04-65

IRRIGATION MANAGEMENT IN RICE: A CASE STUDY FROM GOLAGHAT DISTRICT OF ASSAM

K. Pathak¹, A. Sharma² and H. Baruah³

Krishi Vigyan Kendra, Assam Agricultural University, Golaghat, Assam

¹Sr. Scientist, Directorate of Research (Agri), ²Farm Manager, ICR Farm, AAU, Jorhat-13

³Professor, Soil Science, BNCA, AAU, Biswnath Chariali, Sonitpur, Assam

A case study was conducted on irrigation management autumn rice (*ahu*) and summer rice (*boro*) during 2007-08 in Golaghat district of Assam. With the introduction of Shallow Tube Well (STW) scheme farmers have shown inclination towards the summer and autumn rice particularly to *boro* rice as the growing period of these crops are comparatively free from flood. Farmers have to solely depend on irrigation to grow the crop during these seasons, Moreover, there are some areas where the main rice crop i.e. *Sali* is only a chance crop the only alternative left with the farmers is to go for summer rice either *boro* or early *ahu*. At the same time fuel cost is another matter of concern for giving irrigation to these crops. So, a cost effective technology for water management is the need of the hour. The technology tested was use of irrigation water (5 cm) applied at 3 days after disappearance of ponding water (DADPW) with other recommended practices of crop management. Altogether 21 (twenty one) farmers were selected from 6 (six) different locations of the district and the programme was based on the Farmers Participatory Approach. The study revealed that there was on an average water saving of 2000 m³/ha and water-use – efficiency of 26.4 kg/ ha-cm over the conventional method of irrigation in autumn rice (*ahu*), Similarly, in summer rice *boro* the benefits were 10900 m³/ha and 45.5 kg/ ha-cm, respectively. 35 and 40 per cent as compared to conventional method reduced the cost of irrigation water with a monetary benefit of Rs. 5842.00/ha and Rs. 8594.00/ha in *ahu* and *boro* season, respectively. Ecological impact of the study suggested that less use of ground water is eco-friendly and is saved for future where tube well is used as a source.

04-66

INTERCROPPING OF URDBEAN WITH MAIZE: PHYSIOLOGICAL BASIS FOR YIELD ADVANTAGES

K. Pathak* and N.P. Singh

Department of Agronomy, GB Pant University of Agri & Technology, Pantnagar, Uttarakhand

**Sr. Scientist, Directorate of Research (Agri), AAU, Jorhat-13*

Intercropping of urdbean with maize ensures the most efficient use of the limiting resources for high crop yield. Intercrop productivity is determined by several physiological processes, which affect yields of component crops. Availability of environmental resources to each of the component crops is important in determining the combined intercrop productivity and hence analysis is based on capture of environmental resources and efficiency of conversion of captured resources into growth of harvested organs of the component crops. Intercrops are more efficient when their component crops differ greatly in growth duration so that their maximum requirements for growth resources occur at different times. For high intercrop productivity, plants of early maturing component should grow with little interference from the late maturing crop. Choice of correct cultivars and agronomic manipulations is the key element for high yield. The present investigation involved four genotypes of urdbean for intercropping with maize in three different row arrangements and it showed the variations in efficiency of the systems. Further, crop biomass at maturity is the integral of crop growth rate (CGR) over the whole crop duration, and biomass production is often examined by relating CGR to plant and environmental factors. Similarly, intercropping also modifies the soil environment. The paper highlights the various factors and their effect on system yield as a whole in the light of the physiological processes.



04-67

**ASSESSMENT OF TECHNOLOGY GAP AND PRODUCTIVITY GAIN THROUGH FRONT LINE
DEMONSTRATION IN TORIA (*Brassica campestris*) AT FARMER'S FIELD OF GOLAGHAT
DISTRICT OF ASSAM**

Abhijit Sarma¹, Kalyan Pathak², R.K. Dutta³, P.Saikia⁴ and H.C. Barua⁵

Krishi Vigyan Kendra, Assam Agricultural University, Khumtai, Golaghat-785619, Assam

¹ICAR Farm, ²Directorate of Research, Assam Agricultural University, Jorhat -13

³Krishi Vigyan Kendra, Assam Agricultural University, Nazira, Sivasagar

⁴Regional Agricultural Research Station, Shillongani, Nagaon – 782 001

⁵Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali – 784 176

Front Line Demonstrations on toria were organized at farmer's field during 2003-04 to 2006-07 in Golaghat district of Assam. The demonstration yield was compared with local check where farmers used traditional practices. The use of recommended technology in demonstration increased the productivity by 44.6 per cent over the local check. Such increase was recorded with little extra cost suggesting non-monetary reasons for low productivity in local check. The technology gap and additional return was found to be 271 kg/ha and Rs. 5420/ha.

04-68

**CORRELATION STUDIES IN SEED TRAITS, MOISTURE AND OIL CONTENT OF *JATROPHA*
CURCAS L ACCESSIONS**

Anulekha Rabha, B.S. Bhau and P.B. Kanjilal*

North-East Institute of Science and Technology, Jorhat, Assam

**kanjilalpb2001@yahoo.com*

Variability in seed traits, moisture percentage and oil content of 25 accessions of *Jatropha curcas* collected from different agroclimatic zones of North-East India were assessed. There were significant differences ($P < 0.05$) in seed size, 100 seed weight and oil content among the accessions. The maximum seed weight was recorded in JC-22 collected from Baramura, Tripura and the minimum in JC-13 collected from Roing, Arunachal Pradesh. Oil variability ranged from 25% (JC-20, collected from Mokochung, Nagaland) to 36% (JC-18, collected from Mamit, Mizoram). The moisture percentage in the sun dried seeds varied from 6.06% (JC-5, collected from Lambding, Assam) to 11.32% (JC-6, collected from Lakhimpur, Assam). When the oil percentage of seeds is correlated with the sun dried seed moisture percentage and 100 seed weight, it has been found that the oil yield is negatively correlated with the seed moisture. On the otherhand the seed weight has strong positive correlation with the oil yield.

04-69

**COMBINING ABILITY STUDIES IN A RICE DIALLEL FOR FLOWERING, MATURITY
DURATION AND GRAIN YIELD**

A.C. Sarma, P. Talukdar and R.N. Sarma

Department of plant Breeding and Genetics, Assam Agricultural University, Jorhat –785013 Assam

An 8 x 8 diallel cross (without reciprocals) involving five traditional varieties of Assam and three high yielding varieties of rice was studied during 2008, laid out in a randomized block design with three replications. The performance of the parents and the progenies were assessed for flowering, maturity duration



and grain yield per plant. The combining ability analysis was performed following Griffing (1956) Method II Model I. Highly significant differences were observed among the parents and crosses for all the three characters. Highly significant gca and sca variances were observed for all the characters with preponderance of GCA variance for days to 50% flowering and days to maturity and preponderance of SCA variance for days to maturity Pusa 2-21 for grain yield per plant and Maibee-2 for early flowering and early maturity were observed to be the best general combiners for the respective traits. Among the crosses Pusa 2-21 x Nilazee followed by Vandana x Maibee-2 were observed to be the best specific combiners for grain yield per plant Vandana x Maibee-2 also emerged as the best specific combiner for early flowering and early maturity.

04-70

INVESTIGATION ON PHYSIOLOGICAL EFFICIENCY IN Bt COTTON HYBRIDS

B.C. Patil, K.N. Pawar and Shamaraj

University of Agricultural Sciences, Dharwad Agricultural Research Station, Dharwad-580 007

Four popular Bt cotton hybrids along with their non Bt counter parts were evaluated for their performance at Agriculture research station dharwad during 2006-07, 07-08, 08-09 under rainfed conditions at two dates of sowing Viz., normal and delayed. DHH-44 was the check hybrid. The results indicated that NHH-44 Bt recorded the highest yield (2147 kg/ha) over Non-Bt check DHH-543(1924 kg/ha) however there was no significant difference between Bt hybrids. The Bt cotton hybrids recorded 41.8% more yield as compare to Non-Bt hybrids, among the genotypes the least yield was recorded in RCH-2 Bt. Normal sowing (D1) recorded significantly more yield as compare to late sown crop (D2). There was 31.1% decrease in yield due to delay sowing. The Bt hybrids recorded 15.7% more number of bolls than their counter parts, 7.6% more boll weight than Non-Bt counter parts.

04-71

PHYSIOLOGICAL BASIS FOR GROWTH AND YIELD IN Bt AND NON-Bt COTTON HYBRIDS

K.N. Pawar and B.C. Patil

University of Agricultural Sciences, Dharwad Agricultural Research Station, Dharwad-580 007

A field experiment was conducted under rainfed condition at Agriculture research station, Dharwad to compare the morpho physiological characters and yield potential of different Bt and non-Bt cotton hybrids. The experiment consisted of four Bt hybrids and their non Bt counter parts and one check hybrid laid out in a split plot design with two dates of sowing as a main plot and nine genotypes as subplots with three replication. There was no significant difference between the dates of sowing for many of the growth, yield components and yield. Among the Bt hybrids NHH-44 Bt produced significantly higher seed cotton yield (2465 kg ha⁻¹) and among non-Bt hybrids MRC-6322 non-Bt (1625 kg ha⁻¹). This was mainly attributed to its close association with number of bolls per plant ($r=0.53$). While Bt hybrids recorded 6.95% less plant height, 10.81% less LAI than non-Bt hybrids. Genotypes differed significantly in their growth pattern, morphological characters and phenological characters. Among the genotypes, non-Bt hybrids recorded more plant height, number of leaves and leaf area index compared to Bt cotton hybrids indicating their more vegetative growth. Bt hybrids matured five to eight days early compared to non-Bt hybrids. Bt hybrids recorded less boll damage than non-Bt hybrids. This is because of less number of trichomes in leaves of Bt recorded highest boll damage due to highest trichomes on leaves.



04-72

EFFECT OF PLANT CHARACTERISTICS OF JUTE (*Corchorus* spp.) VARIETIES ON INCIDENCE OF PESTS IN WEST BENGAL, INDIA

Sahidur Rahman^a and Matiyar Rahaman Khan^b

^aDepartment of Entomology, Assam Agricultural University, Jorhat-785013

^bDepartment of Agricultural Entomology, BCKV, Mohanpur, 741252

srahman06@rediffmail.com

Experiment was conducted with a view to understand the effect of plant characteristics on the incidence of pests on most popular jute varieties viz. JRO-524, JRO-632, JRO-878, JRO-7835 of olitorius jute and JRC-212, JRC-321, JRC-4444, JRC-7447 of capsularis jute. Correlation studies of plant characteristics with pest incidence in jute (*Corchorus* spp.) revealed that basal girth of plant exhibited a positive significant relationship with the incidence of *Apion corchori* Marshall but not with other pests like jute semilooper (*Anomis sabulifera* Guen.), bihar hairy caterpillar (*Spilarctia obliqua* Wlk.), grey weevil (*Myloccerus discolor* Bohemus) and yellow mite (*Polyphagotarsonemus latus* Banks). However, plant height showed positive correlation with the incidence of all the major pests of jute. Among the leaf characteristics (number of leaves plant⁻¹, leaf area, leaf thickness, moisture and chlorophyll content of leaves of all the varieties recorded at three different growth stages i.e. at 50, 80 and 110 days after sowing), number of leaves plant⁻¹ had positive and significant relationship with the incidence of all the pests except stem weevil. However, leaf area and moisture content of leaves showed significant positive relationship with the incidence of yellow mite. Leaf moisture also showed a positive role on the infestation of grey weevil. Leaf thickness and chlorophyll content of leaves and stem, fibre thickness and moisture content of stem did show any significant effect on pest's incidence. Comparing the plant characteristics between the two jute species, olitorius varieties had greater fibre thickness than that of capsularis varieties but fibre thickness had no significant impact on incidence of pests.

04-73

KONKAN SAFED VELCHI BEST FOR BANANA CULTIVATION IN KONKAN CONDITIONS OF MAHARASHTRA

S.A. Chavan, M.S. Gavankar, B.R. Salvi, M.B. Dalvi, N.V. Dalvi and M.P. Kandalkar

Regional Fruit Research Station, Vengurle, Dist. Sindhudurg, Maharashtra

Banana (*Musa species*) is a prominent irrigated commercial fruit crop in Konkan region. This crop is grown on an area of about 30,000 ha. with basarai, G-9 and Poovan type of cultivars which are grown in every homestead. The type Safed velchi is being largely cultivated in this region which is a cross between *Musa acuminata* (AA) with A genome and *Musa bulbaisiana* (BB) with B genome have naturally crossed; there by giving specific hybrids which are hardy, parthenocarpic, 2n = 22 chromosomes. Though in konkan we find different cultivars but the "Safed velchi" fruits phase the premium price in the market (Rs.24/-per dozens fruits). These are tall cultivars. Regional Fruit Research Station, Vengurle have collected 14 different types having variability in Safed velchi types under different agroclimatic conditions. Out of these 14 types, 7 types resembling to each other were evaluated for their physicochemical analysis, and yield data during the period from 2004-2008. Yield and quality parameters recorded of 7 elite types of "Safed Velchi" are presented here. Among these "Mulde-2 type" was found promising and was released as "Konkan Safed Velchi" for cultivation under Konkan region of Maharashtra. Banana "Safed Velchi"/ Neypoovan (Somaclonal natural hybrid of Safed Velchi) is a tall growing; the fruits are small, flesh white firm, sweet, golden yellow or light yellow in colour " with thin skin and highly fragrant. Flowering takes place in about 300-350 day after planting. The shape of male bud is of lanceolate



type. The flowers in bud is purple colour with 2 sepals and 2 petals with triandry and monogynoecious bifurcated stigma. Fruits are ready for harvesting within 150-170 days after flowering. Fingers 10-12 cm length, green, distinctly angular, very predominant apex, pale yellow and ripening skin turns black, 8 days after ripening of the fruits; even then flesh inside the fruits is white in colour. It produced average 5 suckers per plant per year. The bunch length is 80.5 cm with eleven numbers of hands per bunch, with average 15-16 kg weight of bunch. We get on an average yield 25 tones/ha as sole crop and 15 tones per ha. as mixed crop. Under konkan agroclimatic conditions of Maharashtra for getting economically more returns and to get premium price for banana cultivation "Konkan Safed Velchi" Neypooan type is recommended.

04-74

KONKAN LEMON A BOON FOR CITRUS CULTIVATION IN KONKAN REGION OF MAHARASHTRA

B.R. Salvi, S.S. Pawar, N.V. Dalvi, M.P. Kandalkar and S.A. Chavan

Regional fruit research station, Vengurle, Maharashtra.

The lemon is one of the 16 distinct species in the genus *Citrus* of the rutaceae family. Traditionally citrus crops are being grown in the hot and dry climate and arid zone of the state. Since konkan region is having hot and humid climate there are limitations for citrus cultivation. The studies were undertaken at Regional Fruit Research Station, Vengurle during the period 2003-2008. It is found that the two crops namely *Citrus lemon* and *Citrus pumellao* are performing well under the agro climatic conditions of Konkan region. At Regional Fruit Research Station, Vengurle the germplasm collected from various parts of the Maharashtra state were collected and maintained; total 46 collections of citrus lemon were planted. Out of these 4 elite lemon types namely Dazi parab type, Uttam parab type, Dalvi type and Sangmeshwar type were evaluated for their physicochemical properties and are being presented in this research paper. The growth parameters, flowering parameters, yield contributing factors of all these 4 types were recorded. The best among these four lemon types was VGL-01-16. The present finding showed that the 'Konkan lemon' variety of citrus lemon evolved during 2008 through mass selection from local lemon type have bold fruits, prolific bearer good for processing with lemonade flavour. The fruits are rounded visually pointed at both the ends. The fruit colour is light yellow. Fruit rind is thick. Its flesh is light and juice sacs are thin and disease pest incidence is negligible. The five year old plant attain mean spread of 2.4 m. Leaves are 75 -105 mm long with serrated margin. It flowers through out the years. Flower buds are single as well as in cluster. The petals are white inside and purple on outer surface. The fruiting starts from second year planting. Normally citrus crops need Bahar treatment. However this particular 'Konkan lemon type' does not need bahar treatment and gives good response to pruning. Flowering and fruiting is throughout the year. The average fruit weight is 104 gm. Fruits mature within 140-150 days from fruit sets. On an average 230 fruits /tree/year are harvested. Fruit yield 23.94 kg/tree/year. Konkan lemon has good lamonide flavour, T.S.S. 4.8⁰ Brix, acidity 3.94%, vitamin C is 19.55 mg/100 gm. Under Konkan agroclimatic conditions among, citrus fruit crops 'Konkan lemon' comes up very well even without bahar treatment and gives fruits throughout the year.



04-75

DRY MATTER ACCUMULATION, PARTITIONING AND YIELD DEVELOPMENT IN WHEAT GENOTYPES UNDER RAINFED SITUATION OF ASSAM

Prakash Kalita, Ranjan Kalita, Kaushik Das B.K. Rabha and Ranjan Das
Department of Crop Physiology, Assam Agricultural University, Jorhat-785 013

Non availability of well adapted genotypes and lack of irrigation facility resulted in low wheat productivity in Assam. In order to address this crucial production constraint, present investigation was undertaken with seven wheat genotypes viz. Sonalika, HDR-77, PBW-343, PBW-154, Raj-3077, C-306 and K-8027, to evaluate their dry matter accumulation and partitioning in relation to yield development. Wheat genotypes were grown in light textured acidic soil (pH 5.16) under rainfed condition as *rabi* crop. Large variation in soil moisture content (12- 13% from sowing to ear emergence; 14-18% during maturity) due to uneven rainfall was recorded. Significant variations in accumulation and partitioning of dry matter to different plant parts were recorded among the genotypes at different stages of growth. At two-leaf and ear emergence stage, among the genotypes, C-306 accumulated highest total plant dry matter. Reproductive dry matter was found to have significant positive correlation with plant dry matter at ear emergence stage. The genotype C-306 recorded highest yield (26.12 q/ha) followed by PBW-343 (21.94 q/ha). These two genotypes accumulated higher stem dry matter at two leaf stage and ear emergence stage which might have been the source of assimilate for superior grain growth and higher yield.

04-76

PHYSIOLOGICAL ASPECTS OF PROPAGATION IN *JATROPHA CURCAS*

B.K. Rabha and Jayanta Kalita
Assam Agricultural University, Jorhat – 785 013

Jatropha curcas has assumed great importance as tree borne oilseed (biodiesel) crop in India. *Jatropha* can be propagated using true seeds and stem cuttings. Seed treatments with IBA and GA improved the germination percentage of *Jatropha* and 30 μLL^{-1} GA produced 11.0 per cent more germination with a time advancement of 1.5 days over the water treated seeds. The stem cuttings of size 1.5-2.0 cm in basal diameter and 20.0-25.0 cm in length showed the most sensitive response to 100 μLL^{-1} IBA treatment in callus initiation and root development. The chronology of rooting pattern revealed that initials of callus formation took place on 7th day, initiations of root formation on 12th day, expression of root initials on 17th day, 1.0-2.0 cm long root length on 21st day and 7 well developed roots formation in 45th day of cutting placement in the media.

04-77

STATUS OF *JATROPHA CURCAS* IN ASSAM

B.K. Rabha and Jayanta Kalita
Assam Agricultural University, Jorhat – 785 013

Till its cultivation started, *Jatropha* was found to be available mostly in wild and semiwild forms in Assam. *Jatropha* is known by different names in different localities of the state, such as Bhot era, Bongali era, Erena, Verena, Bherenda etc. Rural people in Upper Assam maintained one to few plants in backyard of households for medicinal purpose. Besides medicinal use, *Jatropha* had been used as biofencing in lower Assam districts for which slow growing with less fruiting and stress hardy types were preferred. This outlook of domestication was a major concern for non-availability of natural prolific seed and oil yielders in the state.



04-78

THE INFLUENCE OF RHIZOSPHERE MICROORGANISMS ON PHYSIOLOGICAL PERFORMANCE OF SOME GREEN GRAM (*Vigna radiata* L. Wilczek) GENOTYPES DURING KHARIF SEASON

Prakash Kalita, Kaushik Das, B. Haloi, Ranjan Das, D.J. Nath* and S. Alam**

*Department of Crop Physiology, *Department of Soil Science, **Department of Horticulture, Assam Agricultural University, Jorhat-785 013*

A study was conducted to evaluate the effects of inoculums of *Rhizobium*, *Azospirillum* and phosphate solubilizing bacteria on physiological performance of seven improved green gram genotypes viz. Pratap, Samrat, SGC-16, SGC-20, SML-668, TMV-37 and Meha. Treated seeds of these genotypes were grown in earthen pots containing light textured loamy soil during *kharif* season under natural condition. Large differences were recorded in leaf area, dry matter accumulation, photosynthetic and transpirational rate, stomatal conductance, internal CO₂ concentration among the genotypes. Rhizosphere microorganisms were also found to influence the physiological characteristics of the genotypes.

04-79

POLLINATION NEED FOR CROP PRODUCTION

P.K. Das and A. Rahman

Department of Entomology, Assam Agricultural University, Jorhat – 785 013

Pollination has been given little attention probably because lack of pollination is not a factor obviously limiting yield but with improved cultivars and cultivation methods. The pollination has become relatively important and there are indication that many crops benefit from insect pollination. Large areas of vacant land and small acreage of a variety of crops flowering at different time of the year provided ample forage to the crops in the past. But with the increased mechanization of farming and much monoculture of a particular crops, flowering is more concentrated and larger pollinator population are needed for short period outside of which little foragers are available. Commercial use of the solitary bees can rapidly increase its population in manmade nest and many of them show preferences for particular plant species and are well adapted to pollinate them. Among the other wild bees, the stingless bees can be conserved and utilized for pollination ensuring adequate nesting sites. However, pollination of crops dependant on one or more few local insect species but most crops can be visited and successfully pollinated by the bees. Bees visit all most all the pollen and nectar containing plants. The pollen carrying capacity of honeybees and its behaviour on the crop often make it a superior pollinator to other insect visiting the flower. Honey and beeswax become the bye-products of beekeeping industry. Although, the honeybee colony population is in decreasing trend due to environmental hazzards, the beekeepers should encourage for beekeeping by providing subsidies or incentive by the Government machineries besides providing training and financial aids to increase the pollinators for increased crop production.



04-80

EFFECTIVE IPM PACKAGE FOR CONTROL OF SAPOTA SEED BORER, *Trymalitis margarias* Meyric

A.Y. Munj, A.S. Patil, P.D. Patil, B.G. Desai
Regional Fruit Research Station, Vengurle, Dist. Sindhudurg (M.S.)

Sapota is one of the most important perennial horticultural crops grown in Thane District of Maharashtra state. During 1999 the infestation of new unidentified pest was observed in Dahanu Tahasil of Thane District. The pest was identified as *Trymalitis margarias* Meyric which belongs to order Lepidoptera and family Tortricidae. A study was conducted at Agriculture Research Station, Palghar, Dist. Thane (M.S.) to formulate effective IPM package for control of Sapota seed borer during 2001-2005. The objective of the study was to find out at the peak active period of the pest, to study the effect of light trap; effective bio-pesticide and inorganic pesticide for control of the pest. The results of the present study indicate that the infestation was less in well spaced young garden where destruction of fallen leaves and fruits was done as compared to very old dense sapota garden where destruction of fallen leaves and fruits was not done. The light trap study indicate that the light trap is effective tool for attracting and destroying the moth population. Also it is a important tool to monitor the pest population in field. It was found that though the infestation was recorded throughout the year, the peak active period was only October to January which indicate that the plant protection measures are required only during this period. Among the bio-pesticides tested the Azadirachtin 10000ppm @ 30ml/10Lit. and Delfin (*B.t.*) @ 15ml/10Lit. was found effective to some extent. Among the inorganic insecticides the Emamectin benzoate 5 SG (Proclaim) @ 4.5gm/10Lit. was found most effective followed by Lambda Cyhalothrin 5 EC @ 10ml/10Lit., Deltamethrin 2.8 EC @ 10ml/10Lit and Profenophos 40 EC @ 10ml/10Lit.

04-81

EFFECT OF NANO IRON OXIDE ON LEUTIN AND β CAROTENE CONTENT OF GREEN LEAFY VEGETABLE

P. Sudhakar, T.N.K.V. Prasad, P. Latha, M.Balakrishna, Y. Sreenivasulu and K. Raja Reddy
Plant Physiology, Regional Agricultural Research Station, Tirupati, Andhra Pradesh
sudakarp@yahoo.com

Nano materials are third generation bio materials predicted to revolutionise biological activity. Nano based nutrients owing to their smaller size (1-100 nm), there is every possibility of breaking barriers and to improve productivity and nutritional values. Carotenoids are fat soluble pigments comprising of carotenes (α and β carotene) and xanthophylls (leutin, zeaxanthin and β Cryptoxanthin). Green leafy vegetables (GLV) are rich in leutin and β carotene, which offer benefit to human health in general and in particular to eye health. Nano based iron oxide were synthesized using chemical method at this centre. These nano iron oxide of 20 nm size sprayed on *Rumex vesicarius* L. (chukka kura) at grand growth stage. Leutin and β carotene quantities in leaves were determined by reverse phase high performance liquid chromatography. The results of the study showed increased leutin and β carotene by 25% and 68% respectively compared to unsprayed check. This is the first report of effect of nano materials on carotenoid pigment of GLV.



04-82

PHYSIOLOGICAL INTERVENTIONS FOR IMPROVING SUGARCANE AND SUGAR PRODUCTIVITY

A.K. Shrivastava and S. Solomon

Indian Institute of Sugarcane Research, Lucknow, UP

Sugarcane is one of the most efficient quantum converters and endowed with a vast tillering, ratooning and biomass potential. Extensive researches on sugarcane have enriched biological sciences, notably the discovery of C_4 pathway of photosynthesis, studies on sugar synthesis and translocation and crop logging. Besides, inter-generic and inter-specific hybridization were successfully attempted for the first time in this crop. The discipline of Nematology came in to existence by the concerted efforts of Nathan Augustus Cobb who separated it from Helminthology while working with sugarcane, in Hawaii. Crop physiology refers to study of plant functions in a community, quality of the produce and overcoming certain bottlenecks coming in the way of this endeavour. Vast tillering potential, innumerable root primordia, two types of roots and emergence of leaves constitute a *Compensatory Physiologic Continuum* which imparts this plant a unique ability to tide over abiotic stress conditions, gaps in the field and agro-physiological disorders arising in its 12-18 months long cycle. The most important physiological interventions which have contributed to improvement in sugarcane are: volume of the seed cane (6-8 t/ha) has been drastically reduced to 1/3rd by introducing spaced transplanting technique (STP). In addition, use of paclobutrazol has also shown some promise in reducing seed-bulk. Pre-planting soaking setts in water; and thiourea solution have shown improved sprouting. Mechanically damaging the apex of newly emerged shoots leads to profuse and synchronous shoot emergence. Late shoots add to intra-plant competition for water and nutrients. Simple intervention such as earthing up not only suppressed late shoots but also increased average cane weight *vis-à-vis* cane productivity. In subtropical India, in mid-August when critical photoperiod (11.5 hr dark period) approaches and other conditions are favourable, flowering takes place which affect cane weight and juice quality. Sugar losses tend to increase if the crop has to be kept for a longer duration. Application of extra N or Ethrel could prevent such a quality decline to a greater extent. Amelioration of ripening by applying mild stress (by withholding irrigation) and use of chemical ripeners are remarkable interventions and being used on commercial scale in many countries. Post-harvest sucrose losses could be managed by using anti-inversion and anti-bacterial formulations, is another useful intervention to enhance sucrose recovery. The poor sprouting of stubble buds, especially in a winter-initiated ratoon, is an important constraint to productivity of ratoon crops. This could be effectively managed by pre-harvest application of Ethrel, potassium or post-harvest application of potassium and certain chemical formulations to improve productivity of ratoons of early varieties. Crop logging, another useful intervention, refers to a graphic record of the progress of the crop growth and contains a series of nutritional, moisture contents and crop growth data indicating general condition of crop growth. It also suggests changes in the crop management necessary to attain maximum cane and sugar yields. Physiological interventions have been useful in the management of the crop under abiotic stress conditions. Soaking setts in saturated lime water induced drought hardiness. Application of Ethrel and potassium have benefited to tide over drought to some extent. Interventions causing quick growth are helpful in waterlogged/flood situations to some extent. A large number of physiological characteristics have been used for need-based selection of sugarcane varieties at an early stage of their development. Use of meristem culture and application of phosphorus have been used to overcome varietal decline. Sugarcane has substantial carbon flux through metabolic pathways which generate high quantities of sucrose, cellulosic fibres, lignins, epicuticular wax. It has also an enormous capacity for storage of soluble compounds and other sugars such as isomaltulose. These precursor pools, storage capacities and metabolic transformations could be helpful in development of this plant as an industrial crop for the synthesis of several classes of high value bio-products. This '*Molecular farming*' in sugarcane has also met with some level of success. In the recent past, these physiological interventions have immensely contributed to the improvement of cane and sugar yield, and has transformed this plant into a "*Bio-factory*" to produce many high value products.



04-83

PERFORMANCE OF RAPESEED VARIETY TS 38 UNDER IRRIGATED CONDITION IN MAJULI, WORLD'S LARGEST RIVER ISLAND - A CASE STUDY

J. Goswami, S. Barman and Bhaskarjyoti Sarma

Krishi Vigyan Kendra, Jorhat, Assam Agricultural University, Kaliapani – 785 112

Majuli, the world's largest river island is located in Jorhat district of Assam. Humid flood prone and char area are the major agro ecological situations of the island. Rapeseed and mustard, rice, pulses, wheat, potato, vegetables are the major crops grown in the island. Among these crops, rapeseed and mustard is the major crop covering an area of 8500 ha with average productivity of 900 kg/ha, mainly cultivated with local varieties under rainfed condition. Being the soil is sandy in nature with less water holding capacity, the crop suffers from moisture scarcity during critical growth stage. Flowering stage of rapeseed and mustard is considered to be the most critical stage for irrigation. Therefore, the study was conducted in a farmer's participatory mode at Mohkina village of Majuli Development Block to demonstrate the performance of newly release AAU variety TS 38 under irrigated condition. The study was conducted as a Farmers Participatory Action Research Programme, financed by Ministry of Water Resources, Government of India, in collaboration with All India Coordinated Project on water Management, AAU Jorhat. The newly released AAU variety TS-38 was tested providing one irrigation (6 cm) at flowering stage. One irrigation at this critical stage has resulted 62.80 per cent yield improvement over traditional rainfed farming (882 kg/ha) indicating large scope of irrigated rapeseed in Majuli, the 'Oilseed Bowl of Assam'. Likewise maintaining required moisture regime at flowering stage resulted in increase in water use efficiency of the crop. The average yield of TS 38 was found 1405 kg/ha. Production of variety TS 38 with at least one irrigation may change the production scenario of rapeseed in Majuli.

04-84

EFFECTIVE IPM PACKAGE FOR CONTROL OF SAPOTA SEED BORER, *Trymalitis margarias* Meyric

A.Y. Munj, A.S. Patil, P.D. Patil and B.G. Desai

Regional Fruit Research Station, Vengurle, Dist. Sindhudurg (M.S.)

Sapota is one of the most important perennial horticultural crops grown in Thane District of Maharashtra state. During 1999 the infestation of new unidentified pest was observed in Dahanu Tahasil of Thane District. The pest was identified as *Trymalitis margarias* Meyric which belongs to order Lepidoptera and family Tortricidae. A study was conducted at Agriculture Research Station, Palghar, Dist. Thane (M.S.) to formulate effective IPM package for control of Sapota seed borer during 2001-2005. The objective of the study was to find out at the peak active period of the pest, to study the effect of light trap; effective bio-pesticide and inorganic pesticide for control of the pest. The results of the present study indicate that the infestation was less in well spaced young garden where destruction of fallen leaves and fruits was done as compared to very old dense sapota garden where destruction of fallen leaves and fruits was not done. The light trap study indicate that the light trap is effective tool for attracting and destroying the moth population. Also it is a important tool to monitor the pest population in field. It was found that though the infestation was recorded throughout the year, the peak active period was only October to January which indicate that the plant protection measures are required only during this period. Among the bio-pesticides tested the Azadirachtin 10000ppm @ 30ml/10Lit. and Delfin (*B.t.*) @ 15ml/10Lit. was found effective to some extent. Among the inorganic insecticides the Emamectin benzoate 5 SG (Proclaim) @ 4.5gm/10Lit. was found most effective followed by Lambda Cyhalothrin 5 EC @ 10ml/10Lit., Deltamethrin 2.8 EC @ 10ml/10Lit and Profenophos 40 EC @ 10ml/10Lit.



04-85

GENETIC PARAMETERS IN BRINJAL POPULATIONS FOR FRUIT YIELD AND OTHER PHYSIOLOGICAL TRAITS

K. Tamuk, N. Sarma Barua, R.P. Borkakoty, Ranjan Das and S. Gogoi

Department of Plant Breeding & Genetics, Assam Agricultural University, Jorhat-785013, Assam

Six parental lines and fifteen crosses of brinjal (*Solanum melongena* L.) obtained from diallel mating were evaluated in randomized block design with three replications during *rabi* 2008-09. Sufficient genetic variation was observed for days to 50% flowering, days to 50% fruiting, fruits per plant, fruit yield per plant, leaf relative water content (LRWC), stomatal index (SI), leaf area, chlorophyll stability index (CSI) and net assimilation rate (NAR). High heritability was observed for the traits except the phenological traits. High heritability coupled with high genetic advance was observed for the traits *viz.* fruit yield per plant, fruits per plant, SI, CSI and NAR indicating preponderance of additive gene action for the traits.

04-86

PHYSICO-CHEMICAL CHANGES OF SOME EDDOE COLOCASIA CULTIVARS AT DIFFERENT STAGES OF MATURITY

P.C. Barua, P. Borah, P. Buragohain and P. Mahanta

Deptt. of Horticulture, Assam Agricultural University, Jorhat – 13

An investigation was carried out in the Post Harvest Technology and Quality Control Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat during 2007-08, with a view to estimate the physico-chemical changes associated with 10 (ten) Eddoe Colocasia cultivars, *viz.* Saonia, Tekeli, Gangamukhg, Panchamuky, Lasso, Ahina, Bormowa, Koni, Garo and Rangamuria at five different stages of maturity starting from 150 days after planting (DAP) to 210 days DAP. The highest corm weight was recorded in cv. Tekeli at 180 DAP and cormel weight in cv. Rongamuria at 210 DAP. An increase in dry matter % (corm + cormel), ascorbic acid and starch was observed with advancement in maturity and decreased after reaching a peak, which varied from cultivar to cultivar. The scores for mealiness and smoothness in most of the cultivars were higher, indicating good cooking quality of corm and cormels with relatively soft texture during the later stages of maturity i.e. 180 to 210 DAP. However, the scores for mealiness and smoothness in cv. Gangamukhi and cv. Rongamuria were lower at all stages of maturity compared to the other cultivars indicating their poor cooking quality.

04-87

MANAGEMENT OF STEM ROT OF RICE

M.S. Ali and P.C. Dey

Regional Agricultural Research Station, Titabar-785630, Assam

Experiments were conducted in the last two Kharif seasons, 2007-08 and 2008-09 for chemical management of stem rot of rice at RARS, Titabar. The disease is frequently occurred in the cultivated winter rice of Assam, Manipur, Arunachal Pradesh and other parts of the country. The variety Basundhara was grown and seven commercially available chemicals were taken as test fungicides *viz.* Antracol 75 WP, Companion 75WP, Dhanteam 75WP, Dhanustin 50WP, Indofil M-45 70WP, Rhizocin 3L and Sitara 5EC. Three sprays were given at the initiation of the disease followed by another two sprays at 15 days interval. Among the tested chemicals, Sitara @ 2ml/L (hexaconazol) was found to be the best chemical in respect of disease control and enhancement in yield. The disease severity (DS) was 31.3% against 70.4% in control. The grain yield was recorded 53% increase over control. In the second year (2008-09), the performance of the same formulation (hexaconazol) over the other chemicals *viz.* Mitominostrobin 20SC (3 concentrations), Sanit 75 WP (Metiram), Taqat 75WP (Captan + hexaconazol) was found to be superior. Disease incidence (DI) was 82% while in Contaf, it was only 34.8%. DS was only 9.6% against 73.35 in check. Increase yield over control was to the tune of 27%.



Significant differences were recorded in respect of all the parameters viz. DI, DS and yield by using the chemical formulation. The magnitude of less reduction in yield due to application of hexaconazol formulation might be attributed to its effectiveness in controlling the disease and thereby increasing the grain yield by translocation of assimilates from source to sink as evident from significant variations of harvest index as recorded 40-42% against 25-30% in control

04-88

ACCEPTABILITY TRIALS OF RECIPES PREPARED FROM FRESH AND PROCESSED MILKY WHITE AND OYSTER MUSHROOM FOR HUMAN NUTRITION

Mamoni Das*, M.C. Kalita and Y. Rathiah*****

Directorate of Extension Education AAU, Jorhat, ** Department of Food and Nutrition, College of Home Science, AAU, Jorhat, *Department of Plant Pathology AAU, Jorhat*

Mushrooms are assuming increasing importance as a source of food in view of their pleasing flavor, exotic preferences, nutritional and medicinal value. The Indian diet which is predominantly vegetarian and cereal-based has rich calories but suffers from deficient intake of good quality protein. It is universally accepted that the protein of mushroom can effectively supplement the cereals which are deficient in lysine. It is well recognized now that mushrooms being non-conventional source of protein can bridge the protein gap in the Indian diet. Keeping this in view popular traditional Indian recipes were selected for conducting acceptability trials by incorporating fresh as well as dehydrated milky white mushroom and oyster mushroom. Each of the five recipes namely garlic mushroom, mushroom do-piazza, sahi mushroom, mushroom vindaloo & mushroom dumplings were prepared with the two varieties of fresh and dehydrated mushroom. Acceptability trials were conducted using 7 point Hedonic scale by a panel of experts. The results revealed that recipes from fresh mushrooms registered better scores than the processed ones. In case of fresh mushroom variation was observed between varieties & recipes. The recipes prepared from oyster mushroom scored better compared to milky white mushroom. However, in case of mushroom –do-piazza acceptability score was at par. With respect to presentation technique the varieties did not exhibit any significant variation in terms of acceptability, color, taste, texture and flavor. In spite of differences in scores, the product were well accepted for both varieties and techniques.

04-89

EFFECT OF LEAF AREA ON PHOTOSYNTHETIC RATE AND SEED YIELD IN MUNGBEAN

A. Bhattacharya* and Vijaylaxmi**

*Division of Physiology, Biochemistry and Microbiology, Indian Institute of Pulses Research, Kanpur-208 024
*dra_bhattacharya@yahoo.com, **vijaylaxmi01@yahoo.com*

Sixteen mungbean [*Vigna radiata* (L.) Wilczek] genotypes were taken in field experiment during the *kharif* seasons on 2006 and 2007 at the Indian Institute of Pulses Research, Kanpur to evaluate the rate of photosynthesis of small and large leafed genotypes. The crops were raised in each year with recommended agronomical practices and proper plant protection measures were adopted as and when needed. The genotypes were monitored for leaf area and photosynthetic rates using leaf area meter (ÄT, United Kingdom) and rates of photosynthesis at flowering on randomly selected five plants in each replication with Infra Red Gas Analyzer (IRGA, CRIS-1, USA), respectively. The sixteen mungbean genotypes were divided on the basis of their leaf size in two categories. The small leaves size (8) genotypes are PDM 139, PDM 54, IPM 99-4, MUM 2, K 851, Asha, HUM 1, IPM 03-1, and large leaves size (8) are PDM 11, Pusa vishal, Narendra Mung 1, SML 668, IPM 99-125, Pant M-4, V 3518, ML 729. It was observed that genotypes with lesser leaf area exhibited comparatively lower photosynthetic rate as compared to higher leaf area. Effect of photosynthetic rate on seed yield (kg/ha) of mungbean genotypes was found to be linear *i.e.*, seed yield increased with every increment in photosynthetic rates in mungbean genotypes.



Session 05

Molecular Biology and Plant Tissue Culture



05-01

DIRECT AND CALLUS MEDIATED PLANT REGENERATION FROM SHOOT-TIP AND NODAL EXPLANTS OF *Vernonia divergens*

M. Naseem, M. Nizamuddin Ansari, Anand Prakash, M. Sarfraz Ahmad and Chandan Kumar Singh
Tissue culture lab, Univ. Department of Botany, B.R.A. Bihar University, Muzaffarpur-842001

Medicinal plants are in demand since the beginning of human civilization and the plants products feature prominently in traditional therapeutics. The prevalence of diabetes in India is showing a sharp upswing. There are large number of plants which are recommended for it treatment is herbal system of medicine. *Vernonia divergens* Benth (Fam. Asteraceae) commonly known as Insulin plant is a potent sugar killer and is used as an excellent medicine for diabetes mellitus. This plant has a restricted distribution in Muzaffarpur and some diabetic people grow this plant in their courtyard. Keeping in view its immense medicinal uses, tissue culture studies on this plant were being under taken to develop a simple protocol for micropropagation as well as to analyze its biochemical constituents. Direct and callus mediated shoot regeneration were obtained using shoot-tip and nodal segments of *Vernonia divergens* as dxplants. Explants taken from in vivo grown plant (2 years old) were cultured on MS (Murashige & Skoog, 1962) medium containing 3% sucrose, 0.8% agar and different combination and concentration of auxins (2,4-D, NAA) and kinetin (Kn). Techniques have been developed for direct shoot regeneration using nodal & shoot-tip explants. Callus mediated shoots were also obtained on Kn and NAA supported media on subculture. Optional response was obtained on 2mg l^{-1} Kn, 2,4-D ($1\text{-}5\text{mg l}^{-1}$) alone or 2,4-D+Kn resulted in callus differentiation from both the explants. Callus was creamy white, hydrated and crystalline in appearance. Callus turned brown on higher concentration (above 5mg l^{-1}) of 2,4-D subculture. Experiments for rooting and complete plantlet formation are in progress. Explants taken during Dec-Mar were highly responsive.

05-02

IN VITRO PLANT REGENERATION IN *ALSTONIA SCHOLARIS* BY NODAL AND SHOOT-TIP CULTURE

Md. Naseem, Anand Prakash, Md. Nizamuddin Ansari, Chandan Kumar Singh and S.N. Sharma
Tissue culture lab, Univ. Department of Botany, B.R.A. Bihar University, Muzaffarpur-842001

Forest trees represent renewable natural resources and sustained forest yield whether for lumber and bio-energy is dependent on reforestation programme. In this background in vitro propagation offers the potential for rapidly increasing free clones for reforestation and conservation. *Alstonia scholaris* Brown (Fam. Apocynaceae) commonly known as Chatwan is a highly medicinal evergreen tree which is in demand for the cure of malaria, cold fever, toothache, rheumatism and snake-bite. Bark of this tree is used as medicine. In order to develop protocol for micro propagation, nodal and shoot-tip explants were cultured in vitro. Nodal (5-10 mm) and shoot tip (8-10 mm) explants taken from 10 years old tree were cultured on MS (Murashige & Skoog, 1962) medium containing 0.8% agar, 3% sucrose and different combination and concentration of auxin (2,4-D, NAA) and Kinetin (Kn). Hormones were used within a concentration range of $1\text{-}10\text{ mg l}^{-1}$. Direct shoot regeneration was obtained using node and shoot-tip explants on Kn ($2\text{-}5\text{ mg l}^{-1}$) supplemented media. Kinetin (Kn) alone was most effective and induced the formation of direct shoots from nodal explants in culture. Highest % of result was obtained on 2 mg l^{-1} Kn + NAA resulted in shoot formation from the callus. Callus was greenish-white, compact, hydrated and crystalline in appearance. Best callus growth was obtained on 5 mg l^{-1} 2,4-D and 3 mg l^{-1} each of 2,4-D + 2 mg l^{-1} Kn. Higher concentration (above 5 mg l^{-1}) of hormones was inhibitory for differentiation and regeneration. Bulging in explants was prominent prior to callus formation. Experiments for rooting of the regenerated shoots to form complete plantlets are in progress. Effect of seasonal variations on in vitro response of the explants was also studied.



05-03

IN VITRO CALLUS INDUCTION AND REGENERATION IN WITHANIA SOMNIFERA

Ankita Chandola, S.C. Shankhdhar and Deepti Shankhdhar

*Department of Plant Physiology, College of Basic Sciences & Humanities, G.B. Pant University of
Agriculture & Technology, Pantnagar-263145 (Uttarakhand)*

Withania somnifera (solanaceae) has wide application in medicinal drugs, contains various biologically active chemical constituents like alkaloids, steroidal lactones etc. Due to these it has the continuous great demand and categorized as endangered species. It is necessary to conserve their genetic potential in terms of morphological, biochemical and molecular markers. The commercial cultivation of *Withania somnifera* has the problems related to variation in quality and quantity of these active constituents. In vitro propagation is a useful tool for conservation and multiplication of medicinal plants. To develop a protocol for the in vitro multiplication of *W. somnifera* variety Poshita, callus cultures were initiated from nodal segments and cotyledonary leaf segments on Murashige and Skoog (MS) medium supplemented with various concentrations and combinations of NAA and kinetin (KN). MS medium supplemented with NAA (1.0 mg/l) and kinetin (1.0 mg/l) was found to be most effective for callus induction (92.85%) and proliferation from leaf explants, but the frequency of callus obtained from nodal explants was found to be very low (30.76%). The same concentration in MS medium was found to be effective in direct regeneration from nodal explants. MS medium supplemented with BAP (1 mg/l) and kinetin (2.5 mg/l) exhibited only initiation of regeneration through callus obtained from leaf explants. It seems that nodal explants were most effective for direct regeneration than leaf explants. NR activity, nitrogen and protein content were estimated 30, 60 and 90 days after inoculation. 60 days old callus contained maximum NR activity (0.90 UM/g fresh weight), nitrogen (1.36% fresh weight) and protein content (2.25 mg/g fresh weight) in comparison to 30 days and 90 days old callus.

05-04

IN VITRO MULTIPLICATION AND FIELD DEMONSTRATION OF MICROPROPAGATED PLANTING MATERIAL OF DENDROCALAMUS ASPER, AN EDIBLE BAMBOO

Rohtas Singh, Sharbati R. Singh, Naveen Malik, Rajwant K. Kalia and A.K. Dhawan

*Centre for Plant Biotechnology (HSCST, DST, Haryana), CCS HAU New Campus, Hisar-125004
rajwantkalia@yahoo.com*

Dendrocalamus asper, a bamboo species, is valued for its edible, tender shoots as also for fiber and ornamental landscapes. The food industry based on these young shoots is expanding rapidly. However, the available methods for its propagation are time, cost and labour intensive in addition to being season dependent. Therefore, to cater the growing demand for bamboo planting material, a highly reproducible, field-tested and cost effective micropropagation protocol has been developed. Nodal segments used in this protocol showed direct shoot proliferation on Murashige and Skoog's medium supplemented with 1.0 - 4.0 mg/l benzyl adenine (BA) with 2.0 mg/l showing optimal response (8-12 shoots within 4-weeks). Proliferating shoot cultures were further multiplied by sub culturing clumps of 6-10 shoots each on cytokinin supplemented medium. Addition of adenine sulphate (AdS) improved the multiplication rates and 3 - 4 fold multiplication was achieved on MS medium + 2.0 mg/l BA + 5 mg/l AdS. Clumps of 2-4 elongated shoots (3-6 cm long) showed 100% rooting within 8-10 days on half-strength MS medium containing 1.0 mg/l IBA and 1.0 mg/l NAA. Rooted shoots were successfully hardened and acclimatized with 90-95% success in soil and vermicompost (3:1) mixture. After hardening, these were transferred to the soil where they exhibited normal growth. Replacement of sucrose with table sugar during multiplication and rooting further reduced the cost of production. A better growth and



development of the plants was achieved when FYM + urea was used as nitrogen source. With the optimized conditions, more than 10,000 plants can be produced annually from one nodal segment. So far more than 25,000 tissue culture raised plants of *D. asper* have been provided to the forest Department, Haryana under DBT funded bamboo mission. This study has unequivocally demonstrated the potential of tissue culture technique for commercial production of *D. asper*.

05-05

CHARACTERIZATION OF ABIOTIC STRESS SPECIFIC GENES CLONED FROM STRESS ADAPTED CROP PLANT, *Arachis hypogaea* L.

V. Pruthvi and Karaba N. Nataraja

Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore 560065
nataraja_karaba@yahoo.com

Plants experience various kinds of biotic and abiotic stresses during different stages of growth and development. In India, amongst different abiotic stresses, drought which causes more than 50% decline in crop yield is a major threat for productivity. Plant adaptive mechanism to stresses are complex, and different types of stress related genes, both upstream regulatory and downstream functional proteins are reported to be activated upon stress induction. Since stress resistance is controlled by multiple genes, the major focus now is to examine the relevance of upstream factors like transcription factors (TFs) which coordinate the expression of various downstream genes. It is believed that stress specific TFs from resistance plant (e.g., peanut) are ideal of manipulation of candidate crops by overexpression approach. From this context, in the present study, two upstream genes, MYB and NF-Y were cloned from peanut (*Arachis hypogaea* L) to examine their relevance in stress tolerance. These two genes were initially subjected for e-northern analysis using database information, which were found to highly stress responsive. To study the expression pattern of these stress genes in peanut, seedlings were exposed to different level of PEG, NaCl and stress hormone ABA induced stress, and samples were collected at different time points. Total RNA was isolated from the non-stressed and stressed seedlings and used for transcript analysis by semi-quantitative RT-PCR. There was up-regulation of both MYB and NF-Y genes upon stress induction as evidenced by increased expression under stress. The results indicated stress responsive nature of the genes, which may have specific role in imparting stress resistance.

05-06

SALT INDUCIBLE ISOFORM OF PLASMA MEMBRANE H⁺ATPASE GENE IN RICE REMAINS CONSTITUTIVELY EXPRESSED IN NATURAL HALOPHYTE, *Suaeda maritima*

Binod Bihari Sahu and Birendra Prasad Shaw

Environmental Biotechnology Laboratory, Institute of Life Sciences, Nalco Square, Bhubaneswar-751023

To look into a possible involvement of plasma membrane H⁺ATPase (PM-H⁺ATPase, EC 3.6.3.6) in mitigation of physiological disturbances imposed by salt stress, response of the enzyme was studied in two *Oryza sativa* Indica cultivars, salt-tolerant Lunishri and non-tolerant Badami, and a natural halophyte *Suaeda maritima* (L.) Dumort. after challenge of the young plants with NaCl. Significant increase in activity of the enzyme was observed in response to NaCl in all the test plants with *S. maritima* showing maximum increase. Protein blot analysis, however, did not show any increase in amount of the enzyme (protein). RNA blot analysis on the other hand revealed significant increase in transcript level of the enzyme upon NaCl treatment. In the rice cultivars salt treatment also induced expression of a new isoform of PM-H⁺ATPase gene, not reported so far. The induced transcript showed maximum homology to OSA7 (*Oryza sativa* PM-H⁺ATPase isoform 7). Similar



transcript message, however, remained constitutively present in *S. maritima*, along with transcript of another isoform of PM-H⁺ATPase showing resemblance to *OSA3* (*Oryza sativa* PM-H⁺ATPase isoform 3). The latter was the only PM-H⁺ATPase isoform expressed in both the rice cultivars not exposed to NaCl. In the salt treated test plants, both rice and *S. maritima*, the salt inducible PM-H⁺ATPase isoform resembling *OSA7* was expressed in much greater amount than that resembling *OSA3*. Appearance of a new PM-H⁺ATPase transcript, besides increase in the enzyme activity, indicates important role of the enzyme in maintaining ion-homeostasis in plants under salt stress enabling them to survive under saline condition

05-07

DO MALE PARENTS DECIDE MONO OR MULTI HEADS IN SUNFLOWER HYBRIDS?

B. Mohan Raju*, M. Mahadeva Murthy, Y.G. Shadakshari¹, T.G. Prasad, M. Udaya Kumar and
R. Uma Shanker

Dept. of Crop Physiology and ¹AICRP (Sunflower), UAS, GKVK, Bangalore-65

Axillary buds initiation/ multi headedness has become one of the serious problems in sunflower hybrids these days. Although loss of apical dominance due to environmental cues has been considered to be the prime reason for multi headedness in plants, it is not clear so far as to why and how these axillary buds/ multi heads are produced in most sunflower hybrids. However it appears that, due to both physical and physiological stresses, the axillary buds are induced as a sort of insurance to continue their progeny. This is true because, our experiments showed that, the plants exposed to moisture stress, nutrient stress, flooding or combination of all of these stresses resulted in more number of plants with axillary buds/ multi heads. Although stress triggers the production of axillary buds in sunflower hybrids, the trait should come from either of the parents. In this context, the sunflower hybrids derived from mono headed and multi headed male parents were evaluated for axillary buds/ multi headedness. Accordingly, sunflower hybrid derived from mono head male parent showed no axillary buds, while hybrid derived from multi headed male parent exhibited significantly very high percentage of plants with rudimentary axillary buds (more than 90% of the plants with 5 to 6 buds in each plant). Thus, it is very clear that, even though stress triggers the production of axillary buds, the trait should invariably come from either of the parents. In order to control/ suppress the axillary buds, different suckericides were used. Suckericides are known to suppress the growth of side branches in few crops including tobacco. Application of suckericides on the axillary buds resulted in drying of buds within about 48 hours. In fact, almost 90-100% of the suckericide treated buds dried up to indicate the death of axillary buds due to physical killing of buds by the suckericides. Although these buds were rudimentary, its impact on seed yield was checked and found that, the seed yield was not reduced due to the axillary buds. However, in another experiment with prominent axillary buds/ multi heads, significant yield loss was noticed. From the results, we can conclude that, if the axillary buds are rudimentary, one doesn't need to take measures to control the axillary buds, while certainly it is required if they are prominent.

05-08

CYANOGENIC GLYCOSIDES IN FERMENTED BAMBOO SHOOT SLICES

Kananbala Sarangthem

*Department of Life Sciences, Manipur University, Canchipur, Imphal-795003, Manipur
kananbala_s@rediffmail.com*

Fresh Bamboo shoots are traditional component of Asian cuisine. Its consumption increases world wide expanding from the Oriental to Western world and a health warning is appropriate as bamboo contain Cyanogenic glycosides which are phytotoxins occurring as secondary plant metabolites in nature. The cyanogenic glycosides present in bamboo shoots are Taxiphyllin. Taxiphyllin is hydrolysed to glucose and hydroxybenzaldehyde



cyanohydrin. This benzaldehyde cyanohydrin then decomposes to hydroxy benzaldehyde and Hydrogen cyanide (HCN) which can cause both acute and chronic toxicity. In Manipur, India the fresh succulent bamboo shoot slices, locally called 'Soibum' is a highly prized vegetable item. By adequate processing of bamboo shoots (edible bamboo shoots of *Bambusa balcooa*, *B. tulda*, *Dendrocalamus hamiltonii*, *D. strictus*, *Melocanna bambusoides* etc.) like peeling, slicing, fermenting, repeated washing, boiling and cooking, the cyanogenic glycosides and HCN can be reduced prior to consumption, thus significantly reducing the potential health risk.

05-09

ELICITATION OF BACOSIDE A PRODUCTION IN SHOOT AND CALLUS CULTURES OF *Bacopa monniera* (L.) Pennell. BY AMMONIUM NITRATE, SUCROSE AND SOME STRESS-RELATED COMPOUNDS

T.D. Nikam* and A.P. Parale

Department of Botany, University of Pune, Pune – 411 007, Maharashtra
tdnikam@unipune.ernet.in

The influence of ammonium nitrate ($0.1-1.6\text{g l}^{-1}$), sucrose ($30-70\text{g}^{-1}$) and stress-related compounds, copper sulphate ($25-125\mu\text{g}^{-1}$), zinc sulphate ($8.2-43\text{ mg}^{-1}$), NaCl ($0 - 2\text{g}^{-1}$), sorbitol, mannitol ($0 - 0.4\text{M}$) and salicylic acid ($0- 200\mu\text{M}$) on bacoside production was studied in shoot and callus cultures of *Bacopa monniera* (L.) Pennell. The earlier standardized protocol was used for callus culture and shoot culture established from leaf explants on MS medium containing $5\mu\text{M}$ NAA together with $1\mu\text{M}$ 2, 4-D and MS medium fortified with $5\mu\text{M}$ BA respectively. The reduced concentration of ammonium nitrate (400 mg^{-1}) together with increased concentration of sucrose (50 g^{-1}) in the MS medium was most efficient for production of biomass and bacoside A. Comparatively, other supplements were inferior for both biomass and bacoside accumulation. Bacoside A accumulation in the regenerated shoots ($45.8 \pm 1.8\text{ mg g}^{-1}\text{ D.W.}$) was significantly higher than that in the callus ($17.0 \pm 1.1\text{ mg g}^{-1}\text{ D.W.}$) and more to than in the parental plants ($28.7 \pm 1.0\text{ mg g}^{-1}\text{ D.W.}$). In conclusion, the shoot cultures in the presence of low concentration of ammonium nitrate in MS medium provide efficient production of bacoside A in *Bacopa monniera* (L.) Pennell.

05-10

UNDERSTANDING ISOPROTURON RESISTANCE MECHANISM IN *PHALARIS MINOR* FOR SUSTAINABLE AGRICULTURE

Moni Gupta, A.K. Tiku and S.A. Mallick

Division of Biochemistry & Plant Physiology, Sher-e- Kashmir University of Agricultural Sciences & Technology- Jammu, Main Campus, Chatha, Jammu, J&K-180009

Weed infestation adversely affects crop production both quantitatively and qualitatively by reducing yields and decreasing market price of the crop. Simple economics dictates that for cost-effective land use, crop yield and price must be maximized and the cost of weed control must be minimized. *Phalaris minor* is one of the most predominant and troublesome weed of wheat crop. It is morphologically similar to wheat plant until it attains the flowering stage thus is very difficult to be identified during the seedling stage and hence herbicide application is the only answer for weed control. Excessive use of isoproturon in wheat fields has caused resistance against weed, which have become detrimental for wheat crop. Metabolic detoxification and modification of herbicide binding site (D1 protein of chloroplast) have been predicted to be major mechanism conferring resistance in *P. minor* against isoproturon. D1 protein is encoded by chloroplast genome (psbA gene) and Cyt P₄₅₀ mediated detoxification of isoproturon is encoded by nuclear genes. Managing herbicide resistant weeds requires a good understanding of the genetics of resistance. In this paper an attempt has been made to understand the isoproturon resistance mechanisms at molecular level involved in *P. minor* with respect to gene or genes involved.



05-11

**DEVELOPMENT AND STANDARDIZATION OF MULTIPLE SHOOT INDUCTIONS PROTOCOL
IN *Morus indica* var. V1.**

S. Jeba Singh, R.S. Sajeevn, P. Chandrashekar Reddy and Karaba N. Nataraja

*Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore 560065.
nataraja_karaba@yahoo.com*

Sericulture is an important agro-based industry providing employment and earning foreign exchange. Over 90% of Indian silk is *Mori* silk, produced from silkworm *bombyx mori* and the most popular host plant is mulberry (*Morus alba* and *M. indica*). Since cultivated *Bombyx* solely feeds on mulberry, improvement in mulberry varieties plays a vital role in progress of sericulture industry. Besides molecular breeding programs, transgenic approaches are being attempted to improve specific traits in mulberry. The prerequisite for transgenic approach is the development of efficient mulberry tissue culture and transformation protocols. In the present study, an attempt has been made to develop reproducible tissue culture protocol for quick regeneration of V1 variety of mulberry. Nodal explants excised from field grown plants were cultured on medium supplemented with different concentrations and combinations of various plant growth regulators. Nodal explants on Murashige and Skoog (MS) medium supplemented with different concentrations of BAP, TDZ and NAA produced an average of six shoots per node. The protocol developed is reproducible and can be effectively used for plant propagation as well as *Agrobacterium* mediated plant transformation.

05-12

**DEVELOPMENT AND VALIDATION OF GENE CASSETTE FOR OVEREXPRESSION OF
MULTIPLE GENES TO IMPROVE ABIOTIC STRESS TOLERANCE**

K.S. Shailesh, S.V. Ramu, Kiran Ghanti, H.V. Rame Gowda, M. Udayakumar and Karaba N. Nataraja

*Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore 560065
nataraja_karaba@yahoo.com*

Environmental stresses limit crop plant growth and productivity, and threaten the sustainability of agriculture. Plants evolved various stress tolerant mechanisms by coordinated expression of stress-responsive genes under stressful conditions and hence any attempts to induce coordinated expression of stress genes would be useful. One of the options in this direction would be to stack stress genes using modern molecular biology approaches. From this context, in the present study, transgenic groundnut (*Arachis hypogaea*) plants over expressing multiple genes were developed through a bacteriophage (ϕ) based site specific recombination system called Multisite Gateway cloning technology. Three gene cassette including G Box binding factor (stress responsive transcription factor, EcGBF1), 5-Enol-pyruvylshikimate-3-phosphate synthase (EPSPS) gene imparting Glyphosate resistance and DNA unwinding enzyme PDH45 driven by individual promoter and terminator were put together into a single destination vector system for developing a multigene expression system. The multigene expression system was further mobilized into groundnut via *Agrobacterium* mediated gene transfer technique. A novel tissue culture method was developed and standardized to transform groundnut using cotyledonary nodes. Molecular characterisation of the putative transgenics lines confirmed the integration of all the three gene cassettes. The pattern of expression of transgenes was tested by RT-PCR analysis. The putative lines were also evaluated for their resistance to herbicide, glyphosate and all the transformed lines showed tolerance to the herbicide. The transgenic lines overexpressing the stress genes (EcGBF1 and PDH45) showed improved tolerance to methyl viologen induced oxidative stress compared to the wild type plants. The results indicated multi-gene integration and stable expression. The approach standardized in this study would be useful for stacking genes to improve stress resistance.



05-13

IN VITRO PROPAGATION OF *PHAIUS TANKERVILLIAE* (AITON) BL.

Nabami Basumatary* and C.M. Sarma

Department of Botany, Gauhati University, Guwahati- 781014, Assam

An efficient multiplication system based on seed culture *in vitro* is reported for *Phaius tankervilliae*. The present investigation was carried out on two nutrient media viz. MS and VW supplemented with same concentration combinations of auxins, cytokinin and CH. VW medium favoured better seed germination and seedling growth than the MS medium. VW medium supplemented with IAA, IBA and Kinetin (0.1 mg/L each) showed highest (90-95) percentage of seed germination.

05-14

BIOCHEMICAL MARKERS FOR DETERMINATION OF EMBRYONIC AND NON EMBRYONIC CALLUS OF *Clerodendrum phlomidis*

Zankhana Rathod, Santoshkumar Singh and O.P. Saxena

*Plant Tissue Culture Laboratory, Botany Department, University School of Sciences, Gujarat University, Navrangpura, Ahmedabad - 380009
zankhana_rathod1@hotmail.com*

Clerodendrum phlomidis L (Arni) is a medicinal plant used in the treatment of diabetes mellitus. Enzymatic studies have been carried out to differentiate between embryonic and non embryonic callus at very early stage of culture in the present study. *In vitro* experiments were conducted using leaf as an explant. Non embryonic and embryonic callus were cultured on MS basal media supplemented with various combination of 2,4-D : kinetin (1:1, 2:2, 3:3, 4:4, 5:5 mg/l). A large variation was observed in the culture owing to two hormonal variations. Medium with higher hormonal concentration i. e. 5 mg/l 2,4-D and 5 mg/l kinetin resulted in somatic embryoids while lower concentration resulted in non embryonic cells. In two week old culture peroxidase and polyphenols oxidase activity increases in non embryonic callus and decreases in embryonic callus. While IAA oxidase and peroxidase activity decreases in non embryonic callus and increases in embryonic callus. Total amylase activity increases in wall bound fraction of non embryonic callus and decreases in embryonic callus. On the bases of above study enzymes could serve as a biochemical marker to determine the embryonic and non embryonic callus at very early stage of culture.

05-15

MICROPROPAGATION OF *Clerodendrum colebrookianum*, A MEDICINAL PLANT WITH GRATE FUTURE PROSPECTIVE FROM NORTH EAST INDIA

Papori Devi* and C. M. Sarma

*Tissue Culture Laboratory, Department of Botany, Gauhati University
* Department of Botany, Arya Vidyapeeth College, Guwahati-16*

In *in vitro* propagation of *Clerodendrum colebrookianum* (L.) Walp., one major problem is that slight rise in the auxin concentration in the media reduces organogenesis and in reduced auxin concentration the explants fails to show any development and dies. The solution lies in the use of high concentration of cytokinin along with moderate concentration of auxin. Procedures were developed to overcome this problem by culturing single node of aerial stem with auxiliary buds in two commonly used media, Murashige and Skoog medium and Gamborg B₅ supplemented with different combinations of PGRs – two Cytokinins, kinetin and BA and two



Auxins, NAA and IBA. The results were encouraging and direct regeneration was obtained in 2.0+0.5µg/ml of Kinetin and NAA, 1.5+0.5+0.1µg/ml and 2.0+0.5+0.1µg/ml of Kinetin, NAA and IBA, 2.5+0.5µg/ml of kinetin and 2,4-D. But, with slight increase in auxin concentration as in 1.5+0.5+0.5µg/ml of Kinetin, NAA and IBA no organogenesis was observed and explants could not develop on lowering the auxin concentration even with high kinetin as in 2.0+0.1µg/ml of Kinetin and NAA and 2.5+0.1µg/ml of kinetin and 2,4-D.

05-16

PRELIMINARY STUDIES ON THE CYANOGENIC GLYCOSIDES CONTENT OF *Dendrocalamus hamiltonii*

Hoikhokim and Kananbala Sarangthem

Department of Life Sciences, Manipur University, Canchipur, Imphal, Manipur- 795 003.
kananbala_s@rediffmail.com

Bamboo is a well-known plant all over the world. It is particularly popular among the Mongoloids. Bamboo shoots are important dietary items of the people of Manipur. The emerging succulent bamboo shoots are harvested and used as vegetables. In Manipur some bamboo shoots are finely grated and used in salad, soup or salted water for use in assorted dishes. Bamboo shoots contain cyanogenic glycosides that break down to produce hydrogen cyanide which can cause both acute and chronic toxicity in humans. Thus, the level of cyanogenic glycoside contents in the species *Dendrocalamus hamiltonii* i.e., from the leaves, inflorescence, roots, seeds, fresh succulent shoots (apex middle base) and finely sliced shoots after boiling for half an hour and after soaking with sodium bicarbonate were assayed. Cooked shoots which is ready for consumption were screened out. It was found that the hydrogen cyanide contents become more or less negligible and cause no health risk to the consumers.

05-17

BIOACTIVE COMPONENTS FROM CURCUMA SPECIES FOUND IN MANIPUR

Mangvung Jamkhoneng Haokip and Kananbala Sarangthem

Department of Life Sciences, Manipur University, Canchipur, Imphal, Manipur- 795 003.
kananbala_s@rediffmail.com

Curcuma species are a well-known indigenous herbal medicine in Manipur, India. They are used for the treatment of various types of diseases. Therefore, the present study is done for the screening of bioactive secondary metabolites such as total phenols, flavonoids, alkaloids and tannin, since secondary metabolites are involved in plant's protection against biotic and abiotic stresses. Results showed wide variation among the species of curcuma (*Curcuma longa*, *Curcuma caesia*, *Curcuma amada*, *Curcuma angustifolia* etc). Total phenolic content, flavonoids and tannin are highest in *Curcuma longa* and alkaloids content in *Curcuma caesia*.



05-18

GENETICALLY STABLE SHOOT REGENERATION IN LEAF DERIVED CALLUS OF *URARIA PICTA* (JACQ.) DC.

M.L. Ahire¹, S.G. Ghane¹, V.H. Lokhande^{1,2}, P. Suprasanna² and T.D. Nikam^{1*}

¹Department of Botany, University of Pune, Pune – 411 007

²Functional Plant Biology Section, Nuclear Agriculture & Biotechnology Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, M.S
tdnikam@unipune.ernet.in, mlahire@gmail.com

Uraria picta (Jacq.) DC. (Pithvan or Prishnaparni; Fabaceae) is an important medicinal woody herb, used in an Ayurvedic preparation 'Dashmula' and more than 40 other Ayurvedic formulations. The utilization of roots by uprooting the entire plants and the problems associated with the seed germination leads to the plant become rare and endemic. The aim of the present study was to develop an efficient plant regeneration protocol for shoot organogenesis from callus cultures obtained from mature leaf explants in *U. picta*. Induction of organogenic callus was achieved on Murashige and Skoog (MS) medium fortified with cytokinins alone and in combination with auxins. Further, the organogenic callus differentiated into primordia, shoots and shoot elongation was achieved on MS medium supplemented with 4.44 μ M BA alone. Optimum number of shoots per culture was observed on the same medium as compare to the MS medium supplemented with other concentrations of BA alone and in combination with auxins. The elongated shoots on transfer to the MS medium in combination with NAA and IAA shows rooting but it was associated with callus formation at the cut ends. The shoots on MS basal medium with 3% sucrose show rooting without any swelling and callus formation at the cut ends. The well developed plantlets were hardened in soil + sand (1:1) mixture. Analysis of regenerated plants using random amplified polymorphic DNA (RAPD) confirmed the genetic stability of these plantlets.

05-19

EFFECT OF VARIOUS FACTORS ON MICROPROPAGATION OF *RUTA GRAVEOLENS* FROM NODAL EXPLANTS

Sagarika Bohidar¹, M. Thirunavoukkarasu^{1*} and T. Venkatesh Rao²

¹Natural Products Department, Institute of Minerals and Materials Technology, (Council of Scientific & Industrial Research) Bhubaneswar, 751013

²School of Life Sciences, Sambalpur University

A rapid and efficient method for mass propagation of *Ruta graveolens* has been developed from nodal explants. The effects of different plant growth regulators, additives, seasons and composition of basal media on excised nodal segments were studied. Application of a mixture of citric acid and ascorbic acid (75 mg/l and 50 mg/l respectively) was found effective in controlling phenolic exudation and consequent browning of explants. Winter season was found to be better for explant establishment and induction of multiple shoots. Murashige and Skoog medium proved to be more effective than Gamborg's B5 medium in terms of frequency of shoot induction and proliferation. The maximum number of shoots (35.36 ± 2.55) was obtained in Murashige and Skoog medium supplemented with 4.4 μ M benzyl adenine. *In vitro* derived shoots exhibited better rooting on medium containing half-strength MS + 4.9 μ M IBA. After 3 weeks of hardening they were established in the field with 100 % survival.



05-20

FACTORS AFFECTING *IN VITRO* GROWTH AND PROPAGATION OF PAPAYA (*CARICA PAPAYA*) VAR. RED LADY

J.R. Patel, R.M. Patel, K.A. Sinde, B.K. Dhaduk and R.R. Shah

Department of Biotechnology, Navsari Agricultural University, Navsari-396450 (Gujarat)
rameshpatel1960@yahoo.com

The present investigation was carried out on “Micropropagation in papaya” with objective to standardize the micropropagation technique for large scale multiplication during the year 2006-08. While, standardizing the method of micropropagation in papaya cv. Red Lady, the factors influencing *in vitro* growth and proliferation of papaya were examined. Different factors studied were types of explants (2); surface sterilant (HgCl_2 -6 levels); pH (6-levels); sucrose (5-levels); adenine sulphate (4-levels) and light intensity (3-levels). The results revealed that the establishment of explants were influenced by surface sterilization treatments and types of explants used. The surface sterilization treatment was found better for shoot tip explants at HgCl_2 (0.1%) treatment for 3 minutes, while, in case of axillary bud explants, better response was noticed at HgCl_2 (0.1%) treatment for 10 minutes. The pH 5.7 of the medium recorded maximum multiplication of shoots with high proliferation. Sucrose at 3 % in medium was reported optimum level for inducing high frequency of multiplication and proliferation of shoots. Adenine sulphate at 160 mg/l in medium registered maximum multiplication of shoots with high proliferation. High light intensity (3000 Lux) was found most suitable for proper growth of regenerated shoots.

05-21

MONITORING OF OXIDATIVE STRESS BY HIGHER PLANTS

Sunita Kumari and Chirashree Ghosh

Centre for Environmental Management of Degraded Ecosystems, School of Environmental studies,
University of Delhi, Delhi-110 007

Rapid growth in the urbanization and energy demand has caused one of the most serious threats to the living organisms is the presence of various air pollutants in atmosphere. The pollutants emitted from various sources not only have adverse impact on human beings but also have one or the other physiological impact on plants. In the present study, stress level caused by the pollutants present in ambient air to roadside tree species in Delhi has been analyzed by estimating pigment content (chl *a*, chl *b* and total carotenoids), ascorbate (ASC) and dehydroascorbate (DHA) content in three plant species naming *Casia siamea*, *Delonix regia* and *Pongamia pinnata*. In *C. siamea* and *P.pinnata*, DHA were higher (1.1–12.9 and 0.6 – 9.2 mg g⁻¹ f.w. respectively) in comparison to ASC (0.5–4.7 and 0.3–1.4 mg g⁻¹ f.w.). In *D. regia*, ascorbic acid content was higher (0.04–10 mg g⁻¹ f.w.) than DHA (0.7–3.9 mg g⁻¹ f.w.). Their relation with air pollutants were further established using regression analysis and correlation coefficients. Total ascorbate of *C. siamea*, was significantly associated with O₃. With *P. pinnata*, no variable was significant with any physiological parameters. Total chlorophyll of *D. regia* was significant to NO₂ and O₃.



05-22

BUD CULTURE OF *STRELITZIA REGINAE* AIT. BY CONTROLLING OXIDATIVE BROWNING

S. Bora, L. Paswan*, P. Mahanta* and H. Choudhury

Department of Horticulture, B.N. College of Agriculture, AAU, B. Chariali-784176, Sonitpur, Assam

*Department of Horticulture, AAU, Jorhat – 785013, Assam

The terminal buds of *Strelitzia reginae* Ait. Derived from rhizomes were successfully established in modified Murashige and Skoog (MS, 1962) medium supplemented with 4 mg/l BAP, 1 mg/l NAA, 2 mg/l IBA and 30 mg/l Ad-SO₄ with continuous subculture at 10 days interval. In the media, more than three-fold increase in length and more than double in breadth of the buds were recorded after 6 weeks of culture. Before culture, the buds were treated with antioxidant solution by total submergence for 12 hours containing 0.5% ascorbic acid with 10 mg chloramphenicol and oxytetracyclin. Medium supplemented with 4 mg/l PVP and 10 mg/l ascorbic acid and a continuous sub culture to a fresh medium at every 1 week interval was found to have controlled the exudation of phenol IC compounds.

05-23

AN INSILICO APPROACH IN ANALYSING THE Cu/Zn SUPEROXIDE DISMUTASE IN *Oryza sativa*: TOWARDS GENERATING STRESS TOLERANT RICE CULTIVARS

Budheswar Dehury, Sarangthem Vivek, P. Sen, M.K. Modi and Madhumita Barooah*

Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat

*m17barooah@yahoo.co.in

Superoxide dismutase (SOD; EC 1.15.1.1) is a ubiquitous enzyme of metalloenzymes family. It is an indispensable enzyme that catalyses the first step in reactive oxygen species (ROS)-scavenging systems by conversion of superoxide anion radicals to hydrogen peroxide and molecular oxygen and protects almost all living cells against oxidative stress generated under aerobic conditions. Cu/Zn SOD with Accession No: 2111424A, which was taken from rice and searched against Nr database using BLASTP from NCB, resulted in 133 hits. Sequences producing significant alignments with Cu/Zn SOD such as SOD1 from *O. sativa*, SOD4 of *Zea mays*, SOD9 of *O. indica* and SOD from other plant species were chosen for Multiple Sequence Alignment (MSA) based on their e-value and bit score. Results of the analysis were used for constructing a phylogenetic tree using CLUSTALX, PHYLIP and MEGA. The resulted tree showed trichotomy with 3 clusters. The sub-clusters displayed strong bootstrap values to indicate their ancestor. A 3-D reliable model of the enzyme was constructed and assessed by verified and PROCHECK program. This stable structure can be further assessed for docking of substrate, which will provide information of the conserved amino acid residues that play an important role in maintaining functional conformation of the enzyme. The results are expected to provide understanding and increasing the potential of SOD in removing ROS from stressed plants.

05-24

PLANT REGENERATION FROM CALLUS CULTURE OF *Vanda tessелеta* (Roxb.) Hook exG

Munu Devi*¹ and J. Sharma

Department of Botany, St. Anthony's College, Shillong-793 001, Meghalaya

*¹Department of Biotechnology, Assam Agricultural University, Jorhat -13

Totipotent calli of *Vanda tessелеta* (Roxb.) Hook exG, an epiphytic orchid, were induced from leaf base of *in vitro* raised seedlings on Murashige and Skoog medium supplemented with 1mg/l 2,4 Dichlorophenoxy acetic acid (2, 4 D). The calli could be maintained by sub-culturing in Murashige and Skoog medium supplemented with 1 mg/l 2,4 D and 0.1 mg/l kinetin. The calli could be induced to develop further along one of the two morphogenetic routs : (1) shoot buds and (2) granular embryoids.



Session 06

Chemical Regulation of Plant Growth and Development



06-01

EFFECT OF APPLICATION OF LAS ON SPIRILUNA BEHAVIOR

Ajay, Javeed Ahmad Lone, J.K. Saha, S.K. Kundu and A.S. Subba Rao

Indian Institute of Soil Science, Bhopal, MP

ajay@iiss.ernet.in

Linear Alkyl Benzene sulfonate (LAS) is a major component of Detergent, causing water pollution. In this study the famous nutraceutical cyanobacterium – *Spirulina platensis* was studied with 5 levels of LAS in CFTRI medium – 0, 2, 4, 6, 8 and 10 ppm LAS. Abundant growth of micro algae was found only after inoculums 7-10 days conducted during Feb- July of 2009, due to adequate light and temperature conditions. The maximum growth were found as in treatment LAS – 2 ppm and LAS - 4ppm i.e. absorbance 2.39 and 2.21 (LAS seems to be the source of Carbon for cyanobacterium at lower levels) as compared to the Treatment LAS-8 ppm and LAS-10 ppm showing minimum growth of 1.82 and 1.87 in the form of absorbance. The maximum biomass was found in LAS 6-ppm i.e. 109.5 mg 50 mL⁻¹ and minimum biomass was found in LAS-2 ppm i.e. 76.9 mg 50 mL⁻¹. The maximum concentration of protein was found in LAS 6-ppm. i.e. 587.5 µg ml⁻¹ and the minimum concentration was found in LAS 2-ppm 350µg ml⁻¹. The highest nitrate reductase activity was present in LAS-6 ppm (79.2 NR µM NO₂ hr-1/g FW), which seems to be obvious because of having maximum growth, maximum protein and maximum biomass. Highest chlorophyll-a content (4.324 mg⁻¹g fw) was recorded in treatment LAS-4 ppm, which is due to the fact that LAS act as source of carbon at low treatments, which in turn yields good growth. Similarly the highest carotenoid content (0.446 mg⁻¹g fw) was recorded in LAS-2 ppm, followed by 0.451 mg⁻¹g fw in treatment LAS-4 ppm. Overall the 2-4 ppm LAS is good enough for *Spirulina* growth and physiological activity.

06-02

INFLUENCE OF SALICYLIC ACID AND BRASSINOLOIDS ON YIELD AND QUALITY TRAITS OF CHICKPEA

Chetana Mandavia, Lata Raval, M.K. Mandavia* and Vikram Khasiya

Department of Agricultural Botany, *Department of Biochemistry Junagadh Agricultural University,
Junagadh 362 001

A field experiment was conducted to assess the response of salicylic acid and brassinoid on yield and quality traits of chickpea leaves. Foliar spray of salicylic acid @ 50 and 100 ppm and brassinolide @ 40 and 60 ppm was done at vegetative (40 days after sowing) and reproductive (55 days after sowing) stages of chickpea cultivar GG – 1 in *rabi* season. The results showed significant differences in seed yield and quality attributes *viz.*, protein content, total sugar, carbohydrate, alpha amylase and nitrate reductase activity between untreated and treated chickpea leaves. The seed yield increased significantly by treatment with both growth regulators sprayed at both stages compared to the untreated plants. The maximum yield enhancement was observed in plants sprayed with 40 ppm brassinoid at reproductive stage. Between the two growth regulators, 50 ppm salicylic acid was more effective in the case of protein, nitrate reductase and alpha amylase. Lower concentration of brassinolide considerably increased total sugar and carbohydrate content. Application of growth regulators at vegetative stage was better in terms of increased sugar and nitrate reductase activity, whereas, with respect to alpha amylase, reproductive stage elicited remarkable influence. Quality improvement in chickpea leaves as evidenced by increased content of metabolites and enhancement in enzymes activities studied coupled with higher seed yield point out to the beneficial effect of salicylic acid and brassinolide. The results also confirm their role as growth regulators.



06-03

**EFFECT OF PINOXADEN AN ACCASE INHIBITOR ON MANAGEMENT OF
ARYLOXYPHENOXY PROPIONATE RESISTANT BIOTYPES OF *PHALARIS MINOR***

Rupa S. Dhawan, Sunaina Chawla, P. Bhaskar, S.S. Punia and Rajiv Angrish
Agronomy Department, CCS Haryana Agricultural University, Hisar-125004
rupadhawan@hotmail.com

Phalaris minor is a major weed of wheat fields in Haryana. It evolved resistance to phenyl urea herbicide-isoproturon, an inhibitor of photosystem-II, after a continuous use of this herbicide for over 15 years in an area where rice wheat has been the rotation system. Acetyl coenzymeA inhibitors (ACCase) fenoxaprop -p-ethyl and clodinafop-propargyl belonging to the category aryloxyphenoxy propionates were recommended for management of this weed in 1998. While signs of evolution of cross resistance to fenoxaprop started to appear within 3-5 years of continuous use, reports of evolution of cross-resistance to clodinafop appeared 5-6 years later. In area with heavy infestation of this weed a significant decline in wheat yield was obtained. Pinoxaden, another ACCase inhibitor belonging to a category phenylpyrazolin of group I inhibitors was announced in 2006 for managing resistant biotypes belonging to category aryloxyphenoxy propionates. Efficacy of this herbicide was tested by deriving GR50 values from dose response curves on growth, by membrane permeability tests and by pigment retention tests. While GR50 value against one biotype from HAU Hisar was 10 g/ha. It was in the range of 28-35g/ha against biotypes from Uchana, Ambala and Nangla. The GR50 value against biotype from Chanarthal was 12 times higher i.e. 120g/ha. The variability in GR50 values is indicative of its variable efficacy on different biotypes. While it could provide moderate control of medium resistant populations, it was not effective against highly resistant biotypes. The data is supported by pigment retention tests and ion efflux tests.

06-04

**ALLEVIATION OF WATER STRESS EFFECT ON CHLOROPHYLL CONTENT AND YIELD
ATTRIBUTES OF *Oryza sativa* CV IR-36 BY ABSCISIC ACID**

Reetoparna Patowary Kakati
Department of Botany, Cotton College, Guwahati-781001

Rice seeds (*Oryza sativa* cv. IR-36) were soaked in water and in 0.1 µg / ml of ABA solution before sowing. Both set of seedlings were then cultivated under four different water stress regimes, viz, mild, moderate, severe, and very severe stress. All the levels of water deficit affected the growth and development resulting in breakdown of chlorophyll. Agronomic characters like number of panicles, panicle length changed significantly with response to water stress. The yield with respect to filled grains per panicle, and the 1000 grain weight varied significantly with increasing levels of imposed water stress. The present investigation shows that the presowing seed soaking treatments by ABA increased hardiness against water stress. It mitigated the adverse effect of water stress on chlorophyll content of the leaves and yield parameters like number of panicles and number of filled grains per panicle. Use of ABA resulted in better seed setting as observed by average seed weight.



06-05

BIOCHEMICAL METABOLITES AND ENZYME ACTIVITY AS INFLUENCED BY SALICYLIC ACID IN MUNGBEAN (*Vigna radiata* L. Wilczek) IN RESPONSE TO SALINITY STRESS

Pooja, K.D. Sharma and M.S. Kuhad

Department of Botany and Plant Physiology, CCS Haryana Agricultural University, Hisar-125 004

A pot experiment was conducted on mungbean (*Vigna radiata* L. Wilczek) cv. Asha to assess whether foliar application of salicylic acid (SA) could alleviate the adverse effect of salinity stress. After germination, the Cl⁻ dominated salinity was given in two levels i.e. 4 and 6 dSm⁻¹. At the initiation of flowering, two concentration of salicylic acid i.e. 0.25 and 0.5 mM were applied as foliar spray in both control and stressed plants. The different biochemical metabolites, cellular ions contents and antioxidant enzyme activity were estimated after 2 and 6 days of salicylic acid treatments. Biochemical metabolites i.e. protein and chlorophyll content declined under salinity stress while free amino acids, total soluble carbohydrates and free proline content showed sharp rise under salinity stress. A gradual increase was observed in free proline, free amino acid, total soluble carbohydrates, protein and chlorophyll content with 0.5 mM salicylic acid than 0.25 mM salicylic acid. Membrane injury and lipid peroxidation (MDA content) had increased under salinity stress however application of salicylic acid decreased MDA production and increased membrane stability. Salinity stress adversely affects the activity of antioxidant enzymes, catalase and peroxidase however salicylic acid increased the activity of both enzymes in control as well as in stressed plants. Ionic composition i.e. Na⁺, Cl⁻ and SO₄²⁻ increased significantly under salinity stress but K⁺ content declined. Application of 0.5 mM salicylic acid reversed the accumulation trend under salinity. Therefore, it can be concluded that exogenous application of 0.5 mM salicylic acid ameliorates salinity stress and effect of salicylic acid was more pronounced at higher salinity level and 6 days after spray.

06-06

ROLE OF CYTOKININ IN REGULATION OF FLOWER SENESCENCE IN GLADIOLUS (*Gladiolus grandiflora* hort.)

Pankaj Kumar, S.K. Dwivedi, D. Choudhary, G. Agarwal, V.P. Singh and Ajay Arora

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

The experiments were conducted to study the effect of various cytokinins on delaying senescence in gladiolus cultivar Snow Princess in relation to physiological and biochemical parameters and expression of various senescence associated genes (SAGs). The vase life of flower spikes was significantly increased and fresh weight was retained for longer duration by treatment with thidiazuron (TDZ; 100 µM) than other cytokinins and control. The vase solution having TDZ (100 µM) significantly increased uptake of vase solution, increased floret diameter and lowered the pH of vase solution than control. Spikes kept in vase solution containing TDZ (100 µM) also maintained higher membrane stability content, while lipid peroxidation in terms of TBARS and lipoxygenase (LOX) activity was reduced in comparison to control. The activities of various antioxidant enzymes viz., superoxide dismutase (SOD), catalase (CAT), total peroxidase (POX) and ascorbate peroxidase (AP) were higher in TDZ (100 µM) treated florets. The treatment with TDZ (100 µM) solution maintained lower protease content in comparison to control at all the stages of flower development studied. The expression of senescence associated genes (SAGs) viz., *GgCYP1* was downregulated by thidiazuron treatment during the course of flower development and specifically at the terminal stage of flower senescence. However, *GgDAD1*, *GgERS1a* and *GgERS1b* were upregulated by thidiazuron treatment during the course of flower development and the expression pattern of upregulation was more conspicuous during senescent stages (incipient senescent and fully senescent stages) of flower development. The expression of these genes were more or less static from bud to fully open flower stages and then incipient senescent flower stage onwards the expression increased in both control and treated florets but the treated floret maintained higher expression of these genes than control at terminal senescent stage of gladiolus floret.



06-07

MANAGEMENT OF SPONGY TISSUE IN ALPHONSO MANGO BY USE OF GERMINATION INHIBITORS

P.M. Nigade, A.K. Shinde, B.B. Jadhav and K.A. Shinde

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra

A field experiment was conducted at Central Experiment Station Wakawali during 2007-08 with objective to reduce the spongy tissue of Alphonso mango by use of germination inhibitors. Thirty three years old Alphonso trees of uniform size were selected for the study. The foliar spray of germination inhibitors *viz.* ABA, PEG, Tannic acid, Paclobutrazol and germination promoters *viz.* GA₃ and Salicylic acid was done at egg size fruit stage. Second spray was repeated 15 days after first spray. The experiment was laid out in RBD with 3 replications. The recommended package of practices *viz.* fertilizer application, paclobutrazol application, insecticide and fungicide spray were followed. The harvested fruits were categorised in SF (14 Ana maturity), SD (16 Ana maturity) and TR (Tree ripe). At SF category Tannic acid 20 ppm showed no incidence of spongy tissue (0.0 %), which was at par with ABA 10 ppm (3.16 %) and paclobutrazol 500 ppm (3.33%) over rest of the treatments and Control (16.66 %). At SD and TR category ABA 10 ppm showed less spongy tissue incidence over other treatments. Similarly at SF category Tannic Acid 20 ppm showed Nil spongy tissue area whereas in SD and TR stage ABA 10 ppm showed less spongy tissue area. The germination promoters *viz.* GA₃ and salicylic acid increased the spongy tissue incidence and percent area. The days required for germination of stone were significantly increased in Tannic acid 20 ppm (37.66 d) than control (30.33 d) in SF category. The germination percentage of stone was low in ABA 10 ppm at all the categories than other treatments and control. The germination percentage increased with the use of germination promoters and the days required for germination were reduced. Thus ABA 10 ppm and Tannic acid 20 ppm are promising treatments for reducing the stone germination, delaying stone germination and there by reduces spongy tissue in Alphonso mango.

06-08

EFFECT OF SALICYLIC ACID ON MORPHO-PHYSIOLOGICAL ATTRIBUTES, ANTIOXIDANT AND ANTIOXIDANT ENZYME ACTIVITIES OF FIELD PEA (*Pisum sativum* L.) UNDER SALT STRESS

A. Hemantaranjan and Radha Singh

*Department of Plant Physiology, Instt. of Agricultural Sciences, BHU, Varanasi 221 005, U.P.
hemantaranjan@gmail.com*

Field pea is one of the important pulse crops, used as quality vegetable, has been susceptible to environmental stresses, in general, and salinity stress, in particular. The plants grown under induced salinity were duly treated with three different concentrations of salicylic acid (SA) (@ 1.0 mM, 2.0 mM and 3.0 mM). The plant performance was compared for morpho-physiological and biochemical attributes, which revealed that the threshold combined level @ 100 mM NaCl + 1.0 mM SA, induced enhancement in root length, shoot height, leaf area and total dry weight under salinity. Significant increase in number of flowers and pods plant⁻¹ were recorded at different growth stages. Salicylic acid (SA) @ 1.0 mM remarkably increased the superoxide dismutase (SOD) activity followed by nitrate reductase (NR) activity and total chlorophyll under salinity. However, the behaviour of the antioxidant proline accumulated under salt stress was quite in contrast to the SOD activity, NR activity and total chlorophyll. Salicylic acid also influenced the antioxidant defence mechanism, which might be due to SA as an important signaling molecule for modulating plant responses to environmental stresses. As recorded, SA at the threshold level of 1.0 mM has the positive effects on morpho-physiological, biochemical and yield attributes of field pea (*Pisum sativum* L.) under salinity stress. Results suggest that SA regulates the response of plants to salinity stress in field pea crop to develop resistance. The present research, therefore, prompts to extend work with SA for knowing its role in altering mechanisms to develop resistance especially in field pea under the salinity stress.



06-09

**PHYSIOLOGICAL AND BIOCHEMICAL CHANGES WITH PACLOBUTRAZOL IN MANGO
(*Mangifera indica* L.) CULTIVARS**

V.K. Singh and Pooja Saxena

Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow-227107, UP

Physiological and biochemical changes in terms of protein concentration, Peroxidase (POX) and Catalase (CAT) enzyme activity and chlorophyll fluorescence (Fv/Fm) was measured in leaves of two types of mango cultivar i.e. regular bearing 'Amrapali' and biennial bearing 'Langra' at fruit set. Optimum condition for the assay of enzymes activity was established. Rate of enzyme reaction in both the cultivars was proportional to the weight of tissue and maximum activity was obtained at 500mg fresh weight with pH range 6.9 to 7.1 for both the enzymes. The incubation time for optimum enzyme activity was found at 7 minute for Catalase and 6 minute for Peroxidase in Langra while Amrapali showed 5 and 6 minute for corresponding enzyme activity. This indicates faster Catalase activity in Amrapali. The effect of paclobutrazol (PP₃₃₃) (2 to 8 g.a i /tree), a growth retardant having anti-giberellin activity on these parameters was also studied. Paclobutrazol decreases soluble protein content in leaves of both the varieties during fruit set in comparison to control, may be due to its fast mobilization towards fruits (sink). However Amrapali has more soluble protein content (8.30±0.33 mg g⁻¹ FW) than Langra (5.10±0.16 mg g⁻¹ FW) in untreated trees. PP₃₃₃ at all concentrations increases Catalase and Peroxidase activity in both the cultivars. Amrapali showed significantly higher enzyme activities (CAT= 10.85±0.43, POX=19.80±2.28 Unit mg⁻¹ protein) than Langra (CAT= 3.11±0.12, POX=16.50±1.90 Unit mg⁻¹ protein). Fv/Fm values were found higher in Amrapali (0.75) than Langra (0.68) in untreated trees but its decreasing pattern with paclobutrazol at high concentrations (6 & 8 g.a i /tree) was noticed in Langra. Non significant change in Fv/Fm of Amrapali may support its greater photochemical efficiency than Langra.

06-10

**ROLE OF CALCIUM CHLORIDE AND GIBBERELIC ACID IN THE PROTECTION OF
LINSEED (*Linum usitatissimum* L.) FROM NaCl STRESS BY INDUCING ANTIOXIDATIVE
DEFENCE SYSTEM AND OSMOPROTECTANT ACCUMULATION**

M. Nasir Khan*, Firoz Mohammad and Manzer H. Siddiqui

Plant Physiology Section, Department of Botany, Aligarh Muslim University, Aligarh-202 002

** nasirmn4@gmail.com*

Salinity stress affects many metabolic facets of plants and induces anatomical and morphological changes resulting in reduced growth and productivity. To overcome the damaging effects of salinity, different strategies of the application of nutrients with plant hormones are being adopted. The present study was carried out with an aim to find out whether application of calcium (Ca) and gibberellic acid (GA₃) could alleviate the detrimental effects of salinity stress on plant metabolism. Fifteen days old plants were supplied with (i) 0 mM NaCl + 0 mg CaCl₂ kg⁻¹ sand + 0 M GA₃ (control), (ii) 0 mM NaCl + 10 mg CaCl₂ kg⁻¹ sand + 0 M GA₃, (iii) 0 mM NaCl + 0 mg CaCl₂ kg⁻¹ sand + 10⁻⁶ M GA₃, (iv) 150 mM NaCl + 0 mg CaCl₂ kg⁻¹ sand + 0 M GA₃, (v) 150 mM NaCl + 10 mg CaCl₂ kg⁻¹ sand + 0 M GA₃, (vi) 150 mM NaCl + 0 mg CaCl₂ kg⁻¹ sand + 10⁻⁶ M GA₃, (vii) 150 mM NaCl + 10 mg CaCl₂ kg⁻¹ sand + 10⁻⁶ M GA₃. Plants were uprooted randomly at 60 days after sowing (DAS). Presence of NaCl in the growth medium decreased all the growth and physio-biochemical parameters except, electrolyte leakage, proline and glycine betaine (GB) content, thiobarbituric acid reactive substances (TBARS), H₂O₂ content, activities of superoxide dismutase (SOD), peroxidase (POX) and catalase (CAT) and leaf Na⁺ content which exhibited increasing values as compared to the control plants. However, application CaCl₂ in combination of GA₃ appears to confer greater osmoprotection by the additive role with NaCl in proline and GB accumulation. The antioxidant enzymes namely, SOD, POX and CAT were increased under salt stress and further enhanced due to CaCl₂ and GA₃ treatments. The present study exhibited that application of CaCl₂ and GA₃ alone as well as in combination mitigated the adverse of effect of salinity but combined application of these treatments proved more effective in alleviating NaCl stress.



06-11

**EFFECT OF ZINC AND SALICYLIC ACID ON MORPHO-PHYSIOLOGICAL AND
BIOCHEMICAL ATTRIBUTES UNDER SALINITY STRESS IN WHEAT (*Triticum aestivum* L.)**

S.K. Bishnoi and A. Hemantaranjan

Department of Plant Physiology, Instt. of Agricultural Sciences, Banaras Hindu University, Varanasi-221005

The morpho-physiological response of wheat plants to application of Zn @ 0.5 mM and Salicylic acid (SA) @ 1.5 mM was observed, which enhanced length of root, height of shoot, number of leaves, leaf area, total dry matter and number of tillers plant⁻¹ under induced salinity @ 100 mM (NaCl). The photosynthetic pigments in the leaves, biochemical attributes as well as antioxidant enzyme, viz., proline, superoxide dismutase, nitrate reductase activity and chlorophyll contents were significantly increased @ 1.5 mM Salicylic acid (SA) as compared to varying concentrations of Zinc (Zn). Studies indicated that Zinc (Zn) and Salicylic acid (SA) act as a powerful protectants salinity stress in wheat.

06-12

**EFFECT OF LOW COST BIOCHEMICALS ON SEED GERMINATION OF TWO MEDICINALLY
IMPORTANT *POLYGONATUM* SPECIES OF NORTHWEST HIMALAYA**

Poonam Bisht⁺, B.P. Nautiyal* and P. Prasad

High Altitude Plant Physiology Res. Centre, PB No 14, HNB Garhwal University Srinagar Garhwal- 246174

** Department of HAMP, School of ES & NRM, Mizoram University, Aizawl- 796001*

poorna.26@gmail.com

The genus *Polygonatum* (Family: Liliaceae) is characterized by thick fleshy creeping sympodial rhizomes. The genus is distributed in the temperate regions of the northern hemisphere. Out of the 16 species reported in India, two species of medicinal importance, namely *P. verticillatum* (Linn.) All and *P. cirrhifolium* (Wall.) Royle are used in Astaverga of Ayurveda and commonly known as mahameda-meda respectively. Collectively, mahameda and meda are used as tonic and promotes body heat, dries up serious fluids, carminative and antitussive. Also used against loss of vigor, pain in the kidney and hips, swelling and fullness in the abdominal region, accumulation of fluids in bone joints, skin eruptions and cough. To fulfill market demand for medicinal purpose, these species of *Polygonatum* are extracted from nature, which results in decreased natural populations and therefore these species had been included in the list of threatened plants by CAMP (2003). On account of this, in the present study effect of low cost biochemicals viz., nitrogenous compounds (potassium nitrate and thiourea), floor disinfectant (sodium hypochlorite) and ethylene (etheral), on seed germination of these species was investigated. To determine the effect of different biochemicals, the seeds of both species were soaked in these biochemicals and percentage germination (SGP) with time required for germination (MGT) was recorded. The study revealed that, the nitrogenous compounds and ethylene, both were effective in reducing the time taken for germination by the seeds. In *P. verticillatum* maximum germination (SGP) was obtained in thiourea and minimum time for germination (MGT) was taken by ethylene. While, in *P. cirrhifolium* maximum germination (SGP) was obtained in control and time taken (MGT) for germination was minimum in ethylene. This study will help to figure out the baseline for mass multiplication of both *Polygonatum* species through seed germination.



06-13

BIO-EFFICACY OF GA₃ (CHINA MAKE) IN GRAPES

S.D. Ramteke, Sandhya K. Dherange, Arun Suryavanshi, R.G. Somkuwar and P.G. Adsule

National Research Centre for Grapes (ICAR), P.B. No. 3, Manjri Farm P.O., Solapur Road, Pune- 412307
sdramteke@yahoo.com nrcgrape.mah@nic.in

A field trial was conducted at the farm of National Research Centre for Grapes to evaluate the bioefficacy of GA₃ (China make) on Thompson Seedless grapes grafted on Dogridge rootstock at Manjri Farm, Pune. GA₃ (China make) contains powder of 90% Gibberellic acid and is used to increase the berry size and quality of grapes. The data on bunch, berry, quality and yield parameters showed a significant differences in mean bunch weight, berry size, quality and yield parameters. In general, the mean bunch weight was recorded more in GA₃ treatments as compared to the untreated control. The treatments of GA₃ were on par with each other but higher than the untreated control with respect to 50 berry weight. The berry size was also increased in all the treatments of GA₃ as compared to control. However, the TSS was recorded higher in control over the other treatments. Yield per vine was recorded significantly highest in GA₃ treatments and these treatments were on par with each other. No symptoms of any abnormality, toxicity were found either on the leaves, canes / shoot or berries in grapes with the application of GA₃ (China make) up to 40 ppm.

06-14

EFFECT OF BIOREGULATORS AND PHOSPHORUS ON YIELD ATTRIBUTES, YIELD AND QUALITY PARAMETERS OF GREENGRAM (*Vigna radiata* L. Wilczek)

Ajay Kumar Medhi and A. Roy

Bidhan Chandra Krishi Vidyalyaya, Kalyani, West Bengal

A field experiment was conducted to study the response of greengram to foliar application of bioregulator (IAA 25 ppm, NAA 50 ppm, Cycocel 250 ppm, Ascorbic acid 25 ppm, Ethrel 250ppm and GA₃ 30 ppm) along with three phosphorus (20,40, 60 kg/ha) level on yield attributes, yield and quality parameters of seed during two consecutive years. Foliar application of bioregulators significantly influenced the plant growth and yield attributing characters. Phosphorus level could not bring significant effect on number of seed/pod and length of pod. NAA 50 ppm recorded the highest yield 14.66 q/ha followed by cycocel 250 ppm (14.39) which was due to highest number of pods (53.06nos./plant), number of seeds per pod (11.32 nos./pod) and 1000 seed weight (35.54 g). The yield increment were 44.0% and 41.3% increase over control. Among phosphorus, 60 kg/ha gave highest seed yield (13.18 q/ha) as compared to 40 and 20 kg P₂O₅/ha. Nitrogen, phosphorus and potassium content of seed after harvest and their uptake were significantly increased both bio-regulators and phosphorus, whereas highest being observed in NAA 50ppm and 60 kg P₂O₅/ha. Significant improvement in harvest index was observed as a result of bio-regulator and phosphorus application over control. Application of bio-regulator and phosphorus significantly improved quality parameters of seed viz., Total soluble sugar, starch, protein and free amino acid content NAA 50ppm recorded TSS 59.68, starch 429.43, protein 304.80 and free amino acid 18.33 mg/g dry weight of seed. Phosphorus 60 kg P₂O₅/ha recorded highest improvement in all these parameters as compared to other levels of phosphorus.



06-15

EFFECT OF GROWTH RETARDANT (CCC) ON MULBERRY (*MORUS ALBA* L.) FOLIAGE FOR IMPROVEMENT

S. Nautiyal, R.K. Pant* and Ashutosh Mishra

Plant Physiology, Forest Research Institute, Dehradun 248006

**Central Silk Board Dehradun, India*

The effect of 2-chloro ethyl trimethyl ammonium chloride (CCC), a growth retardant was experimented on Mulberry (*MORUS ALBA* L, S₁₄₆ GENOTYPE) foliage for improvement. The study was conducted on tree as well as bush form during spring and autumn season. The main focus was effect of different doses of CCC on leaf yield, leaf moisture content, fresh weight and dry weight of leaves and nutrition status of leaf. It can be concluded that CCC as a growth retardant is capable of improving mulberry foliage both quantitatively and qualitatively. Though treatments of all concentrations are effective but 1000 ppm concentration is capable of bringing higher significant improvement in mulberry foliage in both bushes and tree forms that too in both of the seasons i.e. spring and autumn but higher significant results in cocoon yield and silk filament, the ultimate end product is achieved with 500 ppm. Farmers can use any of the concentrations of CCC based on their economic strata. Therefore, CCC can be used as a tool to improve the quality and quantity of mulberry foliage for production of good quality silk.

06-16

IMPACT OF GROWTH REGULATORS ON CROP SEED PRODUCTION WITH SPECIAL EMPHASIS TO LATE SOWN WHEAT

Prabir Chakraborti and Arunima Ghosh

Dept. of Seed Science & Technology, F/AG, Bidhan Chandra Krishi Viswavidyalaya,

Mohanpur, Nadia, West Bengal

The constraints related to soil or environment during grain development affect to assimilate partitioning capacity of wheat, especially late sown which fails to express fully. The foliar application of plant growth hormones can boost to recover the losing competence which reflects in crop seed production i.e., enrichment of seed quantity in terms of yield with superior quality for the next. Twelve selected genotypes were studied under three hormones with two concentrations in contrast to control (normal). Spraying of hormones was done at heading, before and after emergence of heading. Observations were made on plant yield and yield attributing characters as an instant effect and Germination % of one month old harvested seed as subsequent to outcome. A significant variation among genotypes, within 3 plant growth hormones and its 2 concentrations indicated the differential response of treatments as well as genotypes. NAA was the best and showing significant variation in both characters of seeds number of spike & spikelet where, Hormolin (3GA₃+NAA) was the second. But, NAA showed lowest result in case of other. However, GA₃ showed the maximum peak in 1000 grain weight, yield / plant and plot where Hormolin was the second top. Therefore, an inverse relation may ascertain in between GA₃ & NAA where Hormolin enduring a compromising effect. The Principle Component Analysis (PCA) noticeably showed the greatest effect of treatments allowing for different parameters where lower concentration of either GA₃ or Hormolin was the finest. The genotype CLN5 was most responsive to foliar applications of plant growth hormones on the whole with lower concentration of GA₃ and Hormolin. Finally, GA₃ and Hormolin were found to be responsive in similar manner irrespective of the genotypes, though Hormolin could be regarded as superior due to its low price.



06-17

EFFECT OF PACLOBUTRAZOL ON FRUITING OF JACKFRUITS

A.K. Shinde, B.B. Jadhav and V.V. Dalvi

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. (M.S.)

A field experiment was conducted at Botany farm of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli to study the effect of paclobutrazol on enhancing fruiting of jackfruits. Jackfruits are generally grown in Konkan region of Maharashtra. The jackfruits are generally get matured in the month on May and June. The rains during the month of June causes loss of most of the jackfruits. Paclobutrazol has been known for inducing regular, early flowering and fruiting in mango. Therefore paclobutrazol @ 3.75 and 7.50 g.a.i. per tree was applied in the month of August 2008. The observation on No. of fruits/tree, weight of fruit, length, circumference, harvesting week and fruit yield was recorded and subjected to statistical analysis. It is revealed that paclobutrazol induces early fruiting by 4 weeks in jackfruit and more than 70 % fruits matured in the month of April with application of paclobutrazol whereas in control the fruits matured in be month of May-June. Significantly higher no. of fruits were recorded with 3.75 g.a.i paclobutrazol (57.71/tree) which was at par with 7.5 g.a.i paclobutrazol (56.57/tree) over control 8.71 fruit/tree. There was no significant difference in length, circumference and individual weight of fruit due to application of paclobutrazol. Paclobutrazol @ 3.75 g.a.i./tree produced significantly higher fruit yield (374.94 kg/tree) which was at par with paclobutrazol 7.5 g.a.i./tree (369.23 kg/tree) over control (42.51 kg/tree).

06-18

RESPONSE OF MUNG BEAN (*Vigna radiata* (L.)Wilczek) TO THIOUREA APPLICATION UNDER WATERLOGGING

Pramod Kumar¹, T.P. Singh² and Madan Pal Singh¹

¹ Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi

² Present address: National Bureau of Plant Genetics Resource, New Delhi

Mung bean is very sensitive pulse crop to excessive water (waterlogging). Thiourea is a potential antioxidant and also serves as a source of nitrogen. In this context, it was thought interesting to analyze the effect of thiourea application on mung bean under water logging. Therefore, A pot culture experiment using two diverse genotypes i.e. MH – 96-1(tolerant to waterlogging) MH – 1K – 24 (susceptible to waterlogging) was conducted to identify the optimum dose of thiourea for foliar application on mung bean under waterlogging. Waterlogging treatment was imposed at vegetative stage (30 DAS) for 7 days only by placing the pots in poly bags filled with water in 2/3 of its capacity. Four levels of foliar spray of thiourea viz. 0, 500, 1000 and 1500 ppm were imposed before waterlogging. Sampling and recording were done at 0, 7 days of waterlogging and 7 days after waterlogging termination. Foliar treatment of thiourea @ 1000 ppm was found most effective to enhance the values of growth parameters, membrane stability index, tolerance to water logging, level of photosynthetic pigments (chlorophylls and carotenoids), stomatal conductance, rate of photosynthesis, carboxylation efficiency, fast recovery after water logging termination, grain yield and its attributes under waterlogging in both genotypes. On an average, optimum dose of thiourea was estimated, approximately 750 ppm. Thiourea mediated mitigation response was noted relatively better in susceptible genotype (MH – 1K – 24) than tolerant (less sensitive).



06-19

EFFECT OF GA₃ AND ALAR AND THEIR INTERACTIONS ON GROWTH, METABOLISM AND YIELD OF GROUNDNUT

S. Chakraborty* and C M Sarma**

*Tinsukia College, Tinsukia – 786125, **Retired Professor, Botany Dept., Guwahati University, Ghy-781014
mailto.susmitachakraborty@rediffmail.com

Groundnut seeds (CVJL24) were treated with GA₃ at the concentrations of 0, 100, 250, 500 and 1000 µg/ml. Germination percentage gradually increased up to 500 µg/ml of GA₃ and then declined. Alar (0, 100, 250, 500 and 1000 µg/ml) was sprayed at 4 – 5 leaf – stage. Alar caused the decrease in length of shoots and increase in the number of leaves, number of branches and metabolism of the leaves and seeds. The maximum protein content of the seeds was estimated as 28.5 per cent at GA₃ 500 plus alar 500 µg/ml against 24.5 per cent at control. The maximum fat content was estimated as 50 per cent at GA₃ 500 plus 500 µg/ml against 42.8 per cent at control. The maximum yield was 3,755 Kg/ha at GA₃ 500 plus alar 500 µg/ml against 3,490 Kg/ha at control

06-20

EFFECT OF PGRS ON CAROTENOID CONTENTS IN WHEAT CULTIVAR UNDER SALT STRESS

Sudha R. Mathur and K.B. Shukla

Department of Plant Physiology, Rajasthan College of Agriculture, Udaipur (Raj)
sudharmathur@yahoo.co.in

Wheat is staple crop but its production potential is limited by adverse environmental stress namely drought, salinity and extremes of temperature. Saline condition drastically changes the environment of the root, osmotic potential of the soil solution and the normal equilibrium of the dissolve ions. Salinity adversely affects almost all physiological and metabolic process of plant. The reduction in plant growth due to salinity induced changes in plant relation, ion allocation, photosynthesis, respiration and biochemical reactions. So to reduced effect of salinity on physiological and metabolic processes of crop production in wheat cultivar (RAJ 1482 & RJS 3077) it is necessary to study the effect of PGRs like GA₃, IAA, 2,4,D and kinetin as a seed pretreatment to alleviate inhibitory effect of salinity on germination, quality and biochemical constituents, In present study a pot experiment has was design to asses the reversible effect of PGRs (GA₃ 25 & 50 ppm and IAA 100 & 200 ppm) on carotenoid contents in wheat cultivar (RAJ 1482 & RAJ 3077) under saline condition (NaCl 1%) in the department of plant physiology, R.C.A. Udaipur. The observations were taken at 30, 60, and 90 days after sowing (DAS). The carotenoid pigments have two essential roles i.e., light harvesting and antioxidants. Also enhance synthesis of B- carotenoid in the photosynthetic tissue play very important role against the oxygen radical by accepting the electron of oxygen radical. Data reveals that the interaction among cultivars and different treatment was significant. The saline treatment decrease the carotenoid content in both the wheat cultivar by 15.4% (30 DAS), 24.2% (60 DAS), & 36.5 % (90 DAS) in RAJ 1482 and 11.6% (30 DAS), 16.1% (DAS) & 19.5% (DAS) in RAJ 3007 respectively. All the phytohormone treatments at all concentration increase the carotenoid content. The reversal effect of GA₃ was higher than IAA treatment. Thus the GA₃- (50 ppm) treatment were superior over IAA treatment in reverting the decrease of carotenoid content by salinity.



06-21

INFLUENCE OF HYDROPHYLIC POLYMER ON MORPHO-PHYSIOLOGICAL TRAITS AND YIELD IN TOMATO

Mukesh Kumar Meena, C.M. Nawalagatti, M.B. Chetti and D.S. Uppar

Department of Crop Physiology, College of Agric., University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi*-2008 to study the influence of hydrophilic polymer on morpho-physiological traits and yield in tomato. The experiment consisted of seven treatments viz., six different levels of hydrophilic polymer (0.50, 0.75, 1.00, 1.25, 1.50 and 1.75g /plant) and control. The treatments were imposed at the time of transplanting. The results of the investigation revealed that among the treatments, the application of hydrophilic polymer @1.75 g / plant recorded significantly maximum plant height, more number of branches, canopy spread (top and middle) and more root length as compared to other treatments. The lowest values for all these traits were observed in control. It was further observed that, the growth parameters viz., leaf area index (LAI), absolute growth rate (AGR), crop growth rate (CGR) and biomass duration (BMD) were significantly increased at all the stages due to application of hydrophilic polymer (1.75g /plant). The relative water content (RWC) was also significantly higher with the same treatment. The fruit yield was significantly maximum with the application of hydrophilic polymer (1.75g /plant) and this increase in the yield was due to increase in AGR, CGR, and LAI which showed positive correlation with the yield.

06-22

REVERSAL EFFECT OF PGRS ON CATALASE ACTIVITY IN WHEAT CULTIVAR UNDER SALINE CONDITION

K.B. Shukla and Sudha R. Mathur

*Department of Plant Physiology, Rajasthan College of Agriculture, Udaipur (Raj)
sudharmathur@yahoo.co.in*

Wheat (*Triticum* spp. & durum L.) is one of the cereal extensively grown throughout the world in more than 50 countries. In terms of production wheat occupies the prime position amongst the food crop and the second next to rice. But field crop and their genotypes experience various types of stress conditions and are differ in their response to various biotic and abiotic stresses. Among the abiotic stress salinity and moisture stress are of special significance as most of plants processes are influenced by these stresses. The extent of changes in any plant process mainly depends on the severity and duration of stress and also on the stages of plant development when the stress has effected. When plants are subjected to salt stress the balance between the production of reactive oxygen species and the quenching activity of antioxidants is upset, resulting in oxidative damage and H₂O₂ and O₂ may play an important role in the mechanism of NaCl injury. In present study a pot experiment was design to asses he reversible effect of PGRs (GA₃ 25 ppm & GA₃ 50 ppm and IAA 100 ppm & IAA 200 ppm) on activity of enzyme catalase in wheat (RAJ-1482 & RAJ-3077) under saline condition (NaCl 1%) in department of plant physiology R.C.A. Udaipur. The observations were taken at 30, 60 & 90 days after sowing. The data reveals that all the treatments had significant effect on catalase activity in pot experiment. The saline treatment significantly increase the catalase activity by 30.5% (30 DAS), 16.5% (60 DAS) and 9.1% (90 DAS) over control. All the phytohormone treatments concentrations reversed the increase in catalase activity. The reversal effect of GA₃ (50 ppm) treatment was higher by causing maximum reduction in catalase activity followed by GA₃ (25 ppm) and IAA (100 & 200 ppm).



06-23

INTERACTION BETWEEN GA₃ AND ALAR ON DIFFERENT GROWTH PARAMETERS, QUALITY OF HEADS AND OIL CONTENTS OF SUNFLOWER (*HELIANTHUS ANNUUS*) SEEDS

Deepika Devi¹ and C.M. Sarma²

¹Department of Botany, Arya Vidyapeeth College, Guwahati-16

²Department of Botany, Gauhati University, Guwahati-14

dr.deepika_devi@rediff.com

Sunflower is a rich source of vegetable oil of high quality in the world's oil industry. Field experiments were conducted to find out the effect of GA₃ and alar (Succinic acid, 2,2-dimethyl hydrazide) in combination on different growth parameters, quality of heads and oil contents of seeds. The interaction treatment showed promising effect by increasing the length of shoots. GA₃ 500 µg/ml plus alar 250 µg/ml showed significant increase in leaf number and GA₃ 250 µg/ml plus alar 250 µg/ml showed increased chlorophyll content of leaves over their respective controls. Sunflower heads matured within a short period (days) under the influence of combined treatment of GA₃ 250 µg/ml plus alar 250 µg/ml. Appreciable increase in production of seeds (seeds/head) was noticed at GA₃ 250 µg/ml plus alar 500 µg/ml. Best response was achieved about the head diameter of sunflower was recorded at GA₃ 250 µg/ml plus alar 250 µg/ml. The highest percentage of filled seeds was recorded at GA₃ 500 µg/ml plus alar 250 µg/ml. On the other hand the maximum weight of thousand seeds and the highest percentage of oil content were recorded at GA₃ 500 µg/ml plus alar 500 µg/ml. Thus from the experiment it is inferred that the interaction between GA₃ and alar brought about the modification of metabolic parameters increasing yield and quality of oil.

06-24

EFFECT OF NUTRIENTS AND GROWTH REGULATORS ON IMPROVING THE GROWTH AND PRODUCTIVITY OF BLACKGRAM (*vigna mungo*) Var Co 5 .

K. Krishna Surendar, Mallika Vanangamudi, Vijayaraghavan and Thilagavathi

Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore -3

A field experiment was conducted to assess the physiological manipulation of black gram with nutrients and growth regulators. The experiment was conducted in a Randomized Block Design with three replications. Chosen treatments were imposed at peak vegetative stage (25 DAS) and ten days after the first foliar spray (35 DAS). It is inferred that foliar spray of Urea 2% with 0.1 ppm brassinosteroid favorably influenced the morphological attributes and growth parameters in black gram. Basal application of nitrogen with Foliar spray of Urea 2% + 0.1 ppm brassinosteroid treatment significantly increased physiological and biochemical parameters viz., chlorophyll content, soluble protein, activities of NRase and IAA oxidase enzymes. The treatment also significantly enhanced the uptake of nitrogen, phosphorus and potassium. Various yield components such as days to 50 per cent flowering, days to maturity, number of clusters per plant, number of flowers per plant, number of pods per cluster, number of pods per plant, fertility co-efficient, number of seeds per pod, pod weight per plant, seed weight per plant, seed - pod ratio, pod length, hundred seed weight, grain yield per plot, grain yield per hectare and harvest index were favorably enhanced by the foliar spray of Urea 2% with 0.1 ppm brassinosteroid treatment. This treatment also increased the seed quality parameter of grain protein content. The overall results suggest that the benefit - cost ratio revealed that foliar application of Urea 2% with 0.1 ppm brassinosteroid is advantageous and can be recommended for adoption by the farmers.



06-25

**INFLUENCE OF NAA, PANCHAGAVYA AND HUMIC ACID ON LEAF PHYSIOLOGY
AND YIELD OF JATROPHA**

C. Raja Babu, Mallika Vanangamudi, M. Paramathma and K. SathyaMoorthi

*Centre of Excellence in Biofuels, Tamil Nadu Agricultural University, Coimbatore-641003
crajababu@yahoo.co.in*

The foliar sprays of NAA 40PPM, Ethrel 50 ppm and Humic acid 1% given at vegetative, Flowering stage and Fruiting stage during 2008-2009, Showed a modification leaf physiology and yield determining characters. NAA treated plants showed increased longevity of functional Leaves which resulted in increased grain yield. Application of NAA 40 ppm exhibited maximum yield which was – higher than control. This increase in yield was due to significant increase in leaf weight, leaf area, chlorophyll, pods /plant, fertility coefficient.

06-26

EFFECT OF GIBBERELIC ACID (GA₃) ON GROWTH AND YIELD OF SESAMUM (cv. ST-1683)

M.R. Das and C.M. Sharma

*Department of Botany, Guwahati University, Guwahati-781014
chaudhuri.priyajit@gmail.com*

Sesamum is one of the important oilseed crops in India. It is important cooking oil and used as an ingredient in soap, cosmetics, lubricant and medicine. An experiment was conducted on randomized block design with three replication to investigate the effect of GA₃ on growth, yield and oil content of Sesamum (cv. 1683) under rain fed condition of Assam. The foliage treatments of GA₃ in four concentrations (10, 100, 250 and 500 µg/ml) were sprayed at 15 days after sowing. During the experimentation, various physiological parameters of growth and yield were recorded. The highest shoot length was recorded as 102.15 cm at 500 µg/ml of GA₃. The highest 3.12 number of branches were recorded at 100 µg/ml of GA₃ whereas, highest number of leaves was recorded as 32.67 at 250 µg/ml of GA₃. The total chlorophyll content was highest (2.167 mg/g) in lower concentration (100 µg/ml) of GA₃. GA₃ increased the number of capsules and seed yield of Sesamum and at 100 µg/ml of GA₃ it was recorded significantly highest as 38.76 and 7.29 q/ha respectively. GA₃ was stimulatory in increasing oil content and recorded the highest 52.51% oil, at 250 µg/ml of GA₃.

06-27

**STUDY OF FOLIAR SPRAY OF CHEMICALS ON PHYSIOLOGICAL PARAMETERS OF
SAPOTA CV. KALIPATTI**

V.S. Ghumare, B.V. Padhiar and S.R. Patel

*ASPEE College of Horticulture and Forestry, N.A.U., Navsari. 396 450
vikasghumare@yahoo.com*

The present investigation “Study of foliar spray of chemicals on physiological parameters of sapota cv. Kalipatti” was carried out at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari during the year 2008. The experiment was laid out in a Randomized Block Design with three replication in twelve treatments either alone or in combination of Iron, Zinc and Boron including water spray and control. Effect of these micronutrients on physiological parameters was recorded. Results revealed that the application of micronutrients resulted in improved physiological parameters.



parameters of sapota leaf. The physiological parameters like photosynthetic rate, stomatal conductance and transpiration rate were increased with higher level of micronutrients i.e. $\text{FeSO}_4 2\% + \text{ZnSO}_4 2\% + \text{Borax } 1\%$. Whereas, leaf temperature was not significantly influenced by foliar spray of micronutrients. From this investigation, it can be concluded that among the different physiological parameters studied the rate of photosynthesis, stomatal conductance and transpiration were significantly affected by the use of micronutrients on sapota at higher levels of micronutrients combination i.e. $\text{FeSO}_4 2\% + \text{ZnSO}_4 2\% + \text{Borax } 1\%$.

06-28

BIO-EFFICACY OF ETHOFUMESATE AND METAMITRON IN CONTROLLING WEEDS AND THEIR EFFECT ON YIELD AND PRODUCTIVITY OF SUGARBEET

S.K. Guru¹, Bhavna Thakur¹, Alok Shukla¹ and S.S. Tripathi²

¹ Department of Plant Physiology, ² Department of Agronomy, G.B.P.U.A&T, Pantnagar

Sugar beet is commercially grown for sugar accounting for about 30% of the world's sugar production. However, it is a poor competitor with weeds. To avoid yield loss, weeds should be totally controlled by four weeks after sugarbeet emergence. In the present study, two post-emergence herbicides, Metamitron and Ethofumesate were evaluated for weed control in sugar beet. Among both the herbicides, Metamitron could successfully control grass weeds such as *Phalaris minor* and *Avena ludoviciana* but was less effective in controlling broad leaf weeds, while Ethofumesate could very efficiently control broad leaf weeds such as *Chenopodium album*, *Melilotus alba*, *Medicago denticulata*, *Coronopus didymus*, *Anagalis arvensis*, *Lathyrus aphaca*, *Fumaria parsiflora*, *Polygonum plebejum*, *Rumex acetosella*, and *Aspergula arvensis* but was less effective in controlling grassy weeds. Weed control efficiency, biological yield and beet root yield was highest when Metamitron was applied @ 7.0 kga.i./ha in three split applications at 2, 4-6 and 8-10 leaf stages, as compared to lower doses or higher doses (4.0 kga.i./ha) in single application. Bio-efficacy of Ethofumesate in controlling weeds was enhanced when used in combination with Metamitron. Ethofumesate had adverse effect on sugarbeet yield when used alone. Its efficacy was enhanced when used in combination with Metamitron.

06-29

SUSTAINABLE CROP IMPROVEMENT BY THE APPLICATION OF PLANT GROWTH SUBSTANCES

N. Baruah * and C. M. Sarma**

* Sr. lecturer, Botany Dept, Birjhora Mahavidyalaya, Bongaigaon

** Retd. Prof. and Head of Botany Dept, Gauhati University
neelanjanabaruah@gmail.com

An experiment was conducted to study the effect of plant growth substances on sustainable crop improvement in cucumber. Foliar spray of ethrel at 50, 100, 250, 500 and 1000 $\mu\text{g/ml}$ was made to seedlings of cucumber. The spray significantly increases female flowers over male which led to increase in fruit number. Number of female flowers gradually increased and ethrel at 250 $\mu\text{g/ml}$ was recorded as optimum concentration for maximum number of female flowers in cucumber. Female flowers recorded as (16.9) against (1.5) at control in cucumber. CCC was also applied at 50, 100, 250, 500 and 1000 $\mu\text{g/ml}$ to cucumber. CCC at 250 $\mu\text{g/ml}$ was recorded as optimum concentration for maximum number of female flowers (18.6) against (2.3) at control in cucumber. Thus excessive vegetative growth in cucumber was reduced by both ethrel and CCC. The experiment established reversal of male flower to female leading to increase in number of fruits.



06-30

ROLE OF BENZYLADENINE ON ANTIOXIDATIVE ENZYME SYSTEM UNDER WATER STRESS CONDITIONS IN GROUNDNUT CULTIVARS

J.J. Dhruve, D.N. Vakharia and A.D. Patel

Main Vegetable Research Station, Anand Agricultural University, Anand-388 110

An experiment was conducted to study on the effect of simulated water stress and benzyl adenine on antioxidant activity in 15 days old seedlings of six groundnut (*Arachis hypogaea* L.) cultivars, GG-2, GG-3, GG-4, GG-5, GG-7, and J-11 in laboratory condition. Water stress significantly damaged membrane (MI). Cultivar GG-2 was characterized by the highest leaf RWC, the lowest leaf membrane injury, higher activities of ascorbate peroxidase and catalase. In contrast to this, cv. J-11 had the highest leaf membrane injury, and higher activities of superoxide dismutase. While, cv. GG-7 also had lower activities of catalase and superoxide dismutase. Application of benzyl adenine as seed soaking treatment (100 ppm) positively influenced on the APOX, CAT and SOD in groundnut.

06-31

TO STUDY THE EFFECT OF PLANT α - AMYLASE INHIBITORS FROM MOMORDICA CHARANTIA ON THERMOPHILLUS BACTERIAL α -AMYLASE

V. Mhatre, N. Lokhande, S.V. Amarapurkar and M.S. Dake

man1d_2@rediffmail.com

Plants produce natural enzyme inhibitors against number of enzymes, e.g. trypsin inhibitor against proteases; found in cereals, α -amylase inhibitor is present as lectins, etc. Generally they act as plant defence proteins. Insect pests and pathogens (fungi, bacteria and viruses) are responsible for severe crop losses. Insects feed directly on plant tissues, while the pathogens lead to damage or death of the plant. So, plants and microbes have evolved a certain degree of resistance through the production of defense compounds which prevent the insect attacks and protect plants. In some plants, protease inhibitors can act as α -amylase inhibitors which control the insect attack on plants. The enzyme inhibitors impede digestion through their action on insect gut digestive α -amylase, which play a key role in the hydrolysis of plant starch. In human, disorder of carbohydrate uptake may cause severe health problems such as diabetes, obesity, or caries- all of which threaten an increasing population. Therefore, there is an obvious need for novel agents or therapeutic strategies that could act on the physiological regulations of sugar uptake, blood sugar levels, and prevention of oral diseases. It is a common belief that *Momordica charantia* commonly known as bitter melon, a popular vegetable found in all parts of India can be used in treatment of diabetes. Instead of human pancreatic α -amylase, α -amylases from different species are used to study the effect of inhibitor and changes in the α -amylase structure can be studied. In the present work, the attempts have been made to study the effect of natural plant α -amylase inhibitor on α -amylases from gram positive & gram negative thermophilic bacteria; fungi *Penicillium chrysogenum*; fungal diastase; plant *Zinziber officinale* and human salivary amylase. Studies were done to find out the natural inhibitor as a drug to control diabetes, cancer and as an insect control. The effect of α -amylase inhibitor on enzyme kinetics was studied.



Session 07

Post Harvest Physiology of Perishables



07-01

A CHEMO-TECHNOLOGICAL TOOL IN PHYSIOLOGICAL PRINCIPLE OF LEAF FRESHNESS OF CUT TWIGS OF PLANT

Himangshu Barman

Central Muga Eri Research & Training Institute, Central Silk Board, M/O Textiles, Govt. of India,
Lahdoigarh, Jorhat

In indoor rearing of silkworms particularly Muga, *Antharaea assamensis* Helfer is a great problem due to rapid wilting of leaf of cut food plant twigs. Since water required for physiological growth and development of silkworm achieve through consumption of fresh leaf, it poses utmost essential to have required level of water content in leaf of cut twigs. Several chemicals in single solution and combined solution had been tested keeping cut twigs in bottles filled with solutions for their role in leaf freshness. Solution- II and solution- IV has been screened out as effective chemicals that has physio-chemical rule in leaf freshness. Solution- II keep leaf fresh up to 36 hours while Solution- IV 72 hours. Their pH value are measured as low acidic. These two chemicals were further experimented for best concentration and also pH values. To enhance the effectiveness of these chemicals, the cut twigs were treated with another chemical in water for 3 hours prior to bottling in solution- II and solution- IV. The treated twigs remain fresh for 144 hours in solution- II whereas the same remains fresh up to 10 days in solution- IV. This result lead to a technology for maintaining leaf fresh in cut twigs of silkworm host plant used in indoor rearing

07-02

INFLUENCE OF VESICULAR ARBUSCULAR MYCORRHIZA AND GROWTH REGULATORS ON GROWTH, QUALITY PARAMETERS AND PETAL SENESCENCE ON *Gladiolus grandiflorus* L. CV. JESSICA

Sunil Kumar* and A.K. Gupta**

*Assistant Professor (Floriculture), College of Horticulture & Forestry, Central Agricultural University,
Pasighat-791 102, Arunachal Pradesh

**Retd. Professor (Floriculture), Department of Horticulture, HAU, Hisar-125 004, Haryana
sunul59@yahoo.co.in

A study was undertaken to observe the influence of vesicular arbuscular mycorrhiza (VAM) with respect to the plant survival, growth and yield along with growth regulators viz. GA₃ @ 100 ppm, 200 ppm and kinetin @ 50 ppm, 100 ppm known to retard the senescence and stimulates synthesis of specific RNA which leads to protein synthesis. The possible changes occur in the petals of cut spike when placed in standard solution of sucrose (4 per cent) + 8-HQC during senescence and factors responsible for better longevity was also taken into considerations. During entire experimentation, pre-soaking and foliar spray kinetin 50 ppm followed by pre-soaking and foliar spray FA₃ ppm and pre-soaking kinetin 50 ppm in association with VAM were found more effective in enhancing the plant survival and growth. The minimum numbers of days required for spike initiation, maximum number of florets per spike and fresh weight of cut spike at the time of harvesting as well as quality parameters viz. Maximum days for opening of basal floret, days to senescence of basal floret, ore number of opened florets per spike, maximum number of opened florets per spike before wilting or stem collapse and better longevity were associated with pre-soaking and foliar spray kinetin 50 ppm. Regardless longevity, combined application of kinetin + VAM followed by GA₃ + VAM especially at lower concentration proved most effective. Whereas, at the time of petal senescence of florets, increased pH, water soluble protein, nucleic acid, total sugar and phenol content but decreased total protein, starch content and low pigmentation as compared to fresh fully growth petal was notice.



07-03

SOAK AND EAT RICES FOR SUSTAINABLE AGRICULTURE AND A CLEANER ENVIRONMENT

S.G. Sharma, A. Das and S. Das

Central Rice Research Institute, Cuttack (Orissa)
sgsharmacrri@yahoo.co.in

In the fast changing climate scenario, there is an urgent need to reduce the flow of green house gases to the atmosphere. One vital and viable approach would be to promote food crop varieties that would minimize the use of renewable and fossil fuels in everyday cooking. Assam has a rich store of 'soak and eat rices' which do not require to be cooked by heating; mere soaking the rice for some time in normal water is enough to 'cook' the rice. *Aghonibora* and *Bhogalibora* are released varieties of such rices; *Misiri* and *Chakua* are other two potential varieties for release. The variety *Aghonibora* was grown in CRRI farm, Cuttack and studied for its grain quality, yield, agronomic characteristics, soaking time, amylose content and nutritional composition and above all to see if the 'soak and eat' characteristic is retained in the new environment. The data revealed that the CRRI grown rice required similar soaking time as the Titabar grown rice. A direct relationship was found between the soaking period and amylose content of *Aghonibora*, *Bhogalibora*, *Chakua* and *Misiri* rices. Promotion of such rices would save time and fuel and thus would be a boon for the poor. Not only this, it would help check environmental pollution. Studies with other similar rices are continuing with a view to promote them throughout the country.

07-04

EFFECT OF POST-HARVEST TREATMENTS ON THE PHYSIOLOGY OF TOMATO (cv. Lakshmi)

K.C. Babitha, B.T. Ninganur and M.B. Chetti

Department of Crop Physiology, University of Agricultural Sciences, Dharwad
babithacph@gmail.com

For studying the effect of packaging, storage, and quality in tomato, the mature, uniform sized and injury free, tomato fruits (cv. Lakshmi) were harvested and stored at two different temperatures (Ambient storage-36°C and Cold storage-4°C). Several treatments like Modified Atmosphere Packaging (MAP), Low Density Polyethylene Packaging (LDPE), High Density Polyethylene Packaging (HDPE), Paper packaging, Calcium chloride (1%), Hot water dip at 90°C for 90 min, Hot air treatment at 34°C for 24 h were imposed. Significantly lower physiological loss in weight (4.65%), lower total soluble solids (TSS) (5.24°Brix), higher titratable acidity (0.309%), higher ascorbic acid (21.84 mg/100 g.fr.wt), delayed lycopene biosynthesis (5.320 mg/100 g. fr. wt.), delayed respiratory climacteric (19.89 ml CO₂/kg/h) and lower polygalacturonase activity (4.325 μmol glucose eqv./g. fr.wt./h) were observed in modified atmosphere packed fruits over all other treatments after 28 days of storage. Among the storage conditions, cold storage maintained significantly higher quality of fruits over ambient storage conditions with reduced weight loss, higher titratable acidity, higher ascorbic acid content, delayed lycopene content, lower polygalacturonase activity but, chilling injury symptoms were observed at the end of storage period. However, post harvest treatments and the storage conditions did not make any influence on pH of fruits during the storage period. Modified atmosphere packaging improved organoleptic scoring in terms of colour, texture, aroma and shelf life in both storage conditions.



07-05

EFFECT OF POST HARVEST TREATMENTS ON EXTENSION OF SHELF LIFE IN TOMATO

K.C. Babitha, B.T. Ninganur, M.B. Chetti, J.C. Mathad and D.I. Jirali

Department of Crop Physiology, UAS, Dharwad-580 005

A laboratory experiment was conducted at the Department of Crop Physiology, University of Agricultural Sciences, Dharwad to study the influence of various post harvest treatments on various physio-chemical changes associated with ripening during the storage of tomato hybrid Lakshmi. The experiment was laid out in factorial completely randomized design with three replications. The treatments consisted of modified atmosphere packaging (MAP), HDPE packaging, LDPE packaging, paper packaging, calcium chloride dip, hot water dip and hot air treatments. Significant differences were observed among the physico-chemical parameters due to various post harvest treatments. The tomato fruits kept in modified atmosphere packaging (MAP) had a significantly low physiological loss in weight, total soluble solids, polygalacturonase activity and a delay in the synthesis of lycopene content and respiration rate. Modified atmosphere packed fruits had a higher titratable acidity, ascorbic acid content and organoleptic rating and thus extended the shelf life of tomato fruits by two weeks.

07-06

GENETIC MODIFICATION TO IMPROVE POST HARVEST LIFE OF ORNAMENTAL CROPS

Ajay Arora* and V. P. Singh

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

** romiarora@yahoo.com*

Conventional breeding is still a practical form of increasing the number of flowering buds, extending the longevity of an inflorescence, and improving its postharvest performance. Many of the molecular mechanisms underlying senescence, and the respective genes involved in protein degradation, nucleic acid and chlorophyll breakdown, and lipid and nitrogen remobilization have been extensively studied in many ornamental crops. An understanding of these mechanisms is vital to the use of molecular techniques to clone genes of interest to reverse, for example through antisense technology, the detrimental effects of senescence, ageing or PCD. There is little doubt that the molecular and genetic analyses of flower senescence made in the past 5 years have raised our awareness of the complex interactions that occur to regulate flower development and senescence. Gene technologies have enabled scientists to search for senescence-related genes in plants often described as science models and then translate the data into other species to determine the functional significance of the expression of specific genes in specific tissues after harvest. Interactions between ethylene, cytokinin, sugars and various hydrolytic enzymes are now known to differentially mediate the progression of flower senescence. The individual importance of each signal appears to be species-specific and, in some instances, variety-specific, and varies differentially between floral organs. The challenge for postharvest scientists is to identify a hierarchy of regulators or a specific pattern of events that progresses senescence for certain groups of flower species. Subsequent categorization of cut flowers based on their metabolism and sensitivities will enable targeted application of appropriate postharvest technologies.



07-07

CONTROL OF FLOWER SENESENCE IN GLADIOLUS BY POLYOLS

V.K. Vikas, V.P. Singh and Ajay Arora

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012
drsinghvp@yahoo.com

Flowers are highly perishable in nature and it is estimated that nearly 30% are rendered unmarketable because of post harvest quality losses. This loss is mainly because of senescing flowers and leaves of cut flowers. The death of petal is preceded by a loss of membrane permeability, due in part to increase in reactive oxygen species that are related to up regulation of oxidative enzymes and to a decrease in activity of certain protective enzymes. Flower senescence operates independently of ethylene production in ethylene insensitive species. However it remains unclear in these species how senescence process is initiated and importantly, how the process is regulated. Present study was conducted to test some of the potential polyol compounds for the regulation of flower senescence *vis-a-vis* PCD in ethylene sensitive gladiolus. Although several mechanistic studies on senescence of gladiolus flowers have been reported, the molecular biology of this process remains to be clarified. Effect of various polyols on delaying senescence of gladiolus flowers in terms of physiological parameters, programmed cell death (PCD) in terms of DNA fragmentation and expressions of various senescence associated genes (SAGs) was studied. The vase life of flower spikes was significantly increased and fresh weight was higher and retained for longer duration by treatments with polyols. Flowers kept in inositol (75 mM) showed the highest membrane stability and for longer duration than the other polyols (mannitol and sorbitol) and control treatments. The vase life of polyols treated flowers was more because it delayed the lipoxygenase (LOX) activity, and lipid peroxidation in terms of TBARS and increased the activities of antioxidant enzymes like superoxide dismutase, catalase, glutathione reductase and ascorbate peroxidase. The PCD was delayed significantly in inositol treated gladiolus flowers in terms of DNA fragmentation. The expressions of SAGs (*viz.*, *Gglox1*, *GgCYP1*, *GgERS1a* and *GgERS1b*) were downregulated while *GgDAD1* was upregulated by inositol treatment during the course of flower development.

07-08

CHANGES IN SPROUTING CAPACITY AND ELECTROLYTE LEAKAGE IN AGEING POTATO TUBERS OF THREE CULTIVARS STORED AT 4 AND 12°C

Raghav Dutta and R. Ezekiel

Central Potato Research Institute, Shimla – 171 001 (H.P.)

During storage a potato seed tuber passes through various physiological stages. Sprout growth of a seed tuber is affected by its physiological age, and storage temperature has a strong influence on the physiological age of a seed tuber. An experiment was conducted to determine the effect of physiological ageing during storage at 4 and 12°C on sprouting capacity of seed tubers of three potato cultivars and its relationship with electrolyte leakage. Seed tubers of three potato cultivars *viz.* Kufri Jyoti, Kufri Bahar and Kufri Lalima were stored at 4 and 12°C (RH 85-90%) for 240 days. Sprouting capacity, electrolyte leakage, reducing sugars and sucrose content were determined at 30 days interval. In all the three cultivars the sprouting capacity increased with increase in storage duration up to 90 days of storage (DOS), reached a maximum at 90 DOS and declined thereafter. The sprouting capacity was higher in seed tubers stored at 4°C as compared to those stored at 12°C, and the cultivar Kufri Bahar showed higher sprouting capacity indicating greater vigour. Electrolyte leakage increased with increase in storage duration up to 180 DOS. The correlation between sprouting capacity and electrolyte leakage was positive up to 90 DOS and negative between 120 and 240 DOS. The electrolyte leakage in tubers during storage at 4°C showed a highly positive correlation with reducing sugars ($r = 0.93^{**}$, $R^2 = 0.86$) and sucrose ($r = 0.97^{**}$, $R^2 = 0.94$). In tubers stored at 12°C also a highly positive correlation was observed.



07-09

DELAY IN RIPENING AND BETTER POST-HARVEST LIFE OF TOMATO (*Solanum lycopersicon* L.) FRUITS AT HIGHER STORAGE TEMPERATURE BY USING 1-METHYLCYCLOPROPENE (1-MCP)

Vijay Paul*, Rakesh Pandey, Atar Singh and G.C. Srivastava

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

**vijay_paul_iari@yahoo.com*

In view of large post-harvest losses in tomato, enhancement in its post-harvest life is very important. Being a climacteric fruit, not only the onset of ripening is governed by an increase in ethylene production but the progress of ripening also depends on continuous presence of ethylene and its action. Among all the known action inhibitors of ethylene in plant tissues, 1-methylcyclopropene (1-MCP) is the most potent one. It binds to the ethylene receptor and thereby prevents the ethylene-mediated signal transduction cascade which otherwise triggers the process of ripening in climacteric fruits. Work carried out so far pointed out towards some constraints which have limited the use and rapid commercialization of 1-MCP. These constraints include; modification of 1-MCP response by its concentration, exposure duration, temperature (during treatment and storage), development stage/maturity of the fruit, variety and interaction among these factors. Besides this, most of the studies on 1-MCP have been conducted at lower storage temperatures of 15 to 20 °C and very few at 25 °C and none at storage temperature of more than 25 °C. This study is therefore taken up to find out an effective dose of 1-MCP that could not only delay the ripening of tomato fruits stored at relatively higher temperature but also suitable across the varieties and ripening stages of tomato fruits. The obtained results indicate that treatment with 0.3 ppm of 1-MCP for 24 hrs is most effective in delaying the ripening of tomato fruits (of any variety) harvested either at green mature or breaker stage even if stored at relatively higher temperature of about 25 and 30 °C. The treatment is also found effective for a lot of fruits representing mixture of tomato fruits at different ripening stages (green mature, breaker and turning). Delay in ripening by 5-10 days is obtained with this treatment. Aspects such as present status, safety concerns and commercialization of 1-MCP are also being discussed.

07-10

ADVANCES IN POST HARVEST TREATMENTS OF FRUITS AND VEGETABLES

Ram Asrey

Division of Post Harvest Technology, Indian Agricultural Research Institute, New Delhi-110 012

Fruits and vegetable are biomaterial; their quality retention and loss prevention during handling, storage and retailing has always remained a critical issue for researchers, policy makers, processors and consumers. In past, there were several chemicals in use for post harvest treatment of fruits and vegetables, but due to advancement in green technology, environmental concern and health consciousness of consumers has phased out these chemical with the adoptions of improved ones. In last couple of years, some environmental and consumer friendly post harvest treatment materials like plant based essential oils, ozonized water, edible waxes, 1-Methylcyclopropane and Polyamines are gaining popularity world over. Geranium, mint, palmarosa, and thyme oils were found to exhibit absolute fungitoxic activity. Ozonized water is an ideal and cheap sanitizer which is being used for washing of produce. In developed countries, 1-Methylcyclopropane (1-MCP) is commercially used for fruit treatment in order to minimize ethylene evolution during transit and storage. Edible waxes are now being obtained from plant (carnauba wax, zein protein, alovera, *gwar* gum) and sea fauna (chitosan). These are strong physiological activity retardant and antifungal substances. Polyamines like putrescine, spermidine and spermine are very useful molecules and now being gainfully utilized for minimizing mechanical damage, chilling injuries during storage and overall shelf-life extension of fruits.



07-11

**ENHANCING THE FRESH KEEPING LIFE OF CUT WATERMELONS BY USE OF HONEY,
VANILLIN AND UV-C LIGHT**

S. Siddiqui

Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar-125 004

The cut pieces of watermelon were treated with the vanillin (1000 ppm & 1500 ppm), UV-C light (10 % 20 min), honey (10 % & 15%), and hurdle (1000 ppm vanillin + 10% honey + 10 min UV-C) and stored upto 9 days in a specially designed PVC packs at 10°C. It was observed that texture, pH, and vitamin C decreased, whereas, titratable acidity, juice leakage, phenolic content, and carotenoids increased during the storage period. The different treatments had significant effect on the quality of cut-watermelon. UV-C light treatment resulted in increased phenolic content, reduced drip losses & maintained the texture. However, it caused reduced TSS, vitamin C, reducing and total sugar content. Honey showed improved storage potential with respect to most of the chemical parameters and its higher concentration was more effective. Vanillin (1500 ppm) showed improved texture, and carotenoid content, however, vanillin (1000 ppm) generally did not significantly affect most of the physico-chemical parameters studied. Sensory characteristics of cut-watermelon was affected by storage periods which showed increased acceptability up to the 3rd day in all the sensory attributes and decreased thereafter, but it was not significantly affected by the different treatments used in the present study. It was observed from the present study that there was no individual treatment that could exclusively improve all the quality parameters and enhance the shelf life. The combined honey + vanillin + UV-C hurdle treatment did not show additional advantage over the individual treatments.

07-12

**SCOPE FOR POST HARVEST MANAGEMENT OF TAPIOCA IN NORTH EAST REGION OF
INDIA**

Priyanka Das¹, Abha Phookan² and Basanti Barooah³

¹AICRP on Post Harvest Technology, College of Agriculture,

*²Deptt of Clothing and Textile, ³Deptt of Food and Nutrition, College of Home Science
Assam Agricultural University, Jorhat-785013, Assam*

Tapioca or cassava (*Manihot esculenta* Crantz) is an important tropical tuber crop having high amount of starch. It has much applications in feed, food and industrial sectors. Being a crop which requires minimum agronomic input and care for its growth, it provides food security, income and employment generation in rural areas. However, the perishable and bulky nature of the tubers emphasize the need for *in situ* value addition. In North East India tapioca is cultivated mainly in Assam, Meghalaya, Mizoram and Nagaland with production of more than 50,000 MT. Nothing is known about value addition of the tubers and almost all the produce are used in raw form, as animal feed or after boiling as human feed. In this situation, there exists need for awareness and interest development and efficiency development on value addition. Such type of activities will help in income generation and post harvest loss reduction of tapioca. There exists high demand for cassava starch in India, in adhesive sector, paper industry, textile industry and other sectors. The raw tapioca tubers can be primarily processed to yield dry chips and flour (both plain and parboiled) and starch. From those primary products, with the help of simple technology, many types of secondary products can be obtained ranging from food items to industrial products such as adhesive, laundry starch, safe 'holi' colours, etc. Scope for value addition of tapioca in North East region of India will be discussed in the paper.



07-13

EFFECT OF EDIBLE OILS, CHEMICALS AND PACKAGING MATERIALS ON QUALITY PARAMETERS OF GUAVA (*Psidium guajava* L.) DURING STORAGE CV. 'ALLAHABAD SAFEDA'

R.K. Jat¹, C.B. Patel², P.V. Singh¹, P.M. Chaudhari¹ and M.K. Yadav³

¹ASPEE College of Horticulture and Forestry, Navsari ²Fruit Research Station, Gandevi

³N.M. College of Agriculture, Navsari

Navsari Agricultural University, Dandi Road, Navsari-396450 Gujarat

manoj_kadali@hotmail.com

An experiment was carried out at ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during the year 2007-2008 to study the response of edible oils, chemicals and packaging materials on chemical parameters of guava (*Psidium guajava* L.) during storage cv. 'Allahabad safeda'. The experiment was laid out in completely randomized design with factorial concept involving two factors of edible, oils, chemicals and packaging materials along with control. The treatment was repeated thrice at an ambient temperature and of guava fruits were recorded on 3rd, 6th, 9th and 12th days of storage. The various treatments were light coating with edible oils *i.e.* mustard and groundnut oil, chemicals *i.e.* Benzyl Adenine(BA) and Naphthalene Acetic Acid(NAA) (100 mg/l each) with combination of both edible oils and packaging materials *i.e.* brown paper bag and black polythene bag (200 gauge). The application of BA (100 mg/l) + light coating with mustard oil improved chemical parameters like TSS (%), acidity (%), ascorbic acid (mg/100 pulp) and sugars like reducing, non- reducing and total sugars. The mature guava fruits were packed with black polythene bag (200gauge) and stored for 12 days showed promising results in delaying ripening the chemical process followed by brown paper bag. The mature guava fruits were treated with BA (100 mg/l) + light coating with mustard oil and packed with black polythene bag were found effective in reducing the rate of repining and other chemical changes during storage. It also followed by Benzyl adenine (100 mg/l) + light coating groundnut oil and packed with brown paper bag.

07-14

EFFECT OF DIFFERENT CHEMICAL TREATMENTS ON SHELF LIFE AND POST HARVEST QUALITY OF GUAVA (*PSIDIUM GUAJAVA* L.) CV. L-49

Arti Sharma*, Sonam Rinchen Bhutia, Kartar Singh and Mahital Jamwal

*Working as Assistant professor cum junior scientist in the Division of Fruit Science at Sher-E- Kashmir University of Agricultural Science and Technology- Jammu ,Contact no. 09419796724; email:

aru_rinku@rediffmail.com

An experiment was conducted to study the effect of different chemicals viz. sesame oil emulsion, Potassium permanganate, gibberellic acid as post harvest treatments on the shelf life and post harvest quality of guava cv. L-49. Uniform and healthy fruits of guava (*Psidium guajava* L.) cv. L-49 (Sardar) were harvested from the experimental orchard of Department of Horticulture CCS, HAU Hisar, India, at two stages of maturity viz. colour break stage (CBS) and Post colour break stage (PCBS). Chemicals were applied at both the stages of maturity. Among the various chemicals used gibberellic acid was found to be most effective in prolonging shelf life and improving quality of fruits followed by sesame oil and KMnO₄ in both stages of maturity. Among the stages of maturity fruits harvested at Post Colour break stage (PCBS) retained comparatively high firmness and organoleptic rating during storage but PLW and decay loss were early and higher as compared to colour break stage (CBS)



07-15

STUDY OF STORABILITY OF GROUNDNUT SEEDS IN DIFFERENT PACKAGING MATERIAL

A.K. Shinde, B.B. Jadhav and S.B. Patil

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

An investigation was conducted during 2008 - 2009 with objective to identify the suitable packaging material for storage of groundnut seed. Experiment was laidout in Randomised block design with three replications. Seed were packed in different packaging material viz. Polylined HDPE bag, Polylined cloth bag Polylined Jute canvas with 2 storage conditions of Ambient storage and Cold storage, along with control. The significant effects on germination percentage was observed at 4 and 6 months after storage due to packaging material. Seed stored in Polylined Jute canvas and Polylined HDPE bag at Cold storage showed maximum (61.3 %) seed germination followed by Polylined cloth bag (60.3 %) at 4 month storage. At 4 and 6 month of storage the germination was lower than minimum seed certification standard in all the treatments under study. The initial moisture content of groundnut seed was higher (12-13 %) than required for storage (9-10 %). Therefore seed germination was lower than MSCS at 4-6 months of storage. However, cold storage and Polylined cloth bag Polylined Jute canvas, Polylined HDPE bag showed better germination than other packaging material.

07-16

EFFECT OF PREHARVEST SPRAYS OF CALCIUM ON THE STORAGE OF BER (*Zyzyphus mauritiana* Lamk.) CV. UMRAN

R.K. Sharma, Inderjit Yadav, and S. Siddiqui*

*Department of Horticulture, *Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar-125004, Haryana*

Uniform and healthy trees of ber cv. Umran were sprayed four times at 10 days interval with 0, 1.0, 1.5, 2.0 percent of calcium chloride solution prepared in tap water using teepol as surfactant The fruits were harvested at colour turning stage of maturity from each treatment, ten days after the last spray. The fruits from each treatment were packed in 10% perforated polythene bags (200 gauge), kept in cardboard boxes and stored at room temperature ($30\pm 3^{\circ}\text{C}$). It was observed that pre harvest sprays of CaCl_2 up to 1.5% concentration was effective in enhancing the shelf-life of the fruits by reducing physiological loss in weight, decay loss and retaining more fruit firmness, moisture percentage, TSS titrable acidity, ascorbic acid and sugars during storage. Chlorophyll content decreased but carotenoids were not affected by CaCl_2 sprays during the storage. The higher concentration of 2.0% CaCl_2 proved to be toxic and thus had an adverse effect on quality and shelf life of fruits.

07-17

ROLE OF NITRIC OXIDE (NO) IN REGULATION OF FLOWER SENESCENCE IN GLADIOLUS (*Gladiolus grandiflora* hort.)

S.K. Dwivedi, Pankaj Kumar, G. Agarwal, D. Choudhary, V.P. Singh and Ajay Arora

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

Experiments were conducted to study the effect of nitric oxide, provided by the fumigation from sodium nitroprusside on delaying senescence in gladiolus cultivar Snow Princess in relation to physiological and biochemical parameters and expression of various senescence associated genes (SAGs). The vase life of flower spikes was significantly increased and fresh weight was retained for longer duration by treatment with NO than control. The vase solution having NO (100 ppm) significantly increased uptake of vase solution, increased



floret diameter and lowered the pH of vase solution than control. Spikes kept in vase solution containing NO (100 ppm) also maintained higher membrane stability content, while lipid peroxidation in terms of TBARS and lipoxygenase (LOX) activity was reduced in comparison to control. The activities of various antioxidant enzymes viz., superoxide dismutase (SOD), catalase (CAT), total peroxidase (POX) and ascorbate peroxidase (AP) were higher in NO (100 ppm) treated florets. These results suggest that nitric oxide acts as a free radical scavenger and hence delaying the process of lipid peroxidation and consequently senescence. The expression of senescence associated genes (SAGs) viz., *GgCYP1*, *GgERS1a* and *GgERS1b* were downregulated by nitric oxide treatment during the course of flower development. The expression of these genes increased gradually during early stages of flower development and start declining from incipient senescent stage onwards in both control and treated florets but the decrease in expression was more prominent in control than NO treated florets. However, *GgDAD1* was upregulated by nitric oxide treatment during the course of flower development. The expression of this gene increased gradually from bud to incipient senescent flower stages and decreased in fully senescent stage in both control and treated florets but the treated floret maintained higher expression of these genes than control at terminal senescent stage of gladiolus floret.

07-18

POST HARVEST MANAGEMENT IN PAPAYA (*Carica papaya* L.) CV. TAIWAN RED LADY

Premlata and B.N. Patel

ASPEE College of Horticulture and Forestry, N.A.U., Navsari-396 450
doll_2729@rediffmail.com

With a view to fulfil the objectives of retarding the process of ripening, extending the shelf-life, minimizing the losses and improve the quality of papaya fruits cv. Taiwan Red Lady at cold storage condition and at ambient temperature, an experiment was laid out by using different chemicals, wrapping materials and storage temperatures i.e. GA₃ 100 ppm, KMnO₄ 0.5% and CaCl₂ 2% along with control and wrapping material like butter paper and news paper, storage temperature at 12±10C at 80% RH and 20±10C at 80% RH at the P. G. Research Laboratory, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2008. Post-harvest treatment of GA₃ 100 ppm along with wrapping material i.e. butter paper at 12±10C at 80% RH temperature extended the shelf-life of papaya fruit during all the days of storage i.e. 4th, 8th, 12th, 16th and 20th days of storage and fruits stored at low temperature was effective reducing the rate of ripening and other physical parameters like physiological loss in weight, ripe fruit percentage, marketability, fruit firmness, and organoleptic score.

07-19

POST HARVEST SHELF LIFE OF CUT FLOWERS

Archana Mankad

Department of Botany, Gujarat University, Ahmedabad-380 009, Gujarat
amankad@hotmail.com

Post harvest preservation methods and value addition provide the much needed backup for the striving floriculture industry. Standard protocols are not available for all the commercially useful cutflowers. The Floriculture Industry has a promising future but is seen succumbing to the pressures within and those of the system. An integrated management approach would be required on a long term basis to promote and support the industry. The demand and supply chain generally puts pressure on the need to grow only a specific type of flower, whereas there are a whole lot of other flowers that can be exploited as cut flowers. There is a need to create a market for these so that the industry can offer more and in turn get more. Many garden plants which are not conventionally grown as cut flowers can be exploited. An attempt is made here to survey the nonconventional flowers that can be easily grown locally and have a promising commercial viability, their growing, postharvest shelf life under the influence of chemicals and value addition for floriculture industry.



07-20

POSTHARVEST LIFE OF HELICONIA (*Heliconia rostrata*) AS INFLUENCED BY CHEMICAL PRESERVATIVES

Paramveer Singh, B.K. Dhaduk, M.K. Yadav, S.A. Aklade and V.K. Solanki

*Department of Floriculture and Landscaping, ASPEE College of Horticulture and Forestry, Navsari
Agricultural University, Navsari-396 450
shekhawatdeep@rediffmail.com*

Heliconia belonging to Heliconiaceae are the most attractive of all exotic tropical flowering plants. It has great potential to be used as cut flower due to their diversity in both colour and form and have good potential as commercial cut flower. Its brilliant colour, exotic form and excellent post harvest characteristics make it an outstanding flower for the florist trade. In view of this, an experiment was carried out at floriculture lab, Aspee College of Horticulture and Forestry, NAU, Navsari during 2008 to find out the best chemical preservative for enhancing the vase life of heliconia cut flowers. Experiment was laid out in Completely Randomized Design with three replications. There were seven treatments, comprising control (distilled water), 8 HQC (100, 200 and 300 ppm) and sucrose 2% + 8 HQC (100, 200 and 300 ppm). Stalk of cut flowers were dipped in 300 ml vase solution. Among all treatments, the vase solution of 8 HQC (300 ppm) recorded minimum physiological loss in weight and uptake of vase solution, enhanced vase life with improved cut flower quality of heliconia as compared to control (distilled water).

07-21

IMPACT OF LUQUOSORB (HYDROPHYLIC POLYMER) ON YIELD AND QUALITY IN TOMATO

C.M. Nawalagatti, Mukesh Kumar Meena, M.B. Chetti and D.S. Uppar

Department of Crop Physiology, College of Agriculture, Univ. of Agricultural Sciences, Dharwad-580 005

The experiment to study the impact of luquosorb (hydrophylic polymer) on fruit yield and quality in tomato was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The experiment consisted of seven treatments among which six different levels of luquosorb (0.50, 0.75, 1.00, 1.25, 1.50 and 1.75g/plant) and another was control. The treatments were imposed at the time of transplanting. The results of the investigation revealed that, the biochemical parameters viz., total chlorophyll content, nitrate reductase activity (NRA) recorded higher values with the application of luquosorb (1.75g/plant) as compared to control and other treatments. This treatment also increased significantly the quality parameters like ascorbic acid and lycopene content, total soluble solids (TSS) and fruit juice content. The fruit yield was significantly higher with application of luquosorb @1.75 g/plant. The increase in the yield was attributed to the yield components like number of fruits per plant, fruit yield and fruit volume. From the experiment it is inferred that the soil application of luquosorb (1.75 g/plant) is more effective not only reducing number of irrigations but also found to be more economical in getting higher fruit yield.



07-22

POST HARVEST IRRADIATION AFFECTS THE QUALITY OF KESAR MANGO

M.K. Yadav[#], N.L. Patel, Ankita Hazarika* and S.R. Patel

N. M. College of Agriculture, Navsari Agricultural University, Dandi Road, Navsari (Gujarat)

** Present address- College of Agriculture, Assam Agricultural University, Jorhat (Assam)*

manoj_kadali@hotmail.com

Irradiation is the commercial technology for reducing post harvest losses, microbial infections and extending shelf life of fresh produce. Mango is highly perishable, ripens fast during summer and becomes inconsumable very soon. The abundant supply of mango fruits in the market from the majority of orchard takes place in short span which causes glut in market thereby, causing reduction in price. In spite of being the leading producer of mango in the world, India resisters highest post harvest losses and minuscule exports. The reasons for this paradox are manifold. However, issues related to shelf-life and quality is the major stumbling blocks to trade, both national and international. The aim of this study was to investigate the effect of gamma irradiation on quality of Kesar mango. The experiment was performed in year 2008 at Navsari Agricultural University, Navsari (Gujarat). Fruits were irradiated with 0.0, 0.2, 0.4 and 0.6 kGy from Cobald-60 at ISOMED, Board of Radiation and Isotope Technology, BARC, Vasi- Mumbai. Irradiated and non irradiated fruits were stored at ambient, 9°C and 12°C temperatures and CA storage under a relative humidity of 70-90 per cent. The control fruits without irradiated stored ad ambient temperature. The various observations such as physiological loss in weight, ripening percent, TSS, total sugars, reducing sugars, acidity, ascorbic acid and sensory attributes were recorded. It was observed that irradiated mangoes stored at various temperatures retained quality even after six weeks of storage (at 12°C) whereas; unirradiated (control) mangoes had lower quality when fully ripped on 12 days of storage at ambient temperature.

07-23

IMPROVEMENT IN THE QUALITY OF DEHYDRATED POTATO SLICES BY USE OF PULSED ELECTRIC FILED PRETREATMENT

Seema Rana and S. Siddiqui

Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar-125 004

The present investigation was undertaken to study the effect of pulsed electric field pretreatment (PEF) on dehydration of potato slices. The potato slices from cv. Kufri Chandramukhi were subjected to 10 min dipping pretreatments in the following solutions (i) Water, (ii) 0.25% KMS solution, (iii) 2.0% NaCl solution, (iv) 0.50% CaCl₂ solution. After dipping, the slices were subjected to 0, 2, 4 and 6 kV levels of PEF (15 Hz). The pretreated slices were then dried in a cabinet drier at 60 °C to attain final moisture content of ~ 6%. The conventional method of blanching the slices for 1 min in hot water followed by drying was also taken as one of the treatment. It was observed that various chemicals and PEF pretreatments had no effect on the recovery, moisture content and texture of the dehydrated potato slices. The drying rates were maximum in potato slices pretreated with PEF 2 kV, which did not further increase significantly with increasing levels of PEF. Rehydration ratio and co-efficient of rehydration were higher in PEF treated samples, maximum being observed for KMS-2 kV PEF pretreatment. The browning was lower in potato slices pretreated with PEF 2 kV, which did not further decrease significantly with increasing levels of PEF. Amongst the various chemical treatments, lower browning was observed for KMS pretreated potato slices, followed by CaCl₂ and NaCl. Various chemicals and PEF pretreatments had no significant effect on phenolic content, starch and reducing sugars of dehydrated potato slices. Maximum score for colour and texture was given to the potato slices treated with KMS-2 kV PEF. Thus, the study revealed that PEF resulted in improved quality of dehydrated potato slices, best being for KMS - 2 kV PEF pretreatment.



07-24

EFFECT OF PULSED ELECTRIC FIELD PRETREATMENT ON THE QUALITY CHARACTERISTICS OF DEHYDRATED ONION FLAKES

Munish Siwath and S. Siddiqui

*Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar-125 004
saleemcfst@gmail.com*

The onion flakes were pretreated with 6000 and 12000 KV levels of low frequency (15 Hz) pulsed electric field (PEF). The pretreated flakes were then dried either in fluidised bed drier or tray drier (at 60°C) or solar drier to obtain dehydrated onion flakes with moisture content ~5%. The dehydrated onion flakes were evaluated for various quality characteristics. Pungency of PEF pretreated dehydrated onion flakes was almost similar to the pungency of control sample. Non-enzymatic browning was found minimum in PEF treated onion flakes and increasing levels of PEF resulted in decreased browning during dehydration. Total phenols of dehydrated onion flakes were not significantly affected by lower level of PEF but were significantly reduced by high level of PEF. Polyphenol oxidase activity was found minimum in PEF pretreated onion flakes and increasing levels of PEF decreased it. It was observed that increasing levels of PEF resulted in progressive decrease in sugar content of dehydrated onion flakes. The effect of increasing levels of PEF on sugars was more evident in fluidized bed dried and tray dried than solar dried onion flakes. Dehydration and rehydration ratio were found maximum in PEF treated onion flakes and increasing levels of PEF resulted in increased levels of dehydration and rehydration ratio. Sensory scores of PEF treated onion flakes for color and appearance, aroma and overall acceptability were higher for PEF treated onion flakes. It is concluded from the study that the quality of dehydrated onion flakes was better when treated with 12000 KV of PEF and dried by fluid bed dryer at 60°C.

07-25

PROLONGING THE VASE LIFE OF GLADIOLUS CUT FLOWERS BY PULSING TREATMENT

Ranjita Bora and Pritam Coomar Barua

Department of Horticulture, Assam Agricultural University, Jorhat-13

A laboratory experiment on pulsing treatment was conducted in the laboratory, Department of Horticulture, Assam Agricultural University, Jorhat with a view to prolong the vase life of gladiolus cut flower. Pulsing is a short term treatment with sugar and some other antimicrobial and anti-ethylene chemicals at high concentration which is given to the cut flowers after harvesting but before packing in order to extend the post harvest life of flowers. Eighteen pulsing treatments were undertaken using sucrose and silver thiosulphate (STS) with different concentrations treated for different periods of time. Pulsing with 0.5 mM STS for 30 min showed the highest water uptake, proportionately lower transpiration loss, lowest water loss/uptake ratio, higher fresh weight per cent, highest floret opening per cent and lowest phenol content in the vase water. This treatment was closely followed by pulsing with 40 % sucrose for 12 hr. Best retention of flower colour was found in 40 % sucrose for 18 hr. followed by 0.5 mM STS for 30 min. Pulsing with 0.5 mM STS for 30 min recorded the highest vase life of 17 days followed by 40 % sucrose for 12 hr.



07-26

PROCESSING AND QUALITY EVALUATION OF GUAVA SQUASH

J. Shankara Swamy* and **A.K. Banik**

Department of Post harvest Technology, BCKV, Mohanpur-741252, West Bengal

**Senior Research Fellow, Directorate of Medicinal and Aromatic Plants, Boriavi, Anand -387 310, Gujarat
shankara.swamy@gmail.com*

Guava (*Psidium guajava*) called the apple of tropics is one of the most common fruits in India. Guava yield from rainy season crop is more but quality is inferior when compared to winter season crop and it leads to market glut and gets low price. Hence, value addition of rainy season crop will be an alternative and can fetch more income to poor farmers. Moreover, its excellent flavour and nutritive value have great potential to be utilized for preparation of beverages like squash and ready to serve (RTS). Hence a study was taken to produce a guava squash with proper suspension of fruit pulp which is stable and organoleptically preferred squash by supplementing the soluble dietary fibre in the form of xanthangum at five different levels of concentrations (0.1 to 0.5%). The changes in physico-chemical, sensory and microbiological attributes were evaluated for the different treatments on storage. Bottled guava squash of Cv. Allahabad Safeda was prepared with 25% pulp, 40% Total soluble solids (TSS), 1% acidity and with different concentration levels of xanthangum, an exocellular polysaccharide produced by obligatory aerobic microorganism *Xanthomonas campestris*. The stability of the product was then studied by analyzing chemical and sensory evaluation of bottled squash during the 180 days of storage. There were little changes in quality parameters viz. TSS, pH, titratable acidity, ascorbic acid during the storage. Non-enzymatic browning in guava squash increased with prolong storage period. 0.5% W/W of xanthangum gave stability to the product during the 180 days of storage period. Overall acceptability was highest in pure guava squash containing 0.1% of xanthangum, 40% of TSS and 1% of acidity during the 180 days of storage period. So utilization of guava fruits in the preparation of guava squash has added advantages in the utilization of guava pulp in the way of minimizing the loss of guava fruits during the rainy season.

07-27

ACCEPTABILITY OF PROCESSED AND PRESERVED MUSHROOM

M.C. Kalita*, **Mamoni Das**** and **Y. Rathiah*****

Department of Food and Nutrition, College of Home Science, AAU, Jorhat, **Directorate of Extension Education AAU, Jorhat, * Department of Plant Pathology AAU, Jorhat*

Preservation of mushroom is essential to prevent rapid spoilage and to make it available throughout the year to retain nutrients, texture and to increase per capita consumption in developing countries. Mushroom is gaining immense popularity and the consumer demand for variety has led to the development of ready made processed foods to meet the demand and to increase its self life. The study was undertaken to conduct acceptability trials of preserved and processed products having market potential. Acceptability trials were conducted using Hedonic rating scale by an expert panel. Two varieties of mushroom namely milky white and oyster mushroom were used for developing products like mushroom pickle, chutney and sauces. Moreover dried mushroom powder from both the varieties were incorporated in developing various recipes such as fritters, soups and rotis. Results revealed that products developed from both the varieties in terms of processed and preserved recipes were well accepted. However, pickles made from milky white mushroom had better scores compared to oyster mushroom and chutney and sauces made from oyster mushroom were better than milky mushroom. There was no significant difference between the products made from powdered mushroom.



07-28

STUDIES ON POST HARVEST LIFE OF CUT ANTHURIUM (*ANTHURIUM ANDREANUM* LIND.) FLOWERS

Preeti Hatibarua and Sangita Das

Principal Scientist, HRS, Kahikuchi, P.O Azara, Guwahati, Assam

Studies were conducted on postharvest life of two anthurium cultivars viz. Sunset Orange and Agnihotri, at the Department of Horticulture, Assam Agricultural University, Jorhat. Studies involved pulsing of anthurium cut flowers with 28 chemicals, out of which maximum vase life in terms of spadix drying, spathe blueing and loss of spathe glossiness was observed in 100 ppm BA, followed by 500 ppm AgNO₃ and 200 ppm (Al)₂(SO₄)₃ which were at par. All the pulsing treatments showed improved water uptake over control, out of which maximum uptake was observed in 4% Sucrose, followed by 500 ppm AgNO₃ which were at par. In the holding solution experiment, 100 ppm Citric acid + 5% Sucrose showed significantly higher vase life in terms of spadix drying, spathe blueing and loss of spathe glossiness. Maximum water uptake was observed in flowers held in 5% Sucrose, followed by 100 ppm Citric acid + 5% Sucrose. In the cold treatment experiment, precooling treatment at 15°C for 4 hours resulted in maximum vase life in terms of spadix drying, spathe blueing and loss of glossiness.

07-29

EFFECT OF CHEMICAL PRESERVATIVES IN EXTENDING THE VASE LIFE OF CUT GERBERA (*Gerbera jamesonii* Bolus)

P. Mahanta, L. Paswan, M.C. Talukdar and S. Bora*

Department of Horticulture, Assam Agricultural University, Jorhat, Assam

**Department of Horticulture, B N College of Agriculture, AA, Biswanath Charai, Sonitpur, Assam-784 176*

An experiment was conducted at Assam Agricultural University to study the effect of different preservative treatments in extending the vase life of gerbera cut flowers using cultivar "Popular" in Completely Randomized Design with 4 replications. The results reveal that the treatment AgNO₃ 40 mg + HQS 200 mg + Sucrose 20g per liter exhibited the best performance followed by treatment AgNO₃ 40 mg + HQS 200 mg + Sucrose 10g per litre and treatment AgNO₃ 40 mg + HQS 200 mg + Sucrose 30g per litre in terms of water uptake and water loss at 3 days interval, cumulative water uptake, cumulative water loss, water loss: uptake ratio. pH of the petal cell, sugar content of the petal cell, electrolyte leakage in the vase solution, phenol accumulation and difference in pH. These three treatments also recorded the longest vase life of flowers (15.88 days, 15.66 days and 14.99 days respectively) as compared to control (11.10 days).

07-30

EFFECT OF SHRINK WRAPPING, WAXING AND LOW DENSITY POLYETHYLENE (LDPE) ON STORAGE LIFE OF ROUGH LEMON (*Citrus jamburi*)

S. Alam, A. Saikia, B. Bhuyan and Saikia P. Kalita*

*Dept. of Horticulture, *Dept. of Crop Physiology, Assam Agricultural University, Jorhat -785013*

An experiment was conducted in the Department of Horticulture, AAU, Jorhat to study the storage life of rough lemon (*Citrus jamburi*). Fruits after washing with chlorinated water (1000 ppm) were shrink wrapped, packed in LDPE bags with pin holes and waxed along with control. The treated fruits were stored at room temperature. During storage there was a slight increase in TSS and acidity was found to have decreased. Ascorbic acid content also decreased during storage. Shrink wrapped fruits remained fresh up to 35 days after storage, whereas fruits without any treatment remained fresh only for 3 days.



Session 08

Plant Nutrition



08-01

LONG-TERM EFFECTS OF CONTINUOUS CROPPING (RICE-RICE) AND FERTILIZATION ON CROP YIELDS, SOIL FERTILITY STATUS AND SOIL HEALTH

T.J. Ghose, K.V. Rao*, P.C. Dey, R.K. Chowdhury, S.K. Chetia and R.K. Saud**

**Head, Soil Science Division, DRR, Hyderabad, **Manager, ATIC, AAU, Jorhat
Regional Agril. Research Station (AAU), Titabar*

The long-term field trial in progress at RARS, Titabar since 1989 has been laid out for studying the effects of various fertility treatments on a fixed rotation of rice-rice sequence. This paper makes an attempt to highlight the effect of various treatments on crop yields, nutrient uptake by crops, soil fertility status and soil health. Application of 100% NPK + 5 t FYM/ha recorded highest grain yield over the rest of the treatments. Rice Productivity trends over the last 20 years declined in case of lone N application, sub-optimal dose of fertilizers and also at recommended doses of fertilizer. Corresponding changes in soil fertility parameters were also recorded. Nutrient uptake pattern showed the same trend as that of grain yield. Omission of some of the nutrients or reduction in RDF resulted in significant reduction in nutrient uptake. Soil fertility improved significantly with most of the INM treatments and FYM application alone over the years. This treatment was superior to 100% RDF in case of organic-C (by 13%), available P_2O_5 (by 28%) and available K_2O (by 41%) content. The biological properties recorded maximum value of bio mass – C (285 $\mu\text{g/g}$) and dehydrogenate activity (63.6 $\mu\text{g TPF/g soil/24h}$) with FYM application @ 10t/ha. INM treatments also showed improvement in soil health parameters.

08-02

PHYSIOLOGICAL EVALUATION OF IRON EFFICIENT RICE (*Oryza sativa* L.) GENOTYPES AT DIFFERENT NITROGEN LEVELS

Bhupendra Mathpal, Alok Shukla, Deepti Shankhdhar and S.C. Shankhdhar

*Department of Plant Physiology, College of Basic Sciences & Humanities, G.B. Pant University of
Agriculture & Technology, Pantnagar-263145, Uttarachand*

Nitrogen fertilizers significantly affect the iron content of plant parts and the soil treated with nitrogen fertilizers had the greater nitrogen content. The present study was performed to evaluate the different treatments of nitrogen (N_0 , N_{50} , N_{100} and N_{200}) on the iron content of the leaves, culms, and grains in different genotypes of rice. The effect of same treatments on the phytic acid (anti nutrient) content of the grains was also performed. The iron content of the leaves increased with increasing nitrogen levels for most of the genotypes. The iron content of the culms decreased with increasing nitrogen levels for the genotypes KRH-2, Kasturi and Krishna Hamsa. The iron content in grains of the KRH-2, Vasumati and Tulsi was increased with increasing nitrogen levels. For Kasturi and Krishna Hamsa the maximum iron content was found at N_0 and N_{50} levels, respectively while the minimum for both at N_{100} level. The percent translocation of iron from vegetative parts to grains also showed a genotypic variation. The maximum percent translocation of iron was found in Vasumati and the minimum in Tulsi. There are many plant substances present in grains that inhibit the bioavailability of iron to humans. These include phytic acid, fibers polyphenols, lectins and competitive heavy metals cadmium. The phytic acid content in rice grains showed no correlation with different nitrogen levels however, it had some correlation with iron content in grains. Amongst the genotypes KRH-2 had the maximum and Vasumati had minimum iron content in grains with slight variation in phytic acid content at different levels of nitrogen.



08-03

INFLUENCE OF ORGANIC MANURES AND CHEMICAL FERTILIZERS ON MORPHO-PHYSIOLOGICAL PARAMETERS IN MAIZE

B.B. Channappagoudar, M.B. Chetti and N.R. Biradar

Crop Physiology Department of Crop Physiology, Univ. of Agricultural Sciences, Dharwad-580005

The field studies were conducted on the effect of conjoint use of organic manures and chemical fertilizers on morpho-physiological parameters and yield, at Main Agricultural Research Station, UAS, Dharwad. The treatments comprised of organic manures (FYM, Vermicompost, Poultry manure and Sheep manure) and the recommended dose of inorganic fertilizer (RDF) along with the combination of 50% RDF and organic manures. The experiment was laid in a randomized block design with 14 treatments. The observations on ancillary data and morpho-physiological parameters recorded are days to 50% tasseling, days to 50% siliking, plant height, number of leaves per plant, leaf area, chlorophyll content, photosynthetic rate. The yield and yield attributes recorded like cob weight, cob length, cob girth, 100 grain weight, shelling %, grain yield and partitioning efficiency. Neither the recommended dose of fertilizers alone nor the organic sources alone were effective enough to increase the productivity of maize crop. The higher yield was recorded in 100% organic manures + 100% RDF treatments. Among the organic manures 100% poultry manure in combination with 100% RDF has recorded highest yield. The photosynthetic rate, chlorophyll content was maximum in the above said treatment. The highest partitioning efficiency was also recorded in the above treatment. The highest post flowering LAD was recorded in the treatments with the combination of organic manures and RDF.

08-04

DIFFERENTIAL APPLICATION OF NITROGEN AND ITS EFFECT ON GROWTH, PERFORMANCE AND YIELD OF RICE CULTIVARS

Babita Patni*, Ashish Sharma, Gurdeep Bains, Alok Shukla

*Deptt. Of Plant Physiology, C.B.S.H., G.B.Pant University of Agri. and Tech., Pantnagar-263145
babita28paatni@rediffmail.com*

Rice is one of the most important cereal crops in our country, as much of the Indian population depends on the rice crop as a staple food. It has rightly been said in an old Chinese saying that rice is one of the five most precious things available to mankind. India is a big producer of rice ranking amongst the top 10 in the country but still the scope for increasing productivity is there. Nutrition of the rice plant plays a very important role in limiting the productivity of this crop and the most important nutrient that limits the productivity of rice crop is nitrogen. As because sufficient nitrogen is not available to the crop because the utilization efficiency of nitrogen for the crop is relatively low. So there are two way to enhance the productivity of rice crop either by increasing the nitrogen use efficiency or by increasing the supply of nitrogen for the crop. In view of this an experiment was conducted to test the three rice varieties namely NDR 359 (high yielding variety), PA6444 (hybrid variety) and Pusa basmati-1 (aromatic variety) for their productivity and performance at the four nitrogen doses viz. 0, 50, 100, 200 kg/ha. The data obtained shows that the hybrid rice variety PA6444 is highly N-responsive as compared to Pusa basmati-1 and NDR 359. Where as N-100 is the optimal dose of nitrogen for high yielding and aromatic rice varieties NDR-359 and Pusa basmati-1 respectively.. Higher N response had better yield. In view of this selection of lines which are physiologically high N-responsive are needed in the breeding programme for producing hybrids with high yield.



08-05

NUTRIENT UPTAKE BY WHEAT AND ASSOCIATED WEEDS AS INFLUENCED BY HERBICIDE MIXTURES AND NUTRIENT MANAGEMENT IN WHEAT (*Triticum aestivum* L.)

A.K. Khokhar* and M.K. Porwal**

Division of Plant Breeding and Genetics, Sher-e-Kashmir University of Agricultural Sciences and Technology, FOA, Main Campus, Chatha, Jammu, J&K-180 009

**Asstt. Prof. (Agronomy), Division of Plant Breeding and Genetics, FOA, SKUAST-J Chatha, Jammu*

*** Prof. & Head, Deptt. of Agronomy, Rajasthan College of Agriculture, Udaipur*

A field experiment was conducted during winter seasons of 2004-05 and 2005-06 to ascertain the influence of herbicide mixtures and nutrient management treatments on NPK uptake by wheat and associated weeds. Uncontrolled weeds reduced the wheat yield by 31.4 %. Highest yield of 58.0 q/ha and 55.34 q/ha was obtained with the use of tank mixture of isoproturon at 500 g /ha + sulfosulfuron at 15 g/ha and isoproturon at 500 g /ha + 2, 4-D at 500 g/ha, respectively. Uninterrupted weed growth depleted 20.97 kg N, 3.13 kg P and 26.94 kg K, while NPK depletion by weeds was lowest with isoproturon at 500 g /ha + sulfosulfuron at 15 g/ha. Herbicide treatments significantly increased NPK uptake by wheat as compared to weedy check. Maximum uptake of N (150.20 kg/ha), P (41.00 kg/ha) and K (194.14 kg/ha) by wheat crop was in plots treated with tank mixture of isoproturon at 500 g /ha + sulfosulfuron at 15 g/ha while in weedy check plots N, P and K uptake by crop was 87.87, 23.82 and 118.04 kg/ha respectively. Thus with the application of tank mixture of isoproturon at 500 g /ha + sulfosulfuron at 15 g/ha there was saving of 62.33 kg N, 17.18 kg P and 76.10 kg K/ha. Among nutrient management treatments, vermicompost applied at 1.5 and 3.0 t/ha along with 75% and 50% RDF increased NPK uptake by crop significantly over RDF. The increase in chlorophyll and protein contents and grain yield was highest with 50 % RDF + vermicompost at 3.0 t /ha (50.17 q/ha) followed by 75 % RDF + vermicompost at 1.5 t /ha (48.90 q/ha).

08-06

MORPHO –PHYSIOLOGICAL AND BIO-CHEMICAL STUDIES ON RICE TO OPTIMIZE NITROGEN APPLICATION FOR HIGHER PRODUCTIVITY UNDER RAINFED FAVOURABLE LOWLAND CONDITION

B.K. Mishra, R. Bhol, B. Dey and S.N. Sarangi

*Department of Plant Physiology, Orissa University of agriculture and Technology, Bhubaneswar-751003
mishrabijayakumar@gmail.com*

Field experiments on rice were conducted during *Kharif* 2002 and 2003 at Central Research Station, O.U.A.T., Bhubaneswar in a split plot design with three replications to optimize N application for higher productivity under rainfed favourable lowland condition. Four rice varieties *viz*, IR36 and Lalat (medium duration); Mahsuri and Savitri (late duration) were grown in main plots with four levels of N (0, 40, 80 and 120 Kg/ha) in sub plots. Fertilizer N was applied in equal splits at transplanting, active tillering, panicle initiation and flowering stages along with basal application of P₂O₅ and K₂O @ 60 kg /ha. Grain yield of rice increased significantly by application of N up to 80kg/ha with a substantial yield gain of 41% over control, beyond which there was no significant change in yield. Among the varieties, the late duration Savitri and medium duration Lalat were found to be high yielders with 522.7 and 509.0 g/m² respectively as compared to IR36 (465.7 g/m²) and Mahsuri (350.6 g/m²) at 80 kg N/ha. Similarly, the variation in AE among the varieties across the N levels indicated a higher value of 18.4 kg and 17.0 kg grain per kg N applied in Savitri and Lalat respectively as compared to IR36 (16.1 kg) and Mahsuri (15.5 kg). The higher yield of rice at 80 kg N/ha was due to increase in total and effective tillers per unit area, panicle length, number of filled grains per unit area, 1000-grain weight, HI and shoot-DM



production which were correlated positively with grain yield. Physiological growth attributes like RLGR, RLAGR at active vegetative growth stage, LWR at flowering and LAD at grain filling stage (FL to MT) were increased significantly with increase in N levels and exhibited positive correlation with grain yield. Application of N increased the chlorophyll content and nitrate reductase activity (NRA) of leaves. The post-flowering photosynthate contribution to grain (PPCG), sugar content in grain and uptake of N, P and K increased with increase in the level of N in all the four varieties. Whereas, nutrient use efficiency and apparent recovery (AR) of nitrogen decreased. However, the uptake and harvest index of N, P and K showed positive association with grain yield and other yield attributing characters.

08-07

TRANSPIRATION RATE OF WHEAT CROP WITH TWO DIFFERENT N-LEVELS UNDER BED PLANTING AND CONVENTIONAL TILLAGE SYSTEMS

C.M. Saxena, Sanatan Pardhan, Ravender Singh, Mohan Lal*, A.K. Sutradhar and Sheoraj Singh

*Division of Agricultural Physics, *Nuclear Research Laboratory, IARI, New Delhi-110012*

cm_saxena@yahoo.com

A field experiment was carried out on the Research Farm of I.A.R.I., New Delhi, during *rabi* 2008-09. Studies were made on the plant water status index viz. transpiration rate (TR) of wheat crop under two different tillage systems namely bed-planting and conventional tillage systems with two different nitrogen levels-120 kg N/ha & 180 kg N/ha. Data on TR was recorded at all important stages during the crop growth period with the help of a steady state porometer (LI-1600). Bed planted wheat exhibited enhancement in the transpiration rate as compared to wheat sown with conventional tillage system. N- levels also influenced the TR of the crop and levels could be differentiated with regard to transpiration rate. Crop treated with higher level of nitrogen exhibited higher rates of transpiration as compared to wheat with lower N-level. Moreover Bed-planted wheat treated with lower dose of N (120 kg N/ha) maintained almost the same level of TR as the crop treated with higher dose of N ie. 180 kg N/ha in conventional tillage system thereby reflecting a net saving of fertilizers under bed planting system. From the study of this index it may be concluded that the bed planting system is superior to conventional tillage. Adopting this system there is a net saving of fertilizer. Also as the index is quite sensitive in differentiating the different nitrogen levels, its potential can be exploited in optimizing the nitrogen fertilizer dose which is one of the major component for improving crop growth and productivity.

08-08

EFFECT OF N AND K ON THE GROWTH, YIELD AND QUALITY OF POMEGRANATE CV. GANESH UNDER RAINFED CONDITIONS

Poonam Kashyap and Jungvir Singh Dulta

IARI Regional Station (Cereals & Horticultural Crops), Amartara Cottage, Cart Road Shimla 171004, HP

punam_shanu@yahoo.com, pakhihorti@gmail.com

The pomegranate plants were treated with five levels of nitrogen (250, 375, 500, 625 and 750g/plant) and potassium (200, 300, 400, 500 and 600g/plant) to evaluate their influence on plant growth, fruit quality and yield. The plants were raised and maintained under crescent bund with open catchment pits. Basal dose of FYM (15 kg/plant) and phosphorus (250g/plant) were applied in mid December. Full dose of phosphorus (single super phosphate), potassium (muriate of potash) and half of nitrogen (calcium ammonium nitrate) were applied in the first fortnight of January and second half in the second fortnight of May. In a simple randomized block design with three replications, maximum plant height, annual extension shoot growth, fruit juice, aril, acidity, vitamin C and iron content were recorded with treatment N at 750 g/plant and K at 600 g/plant/year. Whereas



early anthesis, highest fruit set, yield, TSS, percent total sugars and non reducing sugars were recorded with the application of N at 500 g and K at 500 g/plant/year. The application of N at 625 g and K at 600 g/plant/year significantly increased the fruit length whereas, the maximum fruit breadth, volume and weight were recorded with treatment N at 750g and K at 500 g/plant/year. In the present studies, the treatment N at 500 g and K at 500 g/plant/year was found to be superior than the other treatments in enhancing the fruit set, yield, TSS, percent total sugars, reducing sugars and non reducing sugars during both the years of study.

08-09

BIOCHEMICAL CHANGES IN PEA CALLUS UNDER Cu, Mn and B DEFICIENCY STRESS

Nirmala Nautiyal* and Sapna Awasthi

Department of Botany, University of Lucknow, Lucknow-226007

sapawasthi@gmail.com

Tissue culture experiment was carried out to study some biochemical changes of copper, manganese and boron deficiency stress in pea (*Pisum sativum* L.) var. Azad genotype. For this, pea embryo were grown till 30 days in MS medium supplemented with normal Cu, B and Mn and nil supply of Cu, B and Mn respectively. After 30 days, callus growth rate, fresh and dry weight was reduced in Cu, B and Mn callus cells than normal. The reduction in pigment contents such as total chlorophyll ratio and carotenoids was observed more in Mn deficient cells than compared to B and Cu deficient cells. It may be due to progressive declination in photosynthetic activity during 30 days of callus culture under Mn deficiency stress conditions. The specific activity of enzymes such as peroxidase, catalase, starch phosphorylase and starch phosphorylase increased in Cu and B deprived callus than Mn deprived callus. The native PAGE profile study of Cu and B deprived callus showed presence of extra bands although no such response was recorded in Mn deprived callus. This study reveals that pea callus influenced more under Mn deficiency stress than in B and Cu stress. Therefore, *in vitro* regenerated Mn deficient plant of pea var. Azad genotype may produce from callus for the exploration of impact of Mn deficiency stress.

08-10

CHANGE IN ANTIOXIDATIVE SYSTEM DUE TO MERCURY AND OSMOTIC STRESSES IN *Trigonella-foenum-graecum* L.

Pranab Kumar Bandopadhyay¹, Nilima Karmakar² and Arunabha Chakravarty²

¹Department of Plant Physiology, ²Department of Agricultural Biochemistry, Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur, Nadia, W.B., 741252

The induction of different types of stresses on a particular crop showed a range of biochemical and physiological variations from which it is very much clear that heavy metal (mercury) and osmotic stress may adopt its own mechanism of resistance and plant responded in different ways to combat the detrimental effects of stresses. In the present study two types of stresses such as heavy metal (HgCl₂ 10 ppm) and osmotic stress (PEG-1- bar) were applied on 6 days old fenugreek (*Trigonella- foenum- graecum* L) seedlings and maximum abnormality in respect of root and shoot has been depicted by heavy metal compared to osmotic stress. Heavy metal mercury showed maximum catalase (CAT) and minimum peroxidase (POD) activities along with fairly high lipid peroxidation reaction. PEG treatment showed maximum super oxide dismutase (SOD) activity compared to CAT and POD. The effect of total antioxidative activity with the help of a free radical DPPH were studied, it was observed that PEG treatment revealed better antioxidative system to scavenge the free radical than that of heavy metal treatment. From the comparative studies it might conclude that all stresses had substantial damaging effect over *Trigonella* sp. in respect of antioxidative enzyme analysis, where toxicity damages more expressed in metal than that of osmotic stress.



08-11

EFFECT OF ENDOMYCORRHIZAL INOCULATION ON APASE AND ALPASE ENZYMES IN RHIZOSPHERE AND BIOMASS YIELD OF *ELEUSINE CORACANA* (LINN.) GAERTN

Vipin Parkash* and Surichi Sharma¹

*Rain Forest Research Institute (ICFRE), Autonomous council of Ministry of Environment and Forests, Govt. of India, Deovan, Jorhat-785001, Assam
Email: bhardwajvpnpark@rediffmail.com

¹Plant Biotechnology Department, Shoolini Institute of Life Sciences and Business Management, Solan, HP

This study envisaged the status of both alkaline and acidic phosphatase enzymes in the rhizosphere of *Eleusine coracana* (Linn.) Gaertn during whole life cycle and also the effect of different strains of VAM fungi inoculation on both the enzymes in the rhizosphere in the whole life cycle of crop and their effect on growth, biomass and yield of the crop. The alkaline phosphatase (ALPase) activity of all the three strains of VAM fungi i.e. *Acaulospora laevis*, *Glomus mosseae* and *Gigaspora gigantea* was minimum during the germination stage and it was maximum during mature stage of growth and later in the seeding/harvest stage, it started decreasing. The alkaline phosphatase trend for control was similar but least than these strains. But the acidic phosphatase (APase) activity was different in *Eleusine coracana* in all the three strains i.e. *Acaulospora laevis*, *Glomus mosseae* and *Gigaspora gigantea*. In the germination stage, acidic phosphatase (APase) activity was moderate and it was maximum during the early juvenile stage and minimum during the mature stage and seeding/harvest stage. The total VAM spore number, percent colonization in roots, total biomass (shoot + root) were more in *Acaulospora laevis* inoculation treatment followed by *Glomus mosseae* and *Gigaspora gigantea* inoculation treatments. The presence of vesicles, arbuscules and mycelium/hypha were profuse/abundant in *Acaulospora laevis* and *Glomus mosseae* inoculation treatments where these were moderate in *Gigaspora gigantea* inoculation treatment and lowest in control plants (without inoculum). *Acaulospora laevis* treated plants also had more grain yield (spikes) per pot followed by *Glomus mosseae* and *Gigaspora gigantea* treatments. In control plants, all parameters studied above, were lowest respectively.

08-12

PRODUCTIVITY OF VEGETABLES AND CEREAL BASED CROPPING SYSTEMS ON RAISED AND SUNKEN BEDS UNDER HOMESTEAD ORGANIC FARMING

D.P. Patel, Anup Das , G.C. Munda, Jurisandhya Bordoloi and Manoj Kumar

Division of Agronomy, ICAR Research Complex for NEH Region, Umiam-793 103, Meghalaya
pateldpp2001@yahoo.com

Bun system (Raised and sunken bed) of cultivation is very popular among the farmers of Meghalaya. Due to high rainfall (>2000 mm), farmers in Meghalaya generally adopt *bun* system of cultivation for growing crops in uplands. In valley ecosystem also some farmers practice the same system for growing vegetables in paddy fields after paddy for timely sowing/raising of crops. Normally, the farmers raise crops on the *bun* or the raised bed keeping the sunken area (area between the two raised beds) unutilized. Thus, keeping the importance of bun system of cultivation and its utilization in focus, a field experiment was undertaken at Umiam research farm (980 m msl) of the ICAR Research Complex for NEH region, Meghalaya to study the productivity of important vegetables and cereal based cropping systems on permanent raised and sunken beds under homestead organic farming in medium wetland. Treatments consisted of five vegetables and maize based cropping systems viz., Tomato-Bhindi-French bean, Carrot- Bhindi-French bean, Coriander- Bhindi-French bean, French bean-Bhindi-French bean, Potato- Bhindi-French bean and Maize- Bhindi-French bean on raised beds whereas, six varieties of rice -ratoon were taken in sunken beds. The nutrient requirement of the crops was met through the



Cowshed washings, FYM, Rock phosphate and recycling of the crops residue. Experimental results indicate that the cropping intensity as high as 300 % can be achieved under medium wetland with proper land configuration. Among the cropping systems tested on raised beds Tomato-Bhindi-French bean produced highest system productivity (667.7 q/ha) followed by Carrot- Bhindi-French bean (621.9 q/ha) and lowest was observed with Maize (green cob) - Bhindi-French bean (320.4 q/ha). In sunken beds, among the six rice varieties and their ratoon crops, IR 64 produced highest system productivity (79.4 q/ha) followed by Sahsarang 1 (74.8 q/ha) and Aerobic rice line IR72176-307-4-2-2-3 (67.1 q/ha). Thus, it can be concluded that adopting permanent raised and sunken beds of cultivation with proper land configuration in wetlands of Meghalaya will not only would increase the production and productivity of vegetables and cereal crops but would also increase the cropping intensity, which is at present about 120%.

08-13

LONG TERM EFFECT OF NUTRIENT INTEGRATION ON SOIL FERTILITY AND CROP PRODUCTIVITY IN RICE-RICE SYSTEM

T. Esther Longkumer, T.C. Baruah, A. Baishya, A. Basumatary and S. Ahmed
Assam Agricultural University, Jorhat - 785013, Assam

A long term experiment on integrated nutrient management in rice-rice is in progress at Instructional-cum-Research Farm of Assam Agricultural University, Jorhat, under All India Co-ordinated Research Project on Cropping Systems since 1987. The investigation was carried out to study the effect of nutrient integration on soil fertility build up and crop productivity after 14 and 15 years of Rice winter (W)–Rice autumn (A) cropping sequence. Long term application of inorganic fertilizers along with 25% N or 50% N substitution either through rice straw, FYM or Azolla resulted significantly higher organic carbon, cation exchange capacity, per cent base saturation, water holding capacity over chemical fertilizer alone. Major soil nutrients showed higher value in integrated treatments over chemical treatments alone and exhibited improvement than that of their respective initial value. Exchangeable calcium and magnesium depleted over initial value, except a slight build up of Ca in 50% organic matter substituted treatments. Available sulphur showed an improvement with addition of 75 and 100 %NPK and their combined use with different organic N sources. Grain and straw yields at the end of Rice-Rice sequence were found to be the highest in the treatment (T₉) receiving 25% N substituted through rice straw along with 75% NPK fertilizers in rice (W) followed by 75% NPK fertilizers in rice (A). Organic substitution influenced the uptake of major nutrients in greater quantities than those supplied through chemical fertilizers and same treatment (T₉) recorded the highest uptake of nitrogen, phosphorus and potassium. Almost all the soil parameters showed significant positive correlations with plant growth parameters.

08-14

IMPROVING REPRODUCTIVE EFFICIENCY Zn DENSITY AND SEED YIELD OF GREEN GRAM THROUGH FOLIAR APPLICATION OF Zn AT EARLY REPRODUCTIVE PHASE

Girish Chandra Pathak, Bhavana Gupta and Nalini Pandey
Department of Botany, Lucknow University, Lucknow

To study the involvement of Zn in plant reproductive development plants of Green gram (*Vigna radiata* L.) were grown in refined sand culture with sufficient (1 μM) and marginally deficient (0.2 μM) supply of Zn under glass house conditions. At the onset of the reproductive phase, 0.1% ZnSO₄ was applied as foliar spray to both zinc sufficient (S) and zinc deficient (D) plants and these treatments were referred as sufficient foliar (SF) and deficient foliar (DF) respectively. The effect of the Zn treatments was studied on pollen and stigma structure,



its involvement in fertilization seed Zn and seed yield. The plants grown with deficient supply of Zn reduced the size of anthers, pollen producing capacity, the size and viability of pollen grains. *In vitro* germination of pollen grains was reduced and a large number of pollen grains of Zn deficient plants failed to produce pollen tubes. Zinc status of plants affected the activities of acid phosphatase and esterase enzymes in stigma and pollen grains. Zinc deficiency reduced the setting of seeds and their size. In conclusion alleviation of Zn deficiency by foliar application of Zn as ZnSO₄ to deficient plants prior to initiation of flowering minimized the severity of Zn deficiency effect on pollen- stigma morphology, pollen fertility and greatly enhanced seed yield of plants but normalcy was not restored. Foliar application of Zn imposed not only the boldness and vigor of seeds but also the Zn content in seed. Improving the zinc content in seeds due to foliar application being beneficial for human would also acts as starter fertilization for an early establishment of the crop on low zinc soils.

08-15

**GROWTH ANALYSIS OF BT AND NON-BT COTTON (*GOSSYPIUM HIRSUTUM* L) HYBRIDS
UNDER DIFFERENT LEVELS OF N FERTILIZATION**

B. Sivakumari and Jitendra Mohan

Department of Botany, Microbiology & Bio Informatics, Janta Vedic College, Baraut, Uttar Pradesh

A two year field study (2007 and 2008) during *kharif* on a sandy loam soil with 217 kg/ha of available nitrogen at Baraut was carried out to understand the physiological basis of yield superiority of Bt cotton (RCH 134 and RCH 317) as compared to non-Bt cotton (LHH 144) under four levels (kg/ha) of N fertilization (0, 60, 120 and 180). The experiment was conducted in split plot design replicated four times with cotton hybrids in main plot and N dose in sub-plots. The mean data of two seasons indicate that Bt hybrids have produced significantly shorter plants (102.5 cm) than non-Bt hybrid (117.4 cm). Biomass production that was significantly higher in non-Bt hybrid in the initial 100 days, got reversed 120-150 days after sowing (DAS) with Bt cotton having more biomass than non-Bt hybrid and this was ascribed to early square and more bolls formation. Thus crop growth rate (CGR) and relative growth rate (RGR) of Bt hybrids during 90-120 and 120-150 DAS was higher than non-Bt cotton. However, leaf area index (LAI) was significantly more in non-Bt hybrid at all growth stages. RCH 317 Bt required the least duration (159 days) to maturity while non-Bt hybrid took 47 more days to complete life cycle. The greater number of bolls/plant in Bt (55.1 in RCH 134 and 61.2 in RCH 317) as compared to non-Bt hybrid (39.0) lead to 1.06 tonnes/ha of higher seed cotton yield (SCY) of Bt cotton. Each successive increase of 60 kg N fertilization up to 180 kg/ha significantly improved plant height, biomass production, CGR, RGR, LAI, boll number, boll weight. Based on two years mean data, application of 60, 120 and 180 kg N/ha improved SCY by 0.45, 0.28 and 0.13 tonnes/ha over 0, 60 and 120 kg N/ha respectively. The interaction between cotton hybrids and N fertilization reveals that Bt hybrids without N fertilization have productivity at par or greater than non-Bt hybrid grown with 180 kg N/ha fertilization. From the two year study it was concluded that Bt hybrids with 180 kg N/ha application is best for cotton productivity.



08-16

EFFECT OF CADMIUM STRESS ON THE ROOT MERISTEM OF *PISUM SATIVUM* L.

M.K. Meghvansi^{1*}, S. Siddiqui², H.K. Gogoi¹ and Lokendra Singh¹

¹Defence Research Laboratory, Post Bag 2, Tezpur-784001, Assam

²Department of Botany, Institute of Basic Sciences, Bundelkhand University, Jhansi-284128, UP
mk_meghvansi@yahoo.co.in

Cadmium (Cd) is one of the most toxic, highly water soluble heavy metals present in the environment, largely due to human activities such as disposal of house hold municipal and industrial wastes and phosphate fertilizers. The present paper deals with the effect of cadmium (Cd) on root tips of *Pisum sativum* L. Seeds of *P. sativum* were treated with a series of concentrations ranging from 0.125, 0.250, 0.500 and 1.000 mM for 6 h. The influence of Cd was evaluated by studying the percentage seed germination, radicle length (RL), mitotic index (MI) and chromosomal aberrations (CAs) in root tip. The results suggested that Cd had significant impeding effect on the root meristem activity of *P. sativum* at 0.500 and 1.000 mM as revealed by reduction in seed germination percentage and RL compared to control. Furthermore, it also reduced MI in dose related manner compared to control. Additionally, the variation in the percentage of mitotic abnormalities was noticed. The overall percentage of aberrations generally enhanced with increasing concentrations of Cd. Among these abnormalities laggards, bridges, stickiness, precocious separation and fragments were most common. The obtained results demonstrated that the Cd treatment may lead to a significant reduction in MI and increase in CAs.

08-17

BLUE GREEN ALGAE - A POTENTIAL BIOFERTILIZER FOR WETLAND RICE

Farishta Yasmin, R. Baruah* and M. C. Kalita**

Department of Botany, Nowgong College, Nagaon, Assam
fyasmin@rediffmail.com

The wetland rice ecosystem harbours diverse communities of *Cyanobacteria* (Blue Green Algae). The importance of Blue Green Algal (BGA) association in rice fields has been realized for their inherent capacity to fix atmospheric nitrogen thereby enhancing rice productivity and soil fertility. With such tremendous potential for utilization of BGA as biofertilizer, a study was undertaken to explore the possibility of isolating some efficient indigenous BGA from rice fields of Morigaon district, Assam where farmers grow *boro* rice as early *ahu* in low lands mostly inundated with water. The investigation reported 38 numbers of BGA isolates from 12 agricultural circles of Morigaon district. Upon taxonomic characterization, the isolates belonged to 18 genera of BGA. The frequency distribution of individual genus were ranked as *Nostoc* (55)>*Anabaena* (53)>*Cylindrospermum* (21)>*Aulosira* (18)>*Calothrix* (16)>*Scytonema* (13) >*Microcystis* (7)>*Camptylonema*, *Hapalosiphon*, *Nodularia*, *Westiellopsis* (6)>*Gloeotrichia*, *Aphanothece* (5)>*Aphanocapa*, *Gloeocapsa* (4)>*Fischerella*, *Stigonema* (2) > *Spirulina* (1). The estimation of total nitrogen content, measurement of chlorophyll 'a', growth under natural condition and scum formation were taken as screening criteria for selection of efficient BGA among isolates. The five species that showed profuse scum were *Anabaena torulosa*, *Aulosira fertilissima*, *Calothrix marchica*, *Cylindrospermum majus* and *Nostoc commune*. These species therefore, were used for preparation of mixed inoculum for algalization experiment in *boro* rice. The results of composite inoculum on *boro* rice were quite encouraging in terms of grain yield and yield attributing characters that reflected when compared with uninoculation treatment.



08-18

EFFECT OF N,P,K AND FYM ON GROWTH, YIELD AND TSS OF STEVIA

P.V. Nevase*, A.M. Bafna and K.A. Shinde

*Department of Soil Science and Agricultural Chemistry, Navsari Agricultural University, Navsari- 396450
pravinnevase@gmail.com, kiran.shinde48@gmail.com*

The field experiment entitled “Integrated Nutrient Management (INM) in Stevia under Drip Irrigation” envisaging four levels of inorganic fertilizer and two level of organic manure was conducted during summer season of 2007-08 at soil and water management research farm, NAU, Navsari, Gujarat. The world sweetness stevia (*Stevia rebaudiana* Bentoni) belonging to the eupatory of the asteraceae family and is a threatened highly nutritious delicious, non carcinogenic, non-toxic, safe for diabetics with valuable medicinal properties. The present investigation was carried out on effect of N, P, K and FYM on growth, yield and TSS of stevia. The treatment included 4 fertilizer levels and 2 levels of FYM. The all eight treatment combinations were in a factorial randomized block design. Entire fertilizer dose was applied as basal applications. The seedlings were planted at a spacing of 60 cm × 30 cm. The growth parameters like height, number of leaves and branches, weight of fresh and dry leaves and TSS were recorded. Application of N:P:K on 275:112.5:172.5 kg/h and FYM @ 20 t/ha produced significantly higher number of leaves, branches, height, yield and TSS of stevia.

08-19

ALLEVIATION OF ZINC DEFICIENCY BY INTEGRATED USE OF ORGANIC MANURES AND INORGANIC FERTILIZERS

Digvijay Singh* and Amalesh Yadav

Department of Botany, Lucknow University, Lucknow-226007

A field experiment was conducted during the *rabi* season of 2007-2008 at the farmers field near Sohawal village of Faizabad district, Uttar Pradesh, to assess the efficiency of $ZnSO_4$ and various organic manures in correcting the deficiency of zinc in low zinc alluvial soils. Seven treatments were given to the wheat (Var. HD 1949) plants viz. control (T_0), $ZnSO_4$ (T_1), FYM (T_2), vermicompost (T_3), $ZnSO_4$ + FYM (T_4), $ZnSO_4$ + vermicompost (T_5) and $ZnSO_4$ + FYM + vermicompost (T_6). $ZnSO_4$ was applied @ 5 kg Zn ha⁻¹ whereas FYM and vermicompost were applied @ 12 ton ha⁻¹ each. The activities of enzymes catalase, amylase and carbonic anhydrase increased significantly in all the treatments as compared to control. Same way, sugar and protein contents in leaves also increased. At the end of experiment shoot dry matter and seed yield increased accordingly, however, the maximum increase was observed when zinc was applied along with FYM and vermicompost. It is, therefore, suggested that using a blend of organic manure with inorganic fertilizer ($ZnSO_4$) is more beneficial in alleviation of zinc deficiency.

08-20

EFFECTIVENESS OF BORON FERTILIZERS AND MANURES FOR CORRECTING BORON DEFICIENCY IN SOILS LOW IN BORON

Digvijay Singh, Shikha Yadav and Nirmala Nautiyal

Department of Botany, Lucknow University, Lucknow-226007

A soil-pot culture experiment was conducted during 2007-2008 under controlled conditions in a glass house. The aim of this study was to determine the increase in yield of maize (Var. Ganga Safed-2) by the application of boron to a local soil low in hot water extractable boron. Plants were given eight treatments:



control (without treatment); borax at three levels 1, 2 and 3 mg B Kg⁻¹; FYM at two levels 4 and 8 g Kg⁻¹ and poultry manure (PM) at two levels 4 and 8 g Kg⁻¹ soil. Plant height, total dry matter (leaf + shoot) and seed yield were increased in almost all treatments as compared to control. The activities of enzymes peroxidase, poly phenol oxidase and starch phosphorylase decreased with the increasing boron levels as well as in the treatments containing FYM and PM. The results revealed the suitability of poultry manure @ 8 g Kg⁻¹ soil for correction of boron deficiency in alluvial soils low in boron.

08-21

ROLE OF MAGNESIUM IN TIKKA AND RUST DISEASE RESISTANCE IN GROUNDNUT CULTIVARS

N.S. Renukaswamy and M.B. Chetti

Department of Crop Physiology, University of Agricultural Sciences, Dharwad-580 005

To investigate the role of magnesium in tikka and rust disease resistance, a pot culture experiment was conducted in 3 groundnut cultivars (JL-24, TMV-2 and K-134) grown on different soil types collected from 5 different locations such as red soils of Raichur (pH 7.38), Badami (pH 7.25) and Dharwad (pH 6.42), black soil of Dharwad (pH 8.24) and acidic soil of Mugad (pH 6.42). The experiment consisted 7 treatments comprising 10,20,30,40 and 50 kg/ha magnesium in the form of MgSO₄.7H₂O, 250 kg/ha of magnesite and a control for comparison. Among the groundnut cultivars K-134 a resistant cultivar recorded significantly less percent disease index (PDI) for both tikka and rust while, it was highest in TMV-2 which is susceptible for these diseases. Among the soil types highest and lowest PDI was noticed in Dharwad black and Badami red soil respectively. Among the treatments significantly lower PDI was observed in the 50 kg/ha magnesium followed by 40 kg/ha magnesium and 250 kg/ha magnesite treatments. Application of magnesium increases the leaf chlorophyll content in all the 3 cultivars irrespective of soil types. The biophysical traits such as net photosynthesis and stomatal conductance were also improved due to magnesium application. The composition of defense metabolites such as total phenol and tannin contents increased with increased level of magnesium application. All these factors may induce the host resistance for the disease reaction. Maximum pod yield of 15.7g/plant was recorded in JL-24 cultivar grown on black soil of Dharwad with 50 kg/ha magnesium and the lowest pod yield of 4.2 g/plant was recorded in TMV-2 cultivar grown on acidic soil of Mugad under control with no magnesium application.

08-22

OXIDATIVE STRESS IN WHEAT IN RESPONSE TO NITROGEN SUPPLY

Vanita Jain, Renu Pandey, K.P. Singh and D.C. Saxena

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Two wheat genotypes unculm and kalyansona differing in their response to nitrogen (N) supply were grown in low N and compared with control N supply. The genotypes differed in terms of metabolic constituents and leaf area and were analyzed for the maintenance of membrane integrity and activities of the antioxidant enzymes. Free radicals and reactive oxygen species (ROS) which are inevitable by products of biological redox reactions inactivate the enzymes and damage important cellular components. Singlet oxygen also initiates lipid peroxidation. Nitrogen availability affects plant metabolism. Unculm was able to maintain its metabolic components in spite of large reduction in flag leaf area and the present study indicates that one of the reasons could be the maintenance of the higher activities of the antioxidant enzymes till late maturity which protected the membrane integrity of the leaf tissues under low N. N stress resulted in increased formation of H₂O₂ and accumulation of malonaldehyde (MDA) in leaves of both the genotypes. The level of the nitrogen supply



determined the activities of the catalase (CAT), superoxide dismutase (SOD) and ascorbate peroxidase (APX) which were higher in N stressed plants of unicum till maturity and declined early in low N plants of kalyansona as compared to control plants of respective genotypes. The catalase activity did not increase in low N grown plants of kalyansona. Decline in the H₂O₂ scavenging capacity in flag leaves of kalyansona was responsible for the oxidative damage and overall metabolic reduction in the leaves of the N stressed plants.

08-23

RATE OF PROTEIN SYNTHESIS IN FLAG LEAVES IN RESPONSE TO NITROGEN SUPPLY IN WHEAT

Renu Pandey, Vanita Jain, D.C. Saxena and K.P. Singh

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Rates of synthesis of soluble and Rubisco proteins were studied by ¹⁴C leucine incorporation in the flag leaf blades at low (30 kg N ha⁻¹) and control nitrogen (N; 120 kg N ha⁻¹) supply in two wheat genotypes, Unicum and Kalyansona. Protein synthesis was high in the tip at 2/3 leaf emergence and as leaf blades aged maximum rates occurred in the middle region of the leaf blades in both the genotypes. At low N, no detectable amount of protein synthesis occurred at 30 days after full emergence in both the genotypes. In control plants about 10 % of the soluble proteins and 5-6 % of the Rubisco was synthesized. N limitation decreased the final flag leaf length in V1 resulting in only 8 (2 cm) segments compared to the 12 segments in the control plants. The rates of the protein synthesis remained unaltered in this genotype at both the levels of N supply. Kalyansona exhibited a large reduction in the synthesis of soluble protein at low N. This suggests that synthesis of metabolic constituents of photosynthetic apparatus were affected in the kalyansona in response to N limitation. Unicum characteristically possess the ability to maintain protein synthesis rate although leaf size is reduced to greater degree at low N.

08-24

HEAVY METAL ACCUMULATION AND DISTRIBUTION PATTERN IN DIFFERENT VEGETABLE CROPS

Manju Zacharias and S.D. Singh

Division of Environmental Sciences, Indian Agricultural Research Institute, New Delhi 110012

Different vegetable crops grown on heavy metal contaminated soil showed marked difference in metal accumulation, their uptake and distribution pattern. Crop species also showed remarkable difference in metal concentration in various plant parts within species. Based on metal accumulation in edible parts and whole plants, root vegetables viz., radish and carrot showed less accumulation of almost all heavy metals except Zn in radish root. However, leaf vegetables namely palak, amaranthus, mustard, fenugreek recorded higher accumulation of both essential and non-essential heavy metals, except Cd and Ni which showed less accumulation in fenugreek. Potato and onion showed less accumulation of Zn and Cu and higher accumulation of Cd and Ni. Cauliflower and cabbage, however, showed greater accumulation of Pb and Ni, but less accumulation of Cu and Cd. Among fruit type vegetables pea, soybean and cluster bean showed greater accumulation of Pb and Ni and very less accumulation of Cd. Among different vegetables cauliflower and cabbage recorded highest uptake of Zn, Pb and Ni while mustard showed higher uptake of Zn and Cd. In general the uptake of Cd was lowest in almost all the crops except mustard. Generally the root and leafy vegetables viz. radish, carrot, palak, amaranthus, mustard, cauliflower and cabbage showed higher distribution of metals to the edible parts, whereas fruit types vegetables specially tomato and brinjal exhibited least transport of metals to fruits except leguminous fruit vegetables pea and soybean. Leafy vegetables viz. palak, amaranthus and mustard seemed to be unsafe for cultivation on heavy



metal contaminated soil, while root crops like radish and carrot could be safely grown on metal contaminated soil. Most of the fruit type vegetables could be suggested for cultivation on Cd contained soil but not for Ni and Pb contained soil. Thorough washing of vegetables substantially reduced the contamination of non-essential metals like Pb, Cd compared to essential heavy metals viz., Zn and Cu.

08-25

ISOTOPES IN PLANT NUTRITION RESEARCH

Bhupinder Singh

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

An outstanding feature of life is the capability of living cells to take up substances from the environment and use them for the synthesis of their own cellular components or as an energy source. The supply and absorption of chemical compounds needed for growth and metabolism is defined as nutrition and where in the term metabolism encompasses the various reactions occurring in a living cell in order to maintain life and growth. The main factor controlling the mineral content of plant material is the uptake potential for the different nutrients. Ion uptake may be considered as a boundary process where the inorganic domain impinges upon the living world. Results obtained from higher and lower plant species reveal following characteristics of ion uptake (a) Selectivity, (b) Accumulation and, (c) Genotype. The other important factors controlling plant mineral nutrition are (re)-translocation and utilisation of the nutrients once they are taken by the plant. Both stable isotopes and radio-isotopes have been exceptionally useful in the effort to understand the various aspects of ion uptake, translocation and utilisation or assimilation. Their use has helped in: (1) Characterization of ion influx into apoplasm; (2) Understanding the phenomenon of active uptake i.e. (i) to identify active uptake, (ii) to study interactions of ions, (iii) to study efflux process and, (iv) to detect and quantify foliar uptake; (3) Understanding long distance transport processes including (i) radial transport, (ii) upward, downward and lateral transport, (iii) exchange adsorption in xylem, (iv) resorption from xylem (apoplast) into living cells, (v) long distance transport and; (4) Understanding the process of nutrient utilisation/assimilation. The advantages with isotopes are that they can be easily traced and measured in minute quantities and the situations *in vivo* are uncomplicated by the presence of large cellular pools of the ions in question. Dual labelling technique is of particular advantage to trace the translocation and fate of organic complexes. Their implication for improving resource use efficiency and in tracing the biosynthetic pathways will be discussed.

08-26

GROWTH AND BIOCHEMICAL RESPONSES OF NICKEL TOXICITY IN BLACK GRAM (*Vigna mungo*) AND ITS REMEDIATION BY USING BORON AS MICRONUTRIENT

Aditya Verma*, Ram Kumar and Y.K. Sharma

Department of Botany, University of Lucknow, Lucknow-226007

**aditya_kobe@yahoo.co.in*

In pot culture experiment black gram (*vigna mungo*) var.- PU-35 were grown in alluvial soil and irrigated with graded levels of Ni (100 μ M, 200 μ M, 400 μ M & 600 μ M). Recovery treatments of boron (50 μ M and 100 μ M) were given in Ni 200 μ M, Ni 400 μ M and Ni 600 μ M. Pure distilled water is served as control. Various growth parameters, pigments, enzymes activity, total protein and total sugar were analyzed in each treatment at the end of 90th day of experiment. Lower concentration of Ni (100 μ M) showed significant increase in fresh and dry weight, plumule and radical length while they gradually decreased in higher concentrations of Ni (200 μ M,



400 μ M and 600 μ M). Chlorophyll (a, b and total), pheophytin (a, b and total) and total carotenoids were found to be decreased in respect to control and lower dose of Ni (100 μ M). Total protein, total sugar and catalase activity showed decline from control to 600 μ M Ni treatment. Peroxidase showed higher activity with increasing concentrations of nickel. Boron (50 μ M and 100 μ M) treatment led to recover the damage caused by higher Ni (200 μ M, 400 μ M and 600 μ M) concentrations in all parameters respectively.

08-27

INFLUENCE OF MICRONUTRIENTS ON YIELD AND QUALITY OF COCONUT CV. HYBRID D \times T

N.G. Nistane¹, B.V. Padhiar¹, B.K. Dhaduk¹, H.S. Thakare² and A.D. Chuadhary¹

¹ASPEE college of Horticulture and Forestry, Navsari Agricultural University, Navsari – 396 540

²N. M. College of Agriculture, Navsari Agricultural University, Dandi Road, Navsari (Gujarat)

neeraj_nistane@rediffmail.com

The present experiment was carried out at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during the year 2007-08. The experiment was laid out in a Randomized Block Design (RBD) with twelve treatments either alone or in combination of Iron, Zinc and Boron including control. The treatments were replicated thrice. Effect of these micronutrients on yield and quality was recorded. The yield parameters in terms of length of nut (cm) and diameter of nut (cm) before and after dehusking were not affected by the different treatments. Whereas, significantly the maximum nut per spadix (18.92), weight of nut at tender stage (2.97 kg), weight of nut at mature ripe stage (1.120 kg), weight of shell (539.83 g) and weight of copra (299.49 g) recorded in combined application of FeSO₄ 1% + ZnSO₄ 1% + Borax 0.5%. The quality parameters in terms of quantity of water (389.18 ml/nut), Total soluble solids (TSS) of nut water (8.99%), Total sugars of nut water (7.82%), Total soluble solid (TSS) of copra (21.98%) were significantly the maximum in combined application of Iron Zinc, and Boron. From this investigation, the treatment foliar application of FeSO₄ 1% + ZnSO₄ 1% + Borax 0.5% was found superior for improving the yield and quality of coconut cv. D \times T. Results revealed that the application of micronutrients resulted in higher nut yield and improved nut quality of coconut.

08-28

RELATIVE EFFECTIVENESS OF DIFFERENT SOURCES OF BORON ON BROCCOLI (*Brassica oleracea* var. *italica*) IN A BORON DEFICIENT SOIL OF DOON VALLEY

Ratan Kumar and Kavita Kandpal

G.B. Pant Univ. of Agric. & Tech., Horticulture Research & Extension Centre, Dhakrani, Dehradun-248142

ratank2006@rediffmail.com

Boron deficiency is now widespread in Indian soils. It results in reduced yield and quality of many vegetables. Among cole crops, broccoli is sensitive to B deficiency. The present investigation was carried out to evaluate the influence of foliar application of B on growth, yield and quality of broccoli through a field experiment during winter season in a sandy loam soil, low in available boron. Recommended doses of FYM and NPK were applied in the planting furrow before transplantation of seedlings of broccoli cv. Titanic at 45 cm x 45 cm spacing. B was applied twice through foliar application of disodium tetraborate (borax), boric acid and disodium octaborate (solu-B) at 30 and 50 days after transplantation. The treatments comprised of foliar fertilization with various sources of B viz. borax @ 0.2%, borax @ 0.4%, boric acid @ 0.1%, boric acid @ 0.2%, solu-B @ 0.05%, solu-B @ 0.1%, solu-B @ 0.2% and control (water spray). These were replicated thrice under randomized block design. Foliar application of all treatments of B had no significant effect on growth characters viz. plant



height, number of leaves per plant and average plant spread. However, the days taken to curd initiation were minimum (63 days) with the application of solu-B @ 0.1% followed by borax @ 0.2% (64.33 days). Similarly, the days taken to curd maturity were lowest (82 days) with solu-B @ 0.1% followed by borax @ 0.2% (83.66 days). All the B treatments significantly affected curd yield. The maximum curd yield (125.27q ha⁻¹) was obtained with the application of solu-B @ 0.1% which was 95.64% higher than the control (64.03q ha⁻¹). Curd formation (87.89%) and curd weight per plant (288.6 g) were also maximum with solu-B @ 0.1%. Other quality parameters like curd diameter and curd depth were also maximum with solu-B @ 0.1%. Thus, foliar application of B as disodium octaborate (solu-B) @ 0.1% was found most effective for maximization of yield and quality of broccoli.

08-29

CROP GROWTH AND GRAIN YIELD OF WET SEEDED RICE AS INFLUENCED BY DIFFERENT NITROGEN LEVELS AND TIME OF APPLICATION

A. Alagesan and C. Raja Babu

Tamil Nadu Agricultural University, Coimbatore-3, Tamil Nadu
a_alagesan@yahoo.com

The experiment was conducted with five levels of nitrogen (40, 80, 120, 160 and 200 kg N ha⁻¹) and four times of split application of nitrogen in wet-seeded rice. Application of graded levels of N significantly increased the growth viz., plant height, leaf area index, dry matter production. The effect with regard to yield was significant up to a level of 120 kg N ha⁻¹. Nitrogen application at 160 kg ha⁻¹ did not bring any distinct effect on the yield parameters over 120 kg ha⁻¹ level. Application of N in four equal splits at seedling, active tillering (AT), panicle initiation (PI) and flowering enhanced the growth and yield when compared to the recommended practice of three equal splits of 1/3 each at seedling, AT and PI.

08-30

EFFECT OF LEAD ON GERMINATION AND EARLY SEEDLING GROWTH OF TOMATO (*Lycopersicon esculentum* L.)

H. Choudhury*, R.K. Goswami, S. Bora and J. Das

B.N. College of Agriculture, Assam Agricultural Univ., Biswanath Chariali, Sonitpur-784176, Assam
hemenchou@rediffmail.com

An experiment was conducted at the Department of Crop Physiology, B N College of Agriculture, Assam Agricultural University, Biswanath Chariali, Assam during the Year 2008-09 to determine the response of Tomato to the Lead enriched environment in terms of seed germination as well as early seedling growth and vigour. The different concentration of Lead solutions prepared and used in the investigation were 5,10,25,50,75 and 100 ppm and a control was also maintained as 0 (Zero) Lead with distilled water. The design of experiment was factorial CRD with five replications, as such altogether there were 35 different treatment combinations. The healthy tomato seeds of variety *Pusa Ruby* were first surface sterilized with ethanol then after washing with tap and distilled water 25 such seeds were placed in a petridish fitted with single layer of Whatman No 1 filter paper. The treatments were imposed by uniformly irrigating each petridish with respective Lead solution and then kept at laboratory and the data were recorded on 8th day after treatment imposture. The results of the study revealed that the seed germination per cent and early seedling growth of tomato in terms of root length, shoot length, fresh and dry weight of root and shoot, vigour index, tolerance index were maximum at control and there was a gradual decreased of the above mentioned parameters with the increase in Lead concentration and at 100 ppm Lead treatment gave the lowest values, on the other hand, the phytotoxicity percentage was increased with the increase in Lead concentration.



08-31

IMPROVEMENT IN REPRODUCTIVE DEVELOPMENT, SEED YIELD AND QUALITY IN WHEAT BY ZINC APPLICATION TO SOIL DEFICIENT IN ZINC

Nirmala Nautiyal*, Shikha Yadav and Digvijay Singh

Department of Botany, Lucknow University, Lucknow-226007, UP

A soil-pot culture experiment was conducted in a glass house to study the effect of zinc application to a soil low in DTPA extractable zinc, on the reproductive development, yield and quality of wheat (var. SP 343) seeds. Four treatments given to soil collected from zinc deficient area from Bakshi ka Talab, Lucknow included - control (without Zn), 5 mg Zn, 10 mg Zn and 10 mg Zn + 120 mg urea kg⁻¹ soil. Compared to control, zinc addition caused increase in size of anthers and pollen grains, pollen producing capacity of anthers and improvement in ear length. Addition of zinc increased Zn concentration, phytin and starch contents of seeds in relation to the increasing zinc levels. However, the increase in their content was lesser when urea was applied along with 10 mg Zn kg⁻¹ soil.

08-32

INFLUENCE OF MICRONUTRIENT SPRAY ON FLOWERING, YIELD, AND QUALITY OF MANGO CV. KESAR

D.S. Nehete and B.V. Padhiar

*ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari-396 540
nehetedhiraj@gmail.com*

The present experiment on the “Influence of micronutrient spray on flowering, yield, and quality of mango cv. Kesar.” was carried out at the Agriculture Experimental Station, Navsari Agricultural University, Paria, Taluka – Pardi, District – Valsad (Gujrat), during 2007 – 2008. The experiment was laid out in a Randomized Block Design with twelve treatment combinations involving two levels of micronutrients (ZnSO₄ 1% and 2%; FeSO₄ 1% and 2% and Borax 0.5% and 1%) with single application except water spray and control. The treatments were replicated thrice. Spray was carried out at initiation of flowering and second at pea stage. Results of the present study revealed that the application of micronutrients resulted in better flowering, higher yield and improved fruit quality of mango. The lower level of ZnSO₄, FeSO₄ and Borax in combination induced flowering in terms of minimum days taken to 50% flowering and increased length of panicle compared to other treatments and control. The treatment (ZnSO₄ 1% + FeSO₄ 1% + Borax 0.5%) significantly increased the number of fruits per tree, average fruit weight and yield per tree. It also produced favorable effect on fruit quality in terms of TSS, total sugars and reducing sugar and ascorbic acid compared to other treatments and control. On the basis of experimental results, in all the treatments the combine application of ZnSO₄ 1% + FeSO₄ 1% + Borax 0.5% found the most effective treatment for early flowering, higher yield with better fruit quality.



08-33

PHYSIOLOGICAL AND BIOCHEMICAL BASIS OF SALINITY-BORON TOXICITY ON VARIOUS FIELD CROPS OF ARID AND SEMI-ARID AGRO-CLIMATIC ZONES OF INDIA

K.S. Datta, R. Angrish, C. Rani, S. Devi, S. Chawla and V. Arora

Department of Botany and Plant Physiology, College of Basic Sciences and Humanities, CCS Haryana Agricultural University, Hisar-125 004 (Haryana)
profdatta@hau.ernet.in

In arid and semi-arid regions of India like Uttar Pradesh, Punjab, Haryana and Gujarat, the sub soil ground water is brackish due to the presence of salts, which also invariably contains appreciable quantities of boron (B) as well. Continuous use of such water by farmers having B even within the safe limits, have been reported to build up soil salinity and B levels. Therefore, salinity and B co-exist in arid zones including north-western India. However, there is complete lack of delimitation of the toxic effects of B vis-à-vis salinity. Consequently both salinity and B have been shown to have harmful effects on growth, development, yield and its attributes in various cereal and leguminous field crops. Therefore, during our exhaustive experimentations conducted in an ICAR funded ad-hoc project on the studies of salinity and B toxicity effects on crops like barley, wheat, chickpea, mustard, table pea, faba bean, and pigeon pea etc. We have found that the effect of B even within the safe limits under saline conditions is accentuated/aggravated manifolds in terms of decline in growth, development and productivity. Furthermore, the decline in various morphological characteristics, yield and its attributes in these crops have been found significantly correlated to various physiological and biochemical parameters regarding water relations, mineral nutrition, metabolites and enzymes of antioxidant defence system and cell wall constituents. It has been further deduced experimentally that pre treatment with calcium, H_2O_2 and glutathione pro-actively prepares the plant to partially alleviate/tolerate salinity-B toxicity especially in wheat and pigeon pea crops.

08-34

H_2O_2 -INDUCED ANTIOXIDANT RESPONSES OF TWO WHEAT VARIETIES TO SALT AND BORON STRESS

S. Devi, R. Angrish, K.S. Datta, A.S. Nandwal, B. Kumar and C. Rani

Department of Botany and Plant Physiology, CCS Haryana Agricultural University, Hisar-125004
nandwal@hau.ernet.in

Studies were carried out to observe the changes in the activities of enzymes of antioxidant system like catalase, ascorbate peroxidase, glutathione peroxidase, peroxidase, glutathione reductase and superoxide dismutase in two wheat cultivars KRL 1-4 (salt tolerant) and HD 2329 (salt sensitive) under salinity (So, S120 mM), boron (Bo, B10 mM) and H_2O_2 treatments (Ho, H100 μ M) upto 48 h at different time intervals. In both cultivars the relative stress injury and MDA content increased with salt and boron-stress conditions and the effect is accentuated when both salinity and boron were used in combination with each other. However, these effects were partially alleviated under the treatment with H_2O_2 . Time course study of the activity of all the antioxidant enzymes showed sharp decline at 3 h and then increased upto 24 h and then decline thereafter in both the cultivars under salt, boron and salt + boron stress condition. But incorporation of H_2O_2 caused a sudden spurt in all the activities of above mentioned enzymes at 3 h and showed a gradual increase upto 24h, except superoxide dismutase which showed reverse trend with all the treatments. It is suggested that amongst the two wheat cultivars, the tolerant KRL 1-4 maintained a higher activity of reactive oxygen scavenging system as compared to the sensitive HD 2329. It is further suggested that pre-treatment with H_2O_2 proactively prepares the plant to tolerate/alleviate the salt-B toxicity effects in wheat crop.



08-35

PHOSPHORUS NUTRITION FOR HIGHER DROUGHT TOLERANCE AND IMPROVED YIELD OF ARID LEGUMES

B.K. Garg and Uday Burman

Central Arid Zone Research Institute, Jodhpur – 342 003

Arid legumes comprising clusterbean, moth bean, cowpea and horse gram are the mainstay of pulse and forage production in arid regions of the country. However, their yields are generally low due to low and erratic rainfall and poor soil fertility conditions in arid regions. The role of phosphorus nutrition is very important for yield improvement of legumes on phosphorus supply is critical for leaf growth, photosynthetic efficiency, root growth and its functioning and nitrate assimilation. Phosphorus nutrition is also known to impart drought tolerance in several crops under water limited condition. Studies conducted on phosphorus nutrition under water stress and rainfed conditions have revealed the beneficial effects of P application on yield enhancement of clusterbean, moth bean and mung bean. Phosphorus nutrition has been found to significantly increase leaf area, net photosynthetic rate, concentration of chlorophyll, starch, soluble protein and activity of nitrate reductase under drought on water deficient conditions. P application has further been observed to enhance drought tolerance under different intensities of water stress in clusterbean and mung bean. P application significantly ameliorated the detrimental effects of drought at the pre-flowering stage in moth bean genotypes on seed yield and diverse physiological parameters like RWC net photosynthesis, chlorophyll, starch, NR activity and soluble protein. Although the potential gains may be variable in different legumes and their genotypes under various rainfall situations, but the merit of P application for growth and yield improvement is quite obvious.

08-36

NITROGEN PARTITIONING IN IRRIGATED AND UNIRRIGATED CHICKPEA

D.V. Singh, Poonam-Sharma Natu, S.R. Kushwaha and M.C. Ghildiyal

Division of Plant Physiology, IARI, New Delhi-110012

Irrigation during flowering does not generally maximize chickpea yield under north Indian condition as it increases the vegetative growth and decreases the harvest index. Being a protein rich grain legume, nitrogen requirement for seed growth demands continuous nitrogen translocation from vegetative tissues. The present study, therefore, analyzed the effect of irrigation on nitrogen partitioning in four chickpea cultivars. Chickpea cultivars (BG 1090, BG 1063, Pusa 267 and BGD 72) were grown in field under unirrigated and irrigated conditions. The irrigation treatment consisted of two additional irrigation applied at flowering and pod filling stages. Dry matter and nitrogen content of different plant parts were determined in samples taken one week after irrigation at flowering and pod filling stages. Yield components were determined at harvest. N was analyzed in dried samples using nitrogen analyzer (Gerhardt, Bonn). The data showed that irrigation after flowering decreased nitrogen harvest index in chickpea cultivars examined. The extent of decrease, however, showed variation among cultivars. It is suggested that genotype showing less decrease in harvest index and nitrogen harvest index would respond to irrigation with yield advantage.



08-37

**RESPONSE OF SOIL ENZYMES AND MICROBIAL COMMUNITIES TO ROOT EXUDATES
RELEASED IN TRANSGENIC Bt COTTON RHIZOSPHERE**

Usha Mina¹, Anita choudhary² and Anju Kamri³

^{1&2} Division of Environmental Sciences, ³ Division Nematology, IARI, New Delhi-12

Use of transgenic crops, including those expressing the insecticidal *Cry* protein from *Bacillus Thuringiensis* (Bt), is increasing at a rapid rate in worldwide. Field and laboratory studies of transgenic Bt crops have been carried out to detect the persistence and activity of the *Cry* protein in soil and its effect on soil microorganisms to assess their risks to environment. However there were few studies from the world that evaluate the effects of Bt cotton on soil enzymes and key microbial communities. From India reports on this important aspect are almost lacking. In the present study effect of transgenic cotton (MRC6301+Bt) expressing the *CryIAc* insecticidal protein active against lepidopteran pests, on soil enzymes (dehydrogenase, phosphatase, nitrate reductase and urease) activity and microbial communities (meso and micro fauna) at different growth stages of cotton were compared with non transgenic cotton under field conditions at IARI, New Delhi. Rhizospheric soil samples of transgenic Bt cotton and non transgenic cotton were taken at five growth stages of the cotton crop developmental cycle: seedling, vegetative, flowering, bolling and maturing. There were no statistical significant differences ($P>0.05$) observed in phosphatase activity, nitrate reductase activity and urease enzymes activity between rhizospheric soil of transgenic Bt cotton and non transgenic cotton over the cropping cycle. However variation in dehydrogenase enzyme activities were observed. Dehydrogenase enzymes activity was significantly high in the rhizosphere of transgenic cotton plants compared to non transgenic cotton through out the observation period. These results suggest that rhizospheric zone of transgenic cotton plants more active as compared to nontransgenic cotton plants rhizospheric zone. The temporal and spatial variations observed in nematodes population were significant, but the variation in population due due to the interaction of crop age and transgenic and non transgenic trait of cotton was non significant. Variation in collembolan and ants population size due to time (month/age), space (treatments) and their interaction are significant. At most of the growth stages population of meso and microfauna was high in transgenic cotton plants rhizosphere as compared to non transgenic cotton.

08-38

FEASIBILITY STUDIES ON OPEN CULTIVATION OF *Chlorella vulgaris*

A. Bora, K.S. Nakhuru, H.K. Gogoi and L. Singh

Defence Research Laboratory, Tezpur-784001, Assam
ajitabhbora@rediffmail.com

Chlorella vulgaris is a photosynthetic green microalgae belonging to the family Chlorophyceae. An experiment was conducted to study the feasibility of open cultivation of *C. vulgaris* in poly trays under three different growing conditions viz. inside culture room, glass house and in field condition with three replicates under each condition. WC medium was used for culturing *C. vulgaris* in polytrays of the size 36x31x13 cm with a volume of 6 litres per tray. Optical density (OD) value and cell count was taken as parameters for studying the growth kinetics of the culture under study. Peak growth was observed at around 2 weeks time in each condition though the growth intensities differs and the biomass was harvested through centrifugation. The temperature inside the culture room was maintained at 25 ± 2 °C. Maximum temperature inside the glasshouse was recorded in the range of 40-45°C and minimum of 11-29°C, whereas, in the field condition, maximum temperature of 28-31°C and minimum of 7-12°C was recorded. Highest yield of algal mass was obtained from the cultures kept inside culture room (0.3g/l), followed by the one kept in the field (0.22g/l) and the least in that kept inside glasshouse (0.17g/l). Thus, a temperature of around 25°C is found to be suitable for the optimum growth of *Chlorella vulgaris* in open cultivation. No contamination of the culture by other algal species has been observed till the time of harvesting.



08-39

INTEGRATED NUTRIENT MANAGEMENT IN DEGRADED JHUM FALLOW FOR SUSTAINABLE CROP PRODUCTION

Indrani P. Bora, Kuntala N. Barua and Arundhati Baruah

Rain Forest Research Institute, Jorhat, Assam

A field experiment was conducted in degraded jhum land of Men Teron Village (Nilip Block) Karbi Anglong district Assam to study combined application of fertilizer and green manure on yield and yield attributes of agricultural crops. Two naturally grown weed species *Lantana camara* and *Chromolaena odorata* were selected as green manure due to easy availability and rapid decomposition property. Grain yield of rice and maize was found to be increased significantly in application of green manure and NPK fertilizer as compared to also fertilizer application alone. Maximum yield was recorded in *Lantana camara* applied plots than *Chromolaena odorata*. Combined application of green manure with fertilizer increased total N, available P and exchangeable K content in the soil. Significantly high value of potassium was recorded due to *L. camara* application. Addition of green manure improved organic carbon content in soil. In initial year the value was recorded comparatively low because of delay decomposition of green leaves. *C. odorata* incorporated soils showed better value as it is regarded as fast decomposing species with low lignin content. From the results it is concluded that *L. camara* and *C. odorata* can be used as an excellent source of green manure that contributed towards sustaining the productivity and nutrient status in degraded jhum fallow.

08-40

EFFECT OF SALTS OF LEAD ON SEEDLING VIGOUR, CHLOROPHYLL, TOTAL SUGAR, PHENOL AND SOLUBLE PROTEIN CONTENT IN MAIZE UNDER DIFFERENT PH CONDITIONS

M.B. Doddamani*, S.K. Gali, U.V. Mummigatti and C.M. Nawalagatti

Department of Environmental Sciences, College of Agriculture, Univ. of Agril. Sciences, Dharwad-580 005

A laboratory experiment was conducted to ascertain the influence of lead acetate, lead chloride and lead nitrate at varying pH levels on germination, seedling vigour, chlorophyll, total sugar, phenol and soluble protein content in maize. Concentrations of lead were 0.1, 0.4, 0.8, 1.2, 1.6 and 2.0 mM and the pH levels were 4.0, 7.0 and 9.0. At higher pH lead salts are less effective on maize compared to neutral and acidic conditions. Among the three salts of lead, chloride was detrimental on maize compared to acetate and nitrate forms. Effect of lead chloride was more pronounced with its increasing concentration. Seedling vigour, chlorophyll, total sugar, phenol and soluble protein content remained unaffected at lower concentration. At higher concentration significant inhibition in germination, chlorophyll, sugar and soluble protein were recorded. However, phenol content was inversely proportional to the concentration of lead chloride. The order of effect of lead salts on maize were lead chloride > lead nitrate > lead acetate.



08-41

EFFECT OF ORGANIC MANURES AND P APPLICATIONS ON CHANGES IN AVAILABLE P IN A TYPIC PALEUDALF SOIL OF ASSAM

B.K. Medhi^{*1}, D.S. Ruhai, N. Borah^{*2}, R. Saud^{*3}, K. Pathak^{*4} and Abhijit Sarma^{*5}

Department of Soil Science, CCS Haryana Agricultural University, Hisar, Haryana

¹Sr. Scientist, AICRP on IFS, Assam Agricultural University, Jorhat -13, ²Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13, ³Sr. Scientist cum Manager, ATIC, Assam Agricultural University, Jorhat -13, ⁴Sr. Scientist, Directorate of Research, Assam Agricultural University, Jorhat -13

⁵Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13

Organic manures (FYM and green manure – *Sesbania aculeate*) in combination with different levels of P were used to study the changes in available P at different days of incubation. Irrespective of the days of incubation, increase in P levels (0, 50, and 100 $\mu\text{g g}^{-1}$ soil) along with organic manures (1% dry weight basis) significantly increased the available P fraction while it was observed to decrease from the very 1st day of incubation upto 28 days followed by continuous and consistent rise upto 84 days of incubation. Although application of FYM significantly increased the available P upto 28 days of incubation and decreased thereafter but in case of green manure treated soil, after showing a rising trend upto 14 days of incubation, the available P decreased and found to follow a sharp increase upto 84 days of incubation. The mean efficiency of green manure in increasing the P availability was found in the range of 21 to 28 per cent. The effect of green manures in increasing P availability was more pronounced in Typic Paleudalf acid soil.

08-42

KINETICS OF PHOSPHATE RELEASE AS AFFECTED BY ORGANIC MANURES AND P LEVELS IN AERIC HAPLAQUEPT SOIL OF ASSAM

B.K. Medhi^{*1}, D.S. Ruhai, N. Borah^{*2}, Abhijit Sarma^{*3}, R. Saud^{*4} and K. Pathak^{*5}

Department of Soil Science, CCS Haryana Agricultural University, Hisar, Haryana,

¹Sr. Scientist, AICRP on IFS, Assam Agricultural University, Jorhat -13, ²Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13, ³Sr. Scientist cum Manager, ATIC, Assam Agricultural University, Jorhat -13, ⁴Sr. Scientist, Directorate of Research, Assam Agricultural University, Jorhat -13

⁵Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13

An incubation study with the application of organic manures (FYM and green manure – *Sesbania aculeate*) in combination with three levels of P application through KH_2PO_4 was undertaken to study the kinetics of P release in a Aeric Haplaquept soil of Assam. Cumulative Olsen's and Bray's P after each incubation period was fitted into first order, second order and parabolic diffusion equations. Application of organic manures along with graded doses of P application resulted into an increase in solution P concentrations at 0 day which was observed from the intercept (0.950 – 1.530) of the first order, second order (0.030 – 0.122) and parabolic diffusion (3.03 – 15.18) equations. Decrease in solution P concentrations in green manure treated soil at 0 day of incubation indicated higher rate of immobilization as envisaged from the intercept of the first order (1.01 – 1.53), second order (0.030 – 0.106) and parabolic diffusion equations. Added levels of P application along with organic manures increased first order kinetic (KcI) constant (6.14×10^{-3} – 8.71×10^{-3} $\mu\text{g g}^{-1} \text{day}^{-1}$) and overall diffusion (Kcp) rate (4.77-10.42 $\mu\text{g g}^{-1} \text{day}^{-1}$) while second order kinetic (KcII) constant (0.304×10^{-3} – 0.979×10^{-3} $\mu\text{g g}^{-1} \text{day}^{-1}$) was found to decrease reflecting more release of P at the cost of decreasing the number of empty sites occupied with desorbable phosphate.



08-43

PHOSPHATE SUPPLY CHARACTERISTICS OF SOME SOIL SERIES OF ASSAM AND HARYANA

B.K. Medhi^{*1}, D.S. Ruhai, N. Borah^{*2}, R. Saud^{*3}, Abhijit Sarma^{*4} and K. Pathak^{*5}

Department of Soil Science, CCS Haryana Agricultural University, Hisar, Haryana

¹Sr. Scientist, AICRP on IFS, Assam Agricultural University, Jorhat -13, ²Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13, ³Sr. Scientist cum Manager, ATIC, Assam Agricultural University, Jorhat -13, ⁴Sr. Scientist, Directorate of Research, Assam Agricultural University, Jorhat -13

⁵Sr. Scientist, Department of Agronomy, Assam Agricultural University, Jorhat -13

Relationship between soil characteristics and phosphate supplying parameters were determined in well defined soil series of Assam and Haryana. Available P (Olsen's and Bray's) and phosphate supplying capacity based on them were significantly and positively correlated with pH (0.664 and 0.695), EC (0.731 and 0.752), ESP (0.965 and 0.971) and negatively with iron and aluminium *viz.* exchangeable, CBD extractable and oxalate extractable fractions. Adsorbed P at 0.2 ig mL⁻¹ of equilibrium P solution, distribution coefficient, equilibrium phosphate potential, differential phosphate buffering capacity, Langmuir adsorption maxima (b_1 and b_2) and Freundlich K were correlated negatively with pH (0.568 – 0.784), EC (0.625 – 0.734), ESP (0.589 – 0.652) and positively with different iron and aluminium fractions.

08-44

MODULATION OF ANTIOXIDATIVE RESPONSES OF MAIZE (*Zea mays* L. var K-25) BY EXCESS BORON SUPPLY IN SAND CULTURE

Dharmendra Kumar Pandey^{1*2}, Nalini Pandey² and C.P. Sharma²

¹Dept. of Life Sciences, Amity School of Engineering and Technology, AUUP Lucknow-226010

²Department of Botany, University of Lucknow, Lucknow-226007

¹*email: dkpandey_77@yahoo.co.in

In this study we explored the induction of oxidative stress by excess of boron (3.3 and 33 mM B) in plants of *Zea mays* L. var K-25. Plants subjected to excess boron showed retardation in growth along with yellowing followed by necrosis of leaf apices. Excess of boron enhanced lipid peroxidation (MDA), concentration of H₂O₂, proline, total phenols, ascorbate and decreased concentration of chloroplastic pigments in the young leaves. The activities of enzymes polyphenol oxidase (EC 1.14.18.1; PPO), acid phosphatase (EC 3.1.3.2; APase), ribonuclease (EC 3.1.1.22, RNase), super oxide dismutase (EC 1.15.1.1; SOD), ascorbate peroxidase (EC 1.11.1.11; APX) and peroxidase (EC 1.11.1.7; POD) increased in leaves supplied excess boron. However, the activity of catalase (EC 1.11.1.6; CAT) and glutathione reductase (EC 1.6.4.2; GR) was depressed. Marked accumulation of phenols, MDA and H₂O₂ suggested peroxidative damage to membrane lipids, typical of damage from reactive oxygen species. It is, therefore, concluded that excess B (3.3 and 33 mM) induced oxidative stress despite of increased antioxidant production. There was no correlation between tissue boron concentration and boron supplied to plants.



08-45

PHYSIOLOGICAL CHARACTERIZATION OF LETTUCE UNDER TOXIC LEVELS OF CU

Yirmeila V. Zimik and B.K. Rabha

Assam Agricultural University, Jorhat, Assam

Copper status of frequently amended vegetable growing areas is largely undefined. High Cu levels may pose human health problems through consumables. The present study was conducted for morphophysiological characterization of higher level of Cu on lettuce (cvs. Big Boston and Lettuce Revolution) and examine its suitability as indicator plant against Cu toxicity. The Cu levels ranged between 40 ppm and 200 ppm against a control (0 ppm). The lowest Cu level (40 ppm) produced taller plants in both the genotypes but only till to mid vegetative phase. The higher Cu levels induced stunted growth. Root growth was affected more in earlier growth stage and shoot growth in later growth stage. The higher Cu concentrations damaged the old as well as the newly formed laterals to give a pruned tuft-like appearance. Higher Cu induced catchy leaf chlorosis (Big Boston) and water soaked lesions (Lettuce Revolution) leaf senescence was accelerated as indicated by significant LAD reduction in the late vegetative stage (52.37 and 65.05 percents in Big Boston and Lettuce Revolution respectively) with higher levels of Cu. This symptomatic changes in garden lettuce may be indicative of high Cu exposure to other vegetables as well in the garden.

08-46

CORRELATION STUDIES FOR EFFECTS OF Ca ON TWO GENOTYPES OF KHARIF RICE UNDER Fe TOXIC CONDITIONS

Minsura Begum, B. Bharali and B.K. Rabha

Department of Crop Physiology, AAU, Jorhat

An experiment was conducted to evaluate the response of two *Kharif* rice genotypes to CaCl_2 under Fe toxic field conditions. The genotypes Bahadur and Mahsuri are susceptible and resistant towards Fe toxicity respectively. Three concentrations of CaCl_2 (100 ppm, 500 ppm and 1000 ppm) were applied as seedling root-dip treatment. Correlation studies of yield and its associated traits like panicle number, spikelet per panicle, high density grains, test weight and sink capacity showed positive response to CaCl_2 . However, the effects were concentration dependent. Spikelet number per panicle, HD grains, test weight and sink capacity established positive relationship with yield at 100 ppm CaCl_2 . Bahadur produced 43.09 percent higher yield than Mahsuri, indicating genotypic variation as one of the major yield determining factors under Fe toxic field condition. The results suggests that CaCl_2 could be a useful prophylactic proposition to ameliorate Fe toxicity in rice.

08-47

INFLUENCE OF ORGANIC NUTRIENTS ON GROWTH, YIELD AND PROFITABILITY OF CABBAGE (*Brassica oleracea* var. capitata)

I. Sarma, D.B. Phookan and S. Boruah

Department of Horticulture, Assam Agricultural University, Jorhat-785013, Assam

A field experiment was conducted during 2008-09 at Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat to study the influence of various organic nutrients on the growth, yield and profitability of cabbage. The experiment was laid out in randomized block design with six treatments and four replications. Application of different combinations of organic nutrients influenced the growth and yield in cabbage. The results revealed that combined application of Azotobacter + cowdung + rock phosphate + Phosphate Solubilizing Bacteria (PSB) improved the growth traits viz., head weight, number of wrapper leaves, root length, root spread and specific gravity. This treatment gave the highest head yield of 29.39 t/ha with the maximum benefit:cost ratio for the trait. No significant difference was, however, observed among the treatments for N, P, K and ascorbic content of the leaves.



Session 09

Seed Physiology



09-01

HYDRO AND HALO HARDENING OF SEEDS CAN IMPROVE GERMINATION, SEEDLING VIGOUR, NITRATE ASSIMILATION AND PROLINE CONTENT IN RICE VARIETY SWARNA (MTU 7029)

Sananda Mondal*, P. Vijai and Bandana Bose**

Department of Plant Physiology, Institute of Agricultural Sciences, BHU, Varanasi-221005

**mondalsananda@gmail.com, **bandana_bose2000@yahoo.com*

Seeds subjected to one or more cycles of wetting and drying before sowing is referred as hardening (Hafeez and Hudson 1967: first report). In hydro hardening the seeds are provided with only water whereas in case of halo hardening salt solutions are to be taken into consideration. This techniques enhance germination and seedling emergence uniformly even under adverse environmental conditions (Ashraf *et al.*, 2003; Basra *et al.*, 2005a; Sharma and Bose, 2006). In the present study the effects of hydro and halo hardening of seeds with distilled water and $Mg(NO_3)_2$ (Sharma and Bose, 2006: first report) respectively were observed on the performance of rice (*Oryza sativa*) var. Swarna (MTU 7029) starting from its germination to vegetative growth. In between hydro and halo hardening with $Mg(NO_3)_2$ to the seeds better performance was shown by later treatment. Maximum amylase activity in endosperm correlated well with an increase in soluble sugar content were noted in halo hardened seeds of rice, whereas in the same treatment the insoluble content was noted to reduce maximum in comparison to hydro hardened and non-hardened sets. Studied growth parameters like plumule/ shoot length, radicle/ root length, fresh and dry weight of seeding, root number, root number were found maximum in $Mg(NO_3)_2$ hardened one followed by other two treatments. Nitrate assimilation, measured in terms of nitrate reductase activity and nitrogen content of growing leaves, improved maximum in halo hardened one; the same treatment has the capacity to improve the content of an osmoregulatory compatible molecule proline in leaves. Therefore this type of technology is useful in improving the germination/ seedling vigour/ nitrate assimilation and stress ameliorating capacity in growing plants of rice.

09-02

VARIATION FOR RESISTANCE TO PRE-HARVEST SPROUTING IN MUNGBEAN

Vijaylaxmi and Sanjeev Gupta*

*Division of Physiology, Biochemistry and Microbiology, *Division of Crop Improvement*

Indian Institute of Pulses Research, Kanpur-208 024

Pre harvest sprouting in mungbean [*Vigna radiata* (L.) Wilczek] as a trait which reduces seed quality and germination percentage. To determine the extent of genotypic variation towards this trait, the percentage of pods ruptured by sprouting seed under artificial conditions *viz.*, dipped in water for 24 hours, soaked on wet sand for various time durations ranging from 2 to 120 hours, and soaking pods on wet filter paper under a constant temperature in BOD incubator in eight mungbean genotypes. The pods were hand picked from field and screened for resistance in the laboratory conditions during the *kharif* seasons on 2006 and 2007 at the Indian Institute of Pulses Research, Kanpur. Genotypes which showed least percentage of pre harvest sprouting under above mentioned condition were TARM 1, TARM 18, Pusa vishal, Pusa 9072, and Ganga mung 1 and this low percentage of pre harvest sprouting were associated with slower water uptake by seed on a time scale. The presence of pubescences on the pod was also associated with least pre harvest sprouting. These genotypes also showed higher wax content in their pod wall as compared to *cv.*, Kopargaon, which had maximum extent of pre harvest sprouting.



09-03

POST HARVEST SEED PHYSIOLOGY OF THREE MEDICINAL PLANTS OF RUTACEAE

S.S. Parihar, M. Dadlani, N.K. Yadav, Manisha Dhasmana, Preeti, Debarati and Sunil C. Joshi

Division of Seed Science & Technology, Indian Agricultural Research Institute, New Delhi-110012

ssparihar@iari.res.in

Based on their response to desiccation, seeds can be divided into two main groups, orthodox (desiccation tolerant) and recalcitrant (desiccation-sensitive). Desiccation-sensitive seeds cannot tolerate removal of bound water without viability loss and show signs of dehydration stress when 'free' water is being removed. In addition, since desiccation-sensitive seeds cannot be dried, storage is only possible for short periods of time and they therefore pose a significant challenge for *ex situ* conservation of seeds in seed banks. Thus the term orthodox and recalcitrant have been used to describe the post harvest physiology of seeds. A category intermediate between orthodox and recalcitrant is also recognized in which seed survive desiccation but becomes damaged during dry storage at low temperature. Therefore, studies were conducted on seed storage behaviour of three medicinal plants of *Rutaceae* viz. *Murraya koenigii* (L). Spreng., *Murraya exotica* L., and *Aegle marmelos* Correa. The seeds were extracted from mature fruits during May to July 2007 and moisture content in fresh seeds was determined. Seeds with different moisture content (targeted moisture content ranging from 5 to 40 % on fresh weight basis depending upon the species) were stored in three temperature regimes (-20 °C, 15 °C and ambient room temperature) for 12 months. Seed viability was determined at three months interval in all treatment combinations by germinating seeds either in BP (between paper method) or using vermiculite at 25- 30 °C. The study revealed that *M. koenigii* revealed recalcitrant storage behaviour. Seeds of *A. marmelos* and *M. exotica* were found chilling sensitive and exhibited intermediate storage behaviour.

09-04

STANDARDIZATION OF SUBSTRATA AND TEMPERATURE FOR SEED GERMINATION TESTING IN SOME IMPORTANT MEDICINAL CROPS

Rame Gowda, K.J. Sowmya, I. Sriram and B.V. Pavithravani

Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore-560 065

rg_seed@rediffmail.com

The use of plants for medicinal purposes by man due to their therapeutic properties has been in vogue since from pre-historic times. Temperature and substrata are known to affect both rate as well as final percentage of germination. The study was conducted to find out the requirements for seed germination in selected seed propagated medicinal crops like Senna (*Cassia angustifolia*), Roselle (*Hibiscus sabdariffa*) and Tulsi or Basil (*Ocimum sanctum*). The seeds of these species were tested for germination with several combinations of temperature and substrata to standardize their requirements for better and early germination. The seeds of Senna tested in between paper (BP) method at 25/30°C attained maximum germination (86%) and the first count shall be taken on 2nd day and the final count on 5th day of germination test. Similarly for seeds of Roselle between paper method was found better that recorded highest germination (87.3%) at an alternate temperature of 25/30°C. The first count and final count shall be taken on 2nd and 4th day of germination, respectively. However, for Tulsi seeds, Top of paper (TP) method was found better which recorded highest germination (92%) and Bartlett Rate Index (BR1) which is an indicative of speed of germination (0.437) at 25/30°C. Further, the first count (2.7 days) and final counts (6.7 days) were significantly higher in top of paper method at 30°C, which suggested that the first count and final count shall be taken on 3rd and 7th day of germination, respectively. Thus the study suggested that these medicinal crops require differential temperature and an appropriate substratum in order to obtain higher germination in a shortest period.



09-05

STIMULATING EFFECTS OF ELECTRIC FIELD IN SUNFLOWER SEEDS

Anjali Anand, Jyotsana Bhardwaj and Shantha Nagarajan

Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi-110012

anjali_nrl@iari.res.in

The establishment of a uniform plant population for which good quality seed is a pre-requisite can maximize crop yields. Maintenance of seed quality in storage from time of production until it is sown is imperative to assure its planting value. Prolonged storage can lead to loss of vigor and finally viability of the seed. Various physical and chemical approaches like priming with different media, α rays, electron and laser beam, magnetic field, electric field, radiofrequency etc. are being used to improve vigor in seeds. Sunflower seeds are known to lose their vigor and viability when stored under inappropriate storage conditions and a pre-exposure to electric current of a short duration may help in improving vigor of the seeds. We studied the effect of pre-sowing electric treatment on germination, speed of germination, seedling characteristics, vigor and activity of germinating enzymes in sunflower seeds. Sunflower seeds were given an electric current of 200 mA 150V for 2,3,5 min. Electric field treatment did not have any effect on the germination percentage but speed of germination improved by 3 fold compared to control after 3 min of exposure. Root growth was stimulated more than shoot growth in treated seeds. Biochemical analysis of the germination enzymes, alpha amylase involved in carbohydrate metabolism, isocitrate lyase involved in the fatty acid metabolism and respiratory enzyme malate dehydrogenase activity increased significantly over the untreated control between 16- 20 hrs of imbibition in electrically treated seeds. Respiration also increased after 20 hrs of imbibition in treated seeds. These studies indicate that electric field perturbs the structural organization of the enzymes and membranes resulting in enhanced metabolism of the treated seeds. Water movement in the cells is related to the active cell functions i.e the heat generated by the enzymatic catabolism of the stored products that facilitates faster water uptake so that speed of germination is increased.

09-06

GERMINATION AND WATER BINDING CHARACTERISTICS AT DIFFERENT RELATIVE HUMIDITIES AT TWO TEMPERATURES OF MAGNETICALLY TREATED SUNFLOWER SEEDS

Ananta Vashisth¹ and Shantha Nagarajan²

¹Division of Agricultural Physics, ²Nuclear Research Laboratory, IARI, New Delhi-110012

In modern agriculture efforts are on in search of an efficient eco-friendly production technology based on physical treatment of seeds to increase the seedling vigour and crop establishment. Exposure of seeds to magnetic field is one of the safe and affordable potential physical pre-sowing treatments to enhance post germination plant development and crop stand. In our earlier experiment, sunflower seeds subjected to magnetic fields increased germination, speed of germination seedling length / seedling dry weight over control. These enhancement effects were explained by the increased activities of germination related enzymes, α -amylase, protease and dehydrogenase in magnetically treated seeds over untreated seeds during germination. However, all enzymatic reactions take place in aqueous environment and its activity depends on the availability and status of seed water. The binding characteristics of seed water influence its quality and subsequent germination and emergence characteristics. Differences in water binding status of seeds may explain the mechanism of improvement in magnetically treated seeds. Therefore, the present study was undertaken to characterize the



water sorption properties and germination traits of magnetically exposed and unexposed sunflower (*Helianthus annuus* L.) seeds equilibrated over a wide range of relative humidities at 25 and 35°C. Results showed that moisture content increased with increase in relative humidity and decreased with increase in equilibrium temperature. The germination and vigour reduced at high humidities and at very low humidities. Magnetically exposed seeds maintained higher germination percentage, shoot / root length and seedling vigour at both temperatures and at all relative humidities, which indicated the better quality of the magnetically exposed seeds. Leachate conductivity of magnetically exposed seeds was lower than unexposed seeds at all relative humidities at 25°C and 35°C, which indicated better membrane integrity in magnetically exposed seeds. Analysis of the isotherms using D'Arcy–Watt equation revealed that magnetic exposure decreased the number of strong and multimolecular binding sites and increased weak binding sites. This might have increased the molecular mobility of seed water and its availability for various biochemical reactions involved in the germination process and improved germination and early seedling growth of sunflower.

09-07

SEEDS OF MELLOCANA BAMBUSOIDES, AN ADDITIONAL SOURCE OF NUTRITION

Hoikhokim and Kananbala Sarangthem

Plant Physiology Laboratory, Department of Life Sciences, Manipur University, Canchipur-795003, Manipur

Flowering of bamboos occurred at the gap of certain years depending on the species of the bamboo plant and lasted for two to three years. Bamboo seeds is eaten by some peoples as an replacement of rice at the time of food crisis. The mature seeds of *Mellocana bambusoides* available in certain districts of Manipur were analysed for its nutrients content in total carbohydrates content, total soluble protein, amino acids content , chlorophylls ,pH value and the moisture content.

09-08

PREDICTION OF VIABILITY THROUGH SINGLE SEED CONDUCTIVITY MEASUREMENT IN FABA BEAN (*VICIA FABA* L.)

Reshma Shaheen*, Kalyani Srinivasan*, Shahid Umar, B.S. Phogot* and R.S. Rathi***

**National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012. **Jamia Hamdard (University), New Delhi-110 062*

Electrical conductivity of seed leachates is a well developed test to assess the quality of seeds. Membrane integrity and incidence of dead tissue are both influenced by the two major factors determining seed vigour in grain legumes mainly seed ageing and the incidence of imbibition damage. The individual seed conductivity is not as well known as bulk conductivity of the seed to analyze the extent of deterioration of seed. It can identify whether high leakage results from the presence of a few highly damaged seeds or whether this is an overall high amount of leakage within the population. Measurement of single seed conductivity has also been proposed as a means of predicting the germination of a seed sample. In this case, any seed having leachate conductivity above a threshold level is said to be non germinable. However, a common threshold value can not be applied to all seeds within a species due to differences in leakage that arises due to genotype and seed size. Therefore the present investigation was carried out to investigate the relationship between conductivity of individual faba bean seeds of three varieties subjected to deterioration and their germination as well as vigour after measuring conductivity. Freshly harvested seeds of three varieties of faba bean (*Vicia faba* L) were used for the present study. Seeds were conditioned to 20% moisture content and subjected to controlled ageing by keeping at a constant temperature of 45° C for 48, 72, 96 and 120 hrs. Fifty seeds from each treatment were weighed



individually and soaked in 5 ml distilled water in small beakers incubated at 25° C for 16-18 hrs. Conductivity of the leachates from single seeds was measured and the net conductance calculated per gram fresh weight of seed. After having determined the leachate conductivity, the same seeds were subjected to germination test. Each seed was numbered and identified clearly in order, throughout the whole experiment so that its conductivity could be related with the subsequent performance in the germination test. The data was analyzed statistically. Results revealed that the conductivity of seeds which were scored as abnormal or dead was always greater than those which produced normal seedlings. The usefulness of this non-destructive method for assessment and prediction of seed viability is discussed.

09-09

EFFECT OF TEMPERATURE ON GERMINATION OF *LEPIDIUM SATIVUM* L.

Debarati Mukhopadhyay, S.S. Parihar, Malavika Dadlani, Preeti, Sunil. C. Joshi

Division of Seed Science and Technology, Indian Agricultural Research Institute, New Delhi-110012
debarati129@gmail.com

Lepidium sativum L. belongs to the family Brassicaceae, commonly known as Chandrasur in Ayurveda. It is a Rabi crop predominantly grown in temperate region. The seed of this crop is of medicinal importance used to prevent post natal complications. The objective of the proposed experiment was to find out the dormancy status, germination and effect of different temperature on the germination in order to determine the optimum temperature for germination test. The seeds are reddish in colour and elliptic in shape with spatulate embryos and thousand seed weight varied from 1.545 gm – 1.752 gm. Germination tests were carried out on top of the paper method with three fresh seed lots. Four replications each containing 100 seeds were kept for germination at five different temperatures viz. 15°C, 20°C, 25°C, 15/35°C (alternating temperature of 15/35°C, 15°C for 16 hours and 35°C for 8 hours) and 31-33°C. The germination was considered as development of seedlings from seeds with all essential structures visible. First count was earliest in 25°C on third day while second count was on fourth day. A delay in germination was observed in 15/35°C. No significant difference in germination percentage was observed at 15°C, 20°C, 25°C, 15/35°C However significant reduction in germination observed at 30-33°C suggesting the inhibitory effect of higher temperature on germination. The root and shoot length varied at different germination temperatures. Highest root length was 3.98 cm and shoot length was 1.96 cm on the first count at 25°C. The fresh seeds did not exhibit dormancy.

09-10

STUDIES ON RELATIVE PERFORMANCE OF SEED PRIMING WITH TAP WATER AND IN-ORGANIC SALTS ON GERMINATION, INVIGORATION GROWTH AND YIELD OF WHEAT (*Triticum aestivum* L.)

T.N. Tiwari, Asit B. Mandal* and S.K. Dwivedi

Directorate of Seed Research, Kushmaur, Mau-275 101, UP
tntdsr@gmail.com

In a field experiment one year old seed of two late sown wheat varieties namely HUW 234 and WR544 were primed with tap water and inorganic salts in 0.2% solution for 12 hours. After priming the seeds were taken out and allowed for shade drying till attaining their original moisture. One set of unprimed control was also kept simultaneously. These primed and unprimed seeds were sown in the second fortnight of December 2008 in allocated plots in four replicate following factorial randomized block design (RBD) at a part of the research farm of IISR, Lucknow which is under the control of Directorate of Seed Research- Mau. The



recommended doses of fertilizers NPK 120:60:40 kg/ha. were applied, half of the nitrogen and full of phosphorus and potash were applied at the time of sowing and remaining half of nitrogen doses were applied in two split one at tillering and an other at spike initiation stage. Cultural practices including irrigation, weed control, plant protection measure adopted time to time as per recommendations. The germination was recorded one week after sowing both under field and laboratory. The shoot/root length were recorded 15 days after germination count and at the same time, 50 seedling were uprooted and kept for drying at 80°C in oven and after drying the seedling dry weight was recorded treatment/variety wise with the help of electronic balance. The data of germination percentage and seedling dry weight were used to calculate the vigour index as Vigour Index = germination % x seedling dry weight. Growth characters including tillers/ run. meter was counted at 60 days after sowing where as the plant height recorded after spike emergence. Yield attributes like spike length, no. of spikelets/ spike, no. of grain/ spike, test weight, total biomass and grain yield were recorded at harvest. The data obtained revealed that seed priming with tap water and inorganic salts including KNO₃ and Mg (SO₄)₂ singly in 0.2% solution for twelve hours significantly enhanced the germination, shoot/root length, seedling dry weight, vigour index and finally total biomass and grain yield in both the varieties evaluated over unprimed control. Among the treatment KNO₃ priming displayed maximum values in respect of all the character studies followed by Mg (SO₄)₂ and tap water. Varieties differed significantly in respect of shoot/root length, seedling dry weight, and spike length, no. of spikelets / spike, no. of grain and test weight. Variety HUW 234 supercede over WR 544 in respect of seedling dry weight, vigour index, tiller/ run meter and total biomass where as WR 544 gave maximum germination shoot/root length, plant height and finally the total grain yield.

09-11

STUDIES ON SEED GERMINATION OF SOME IMPORTANT SOLANACEOUS MEDICINAL CROPS

K.J. Sowmya¹, Rame Gowda¹, I. Sriram¹ and K. Bhanuprakash²

¹Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore-560065

²Division of seed Science and Technology, IIHR, Hessarghatta, Bangalore
sowmyaseed@gmail.com

Medicinal crops are gaining much importance for their ayurvedic and allopathic properties and gaining lot of export potential and as such their cultivation became indispensable. For successful cultivation of these crops, knowledge on their propagation technique is utmost important. The selected medicinal plants for the study are multiplied through seeds and are economically important worldwide. Therefore, a comprehensive study was under taken to find out the optimum requirements for better and quick germination in some of the Solanaceous medicinal crops like steroid bearing solanum (*Solanum viarum*), black nightshade (*Solanum nigrum*) and ashwagandha (*Withania somnifera*). The seeds of these species were imposed with several combinations of treatments to improve their germination potential. The study revealed that although the seeds of these species showed differential response to germination treatments, the seeds soaked with GA₃ @ 500 ppm for 18h recorded significantly higher germination in all the three species. Further the seeds of *S. viarum* tested in Between Paper (BP) method at 25/30°C attained maximum germination (86%) as against the control (5.30%). However, Bartlett Rate Index (BRI) (0.334), first count (9 day) and final count (13.7) were highest in Top of paper (TP) method at 25/30°C over other combinations of media and temperature. Similarly the seeds of black nightshade tested in TP method at an alternate temperature of 25/30°C recorded maximum germination (95.3%) than control (5.00%). However, BRI (0.314), first count (5days) and final count (9.7 days) were significantly higher either in TP or BP method at 25/30°C. The seeds of ashwagandha tested in BP method at a constant temperature of 30°C registered higher germination (94%) than control (8.30%). However, BRI (0.315), first count (4days) and final count (6 days) were significantly higher in BP method at 30°C. Thus the study suggested that these medicinal crops require differential temperature and additional treatment of GA₃ @ 500ppm in order to obtain higher germination in a shortest period. Further the final germination counts can be taken preferably on 10th day for Ashwagandha and *Solanum nigrum*, 16th day for *Solanum viarum*.



09-12

EVALUATION OF SEED QUALITY TRAITS AND REMOVAL OF HARD SEEDEDNESS IN RICE BEAN [*Vigna umbellata* (Thunb.)] – A POTENTIAL LEGUME

B.V. Pavithravani¹, Rame Gowda¹ and Chikkadevaiah

¹Department of Seed Science and Technology, Univ. of Agricultural Sci., GKVK, Bangalore-560065
pavi_bv@rediffmail.com

A study was conducted to evaluate the seed quality attributes in one hundred elite rice bean genotypes produced during Kharief 2008. Variations were observed among the genotypes for all the tested seed quality attributes. The genotype LRB 292 recorded highest 100 seed weight (7.50 g). Germination was highest in LRB 93 (88.5 %) but LRB 68 registered higher percentage of hard seeds (73.5). On the contrary, LRB 325 did not record either any hard seeds or fresh ungerminated seeds. Seedling vigour based on seedling length was highest in LRB 89 (3113) as the genotype possessed higher germination (98.5 %) and highest seedling length (31.6 cm). However, the seedling dry matter accumulation was highest in LRB 44 (1.76mg) as it had higher germination (97.5 %). The electrical conductivity of seed leachate was lowest in LRB 31 (0.007 dSm⁻¹) and highest total dehydrogenase activity was noticed in LRB 212 (3.35) which is an indication of better quality. Hard seeds were observed to the extent of 74 per cent in germination test which is an undesirable trait. Therefore, all the hard seeds observed were collected and pooled for breaking the hard seed coat through different treatments. They were subjected to various treatments *viz.*, soaking in water (18 h), washing in running water (18 h), soaking in hot water (10 min), scarification by using sand paper (5 min), soaking in concentrated H₂SO₄ (5, 10 and 15 min) and HCl (5, 10 and 15 min). Among the different treatments, hard seeds treated with H₂SO₄ either 5, 10 or 15 minutes or sand paper scarification recorded higher germination (98 to 100%). Further, increased germination was also observed with water soaking (81%) or even in running water (79 %) as against lowest recorded in control (46 %). However, soaking in hot water for 10 minutes found lethal to embryo and seeds were highly infected with mycoflora. Seedling vigour index was also highest in H₂SO₄ treated seeds (2450). Thus the study suggested problem of hard seeds can be safely eliminated either by sand or acid treatment. But it is advisable to practice sand scarification since it is cheap and eco-friendly.

09-13

ESTIMATION OF NON STRUCTURAL CARBOHYDRATE, PROTEIN AND MINERALS FROM SEEDS OF SOME NON CONVENTIONAL PLANTS OF SEMI- ARID REGION OF GUJARAT

Manisha Sarma, B. R. Pandit and Manish Das*

Department of Life Sciences, Bhavnagar University, Bhavnagar, Gujarat

*Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat

*manishdas50@gmail.com

Seeds of twelve non conventional plants namely *Amaranthus peniculatum* L., *Citrullus lanatus* Thunb., Mat and NaK., *Cucumis melo* L., *Carvia callosa* (Nees.)Bremek, *Eleusine coracana* L. Gaertn., *Echinochloa frumantacea* Link., *Echinochloa colonum* L., Link., *Hordeum vulgare* L., *Nymphaea pubescens* Willd., Hk. F and Th., *Paspalum scrobiculatum* L., *Seteria italica* L., P. Beauv and Samli were selected for the study on the basis of frequent use by tribal and rural community of semi-arid region of Gujarat. All reported seeds were analyzed for its non structural carbohydrate, protein and minerals like Ca, Mg, Na, K, and Fe. Total carbohydrate ranged from 0.71-33.07 mg/g in *Paspalum scrobiculatum* L and *Citrullus lanatus*, respectively. Total protein was high in seeds of *Cucumis melo* (62.11 mg/g) and was low in *Paspalum scrobiculatum* (8.79 mg/g). Ca was high in Samli (8.79 mg/g) and was low in *Seteria italica* (4.12 mg/g), Mg was high in *Echinochloa colonum*



(36.24 mg/g) and was low in *Echinochloa frumentacea* (20.54 mg/g). Seeds of *Nymphaea pubescens* contained highest Na i.e. 0.29 mg/g amongst all reported plant species. While K was high in seeds of *Paspalum scrobiculatum* (0.8 mg/g) and was low in *Echinochloa colonum* (0.04 mg/g). Seeds of all reported plant species contained very low amount of Fe. It was high in seeds of Samli (0.67 mg/100g) and was low in seeds of *Cucumis melo* (0.007 mg/100 g). It could be concluded that seeds of these non-conventional plants contained appreciable amount of nutrients.

09-14

ENHANCEMENT SEED QUALITY THROUGH INVIGOURATION IN ONION

Rame Gowda, M. Sureka, B.V. Pavithravani, and K.J. Sowmya

Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore
rg_seed@rediffmail.com

Onion (*Allium cepa L.*) is an important bulb crop grown extensively in India and it belongs to family Alliaceae. Onion seed is classified among poor storer, as it loses viability and vigour very early predominantly in tropical country like India. Production and accessibility of quality seeds is one of the major constraints for yield stability in onion besides, upholding of seed quality in storage. Physical stresses such as extreme temperatures, excess or deficit of water, salinity or soil crusting and other biological stresses is not conducive to rapid germination and seedling growth. There have been many attempts to devise pre-sowing treatments to improve performance of seed under such stress conditions in the field. An investigation was carried out to know the effect of seed invigouration treatments on seed quality. Onion seeds of cultivars Arka Pithamber and IAHS-1 were subjected for accelerated ageing at $40\pm 1^\circ\text{C}$ and $90\pm 1\%$ RH for 3 and 6 days to obtain different vigour levels. Non-aged seeds constituted high vigour level seeds ($>85\%$ germination). Seeds were then given various invigouration treatments among which, hydration-dehydration treatment for a period of 18h both in cvs. IAHS-1 and Arka Pithamber recorded higher germination (87.75% and 73.42%), SVI (1504 and 1118), TDH (0.41 and 0.55, 8h soaking in V_2), lower EC (27.8 and 25.75 dS/m), respectively. Osmo-conditioning with PEG @ -1.25Mpa resulted in higher germination (80.17%), seedling vigour index (1400), total dehydrogenase (TDH) activity (0.25) and low electrical conductivity of seed leachate (22.7 dS/m). Among different inorganic chemicals used as chemo priming treatments, seeds treated with KH_2PO_4 and NaCl recorded higher germination (77.3%; 59.83%), SVI (1377; 1113), TDH (0.38; 0.34) and lower EC (30.5; 35.8 dS/m) compared to seeds treated with KNO_3 , KI and untreated control. Drying of chemo primed seeds found to reduce the plausible effect gained due to chemicals. The non-dried seeds recorded higher germination (75.3%; 62.67%), SVI (1233; 1027), TDH (0.32; 0.24) and lower EC (32.0; 36.8 dS/m). The invigorated seeds showed slight reduction in quality due to drying except PEG priming. However, the beneficial effect was much higher in medium and high vigour seeds rather than low vigour seeds of onion.

09-15

STUDIES ON THE EFFECT OF ACCELERATED AGING ON SEED QUALITY AND PHYSIOLOGICAL PARAMETERS IN TWO WHEAT GENOTYPES

H.R. Sowmya¹, D. Dayal Doss² and G. Rame Gowda³

^{1,2}Department of Biotechnology, ³Department of Seed Sci. & Tech., UAS, GKVK, Bangalore
sowmyahreddy@gmail.com

Wheat is the most important staple food crop of the world. It is rich in available energy and essential proteins. Wheat seed is can be stored for medium to long periods if stored in as dry condition as possible. High



seed moisture and relative humidity increases the seed respiration, hence decreases the viability and vigor of seed. This decrease is due to changes in physiological and biochemical constituents of seeds. The experiment was conducted to study the effect of aging on physiological status of two varieties of wheat (NI 5439 and DWR 2006). Seeds were artificially aged by incubating for 0, 3 and 5 days at 40°C and 90%RH to get three vigor levels. The effect of aging was studied by estimating various seed quality parameters such as seed germination, seedling root length, seedling shoot length and physiological parameters such as electrical conductivity total soluble sugar content, total soluble lipid content, total soluble protein content, total dehydrogenase content and lipid peroxidation rate. The results showed that the seed germination and seedling vigour index were decreased on aging, so also the physiological parameters such as total soluble sugar content, total soluble protein content, total lipids, micronutrients and enzymes such as total dehydrogenase and beta amylase activities. Whereas electrical conductivity and lipid peroxidation rate were increased in aging. The decrease in viability and vigor of stored seeds can be attributed to the changes in physiological parameters, hence the study of these would be help full in reducing the seed shortage for germination in future.

09-16

EFFECT ON THE ANTINUTRIENT POOL OF GERMINATING MUNG BEAN POST, IRRADIATION WITH GAMMA RAYS

Shailesh Kumar

*Department of Botany and Plant physiology, Faculty of Basic Sciences & Humanities, Rajendra Agricultural
University, Pusa, Samastipur, Bihar
shailesh_agri@yahoo.com*

Mung bean cultivars (Pusa Vishal and Pusa 9531) seeds, were irradiated with gamma ray (⁶⁰Co source, available at Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi) at radiation doses 0.1, 0.2, 0.5, 1.0, 3.0 and 5.0kGy and were germinated subsequently for 24, 48, 72, 96 and 120 hr at 25°C in an incubator to determine the changes in their antinutritional pool. The antinutritional studies revealed that, irradiation with gamma rays caused a significant decrease in all the antinutrients (Phytate, tannin, trypsin inhibitor and polyphenol contents) present in these genotypes with subsequent increase in germination time, at low radiation doses but showed no significant change at medium doses when compared with control. While germination caused significant reduction in the phytate and tannin contents, the trypsin inhibitor and polyphenol contents remained less effected. Significant reduction in phytate content was observed at 0.5 kGy gamma radiation dose after 120 hrs of germination in both the mung bean genotypes. Tannin content of both the genotypes showed a similar pattern, however the reduction was not significant at increasing doses of the radiation. Gamma radiation treatment of mung bean seeds had no effect on the trypsin inhibitor content although it decreased only slightly till 96 hours of germination only to increase after that. The polyphenol content of both the mung bean genotypes reduced at low doses of gamma radiation (0.5 kGy) while at higher doses the reduction non significant. Hence, it is concluded that low doses (0.1-0.5 kGy) of gamma irradiation significantly improves the nutritional value of the mung bean, by reducing the antinutritional factors, over the germination time. Although, germination is an essential physiological change that improves the nutritional status of the mung beans but the presence of antinutritional factors impairs their availability. Gamma irradiation plays a very important role in significantly decreasing the antinutritional components in mung bean which allow increased bioavailability of nutrients and thus, proves an important milestone technology towards improving the nutritional quality of pulses, contributing to sustainable agriculture.



09-17

RESPONSE OF SEED SOAKING WITH ZINC SULPHATE ON GROWTH AND PHYSIOLOGICAL PARAMETERS OF WHEAT (*Triticum aestivum* L.)

R.K. Yadav, A.H. Khan, Roopam Mishra, P.N. Singh, S.P. Singh, and N. Singh, Uma Singh

Centre of Advanced Studies, Department of Crop Physiology, N.D. University of Agriculture & Technology, Kumarganj, Faizbad

Zinc is an essential plant micro-nutrient and its widespread deficiency has been reported in several states of India, including Indo-Gangetic plains of Uttar Pradesh. Due to its higher cost, resource poor farmers do not use zinc in wheat fields. Seed soaking through zinc sulphate may be an effective and easy method of application for accelerating overall growth and physiological parameters of the wheat crop. The experiment was laid out in randomized block design under field conditions with three replications to test the zinc response. Seeds were soaked in the different concentrations solution (200, 400, 600, 800 and 1000 ppm) of zinc sulphate for four hours. After that, seeds were dried in shade and sowing was done in the field. Recommended doses of NPK (120: 60: 60 kg/ha) were applied to the crop. In general, growth and physiological parameters were recorded at different growth stages (tillering, heading, milk and dough). Seed soaking showed greater impact on morphological and biochemical characters than non soaked seed. Increasing concentration of ZnSO₄ from 200 ppm to 800 ppm increased plant height, number of tillers per plant, number of leaves per plant, dry matter accumulation per plant, relative growth rate, net accemelation rate, chlorophyll content and seed protein content, but the effect of 800 ppm was most promising in comparison to other concentration of ZnSO₄. However, the effect of 1000 ppm proved either supra-optimal or toxic.

09-18

EFFECT OF GERMINATION ON PHYSICO-CHEMICAL, ANTI-NUTRITIONAL AND FUNCTIONAL PROPERTIES OF CHICKPEA SEEDS

Virendrakumar R Sharma¹, A. Dhaka¹, Manish Das² and G. Jadeja¹

¹*Smt. K. P. Patel College of Home Science, Anand – 388 001, Gujarat*

²*Directorate of Medicinal and Aromatic Plants Research, Anand – 387310, Gujarat*

²*manishdas50@gmail.com*

An investigation was carried out to study the effect of germination and length of germination on physico-chemical, anti-nutritional and functional properties of chickpea seeds (*Cicer arietinum* L.). Seeds were collected locally and subjected to germination test after thorough curing. After putting seeds into water soaking for 12 hours, seeds were subjected to different germination period for 0, 12 and 24 hours after initiation of germination (radicle emergence) at room temperature condition in petriplates under dark condition. In another condition, seeds were subjected to a germinator for a comparison. Seeds without any treatment were considered as control. After germination, seeds were brought into powdered form and then different parameters were determined. In the present study, protein content, vitamin- C, ash, moisture and minerals like calcium, iron and phosphorus were determined which were significantly increased due to change in germination period in green, small and big chickpeas. Decrease in tannins and oxalic acid was also observed during germination. However, water holding capacity was noted to decrease with increase in germination period in green, small and big chickpeas. On the contrary, oil holding capacity increased with increase in germination period. Green chickpea contained higher amount of minerals like iron, calcium and phosphorus, ash, protein and vitamin-C as compared to small and big chickpea seeds. The result of this study revealed that green chickpeas are good source of minerals, protein and vitamins compared to small and big chickpeas.



09-19

GERMINATION AND SEED STORAGE BEHAVIOR IN *Nyctanthes arbotristis* L.-A MEDICINAL PLANT

Sunil C. Joshi, S.S. Parihar, N.K. Yadav, Manisha Dhasmana, Debarati and Preeti

Division of Seed Science and Technology, IARI, New Delhi-110012

scj.seed@gmail.com

Nyctanthes arbotristis L., commonly known as Parijat, is a small tree and well known medicinal plant. It is a native of India and commonly planted as an ornamental tree. Information is not available on germination, dormancy, desiccation sensitivity and seed storage behavior of the species as this information is vitally important after *ex-situ* conservation of seeds in seed banks/ gene banks and also for its propagation. Therefore, an experiment was conducted with the objective to know the germination, dormancy and seed storage behavior. Mature seeds were extracted from the fruits and seeds with different moisture content (viz. 5, 7, 8 and 10 % moisture content on fresh weight basis) were prepared by drying the seeds in silica gel and germination was determined using sand as a medium. Seeds with different targeted moisture content were stored in three storage temperature viz. ambient laboratory conditions, 15°C and -20°C in order to test the chilling and desiccation sensitivity of seeds. The germination tests were conducted at 3 months interval and upto 12 months to test the viability of seeds. Perusal of data revealed that no significant reduction in germination was observed in any storage condition with seeds having 5 and 7% moisture content upto 12 months. Seeds with 10% moisture content exhibited significant reduction in germination from 95 to 82% under ambient storage condition. The results suggest that seeds exhibit orthodox storage behavior although seeds morphological characteristics (flat spherical seed with 1000 seed weight of 84.25 gm.) suggest recalcitrant nature of seeds. The non-endospermic seeds were not-dormant at maturity and can ideally be stored in seed banks for *ex-situ* conservation of seeds for the conservation of biodiversity.

09-20

INTERACTIVE EFFECT OF GENOTYPE, STORAGE CONDITION AND STORAGE DURATION ON SEED QUALITY OF *Vigna radiata*

Mousumi Chetia and B.K. Rabha*

*Central Plantation Crop Research Institute, Guwahati, *Assam Agricultural University, Jorhat*

Two genotypes of *Vigna radiata* (Pratap and AAU-34) were subject to different storage duration (1-7 months) under four different storage conditions. The seeds of the genotypes were then evaluated for seed quality through germinability and seedling vigour tests. Pratap retained significantly greater germination percentage than AAU-34 irrespective of the treatments. The rate of decline was gradual till the fifth month and then became faster in the 6th month of storage which coincided with high RH and ambient temperature of July. Tincan stored seeds produced the highest mean germination percentage (83.35) followed by polyline jute canvas bag (80.80) and high density polyethylene interwoven bag (78.84) as against seeds stored in jute canvas bag (71.17). The genotype, storage condition and storage duration produced significant variation on seedling vigour index assessed in terms of root and shoot lengths of the seedlings which followed a more or less similar trend to that of germination percentage.



Session 10

Physiology Flowering, Medicinal and Aromatic Plants



10-01

A STUDY ON GREEN LEAFY VEGETABLES OF ASSAM WITH REFERENCE TO THEIR ETHNOMEDICINAL IMPORTANCE

Sushanta Borah and Ananta madhab Baruah¹

Department of Botany, Chaiduar College, Gohpur, Sonitpur, Assam

¹*Department of Biochemistry & Agricultural Chemistry, Assam Agricultural University, Jorhat, Assam*

Assam is excellently vast wealth of plant genetic resources. The indigenous peoples of the region, a large number of natural plant species and their wild forms use as usual vegetable, which make available sufficient nutrients and medicinal values to them. These include varieties of tubers, roots, shoots, leaves, flowers, seeds, mushrooms etc. It is the usual practice of the inhabitants of the region to collect from their wild habitat and use as either vegetables or herbal medicines or both. These are used either cooked or in raw form. These vegetables are certainly contained micronutrient, vitamins and protective chemicals, which confined balanced diet and health care to the people of Assam. Highly nutritious these vegetables also use for their ethno-medicinal prospects. A number of ailments can be relieved by the common vegetables. Some vegetables are also containing anti-inflammatory properties. The work aimed at determining the presence of few nutritionally important biochemical's on these vegetables and the field observations regarding the traditional applications as medicine by the people of Assam.

10-02

INFLUENCE OF TRANSPLANTING DATES ON THERMAL AND DARK PERIOD REQUIREMENT FOR DIFFERENT PHENOLOGICAL STAGES AND SUBSEQUENT YIELD IN RICE

P.C. Dey, B. Haloi*, T.J. Ghose and R.K. Saud**

** Prof. and Head, Deptt. Of Crop Physiology, FA, AAU, Jorhat, ** Manager, ATIC, AAU, Jorhat
Regional Agricultural Research Station, AAU, Titabar-785630*

Rice is known to be a quantitative short day plant. However, based on the diurnal cycles, unless specific thermal (temperature) and nyctoperiod (dark period) receives, the plant does not flower. Keeping in view, an attempt was made by conducting a field experiment in kharif, 2007 to quantify the thermal and dark period requirement of sixteen rice cultivars of 3 duration groups (Early, medium and late) as test materials. Group wise late duration types (140-150 days duration) had shown a significant reduction in yield when sown under late condition and are sensitive to cumulative degree days(CDD) and cumulative nyctoperiod (CNP) variations. However, the yield levels of individual genotypes were in the range of 116.7-755.3 g m⁻² and 90.0-360.0g m⁻² for early sown and late sown set respectively. Between early and late sown sets, the mean CDD values differed by 60, 32, 124 at PI, flowering and maturity stages respectively. On the other hand, mean CNP values varied from 112, 118, 8 at the above respective stages. From this, it is clear that the CDD assumes importance at the maturity stage, while CNP plays an important role in the first two phonological stages. The study revealed that HPR-236 from early group and NDR-2706 from medium group were found promising in respect of less reduction of grain yield under late sown condition whereas all cvs under late duration group were found sensitive to late sown condition. The physiological processes that were taking place linked with the node number wherein the number of node remain similar under both normal and late sown conditions.



10-03

PHYSIOLOGICAL STUDIES ON WEED CONTROL EFFICIENCY IN TURMERIC

B.B. Channappagoudar, M.B. Chetti and N.R. Biradar

Department of Crop Physiology, University of Agricultural Sciences, Dharwad-580 005

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during Kharif 2007-08 to study the influence of herbicides and crop-weed competition on weed control efficiency in turmeric. The experiment was laid out in randomized block design (RBD) with Selum variety of turmeric and five herbicides with varied concentration (Alachlor @ 1.0 kg a.i./ha, Butachlor @ 1.0 and 1.5 kg a.i./ha, Pendimethalin @ 1.5 and 1.00 kg a.i./ha, Pretilachlor @ 1.0 and 1.5 kg a.i./ha and Oxyfluorfen @ 0.30 and 0.20 kg a.i./ha), weed free check, weedy check (control). The application of oxyfluorfen @ 0.30 kg a.i./ha was found to be phytotoxic. Pendimethalin @ 1.5 and 1.0 kg a.i./ha did not show any phytotoxic effect in turmeric. The number of monocot, dicot and total number of weeds were found to be maximum in unweeded control and the herbicide treatments viz., Pendimethalin @ 1.5 and 1.00 kg a.i./ha decreased these parameters to a greater extent. All these parameters significantly increased from 60 DAP to harvest. The total dry weight of weeds was found to be significantly higher in unweeded control and the application of Pendimethalin @ 1.5 and 1.0 kg a.i./ha significantly decreased the weed dry matter. The weed control efficiency was highest with the Pendimethalin @ 1.5 kg a.i./ha followed by Pendimethalin @ 1.0 kg a.i./ha and Alachlor @ 1.0 kg a.i./ha. The important growth analysis parameters viz., leaf area, leaf area index, RGR, CGR, NAR, SLW, LAD and BMD were significantly higher in weed free treatment and these values were found to be lowest in unweeded control. Among the herbicides, Pendimethalin @ 1.5 kg a.i./ha was very effective and increased all the growth parameters markedly. However, the parameters viz., AGR, SLA and LAR were found to be more in unweeded control as compared to other treatments. The rhizome yield was significantly higher in weed free check (7.08 t/ha) as compared to unweeded check (3.74 t/ha). Among the herbicides, rhizome yield was highest with Pendimethalin @ 1.5 kg a.i./ha (6.03 t/ha) followed by Pendimethalin @ 1.0 kg a.i./ha (5.74 t/ha) and Alachlor @ 1.0 kg a.i./ha (5.67 t/ha). From the point of economics, the benefit:cost ratio was highest with application of Pendimethalin @ 1.5 kg a.i./ha (2.13) followed by Pendimethalin @ 1.0 kg a.i./ha (2.10) as compared to other herbicides with net return Rs. 164250 and 160850 per ha., respectively.

10-04

STUDIES ON PHYSIOLOGICAL AND BIOCHEMICAL TRAITS ASSOCIATED WITH YIELD AND QUALITY OF TURMERIC (*CURCUMA LONGA L.*) GENOTYPES

A.K. Singh, Mudit Srivastava and V.P. Pandey

Centre of Advanced Studies in Plant Physiology, Department of Crop Physiology, N. D. University of Agriculture & Technology Kumarganj, Faizabad

The present work was under taken to identify traits associated with yield and quality of turmeric genotypes. The experiment was laid down in randomized block design (RBD) involving seventeen turmeric genotypes. Various parameters such as plant height, plant girth, No. of leaves per plant, leaf area, leaf area ratio (LAR), net assimilation rate (NAR), leaf area index (LAI), chlorophyll content, peroxidase activity in leaves, protein content, curcumin content, leaf oil %, oleoresin per cent and weight of rhizome were recorded at various stages of crop. The dry matter accumulation increased as the age of the crop gets advanced in genotypes. The higher dry matter accumulation in NDH-98 and NDH-18 would be attributed to the higher plant height, leaf number, leaf area index, leaf area ratio and net assimilation rate. In biochemical traits, such as chlorophyll content, protein content & peroxidase activity, were found higher in NDH-18, Prabha, R. Sonia in comparison



to NDH-5-3, NDH-45 etc. Maximum chlorophyll content was recorded at 150 days after planting. This might be due to postponement of senescence and enhancement of uptake of iron and it has strongly associated with leaf oil percentage. Moreover, leaf area, chlorophyll content, dry matter content, protein content, weight and rhizome yield per plant emerged as characters which may be provide high response to selection owing to their high heritability in the environment.

10-05

PHYSIOLOGICAL BASIS OF YIELD AND QUALITY VARIATION IN TURMERIC (*curcuma longa* L.) GENOTYPES

Mudit Srivastava, A.K. Singh and V.P. Pandey

Centre of Advanced Studies in Plant Physiology, N.D. University of Agric. & Tech., Kumarganj, Faizabad
ashok_singh@india.com

An experiments were conducted at Main Experimental Station (MES) during the Kharif season 2008-09 w.e.f. to evaluate turmeric genotypes for yield and quality variation on physiological basis. The experiment was laid down in randomized block (RBD) involving seventeen turmeric genotypes various quality parameters such as leaf oil, catalase activity, sugar content in rhizome, curcumin content, oleoresin % was recorded at various stages of crop growth. The considerable range of variation existed among all the genotypes was observed for chlorophyll content after 150 days from sowing the crop. Whereas, highest leaf oil content was recorded after 150 days in variety NDH-58 (2.26%) followed by germplasm NDH-45 (2.10%) and NDH-18 (1.18%) respectively. Greater genotypes variability existed among all genotypes. Oleoresin %, curcumin content, sugar content in rhizome showed very high genetic advance in per cent of mean along with high estimates of heritability. The mean performance of the genotypes revealed that genotypes NDH-98, NDH-18, NDH-14 were found to be best with respect to rhizome yield per plant and related attributes as compared to remaining genotypes as well as check. Thus, in case of long duration commercial crops like turmeric, knowledge on growth analysis will give better understanding of growth physiology and physiological parameters had direct and indirect effect on yield and quality of turmeric.

10-06

ORCHIDS OF ASSAM II: AN ECO-PHYSIOLOGICAL APPROACH

R.K. Bora^{1*}, N. Basumatary² and C.M. Sarma³

¹Sr. Lecturer in Botany, Pragjyotish College, Guwahati-781009, Assam, ranjankumarbora@yahoo.com

²Sr. Lecturer in Botany, Bhola Nath College, Dhubri-783324, Assam, nabamibasumatary@rediffmail.com

³Former Professor and Head, Dept. of Botany, Gauhati Univ., P.O. Box No. 35, GUHPO, Guwahati-781014

Assam, a biodiversity rich state of India, harbours 290-odd species of orchids under 90 genera of which majority of them are epiphytic. Availability of nutrients, light intensity, humidity, temperature, photoperiods are some major factors which determine the growth of orchid vegetation in an area. Growth of an epiphytic orchid species on host plant is not determined by the age of the host but by the microhabitat required for the germination of seeds and subsequent growth. Host specificity of orchid is mainly determined by the presence of alkaloids, latex and other chemical compounds. Shade loving orchids usually prefer to grow on barks near the ground. Tiny orchids usually prefer to grow on small twigs under the canopy to get more moisture content. High humidity and moderate temperature favours the growth of the epiphytic orchids. Mineral nutrients required for growth is supplied to the epiphytic orchid by stem flow. Flowering may be directly affected by the length of photoperiod.



10-07

VARIATION IN ESSENTIAL OIL AND CHLOROPHYLL PIGMENT OF *Houttuynia cordata* Thunb. COLLECTED FROM DIFFERENT LOCATIONS OF BRAHMAPUTRA VALLEY OF ASSAM

N. Bhattacharyya^{1*}, S. Sarma²

¹Department of Botany, Nowgong College, Nagaon, Assam- 782001, India

²Department of Biotechnology, Gauhati University, Guwahati, Assam-781014, India

Houttuynia cordata Thunb. is a medicinal herb under the family Saururaceae, distributed in South-East Asia, mainly in China, Japan, Thailand and North-East India. The herb is traditionally ingested against various troubles like measles, dysentery, gonorrhoea, eye troubles, skin diseases, haemorrhoids etc. The essential oil contains several pharmacologically important components among which n-Decanoic acid, α -Terpineol, β -Myrcene, 1-decanol, and methyl nonyl ketone are the most important. In the present study, the variation in the percentage of extractable essential oil and total chlorophyll pigments found in *H. cordata* plants from five different populations of Brahmaputra valley of Assam have been studied. Five populations of the plant were selected from Nalbari (26°-27°N and 91°-97°E), Guwahati (26.21°N and 91.46°E), Nagaon (26.21°N and 92.41°E), Jorhat (26.44°N and 94.10°E) and Dhemaji (27.29° N and 94.35° E). On steam distillation, the plants yielded a light brown essential oil with a strong, somewhat dis-agreeable odor. It was observed that the percentage (%) of extractable oil varied from 0.060 ± 0.006 (in Guwahati) to 0.075 ± 0.005 (in Jorhat). The total chlorophyll percentage (%) varied from 0.19 ± 0.03 (in Jorhat) to 0.34 ± 0.04 (in Guwahati). It was found that the oil percentage is the maximum in the samples from Jorhat, which could be related to the lowest chlorophyll percentage. The total chlorophyll percentage was found inversely proportionate to extractable oil percentage.

10-08

EFFECT OF PLANT POPULATION DENSITY ON GROWTH AND DEVELOPMENT OF GUGGAL AND ITS OLEO-GUM-RESIN PRODUCTION

Sridhar Gutam

Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand 387310, Gujarat
gutam2000@gmail.com

Guggal, *Commiphora wightii* (Arn.) Bhandari is a very important medicinal plant of the Burseraceae family from which the oleo-gum-resin (Guggulu) is extracted for the treatment of arthritis and to prevent heart attacks. Guggulu has active components, E & Z-guggulsterones which have an ability to lower both cholesterol and triglyceride levels. Guggal grows in the arid regions of Rajasthan, Gujarat, Madhya Pradesh and Karnataka states in India. Due to the over exploitation of guggal for guggulu, it is considered as a critically endangered species and is included in the IUCN Red Data Book. As there is no organised cultivation of guggal, tapping for guggulu is done erratically and plants are neglected without any survival interventions in their natural habitat. A field experiment was laid out to study the growth and development of guggal with an objective to increase oleo-gum-resin production per unit area. Four different plant population densities viz., 11 plants/m² (T1), 6 plants/m² (T2), 4 plants/m² (T3) and 1 plant/m² (T4) were taken as treatments with five replications. The results of the experiment revealed that the thickness of the stem was in range of 12 – 14 mm at 6 months after planting (MAP), 22 – 24 mm at 12 MAP and 25 – 31 mm at 18 MAP. The stem weight was in range from 12 – 19 g at 6 MAP, but increased at 12 MAP (63 – 83 g) and reduced to 45 – 80 g at 18 MAP. Higher stem thickness (83 mm) and heavier stem (80 g) was found in T4 (1 plant/m²) at 18 MAP due to lesser density of plant population and lesser competition for resources when compared to other treatments. When the dry matter partitioning was analysed, at the initial days (6 MAP), more partitioning was towards stem (47%) followed by brances (36%),



leaves (14%) and roots (4%). However, with the increase in plant's age, more partitioning was seen towards branches (61% at 12 MAP; 65% at 18 MAP). When compared among the treatments, in T4, higher dry matter was partitioned into stems (71%) at 18 MAP. When guggal is tapped at 18 MAP, guggulu yield was 4 g/m² at 44% tapping success rate in T4 whereas, T1 and T2 yielded 187 g/m² and 120 g/m² respectively with corresponding 28% and 19% tapping success rate. Still the research work is in progress and the details regarding the best method of plantation (plant population density), age and frequency of tapping for guggulu are awaited for increasing the guggulu production per unit area under commercial cultivation.

10-09

EFFECT OF PACLOBUTRAZOL (AUSTAR) ON FLOWERING AND YIELD OF ALPHONSO MANGO

B.B. Jadhav, A.K. Shinde, P.M. Nigade, K.R. Patil, and R.N. Shelke

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

Alphonso is alternate bearing variety of mango with characteristics sugar-acid blend, attractive colour, pleasant aroma, highly acceptable flavor, taste and long keeping quality. A Cultar Paclobutrazol a gibberellin biosynthesis inhibitor has been demonstrated to induce the flowering in number of commercially important mango cultivars. Therefore the experiment was conducted to study the effect of Austar and cultar (Paclobutrazol) on flowering and yield of Alphonso mango. The soil drenching of paclobutrazol was done near manuring ring in the month of August. Significantly higher flowering was observed in Cultar 3ml/m canopy diameter (83.7%) which was at par with Austar 30 ml/tree (80.00 %) over control (16.2 %). The maximum number of fruits/tree were recorded in cultar 3ml/m canopy diameter (153.5) which was at par with Austar 30 ml/ tree (144.2) than control (11.17). Similarly, significantly higher fruit yield was recorded in cultar 3ml/m canopy diameter (41.0 kg/tree) which was at par with Austar 3ml/m canopy diameter over control (9.1 kg/tree). There was no significant difference in fruit weight and spongy tissue of Alphonso mango due to paclobutrazol application. Maximum individual fruit weight was observed in control (263.09) than paclobutrazol treatment. This may be due to increase in number of fruits/tree in paclobutrazol treatment. The TSS was in the range of 16.1 to 17.0⁰ and acidity in the range of 0.30 to 32 %. Maximum spongy tissue was recorded in control (8.0 %) and the paclobutrazol treatments slightly reduced the spongy tissue.

10-10

VALUATION OF ANTIMICROBIAL ACTIVITY OF *IN VIVO* AND *IN VITRO* PRODUCED SAPONINS OF *CONVOLVULUS PLURICAULIS* CHOICSY

Santoshkumar Singh, Zankhana Rathod and O.P. Saxena

*Plant Tissue Culture Laboratory, Botany Department, University School of Sciences, Gujarat University,
Navrangpura, Ahmedabad - 380009
santosh_singh0313@hotmail.com*

The development of resistant microorganisms on prolonged exposure to existing antimicrobial agents has been known for a long time. This has led to the continual search for ways of eradicating resistant strains of micro organisms. *Convolvulus pluricaulis* Choisy a well known medicinal plant of Convolvulaceae family is used in India for hundreds of years. In the present study a tissue culture protocol was developed for *in vitro* production of saponins through leaf culture on MS media supplemented with 1 mg/l 2,4-D and 1 mg/l kinetin. Comparative study of *in vivo* and *in vitro* produced saponins of *C. pluricaulis* through HPTLC in UV-200 nm revealed 13 fluorescent zones. Seven spots resolved at Rf 0.01, 0.12, 0.24, 0.32, 0.33, 0.47 and 0.64 were



produced common in both the sample *in vivo* and *in vitro*. Substance resolved at Rf 0.05, 0.20, 0.64 and 0.91 were restricted to *in vivo* sample only while two distinct spots at Rf 0.22 and Rf 0.80 were noticed only from *in vitro* sample. 11 fluorescent zones of saponins produced *in vivo* and *in vitro* were reported from chromatogram studied in UV-254 nm. Four saponins produced from both the sample were resolved at Rf 0.17, 0.24, 0.64 and 0.91. Two saponins synthesized only in *in vivo* sample were resolved at Rf 0.04 and Rf 0.20. Five new substances from *in vitro* samples were resolved at Rf 0.13, 0.26, 0.35, 0.51 and 0.76. The antimicrobial activity of *in vivo* and *in vitro* produced saponins of *C. pluricaulis* was investigated against *Escherichia coli* (gram negative), *Staphylococcus aureus* and *Bacillus subtilis* (gram positive) bacteria. Activity of *in vivo* produced saponin was especially higher against *S. aureus* followed by *B. subtilis* and *E. coli* on the bases of inhibition zone area but in case of *in vitro* produced saponins *E. coli* was most sensitive in comparison to other two microorganisms. It concludes that *in vivo* produced saponins are more effective against gram positive and *in vitro* produced saponins are microcidal against gram negative bacteria.

10-11

SODIUM-DIKEGULAC INDUCED CHANGES IN GROWTH, BIOMASS AND ALKALOID YIELD OF *Sida rhombifolia* L. AN IMPORTANT MEDICINAL PLANT

Sangita Sen¹ and Kajal Gupta²

¹Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi 110012

²Plant Physiology and Biochemistry Laboratory, Botany Department, Burdwan University, Burdwan 713104, West Bengal

Sida rhombifolia L. (Berela), a plant with high therapeutic value in the Indian system of medicine, is generally regarded as a weed of waste places. No systematic effort has been made to its introduction as a cultivated medicinal plant. In the present study, healthy seeds of *S. rhombifolia* were sown in nursery beds and thirty day old uniform seedlings were transplanted in April, at 30 cm X 45 cm spacing. Each plot is divided into four subplots, with 25 plants in each. Foliar applications of plant growth retardant Sodium-dikegulac (DK), at different concentrations (100, 200 and 500mg/L) were made for three consecutive days starting from seventy five day old plants. This application was repeated at six days interval and continued for 117 days of plant age. Control plants were sprayed with distilled water. Plants were harvested after 180 days. In DK treated *S. rhombifolia* plants, the reduction in plant height were concentration dependent, 500mg/L being the maximum. However, no significant increase in root length was observed. All the three concentrations of DK were effective in increasing the primary branch numbers over control, 100 mg/L and 200 mg/L being most significant throughout the 4th, 5th and 6th month of the plant age. Number of secondary branches was also increased significantly. Significant increase in dry weights of biomass and seed yield per plant was observed, except in 500 mg/L DK treatment. Plants treated with 200 mg/L DK, produced higher biomass and yield in comparison to 100 mg/L DK treated plants. Significant increase in stomatal resistance was observed in 200 mg/L and 500 mg/L DK treated plants at 4th month stage. This observation indicates the maintenance of higher water status in plants resulting in delay of senescence. Thus plants remain physiologically functional for longer time. This may possibly attribute to the greater yield in DK treated plants. Further the DK induced increase in total alkaloid concentrations in leaves and roots in all the three treatments over control, indicated DK induced enhanced synthesis of secondary metabolites.



10-12

JAMUN DRINK - PANACEA FOR MANY AILMENTS

Jagvir Singh*, R.K. Pal and Manish Kumar Singh

Division of Post Harvest Technology, Indian Agriculture Research Institute, New Delhi-110 012

India holds a premium position as the world's largest producers of fruits next to China. Apart from the major commercial fruits, there are several fruits of indigenous origin having tremendous potentiality for value addition due to their medicinal values. Value addition of the indigenous fruits has the great future in view of rising demand of incorporation of phyto nutrients in daily diet in the Indian urban Population. Further due to change in life style and consumption of various synthetic foods people are prone to various diseases viz. diabetes, hypertension and blood pressure and there is dire need to explore the potentiality of healthy drinks rich in nutraceuticals. Jamun (*Syzygium cumini* L.) is one such fruit which because of its curative properties is used in Indian systems of medicine viz. Ayurveda & unani since time immemorial. Jamun is panacea for many ailments like diarrhea and diabetes. It is believed to possess diuretic, carminative, stomachic, properties and it also helps in lowering blood pressure. The seeds are also used in lotion for curing of ringworm. Jamun seeds contain a type of glucose called Jamboline, which checks the conversion of starch into sugar and thus check high sugar level in blood. But the life span of Jamun is very short and need proper attention to preserve for long time. Jamun fruit drink is one such alternative for its long term utilization. Technology has been standardized by the Post Harvest Technology Division at IARI, New Delhi to prepare Jamun juice along with seed. A ready to serve (RTS) Jamun drink was also standardized for commercial sale with FPO license. The chief characteristic of this drink is that no synthetic colour, flavour and class-II preservatives are used for the preparation of this drink. More over goodness of the drinks is retained up to ten to twelve months with all the nutraceutical properties.

10-13

EVALUATION OF ISABGOL (*Plantago ovata* F.) GENOTYPES FOR QUANTITATIVE AND PHYSIOLOGICAL CHARACTERS

A.R. Aher¹, S. P. Jadhav² and S. R. Gadakh³

*¹Junior Research Assistant, Scheme for Medicinal and Aromatic Plants, ²M. Sc. (Agri) Plant Physiology student, ³Associate Professor of Botany, Scheme for Medicinal and Aromatic Plants
Department of Agricultural Botany, Mahatma MPKV, Rahuri- 413 722, Ahmednagar (MS)*

Eight genotypes of Isabgol (*Plantago ovata* F.) were selected to study yield and yield attributes and correlation between yield and yield contributing characters. In the present investigation the higher magnitude of mean values for plant height, leaf area, leaf area index, leaf area duration, dry matter production, harvest index are yield contributing characters indicating that these physiological traits may be involved in the developments of ideotypes for achievement of higher productivity in isabgol. It was noticed that the physiological basis for differences in seed yield amongst the high and low yielding genotypes was mainly due to the variation in morphological and physiological characters along with yield contributing characters. High yielding genotype Niharika and GI-1 produced higher seed yield due to higher dry matter production and also recorded highest values for yield contributing characters. The correlation study revealed that mean plant height, leaf area, leaf area index, leaf area duration, total dry matter, 1000 seed weight, number of spikes/plant, number of seeds per spike and husk yield per plant showed positive significant correlation with seed yield per plant.



10-14

**DROCERA PELTATA SMITH. IS NOT ONLY INSECTIVOROUS BUT POSSESSES
ANTIBACTERIAL PROPERTIES AS WELL**

Sandeep Acharya and R.C. Srivastava

*Plant Physiology and Biochemistry Research Laboratory, Department of Botany, Tripura University,
Suryamaninagar, West Tripura-799130*

In this comparative study, an attempt has been made to evaluate the antibacterial activity of glandular leaves of *Drosera peltata* by a modified diffusion silica cotton technique for comparison with the conventional disc-diffusion method. A total of eight extracts were prepared in different solvents in constant volume. The sample extracts were evaluated against the bacterial pathogen – *Xanthomonas oryzae* pv. *oryzae* of rice and *Ralstonia solanacearum*-bacterial wilt pathogen of plants of solanaceae family. Compared to Streptomycin and Tetracycline, the leaf extracts exhibited high antibacterial activity.

10-15

**PRE SOAKING CHEMICAL TREATMENTS ON SEED GERMINATION OF *Hippophae rhamnoides*
L. UNDER LABORATORY CONDITION**

Chetna Bisht, Rajiv K. Vashishtha and M.C. Nautiyal

*High Altitude Plant Physiology Research Center, H.N.B. Garhwal Univ., Srinagar- 246 174, Uttarakhand
bishtchetna@yahoo.com*

Despite abundant wild edible plant resources with immense potential for economic development, Uttarakhand, a newly created hill state situated in the Central Indian Himalaya, remains underdeveloped, owing primarily to inaccessibility and poor infrastructure. Development initiatives show little concern for mountain perspectives. Yet the region is rich in resources and underutilized plant species with potential food value, about which there is little knowledge. *Hippophae rhamnoides* L. is also known as sea buckthorn, belong to the family Elaeagnaceae. High quality medical oil is produced from the fruit of sea buckthorn and used in the treatment of Cardiac disorders. Russian cosmonauts have used its oil for protection against radiation burns in space. Overall the barriers have proven to be among the most nutritious fruits known, a part from the lesser spotted Pablo fruits. If there is one word that best describes sea buckthorn it is ANTIOXIDANT. The fruits, seeds and leaves contain an impressive array of antioxidant compounds. A variety of value-added edible products such as jam, jelly, juice, and squash were made to generate income from Himalaya wild edible fruits, particularly for poor rural people. This was demonstrated locally to encourage people to engage in small-scale village-level cottage industries. In the present investigation the seed germination of *Hippophae rhamnoides* L. was conducted. The seeds were collected from Pothibasa Nursery (2200 m), a temperate zone situated in district Rudraprayag of Uttarakhand and air dried at room temperature for experimental purpose. In the present study, seeds were treated with different concentrations of chemicals viz, Sodium hypochlorite (NaHClO_3) with 15 min. and 30 min., Thiourea ($\text{NH}_4\text{N}_2\text{S}$), Potassium Nitrate (KNO_3) of 100 and 200 ppm and Ethanol ($\text{C}_2\text{H}_5\text{OH}$, 30 sec. and 60 sec.) at two different temperatures (20 and 25°C) in laboratory condition. Maximum seed germination (100 %) was observed in control, Sodium hypochlorite with 30 minutes and Ethanol with 30 and 60 sec. at laboratory condition ($20^\circ\text{C} \pm 2.25 \pm \text{C}$). In 25°C maximum germination (70.66 %) was observed in Potassium nitrate (100 ppm) treatment. As compared with expensive plant growth regulators, the use of relatively inexpensive KNO_3 , $\text{C}_2\text{H}_5\text{OH}$ and NaHClO_3 have been suggested as beneficial tools for mass multiplication in cultivation. Our study indicate that seed treatments with KNO_3 , $\text{C}_2\text{H}_5\text{OH}$ and NaHClO_3 with temperature 20°C are economically feasible for *Hippophae rhamnoides* L. and can be easily applied by nursery workers and poor farmers developing mass planting stock. An appropriate nursery-based germination protocol and the no uniformity in germination behavior in *Hippophae rhamnoides* L. need further research.



10-16

**ALLELOPATHY EFFECT OF *Ipomoea tricolor* L. EXTRACT ON MAJOR WEEDS OF ONION
(*Alium cepa* L.)**

U.V. Mummigatti*, M.B. Doddamani and C.P. Patil

Directorate of Research, University of Agricultural Sciences, Dharwad-580 005

A laboratory experiment was conducted to find out the allelopathic effect of pre and post flowering *Ipomoea tricolor* L. extract at 5 and 10 per cent concentrations on germination, morpho-physical and biochemical parameters of major weeds of onion. Significantly lower germination was found with *Cynotis cuculata*, *Dinebra retroflexa* and *Portulaca oleracea* (7.73, 57.73 and 56.39 respectively) compared to *Digera arvensis* (72.39). The botanical *Ipomoea tricolor* at 10 per cent pre flowering stage observed significantly lower seedling vigor index (231.48) compared to 10 per cent post flowering stage extract (243.86). Among weed species, *Cynotis cuculata* and *Phyllanthus niruri* recorded maximum inhibition in seedling vigor index (50.17 and 202.47 respectively) compared to *Chenopodium album* (642.80). The interaction effects between treatments and weed species produced significant differences. The lower seedling vigor index was noticed with the weed species, *Cynotis cuculata*, *Phyllanthus niruri* and *Dinebra retroflexa* (32.52, 155.94 and 163.66 respectively) at 10 per cent pre flowering stage extracts over other interactions. Among the treatments, 10 per cent pre flowering stage extract produced lower sugar content (0.330) compared to 10 per cent post flowering stage extract (0.341). Significantly lower sugar content (0.313, 0.303 and 0.267) was recorded with *Cynotis cuculata*, *Dinebra retroflexa* and *Portulaca oleracea* respectively. Among the treatments, at 10 per cent pre flowering stage extract produced higher phenol content (0.029) compared to post flowering stage extract (0.027). The data on different weed species indicated that significantly higher phenol content (0.038) with *Portulaca oleracea* compared to other weed species.

10-17

DYNAMICS OF PHYSICO-CHEMICAL VALUES IN *Sohshang* (*Elaeagnus latifolia* L.) ACROSS MATURITY

R.L. Lamare, Bidyut C. Deka*, A. Nath and R.K. Patel

Division of Horticulture, ICAR Research Complex for NEH Region, Umiam-793103, Meghalaya

*bidyutdeka@yahoo.com

Sohshang (*Elaeagnus latifolia* L.) is a large evergreen spreading type woody shrub mostly grown in semi-wild condition in the backyard garden of Northeast India. It is harvested during February-April when most of the major fruits are not available in the market. However, a bulk quantity of the fruits gets damaged during the process of handling and marketing due to harvesting of fruits at improper stage. Therefore, standardization of harvest maturity is very much required since no systematic study has so far been reported. Dynamics of physico-chemical values like Fruit colour, pulp: seed ratio, moisture content, Specific gravity, fibre, texture, TSS, ascorbic acid, total carotenoids, β -carotene, tannins etc were determined at different stages of maturity to determine the harvest maturity of *Sohshang*. The present study indicated that 75-80 days after fruit setting when the fruits develop deep orange colour is the right stage for harvesting of *Sohshang* as the fruits attain optimum fruit weight (11.55-61 g), TSS (>11.0 °Brix) and TSS: Acidity ratio (>3). Moreover, the fruits harvested at 75-80 days after fruit set (DAF) had all the desirable qualities with better shelf life.



10-18

EFFECT OF POTTING MEDIA ON FLOWERING CHARACTERS OF GREENHOUSE DUTCH ROSE CV. NARANGA

Ankita Hazarika*, B.K.Dhaduk, Alka Singh and M.K.Yadav

ASPEE College of Horticulture and Forestry, NAU, Dandi Road, Navsari-396450

**Assam Agricultural University, Jorhat, Email id-ankita hazarika @yahoo.co.in*

The investigation was carried out at the greenhouse complex, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2007-2008. The experiment was laid out in a Completely Randomized Design with seven treatments of different media combination including control. The treatments are replicated 5 times. In the present study, the different substrates assessed were coco peat, rice husk, leaf mould, red soil, soil, sand, and FYM in various combinations. The plant grown in the growing media consisting of coco peat + leaf mould (1:1) required minimum days for flower bud initiation (16.67 days) and flower bud opening (18.07 days) as compared to the other treatments. The same media had a striking influence in enhancing the flower quality attributing characters *viz.* length of petal (6.14 cm), width of petal (5.79 cm), number of petals/flower (52.67), diameter of flower (10.87 cm), stalk length (54.23 cm).

10-19

FOLIAR APPLICATION OF ZINC AND SULPHUR: IMPLICATION FOR MANAGEMENT OF IN BLACK PEPPER IN PLANTATIONS

**Bhauasaheb Tambat^{1#}, G.N. Chaithra², M.G. Awati³, R.V. Kumarswamy¹, N.S. Prasanna¹,
P.R. Ramesh⁴, G.N. Dhanapal⁵**

¹*Department of Crop Physiology, Agricultural College, UAS (B), Hassan, Karnataka, India.*

²*Department of Biosciences, Hemangothri PG centre, Mysore University, Hassan, India.*

³*Division of Plant Physiology, Regional Coffee Research Station, Thandigudi, Tamil Nadu, India*

⁴*Division of Soil Science, Indian Institute of Horticultural Research, Hesarghatta, Bangalore*

⁵*Department of Agronomy, Dryland Agricultural Project, UAS, GKVK, Bangalore, India*

#Author for correspondence: btambat@yahoo.com

Black pepper (*Piper nigrum* L.) is one of the important spices grown in Western Ghats. Rather than a main crop, it is mostly cultivated as an intercrop in commercial plantations with minimum care. Although nutritional requirement of crops varies, yet at several places fertilizer application is restricted only to main crops. Thus, we hypothesized that black pepper is suffering due to non-availability of required nutrition in plantations and application of additional nutrients to plants would lead to higher yield. To test our hypothesis, we applied nutrients through foliar spray at farmers' field in Hassan district, Karnataka, India. In each plantation, similar aged and uniformly grown pepper vines were selected and tagged. During early fruit initiation stage nutrients were sprayed (with 10 replications); Zinc @0.5 % and Sulphur @0.5 %, we also the treatment also included control (water spray). We recorded the premature drop of inflorescence, inflorescence length, berry weight (both fresh and dry) and berry volume (both fresh and dry). Our results indicated that application of nutrients particularly Zinc and Sulphur helps to increase inflorescence length, fruit weight and fruit volume over control. We also observed that Sulphur application leads to increased chlorophyll content in leaves. Further, comparison between two plantation types namely coffee and areca indicted that response of black pepper to foliar application of nutrients depends on microclimatic conditions. It was concluded that foliar sprays of nutrient solution at fruit ignition stage helps in enhancing yield and yield components of Black pepper in plantations.



10-20

ECO-PHYSIOLOGICAL STUDIES IN BLACK PEPPER: IMPLICATIONS FOR YIELD ENHANCEMENT

**Bhousaheb Tambat^{1#}, G.N. Chaithra², P.R. Ramesh³, N.S. Prasanna¹, R.V. Kumarswamy¹,
M.G. Awati⁴, G.N. Dhanapal⁵**

¹Department of Crop Physiology, Agricultural College, UAS (B), Hassan, Karnataka, India.

²Department of Biosciences, Hemangothri PG centre, Mysore University, Hassan, India.

³Division of Soil Science, Indian Institute of Horticultural Research, Hesarghatta, Bangalore

⁴Division of Plant Physiology, Regional Coffee Research Station, Thandigudi, Tamil Nadu, India

⁵Department of Agronomy, Dryland Agricultural Project, UAS, GKVK, Bangalore, India

#Author for correspondence: btambat@yahoo.com

Black pepper (*Piper nigrum* L.) is an important spice species. Fruits/berries are used as an ingredient in many food preparations and medicine. Pepper is mostly cultivated as an intercrop in commercial plantations rather than a main crop. Although, microclimate and eco-physiological condition differ across the plantation types, Yet there are very few studies that have assessed the influence of eco-physiological parameters on growth, development and yield of black pepper. In this study, an attempt was made to analyze the ecological conditions of coffee and areca plantations and their influence on plant traits and yield was assessed in Hassan district of Karnataka, south India. Plantations (farmers' field) having similar macroclimate and growing *Panniyur-1* pepper were identified and selected. Various ecological and physiological parameters were recorded during fruiting season. Our results indicated that light intensity was significantly higher and canopy cover was significantly lower in coffee plantation(s) compared to areca. Soil in coffee plantation was acidic in nature whereas it was having neutral pH in areca. The available Phosphorus (P kgs/ha) was low and exchangeable Potassium (K kgs/ha) was medium in coffee plantation. However, in areca plantation 'P' was medium and 'K' was high. Plants obtained from areca plantations had relatively higher Specific leaf area (SLA) and lower Chlorophyll a/b ratio compared to coffee plantation plants. Yield attributes such as inflorescence (spike) length, berry weight (fresh & dry), berry volume were also different for two plantation types. The study signified that with respect to eco-physiological parameters and yield attributes, there is a considerable variation exists across the two agro-ecosystems studied. The results help in management of black pepper in the plantations.

10-21

INVESTIGATION ON THE EFFICACY OF "BIO-PRODUCT"- A BIO-CONTROL AGENT ON PATCHOULI (*Pogostemon cablin* Benth.)

M. Zaman*, M. Ahmed and P. Gogoi

NEDFI R & D Centre for MAPs, Khetri, Kamrup-782403, Assam

*zambul007@gmail.com

Fusarium sp. was found to be the most prominent among the fungi causing root rot diseases in Patchouli (*Pogostemon cablin* Benth.). Protection of the Patchouli from the diseases using chemical fungicides has been regular practice. However, constant uses will lead development of resistant to fungicides in the pathogens and also may harm to the beneficial rhizosphere microbes. The present work was undertaken to evaluate the efficacy of commercially available bio-control agent such as Bio-product (*Trichoderma viride*, *Trichoderma harzianum* and *Pseudomonas flourosences*) on the control of *Fusarium sp.* root rot disease in Patchouli and accelerate growth. *In-vitro* experiment (dual culture technique) also exhibit significant inhibition of growth of *Fusarium sp.* by the above mentioned microbes. It was found to be very efficient in controlling the disease.



10-22

IN VITRO PROPAGATION OF AN ANTI-ASTHMATIC PLANT: *TYLOPHORA ASTHMATICA*

Monika Yadav, Pallavi Singh, Vineet Kumar Singh and Padmanabh Dwivedi*

Laboratory of Plant Tissue Culture & Stress Physiology, Department of Plant Physiology, Institute of
Agricultural Sciences, Banaras Hindu University, Varanasi 221 005

*pdwivedi25@rediffmail.com

Tylophora asthamatica, a perennial climbing plant and member of Asclepiadaceae, has got medicinal value in Ayurvedic and Greek system of medicine. It is generally used for anti-asthmatic and anti-allergic treatment. Besides being effective in the treatment of bronchial asthma, bronchitis, hay fever, rheumatism and dermatitis, its major constituent alkaloid tylophorine also has anti-inflammatory action. Overexploitation of *Tylophora* for its above mentioned medicinal properties has prompted us to undertake its conservation strategies through plant tissue culture technique. For regenerating shoots of *Tylophora asthamatica* nodal segments were inoculated on to MS half strength and MS full strength media containing different concentrations of auxins and cytokinins. The best response, in terms of production of multiple shoots, number of leaves, length of leaves, number of roots was observed in the combination of hormone BAP and IBA having concentration of 0.5 and 1.0 mg/l each in MS full strength medium, after 30 days of inoculation of explants. The plantlets thus developed were hardened in mixture of soil (garden) and sand (1:1) and are now ready for transplantation into the field. The detailed results will be highlighted and discussed.

10-23

GROWTH, PHOTOSYNTHETIC EFFICIENCY, YIELD AND SWELLING FACTOR IN *PLANTAGO INDICA*

Manish Das

Directorate of Medicinal and Aromatic Plants Research, Boriavi - 387310, Anand, Gujarat
manishdas50@gmail.com

A field study was carried out during 2006-08 at DMAPR, Boriavi, Anand to evaluate the influence of crop geometry and different dates of sowing on growth, photosynthesis, chlorophyll content, dry matter partitioning, yield and swelling factor of *Plantago indica* as a part of assessing Good Agricultural Practices (GAP). *Plantago indica* is an important commercial species of genus *Plantago* also grown for its husk and seeds. The mucilage present in its husk has medicinal properties and used against constipation. In the present investigation six spacings (50, 60, 65, 70, 75 and 80 x 15 cm) and five dates of sowing (30th October to 30 December at an interval of 15 days) were tried. Results revealed that maximum growth could be achieved when plants were spaced at 50 x 15 cm followed by 60 x 15 cm and when sown between 15th to 30th November. Gas exchange parameters also were influenced due to spacing and dates of sowing which were correlated with LAI and seed yield. However, LAI was not correlated with leaf area and number of leaves. Chlorophyll content and dry matter accumulation were marginally influenced due to the treatments. Swelling factor was not significantly influenced due to the treatments which varied between 9 to 12 cc g⁻¹. Seed yield was significantly influenced and a maximum seed yield of 10-12 q ha⁻¹ could be obtained when spaced at 50 cm and sown on 15th November followed by 60 cm spacing and 30th November sowing. Thus it could be concluded that *Plantago indica* could be sown between 15-30 November with a spacing of 50-60 x 15 cm for achieving a maximum seed yield of 12 q ha⁻¹.



10-24

STUDIES ON SEED TESTING PROTOCOLS IN KALMEGH (*Andrographis paniculata* Nees.)

Preeti, S.S. Parihar, Debarati Mukhopadhyay and Sunil C. Joshi

Division of Seed Science and Technology, Indian Agricultural Research Institute, New Delhi-110012
preetyrosa@gmail.com

Andrographis paniculata, the Kalmegh of Ayurveda is an erect annual herb extremely bitter in taste. It is one of the most important medicinal plant of India and widely distributed throughout. It is a promising new herb for the treatment of many diseases including HIV-AIDS and the symptoms associated with autoimmune disorders. It has been used for medicinal purposes for centuries in India and China. The objective of the proposed experiment was to find out the information on seed testing protocols viz. requirement of substrate, optimum temperature for germination, dormancy status and need of additive and pre-treatment, and time required for germination. Therefore, four seed samples of *Andrographis paniculata* were procured and germination studies were conducted on top of the paper method using 100 seeds in 4 replications by incubating seeds at 20^o, 25^o and 30-32^o C. Perusal of data reveals that optimum temperature for germination was 25^o C. Time taken for germination i.e. first count and final count was on 9th and 12th day at 25^o C. No dormancy was observed. However, variation in germination was recorded in different seed samples and germination ranged from 95 per cent to 20 per cent. Seed quality variation was also noted due to seasons. For example seed collected from IARI field during November was poor in germination compared to seed harvested in March. The seeds of *Andrographis paniculata* are elongated, brown in colour and measures 2.9 x 2 x 3.64 mm with a spatulate and slightly bent embryo. 1000 seed weight was 1.5 gm. The working sample for physical purity analysis, submitted sample and working sample for count of other species were 4, 40 and 40 gm respectively.

10-25

FLOWER DEVELOPMENT AND SENESCENCE IN *Helleborus orientalis* cv. OLYMPICUS

Waseem Shahri, Inayatullah Tahir, Fahima Gul, Sheikh Tajamul and Mushtaq Ahmad

Plant Physiology Research Laboratory, Dept. of Botany, University of Kashmir, Srinagar-190006

Flowers of *Helleborus orientalis* cv. Olympicus growing in the University Botanic Garden were utilized to understand the changes occurring during development and senescence. Flower development and senescence was divided into six stages (I to VI) deciphered as tight bud stage, mature bud stage, half open stage, fully open stage, partially senescent stage and senescent stage. The average life span of individual flower after it opens fully is about 6 days. The green buds bloom into flowers with creamy white sepals which later on turn greenish during senescence. Flower diameter, fresh and dry mass increased during flower development upto IV to V stages and declined thereafter at senescence, during which period there was a marked increase in the fresh and dry mass of pistil. Membrane permeability of sepal tissues estimated as conductivity of leachates (μ S) increased during senescence. The content of sugars and soluble proteins in the sepal tissues increased during flower development from stage I to IV and declined thereafter during senescence, however increase in the concentration of proteins was pronounced during flower opening from stage III to IV. The α -amino acid content declined as the flower progressed towards opening and senescence. The protease activity as also the phenolic content increased during flower development, decreased during opening and increased as the flower progressed towards senescence. SDS-PAGE of protein extract from sepal tissues suggested a decrease in the expression of some high molecular weight proteins and an increase in some low molecular weight proteins during flower development and senescence. The study suggests that changes in membrane integrity and protein degradation by specific proteases are the prime causes of floral senescence; besides the regulation of senescence is linked to *de novo* protein synthesis and the identification of suitable marker proteins could help in modulating floral longevity in this potential cut flower.



10-26

SUSTAINABLE FARMING: GROWING MEDICINAL AND AROMATIC PLANTS IN OLD COCONUT PLANTATION

B.K. Saud, J.C. Nath and G. Medhi

Horticultural Research Station, Assam Agricultural University, Kahikuchi, Azara, Guwahati-781017
bijit1969@rediffmail.com

An experiment was carried out for sustainable coconut cultivation in Assam by growing indigenous/commercial medicinal and aromatic plants. The study was conducted during 2005-06 to 2007-08 at Horticultural Research Station, Assam Agricultural University, Guwahati. The medicinal and aromatic plants were grown under old coconut plantation (about 53 years) as intercrop. The five treatments were T₁: Coconut + Pipali (*Piper longum*), T₂: Coconut + Patchouli (*Pogostemon cablin*), T₃: Coconut + Citronella (*Cymbopogon witerianus*), T₄: Coconut + Bhedailata (*Paederia foetida*) and T₅: Coconut + Madhusaleng (*Poligonum chinensis*). The experiment was laid out in a Randomized Block Design with four replications. The crops were grown organically without application of any chemical fertilizer and pesticides. Out of these five treatments coconut and patchouli (*Pogostemon cablin*) combination had produced maximum coconut equivalent yield (23,529.54 nos. ha⁻¹) and earned highest net income (Rs 1, 31,934.80 ha⁻¹). The productivity of the farm land increased maximum (231.68%) by growing coconut and patchouli. Patchouli (*Pogostemon cablin*) intercropping in coconut garden in Assam condition is co-friendly and highly remunerative and could be cultivated with minimum input.

10-27

EFFECT OF SOIL MOISTURE STRESS ON CHLOROPHYLL FLUORESCENCE KINETICS OF ALOE

R. Saravanan

Directorate of Medicinal and Aromatic Plants Research, Boriavi – 387 310, Anand, Gujarat
rajusar@gmail.com

Aloe (*Aloe barbadensis*) is an important medicinal plant which is used for healing various diseases and an active ingredient in cosmetics. A pot study was conducted to understand the response of aloe to progressive soil moisture deficit and its effect on physiological functions and Chlorophyll Fluorescence Kinetics at DMAPR, Boriavi, Anand. Soil moisture stress was imposed by withholding water to plants grown in pots for 90 days. Since measurement of carbon assimilation through gas exchange measurement is difficult considering leaf thickness and CAM metabolic pathway in aloe, chlorophyll fluorescence kinetics was monitored in the young, mature and older leaves. Fv/Fm (Maximum quantum efficiency) was 0.73, 0.76 and 0.70 in the young, mature and older leaves of control plants respectively. It did not alter significantly in all the leaf types. PSII maximum efficiency (Fv'/Fm') reduced marginally in the young and older leaves compared to mature leaves. PS II efficiency (Phi PS2) factors were 0.134, 0.114 and 0.123 in the young, mature and older leaves of control plants respectively and drastically reduced under stress. Both photochemical and non-photochemical quenching quotients were altered significantly under stress. There was a reduction of 60% in the qP in all leaf types at the end of the treatment period. Large increase in NPQ of 26.79%, 17.53% and 56.51% respectively in young, mature and older leaves were recorded. Electron transport rate got reduced upto 69.60%, 53.99% and 62.11% in young, mature and older leaves. Chlorophyll Fluorescence Kinetics can be reliably used to quantify the intensity of soil moisture stress quickly and non-destructively for aloe.



10-28

EFFECT OF N, P, K AND FYM ON GROWTH, YIELD AND TSS OF STEVIA

P.V. Nevase, A.M. Bafna and K.A. Shinde

*Department of Soil Science and Agricultural Chemistry, Navsari Agricultural University, Navsari -396450
pravinnevase@gmail.com, kiran.shinde48@gmail.com*

The field experiment entitled “Integrated Nutrient Management (INM) in Stevia under Drip Irrigation” envisaging four levels of inorganic fertilizer and two level of organic manure was conducted during summer season of 2007-08 at soil and water management research farm, NAU, Navsari, Gujarat. The world sweetness stevia (*Stevia rebaudiana* Bentoni) belonging to the eupatory of the asteraceae family and is a threatened highly nutritious delicious, non carcinogenic, non-toxic, safe for diabetics with valuable medicinal properties. The present investigation was carried out on effect of N, P, K and FYM on growth, yield and TSS of stevia. The treatment included 4 fertilizer levels and 2 levels of FYM. The all eight treatment combinations were in a factorial randomized block design. Entire fertilizer dose was applied as basal applications. The seedlings were planted at a spacing of 60 cm × 30 cm. The growth parameters like height, number of leaves and branches, weight of fresh and dry leaves and TSS were recorded. Application of N:P:K on 275:112.5:172.5 kg/h and FYM @ 20 t/ha produced significantly higher number of leaves, branches, height, yield and TSS of stevia.

10-29

PHYSIOLOGICAL STRESS NECESSARY FOR FLOWERING OF ALPHONSO MANGO

M.P. Kandalkar, B.R. Salvi, S.A. Chavan, N.V. Dalvi and A.Y. Munj

Regional Fruit Research Station, Vengurle, Dist. Sindhudurg (Maharashtra)

Alphonso the leading commercial variety in Konkan region of Maharashtra is grown on an area of 1.64 lakh ha with total production 3,10,000 M.T. and the average productivity 3 M.T./ha. Alphonso is alternate bearing cultivar which requires favorable climatic conditions to express its genetic potential. The accumulation of carbohydrates coupled with favorable cold climatic below 17°C for continuous 8-9 days induces flowering. The experimental findings of the research carried out for last three decades has proved that Alphonso mango tree needs stress to induce flowering. The stress which has direct impact on induction of Alphonso flowering are temperature, salt and indigenous level plant growth regulators. The research with various aspects of physiology was carried out at Regional Fruit Research Station, Vengurle since 1975. The various studies like thinning and pruning, water stress through irrigation treatments proximately to sea, use of paclobutrazol for regulation of flowering and regulation of flowering with different chemicals was carried out. The various experiments conducted have given out the results which has help to build up certain assumptions regarding, the stresses necessary for induction of flowering in Alphonso mango trees. For this purpose, the observations related to meteorological parameters like temperature, relative humidity and rainfall were collected. Similarly phenological observations were also collected simultaneously to correlate the stress physiology in Alphonso mango. Different chemicals like paclobutrazol, thiourea, KH_2PO_4 , K_2HPO_3 , KNO_3 were applied as soil and foliar applications. The results obtained of the different research trials conducted over the period have shown that the Alphonso orchards near to sea coast flowers earlier than those away from the sea coast. This suggests that excess deposition of salts (Sodium chloride and potassium nitrate) on foliage of mango trees creates a stress, stress of water. The induction of flower primordia formation by July month there by flowering on the start of November month. The soil application of paclobutrazol which is a anti gibberellins acts as inhibitor restricts the vegetative growth and promotes the induction of flowering after 90-105 days of soil application. This creates a stress condition by acting as inhibitor for gibberellins production. Or otherwise hot and humid climatic of konkan region favours the continuous production of gibberellins there by the initiation of three vegetative flushes in the months of



June, October and March every year. The temperature plays an important role in induction of flowering. For flowering the levels of carbohydrates and nitrogen should be in the ratio of 3:2 and the auxins, cytokinines and lipids levels are required to be more compared to the level of gibberellins. The continuous fall in night temperature i.e. below 17°C and at least for 8-9 days helps for induction of flowering in Alphonso mango. Research carried at Regional Fruit Research Station, Vengurle have proved that Alphonso mango when gets stress of salt, water and cold temperature or extreme high temperature due to dry spells during rainy season helps to create stress under natural conditions and use of paclobutrazol which acts as inhibitor for gibberellins; thus physiological stress is produced which helps for induction of flowering in Alphonso mango.

10-30

GROWTH AND FLOWERING OF TUBEROSE (*Polianthes tuberosa* Linn.) CV. CALCUTTA DOUBLE, AS INFLUENCED BY LIME AND BORON LEVELS

S. Bhuyan, L. Paswan, D.K. Bora, M.C. Talukdar and P. Hatibaruah

Assam Agricultural University, Jorhat- 785013

Field experiment was conducted to study the effect of five levels of lime (0% LR, 10% LR, 25% LR, 50% LR, and 100% LR) as soil application and four levels of boron (0 ppm, 50 ppm, 100 ppm and 150 ppm) as foliar application along with blanket dose of NPK fertilizers and FYM on tuberose cv. calcutta double during 2007 at the experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat. Investigation revealed that tuberose responded significantly to the application of lime and boron. Growth characters viz. early emergence of shoot (20.08 days), maximum plant height (80.42 cm), number of leaves/plant (97.00) and leaf area (92.36 cm²) and flower characters viz. maximum length of spike and rachis (83.25 cm and 49.43 cm), number and size of florets (49.68 and 6.38 cm), girth of stalk (1.054 cm) resulted with highest level of lime (100% LR). All the above growth and flower characters except the days to emergence of shoot were found to increase with up to boron level @ 100 ppm but further increase in the level of boron showed reverse affect. The treatment combination with 100% LR + 100 ppm boron was found to be optimum for better growth and flowering of tuberose, cv. calcutta double.

10-31

RESPONSE OF LEVELS OF NPK ON GROWTH AND FLOWERING OF GERBERA

Hunmili Terangpi * and L. Paswan

*Research Associate ** Prof. & Head, Department of Horticulture, Assam Agricultural University
Jorhat-785013, Assam

Experiments with three levels of NPK @10,20,30g/m² each were carried out at Assam Agricultural University, Jorhat on gerbera cv. Popular for two years during 2001-2003 to find out the best NPK combination for its growth and flowering. The highest levels of nitrogen (30 g/m²) recorded the maximum values for all the vegetative characters. The highest levels of nitrogen and phosphorus delayed the visibility of flower buds. The highest level of phosphorus delayed full bloom from bud opening while it was hastened with the higher levels of potassium. Higher levels of phosphorus and potassium increased the length of flower stalk, whereas higher levels of NPK @ 30, 10, 20 g/m² combinations resulted in maximum large sized flowers (12.15 cm) and highest diameter of flower stalk (0.58 cm). The highest levels of nitrogen and potassium resulted in the longest self life and vase life of flowers. The levels of NPK@ 30 g N, 10 g P₂O₅, 20 g K₂O/m² was considered to be the best economic level for the agro-climatic conditions of Jorhat, Assam which gave the maximum cost benefit ratio of 1:3.88.



10-32

EFFECT OF CALCIUM AND BORON ON GROWTH, FLOWERING AND QUALITY OF ANTHURIUM (*Anthurium andreaeanum* Lind.)

J.D. Traite and L. Paswan

Department of Horticulture, Assam Agricultural University, Jorhat-13, Assam-785013

An experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat to investigate the effect of foliar application of Calcium and Boron on growth, flowering and quality of Anthurium (*Anthurium andreaeanum* Lind.) cv. Cherry Red. The experiment was laid out in Randomized Block Design with three levels of calcium (50, 100 and 150 ppm) and two levels of Boron (1 mg and 2 mg) and a control consisting of 12 treatments replicated three times. Vegetative characters like plant height, leaf number, number of suckers and flower character like days to emergence, full bloom, spathe length and breadth, number of flowers and self life were found to be maximum in higher concentration of calcium 150 ppm without boron. Flower stalk length and vase life was increased by combination of calcium and boron at moderate levels.

10-33

RESPONSE OF A FEW MEDICINAL PLANTS OF ASSAM HILLS TO VARIATION IN SOWING DATES

S. Maibangsa

Senior Scientist (Crop Physiology), Regional Agricultural Research Station, Assam Agricultural University, Diphu-782 460, Assam

Seeds of *Andrographis paniculata* at the rate of 2 Kg per hectare were directly sown in the field at 15 days interval from 1st March to 15th August during 2001-02 and 2002-03. Twenty days after sowing the plant population was maintained at 25 plants per square metre and the whole vegetative parts were harvested at flowering stage to record the yield. In the case of *Rauwolfia serpentina* and *Asperagus racemosus*, 200gms of seed were sown in a square metre of seed bed respectively at 15 days interval from 1st March to 15th August in both the years. *Rauwolfia serpentina* seedlings at 3-4 leaf stage and 60 days old seedlings of *Asperagus racemosus* were transplanted in the field at a spacing of 75cm x 75cm. Intercultural operations were carried out as per need. The roots of both the crops were harvested in the second year during the month of December. Plant growth in terms of height and branch number of *Andrographis paniculata* increased gradually with progressive dates of sowing attaining a maximum height of 64.8cm with 15th June sowing while maximum branch number (12.8) was recorded with 1st June sowing. Highest crop yield (47.6t/ha) was recorded when the crop was sown on 1st June. Root numbers per plant of *Rauwolfia serpentina* was not affected due to sowing dates during the period 1st April to 1st July. During this period root weight and root yield per ha also remained high. Highest yield of 54.1t/ha was recorded with 15th June sowing beyond which the yield declined. There was no significant variation in the yield of *Asperagus racemosus* when the crop was sown during the period from March to mid May. However, a highest yield of 40.3t/ha of fresh root of *Asperagus racemosus* was recorded when the crop was sown in the middle of March.



Session 11

Tea, Plantation Crop and Forestry



11-01

**EFFECT OF WATERLOGGING ON MORPHOLOGICAL, PHYSIOLOGICAL AND
BIOCHEMICAL ATTRIBUTES IN TEA (*Camellia sinensis* L.) GENOTYPES**

D.K. Deka*, D. Borah, T. Lahon, U. Baruah, A.K. Handique and T.S. Barman**

Department of Plant Physiology and Breeding

Plant Improvement Division, Tocklai Experimental Station, Jorhat 785008, Assam (India)

**Corresponding author: E-mail: dhrubakd2004@rediffmail.com*

*** Department of Biotechnology, Gauhati University*

A vast area of tea plantation is often subjected to transient waterlogging during the peak harvesting monsoon season in North East India. Despite this, little is known about the behaviour of tea genotypes to waterlogging. Two years old pot grown plants of clones TV1, TV2, TV9, TV25, and S.3A/3 were subjected to full root zone submergence treatment. Morphological, physiological and biochemical changes were recorded at different intervals of time viz. 0, 5, 15, 25, 35, 40 and 45 days after submergence. All the clones could not survive till 45 days of waterlogging. Longer duration of waterlogging stress results in increasing leaf angle, chlorosis and abscission of leaves. Leaf water potential decreased with increasing duration of waterlogging stress. Decreased leaf water potential was associated with declining rate of photosynthesis, transpiration, stomatal conductance and water use efficiency. The leaf chlorophyll content was also reduced by waterlogging. However, increase in leaf proline, leaf wax and endogenous abscisic acid content was observed which might confer tolerance to unfavourable abiotic conditions. The result shows that the test clones have distinct degree of tolerance to waterlogging. Clones TV1 and TV2 were highly susceptible while TV9 was moderately tolerant and TV25 and S.3A/3 were tolerant to waterlogging. The results indicate a high degree of genetic variability among the clones and support the assertion that germplasm evaluations are necessary to direct the use of appropriate clones in waterlogged conditions. It also indicates that clones TV25 and S.3A/3 are suitable materials for cultivation in such areas.

11-02

**SEARCH FOR WATERLOGGING TOLERANT TEA GERMPLASM FROM THE OLD SEED JAT
POPULATION OF BRAHMAPUTRA VALLEY**

D.K. Deka*, D. Borah, T. Lahon, U. Baruah, A.K. Handique and T.S. Barman**

Department of Plant Physiology and Breeding

Plant Improvement Division, Tocklai Experimental Station, Jorhat 785008, Assam (India)

**Corresponding author: E-mail: dhrubakd2004@rediffmail.com*

*** Department of Biotechnology, Gauhati University*

The present scenario of high water table during peak harvesting season of tea is alarming for the industry of North East India. It leads to heavy crop loss. To minimize the crop loss, the industry needs waterlogging tolerant cultivars. To find out such cultivars, around 5524.68 ha of plantation area, affected by waterlogging, of 12 different tea estates of South Bank (Jalan Nagar (S), Maijan, Greenwood, Thanai, Kharjan, Nandanban, Dinjan) and North Bank (Monmohinipur, Manobag, Gingia, Nyagogra, Dufflagarh) of Brahmaputra Valley of Assam were surveyed. Sixty nine germplasm of old seed jat (80 years old) population growing luxuriantly under acute waterlogging condition were selected. Passport data were collected from all the selected plants following the format of International Plant Genetic Resource Institute, Rome, Italy. To measure the water table through out the year at the selection sites, 37 numbers of piezometers were installed. For multiplication, scions were collected from the selected germplasm and propagated in the nursery. After two years, well established sleeve grown plants were transplanted to Field Gene Bank of Tocklai Experimental Station, Jorhat for further evaluation under laboratory and field conditions.



11-03

**CHANGES IN MORPHO-PHYSIOLOGY OF *JATROPHA CURCAS* L. GROWN UNDER
DIFFERENT WATER REGIMES**

Neha Tiwari, Mamta Purohit and A.R. Nautiyal

High altitude Plant Physiology Research Centre, H.N.B. Garhwal Univ., Srinagar, Garhwal, Uttarakhand
neha.tiwari7@gmail.com, arnautiyal@gmail.com

Jatropha curcas L. (Physic nut), a native of Central America has recently come into prominence as a source of biodiesel. Besides, *Jatropha* is a traditionally used medicinal plant for treatment of variety of ailments in large number of countries. In the present study, the response of *J. curcas* to water stress in terms of changes in growth attributes, photosynthesis and changing leaf water potential was studied. The seedlings of *J. curcas* were provided with three different levels of water supply i.e. daily watering, watering after two days and watering after five days for a period of one month. Due to water stress there was a sequential decrease in all growth parameters i.e. leaf number, leaf area, shoot length and root length. Tissue water potential is the best parameter to measure water stress in studies of plant response to water stress. During the experimentation minimum leaf water potential was recorded in plants with five day watering cycle which was -1.95 MPa whereas maximum leaf water potential was recorded in daily watered plants i.e. -0.49MPa. Water contents in a tree under drought conditions disrupt life processes. A major drought effect is the reduction of photosynthesis. Due to water stress, there was a drastic reduction in the photosynthetic rate and stomatal conductance. When compared to control, the rate of photosynthesis and transpiration decreased whereas leaf temperature increased in the water stressed plants. Although *J. curcas* is regarded as a drought tolerant plant but the current findings indicate that water stress retarded the overall growth and physiological processes studied. Such a response of a drought tolerant species to water stress could be an area of further research.

11-04

**ACCESSION SOURCE VARIATION IN GROWTH PERFORMANCE OF *JATROPHA CURCAS*
LINN. IN NORTH EAST INDIA**

S.P. Saikia, P.R. Bhattacharyya, B.S. Bhau, B.P. Mishra and P.B. Kanjilal

Division of Medicinal, Aromatic and Economic Plants, North East Institute of Science and Technology
(CSIR), Jorhat 785 006

Adaptive trials on *J. curcas* were undertaken at the North East Institute of Science and Technology, Jorhat, Assam. *Jatropha* (*Jatropha curcas* Linn.) is a non-edible oilseed plant with adaptability to marginal semi-arid lands and wastelands. Utilization of *J. curcas* oil as a new source for diesel engine has tremendous scope in contributing to growing needs of energy resources in India. The Indian Government is promoting *jatropha* to reduce dependence on the crude oil and to achieve energy independence by the year 2012, under the National Biodiesel Mission. The aim of the study was to determine source variation in *J. curcas* accessions collected from different states of India and to identify the best sources to be utilized for reforestation and future genetic improvement work. The evaluation of cultivars revealed a good degree of variation for plant height, stem girth, branches per plant and seed weight. The accessions have shown measurable growth responses, which were sufficient for a conclusive remark. Hence the present study was carried out with the respective first and second year growth performances. Variation in the physiological parameters of different sources was also studied. The pattern of variation exhibited for different characters was found to be different and varied with age. Such variation among different populations may be due to different intensities of natural selection acting upon the traits in their natural habitat. High seed weight was observed in one cultivar. This work will facilitate selection of promising accessions for multi-location evaluation and will also hasten the process of utilization of germplasm.



11-05

SHOOT AND ROOT GROWTH IN MEDIUM PRUNED TEA AS INFLUENCED BY ROOT PRUNING AND EXOGENOUS APPLICATION OF AUXIN

M. Taparia, S. Baruah and S. Dutta

Department of tea Husbandry and technology, AAU-Jorhat

A field trial was carried out to investigate the effects of root pruning alone or in combination with exogenous application of auxin (NAA 20 ppm and 100 ppm) in medium pruned tea (clone TV 9). The root pruning especially under the influence of applied auxin profoundly influenced the regeneration of new fibrous roots. Root volume and root weight were significantly higher. There were early and more bud break at the pruned branches. The regeneration of new roots not only accelerated the bud break but also produced faster growth of the primaries which helped in earlier formation of plucking table, early and total crop. The primaries were more productive and the size of plucking table also increased significantly which culminated in overall improvement in productivity of tea bushes. However, there were some deleterious effects when root pruning was done alone but showed much improvement in productivity compared to pruned tea without root pruning.

11-06

MORPHO - PHYSIOLOGICAL SELECTION CRITERIA IN STRAWBERRY (*Fragaria x ananassa*) USING ESTIMATES OF HERITABILITY, CORRELATIONS AND SELECTION RESPONSE IN TWO CROPPING SYSTEMS

Mohar Singh¹, Girish Sharma² Ranjana Gupta³, S.K. Sharma⁴, T.P. Singh⁵ and S.K. Mishra⁶

^{1,4,5,6}*National Bureau of Plant Genetic Resources, Pusa New Delhi-110 012.*

^{2,3}*Department of Fruit Breeding and Genetic Resources, Dr Y.S. Parmar University of Horticulture and Forestry Nauni-Solan 173 230*

One of the areas of research on increasing plant productivity in developing countries is the maintenance of inherent stability of traditional farming systems. Such farming systems are characterised by small holding and growing of different crops under mixed and intercropping systems in variance to mono-cropping employed in big farms in developed countries. One such instance is the intercropping of strawberry with apple as a secondary crop component in the hilly tracts/ temperate segments of the country. The objective of the study is to identify useful new morphological indirect selection criteria by analysing broad sense heritability and genetic and environmental correlations (r_G and r_E). The material for the present study included twenty strawberry cultivars selected on the basis of certain agronomic and morphological traits representing different plant types namely 1, Brighton; 2, Selva; 3, Confictura; 4, Catskill; 5, Blackmore; 6, Douglas; 7, Gorella; 8, Chandler; 9, Howard; 10, Torrey; 11, Addie; 12, Jatog Special; 13, Belrubi; 14, Etna; 15, Pajaro; 16 Seascape; 17, Elesenta; 18, Shasta; 19, Missionary; and 20, Fern. The experiment was conducted under rainfed conditions in randomized complete block design with three replications under two cropping systems, i.e. monoculture and in association with apple (Royal Delicious, a recommended apple variety in the state). For intercrop, one block was added outside the tree basin in the well established orchard with an inter plant distance of 8 cm apart. In this investigation several physiological traits viz; leaf area/plant, crop growth rate, leaf growth rate, specific leaf weight, net assimilation rate and fruit yield/plant were studied for various genetic parameters. Cropping system effects and interaction of cropping system with genotypes were significant for majority of traits. There was no effect of cropping system in the manifestation of phenotypic and genotypic variability. The estimates of heritability and genetic advance for fruit yield and other physiological traits were comparatively less in intercropping than in the sole crop. Further, correlation coefficients between various physiological traits were found to differ, both in



nature and magnitude, between monoculture and intercropping. In sole cropping, leaf area/ plant, crop growth rate and net assimilation rate were positively correlated with fruit yield. The present observations revealing that the genotypes and the traits to be utilized in developing varieties for monoculture and intercropping have been suggested.

11-07

IN-VITRO EVALUATION OF DIFFERENT PHYSIOLOGICAL REQUIREMENTS FOR THE GROWTH OF *FUSARIUM SOLANI*, THE CASUAL AGENT OF DIEBACK IN TEA [*CAMELLIA SINENSIS* (L) O KUNTZE].IN ASSAM

S.R. Sarmah, P.K. Boruah and S.C. Das

Mycology and Microbiology Dept., Plant Protection Division, Tocklai Experimental Station, Jorhat 785008

Tea, *Camellia sinensis* (L) O Kuntze is one of the most important beverage crop which earns foreign exchanges. Around 10-20% crop losses, due to biotic stress like pest and disease attack in spite of taking proper care. Besides other existing diseases a new strain of pathogen *Fusarium solani*, emerges in a devastating way by causing die back of primaries in clones and seed decay in some seeds in N.E. India and it sounds alarm to the industry. The responsible pathogen of these maladies *F. solani* was isolated after a series of investigations. Laboratory experiments were conducted to study the physiological stress for the limitation of growth of the pathogen. The requirement of Carbon, Nitrogen, P^H, temperature, light and micro and macronutrients in culture media were standardized. Among the various carbon sources dextrose and sucrose was found to be the most favourable. Three types of nitrogen sources i.e. inorganic, organic and complex nitrogen sources were tried. Complex nitrogen sources namely yeast extract, peptone and casein- hydrolysate, inorganic sources ammonium nitrate, sodium nitrate and organic sources asparagine and tyrosine were the best sources providing maximum vegetative growth. The P^H 4.5 and temperature between 25 to 27° C were also found to be the best for the maximum growth. Normal light condition helped in profuse growth of the organism. The presence of different micro and macro elements had also influenced on the growth of the organism.

11-08

FIELD EFFICACY OF AQUEOUS EXTRACTS OF INDIGENOUS PLANTS ON TEA MOSQUITO BUG, *Helopeltis theivora* WATERHOUSE (HEMIPTERA: MIRIDAE)

M.K. Deka, G.K. Saikia and B. Bhagabati

Entomology Department, Assam Agricultural University, Jorhat-785013

Field experiment conducted with different aqueous extracts of indigenous plants viz. *Azadirachta indica*, *Clerodendron inerme*, *Melia azedarach*, *Pongamia pinnata*, *Polygonum orientale*, *Lantana camara*, *Adhatoda vasica* and *Cassia tora* showed that all the extracts reduced the infestation of *Helopeltis theivora*, significantly. Among all the plants the efficacy of *A. indica* followed by *C. inerme* showed promising results. The highest reduction of infestation over control at 10% of *A. indica* was 51.66, 48.90, 52.78 and 48.45% after 1st, 2nd, 3rd and 4th week, respectively. The other concentrations viz. 8.0, 6.0, 4.0, and 2.0% also gave significant reduction of pest over control. Likewise, the reduction with 10% extracts of *C. inerme* was 47.23, 45.00, 46.25 and 48.33% after 1st, 2nd, 3rd and 4th week, respectively. Similar pattern of results were also observed with all other aqueous extracts of plants. The order of effectiveness of plants was, *A. indica* > *C. inerme*, > *M. azedarach*, > *P. pinnata*, > *P. orientale*, > *L. camara*, > *A. vasica* > and *C. tora* respectively.



11-09

**PHYTONUTRIENTS, ANTIOXIDANTS AND ITS ACTIVITY IN FRESH FRUITS OF BER
(ZIZIPHUS MAURITIANA) AND ITS CULTIVARS AT DIFFERENT DEVELOPMENTAL STAGES**

Neelam Poonar, Prantal Kachwaha and H S Gehlot

Stress Physiology and BNF Laboratory, Department of Botany, J.N.Vyas University, Jodhpur

Ziziphus mauritiana (Indian Jujube,) is a tropical fruit tree species, belonging to the family Rhamnaceae. It is native to southern Asia mainly India. *Ziziphus* species (*Z. nummularia*, *Z. rotundifolia*, *Z. mauritiana*) is growing in arid and semi arid area and is an important source of low cost, nutritious fresh as well as dry edible fruits. Fruits of *Ziziphus* species at three different developmental stages mature green stage, breaker stage and ripened stage were evaluated for their phytonutrient value. Antioxidants like phenols, tannins, ascorbic acid and antioxidant activity in terms of DPPH radical scavenging activity and Ferric reducing power was also estimated in all the three stages of fruit development. Total carbohydrates content increases as fruit matures and was found to be maximum in cv. Illaichi in all the three stages of development. The amount of protein and free amino acids decreased throughout maturity. Likewise phenol, tannins also shows the trend of decreasing as the fruit matures. It exhibits high concentration in Illaichi, followed by Chuara, Gola, Tikadi. *Z. nummularia*, *Z. mauritiana* and same trend of tannins concentration is seen at breaker and ripened stage of fruit development. Ascorbic acid increases as fruit matures. Maximum amount of ascorbic acid is present in cv. Chuara and minimum was present in *Z. nummularia* at all the three stages of development. DPPH radical scavenging activity and ferric reducing power decreases as the fruit attains maturity. Maximum radical scavenging activity was found to be present in cv. Chuara followed by cv. tikadi, *Z. nummularia*, *Z. mauritiana*, cv. Illaichi and cv. Gola at very young stage of development and similar decreasing order of radical scavenging activity was found in young and ripened stage. Maximum ferric reducing power was estimated in cv. Illaichi following cv. Gola > cv. Chuara > *Z. mauritiana* > cv. Tikadi > *Z. nummularia* at very young stage. Whereas, in young as well as ripened stage cv. Chuara has highest reducing power and *Z. nummularia* has the lowest. Results reveals that the fruit of ber is highly nutritive and have high antioxidant properties as compared to some other costly fruits available in the market and therefore must be considered as 'poor men's apple'.

11-10

**BIOCHEMICAL PROFILING IN ARABICA (*Coffea arabica* L.) AND ROBUSTA (*Coffea canephora*
pierre Ex. Froehner) COFFEE**

G.F. D'Souza, Pradeep Kumar, C.G. Anand, N.S. Renukaswamy, M.G Awati, B. Lamani and Jayarama

*Central Coffee Research Institute, Coffee Research Station-577117, Chikmagalure Dist., Karnataka
dsouzagfcri@yahoo.co.in*

Profiling of biochemicals in the matured leaves was undertaken in commercially important coffee genotypes such as arabica (cv. S.795, Sln.9 and Chandragiri) and robusta (cv. S.274). The results indicated significant variability in biochemical composition and enzyme activities among the genotypes. Significantly higher protein content (17.88 and 17.28 mg g⁻¹) was observed in Sln.9 and Chandragiri arabica varieties compared to S.795 and S.274 robusta (12.86 and 13.38 mg g⁻¹) respectively. The free proline content was significantly high (12.62 μ moles g⁻¹ f.w) in robusta genotype compared to arabica genotypes such as S.795, Sln.9 and Chandragiri (6.32, 6.93 and 6.61 μ moles g⁻¹ f.w) respectively. The total carbohydrate was significantly low (5.16%) in Sln.9 than S.795, Chandragiri and S.274 (5.72, 5.66 and 5.59%). The Epicuticular wax content (ECW) was significantly high (69.75, 68.50, 68.15 mg cm⁻²) in S.795, Sln.9 and Chandragiri arabica genotypes than robusta (63.31 mg cm⁻²) genotype. The nitrate reductase activity was significantly more (0.99 μ moles No₂



hr⁻¹) in robusta genotype followed by S.795, Chandragiri and Sln.9 (0.78, 0.66 and 0.64 μ moles No₂ hr⁻¹). The robusta genotype showed significantly high caffeine, phenol, super oxide dismutase activity, NR activity and Chlorophyll fractions compared to arabica genotypes, which could have been due to pest and disease resistance and vigorous behavior of this genotype. The high ECW observed in arabica genotypes may be due to tolerance to abiotic stress as these genotypes were known for higher ECW and drought tolerance.

11-11

BIOCHEMICAL AND IONIC COMPOSITION OF LATEX RELATED TO YIELD ATTRIBUTES AND PRODUCTIVITY IN *Hevea brasiliensis*

Molly Thomas, Jayasree Gopalakrishnan, P. Prasannakumari, Joshua Abraham, R. Krishnakumar and James Jacob

*Rubber Research Institute of India, Rubber Board, Kottayam 686 009, Kerala
mollyrrii@yahoo.com*

Hevea brasiliensis Mull. Arg. is a tree that produces natural rubber, an industrially vital isoprenoid polymer. Rubber is synthesized on the surface of rubber particles suspended in latex, which constitute the cytoplasm of latex producing cells. In the present study, sucrose, thiols and ionic composition of latex were correlated with flow characteristics and yield in seven clones of *Hevea*. Thiols showed significant positive correlation with total volume and significant negative correlation with plugging index. Level of sucrose showed significant positive correlation with initial flow rate, total volume and yield. Among the ionic components, inorganic phosphate (Pi) showed significant positive correlation with initial flow rate, total volume and yield, while calcium (Ca) showed significant negative correlation with total volume and yield. The biochemical or inorganic ions present in the latex of clones investigated did not show any significant correlation with the physiological disorder namely Tapping Panel Dryness (TPD) which is supposed to have negative correlation on yield.

11-12

UP-REGULATION OF TAPPING PANEL DRYNESS SPECIFIC TRANSCRIPTS UNDER DROUGHT STRESS IN *Hevea brasiliensis*

M.B. Mohamed Sathik, Molly Thomas, Geetha Natesan, Linu Kuruvilla, Lisha P. Luke, Sumy Elizabeth Joseph and James Jacob

Rubber Research Institute of India, Rubber Board, Kottayam 686 009, Kerala

In India, the natural rubber tree (*Hevea brasiliensis*) is cultivated mainly in traditional regions like Kerala and Kanniyakumari District of Tamil Nadu and in non-traditional regions like North-East India where it is exposed to severe cold conditions during winter and in some parts of Maharashtra, Karnataka and Madhya Pradesh where it is exposed to severe drought during summer. The productivity of natural rubber is mainly affected by these abiotic factors and also by a physiological disorder called Tapping Panel Dryness (TPD). The transcripts associated with TPD have been characterized by DD RT PCR and the selected transcripts were used to develop a microarray. When cDNA from drought treated plants of clone RR1105 were allowed to hybridize with this array, transcripts such as TPD24 (a NAC transcription factor) and TPD27 (an unknown protein) were found up-regulated. Further to confirm the association of these TPD specific transcripts with drought, a qPCR analysis was performed using cDNA from drought treated plants of clones RR1105 (drought susceptible) and RRIM600 (drought tolerant). The results indicated the up-regulation of TPD24 in both the clones and up-regulation of TPD27 only in clone RRIM600. Up-regulation of TPD27 in clone RRIM600 may be associated with drought tolerance. However, these results indicate the existence of common signaling pathway as a response for both drought stress and TPD conditions in *Hevea*.



11-13

IMPROVEMENT OF SEED GERMINATION IN *Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm

Gunjan Sharma and Anant Ram Nautiyal

High Altitude Plant Physiology Research Center, HNB Garhwal University, Srinagar-246174, Uttarakhand
gnjnsharma86@gmail.com, arnautiyal@gmail.com

Cinnamomum tamala Nees and Eberm. (Family-Lauraceae) is an evergreen tree commonly occurring as an associated species in transitional evergreen broadleaf forest in the sub-tropical zone of Himalaya. Its leaves are widely used as a spice and also yield an essential oil on distillation. The essential oil of the leaves (tejpat oil) is medicinally used as carminative, antifatulent, diuretic, and in cardiac disorders. "Ayurveda" describes the use of *C. tamala* leaves in the treatment of ailments such as anorexia, bladder disorders, dryness of mouth, coryza, diarrhea, nausea and spermatorhea. The main constituents of leaves are *a*-pinene, camphene, myrcene, limonene, eugenol, *p*-cymene, methyl eugenol, eugenol acetate and methyl ether of eugenol. Owing to its high medicinal value and being an important spice ingredient, the demand of *C. tamala* is increasing day by day and the species is being exploited from its natural pockets illegally. The blatant exploitation of the species from the forest in the recent years has created serious concern about its long term health in the already diminishing natural populations and the species has resulted to vulnerable status in Uttarakhand (Ved *et al.*, 2003). The habitat specific occurrence, poor regeneration status and short life span of seed has further compounded the problem (Sharma *et al.*, 2009). Therefore, to raise high quality individuals in large scale in short span is the only way to fulfil the increasing demand and help in conservation of the species. A step in the direction of mass multiplication and conservation of the species is present communication, which aims to establish a protocol of seed germination of the species for large scale cultivation to fulfill the species demand. Comparative study on the germination behaviour of *C. tamala* was conducted in laboratory as well as in natural habitat. While in laboratory, experiment was conducted at three temperatures (20, 25 and 30°C), on forest floor it was studied under four micro-habitat conditions representing forest disturbance (disturbed and undisturbed forest) and canopy closure (open tree canopy and under tree canopy). For this purpose, ripe fruits (drupe) were collected from its natural population (geographic co-ordinates 30°29' N latitude and 79°05' E longitude at 990-1060m asl altitude Rudraprayag, Uttarakhand) in the month of May. Two types of seed conditions were applied for germination experiments - one pulped and another de-pulped state. Random block designing was followed and 3*3 (50 seeds each) replicates were laid. Results obtained were significantly different in laboratory and natural habitat in both pulped and de-pulped seeds. Germination in de-pulped seed ranged between 95-100% in laboratory and 72-100% in natural habitat. On the other hand pulped seed exhibited 10-18% germination in laboratory and 22-60% in natural habitat varying with micro-habitats. The observations displayed that pulp is the chief determining factor which inhibits germination in *C. tamala* seeds in laboratory as well as in natural habitat.

11-14

FINE ROOTS PRODUCTION AND NUTRIENT DYNAMICS IN POPLAR PLANTATIONS

K. Rakesh and K. Bimlendra

Department of Forestry, Haryana Agricultural University Hisar

The study was carried out under three age of poplar (*Populus deltoides* clone G₄₈) plantations (1-, 3-, 7-year) on sandy-loam soil, good in organic matter and N, K content with intercrop turmeric in all age plantations. The standing crop, rate of production, mortality and nutrients (NPK) dynamics of two size classes of root, fine root (1-2 mm dia.) and very fine roots (<1 mm dia.) at different soil depths were estimated. Fine root (FR) and very fine root (VFR) production increased with increase in age of plantation. FR production (live or dead)



ranged from 1024.6 kg ha⁻¹ to 1640 kg ha⁻¹ and 413.3 kg ha⁻¹ to 707 kg ha⁻¹, respectively. Maximum root density (live or dead) was found at 0-10 cm soil depth, i.e. 45 per cent and 43 per cent, respectively. Month-wise maximum FR root production (live or dead) was found in October, i.e. 322 kg ha⁻¹ and 126 kg ha⁻¹, respectively, and minimum was in April, i.e. 27 kg ha⁻¹ and 15 kg ha⁻¹, respectively. Maximum VFR production (live or dead) was found 1670 kg ha⁻¹ and 786 kg ha⁻¹, respectively, and minimum was observed 455 kg ha⁻¹ and 193.7 kg ha⁻¹, respectively. Maximum root density of VFR (live or dead) was found at 0-10 cm soil depth, i.e. 48.8 per cent and 46.7 per cent, respectively. Month-wise maximum VFR production (live or dead) was found in October, i.e. 328.9 kg ha⁻¹ and 141.3 kg ha⁻¹, respectively, and minimum was in April, i.e. 22.1 kg ha⁻¹ and 10.6 kg ha⁻¹, respectively. Nutrients contents (NPK) decreased with increase in age of plantation. Maximum nutrient content (NPK) in live FR was found at 0-10 cm soil depth in August (2.41%, 0.41%) and October (2.22%), respectively, and minimum was in December (0.13%, 0.40%, 0.13%), respectively. Maximum nutrient content (NPK) in dead FR was found at 0-10 cm soil depth in August (1.43%, 0.25%, 1.31%), respectively, and minimum was in April (0.11%), February (0.06%), December (0.15%), respectively. Maximum nitrogen and phosphorus in live VFR was found more in February (2.05%), August (1.31%), respectively, and minimum was found in April (0.12%), December (0.02%, 0.08%), respectively. Maximum nitrogen and phosphorus in dead VFR was found more in August (1.12%) and February (0.22%), respectively. But in exception, potassium was found more in 7-year age of plantation in August (1.09%), and minimum was in April (0.02%, 0.80%), respectively. DBH and height was found maximum (34.8 cm, 24.6 m, respectively) of 7-year and minimum (11.6 cm, 1.0 m, respectively) of 1-year old poplar plantations.

11-15

MANAGEMENT OF *Helopeltis theivora* WATERHOUSE ON TEA WITH COMBINATIONS OF *Beauveria bassiana* (Bals.) Vuill. AND SOME INSECTICIDES

Mayuri baruah and Benazir Ahmed*

Department of Entomology, Assam Agricultural University, Jorhat-785 013, Assam

**Assistant Professor, College of Agricultural Biotechnology, Pokhrani, Maharashtra*

Field experiments on the efficacy of two recommended insecticides, Endosulfan and Cartap hydrochloride alone or in combinations with a mycopathogen, *Beauveria bassiana* were conducted against Tea mosquito bug, *Helopeltis theivora* Waterhouse in Experimental Garden for Plantation Crops, Assam Agricultural University, Jorhat during 2000-2003. The treatments were Endosulfan (0.07%), Caldan (0.05%), Endosulfan (0.035%) + *B. bassiana* (1×10^7 spores/ml), Caldan (0.025%) + *B. bassiana* (1×10^7 spores/ml), *B. bassiana* (1×10^7 spores/ml) and control (water mixed with Tween 80@0.23%) taken against the serious pest of the major plantation crop of our nation. Six bushes were selected at random for counting the pest population and infested shoots. The highest reduction of the pest population was recorded with Endosulfan 0.07% with 100% and caldan (0.05%) with 94.31% mortality. The combination of Endosulfan + *B. bassiana* recorded significant reduction of pest population over control (72.93%). All the treatments were highly effective making the plantation free from shoot infestation whereas *B. bassiana* showed 39.03 and 24.57 per cent shoot reduction. Highest yield was recorded in endosulfan treated plots (532.22 kg/ha) followed by caldan (457.78 kg/ha). The combined treatment of endosulfan + *B. bassiana* recorded 425.33 kg/ha whereas caldan + *B. bassiana* recorded 416.11 kg/ha. Sole treatment of *B. bassiana* recorded only 357.22 kg/ha. The combination of chemical and myco-insecticides revealed a promising result in management of tea mosquito bug.



11-16

GROWTH AND YIELD PERFORMANCE OF *HEVEA* CULTIVATION AT TWO DIFFERENT SLOPES OF WEST GARO HILLS, MEGHALAYA

A.P. Thapliyal, R.P. Singh and P. Khoyumthem

Rubber Research Institute of India, Regional Research Station, Rubber Board, Tura-794001, Meghalaya

Growth and yield performance of RRIM 600 clone were compared when planted in two different locations, North North East (NNE) and South West South (SWS) aspect of slope, under varying agro-climatic conditions of Garo Hills of Meghalaya. Analysis showed that soil moisture content was higher in NNE aspect of slope as compared to SWS aspect of slope. Significant differences of soil moisture content in different month were observed in both the slopes. Plants grown in NNE aspect of slope showed higher yield and significant positive correlation between yield and soil moisture content and air temperature while low yield observed in SWS aspect of slope and did not show significant correlation with soil moisture content and air temperature. However, plants grown in NNE and SWS aspects of slope did not show significant variation in growth. The study revealed that NNE aspect of slope is more suitable in terms of yield for rubber cultivation under agro-climatic condition of Garo Hills of Meghalaya where land is not a limiting factor.

11-17

ACHIEVING FOOD SECURITY IN ARID ZONE – A CASE OF *TECOMELLA* BASED AGRO-FORESTRY SYSTEM

B.K. Garg and Praveen Kumar

Central Arid Zone Research Institute, Jodhpur 342003, Rajasthan

Food security of desert dwellers may be achieved either by increasing productivity or by increasing their purchasing power. Either of them encompasses integration of host of crop management practices which owe their success to sound physiological basis of different interventions like selection of genotypes and spacing besides application of fertilizers and growth regulators. Though pearl millet is a traditional crop of Indian arid zone but economic gains of the interventions are more pronounced in clusterbean as it has commercial value. However, in arid zone due to frequent crop failures there is need for an insurance against aberrant weather which is possible through introduction of perennial component in a cropping field. In arid zone, however, suitability of trees shall depend primarily on change in plant water status upon water stress, lateral root regeneration potential and root characteristics. *Tecomella undulata* holds promise in this regard. In the present paper, physiological basis of the advantages of *Tecomella – Cyamopsis vis-a-vis Tecomella – Pennisetum* agro-forestry system is discussed in comparison to the sole crop system with emphasis on temporal and spatial variation in moisture and nutrient availability and impact on crop water status, growth, chlorophyll fluorescence and yield.

11-18

EFFECT OF LEAF EXTRACTS OF SOME AGRO FORESTRY TREE SPECIES ON GERMINATION AND GROWTH OF FOOD CROPS

Luna Barooah and B.P. Bhatt

I.C.A.R. Research Complex for N.E.H. Region, Nagaland Centre, Medziphema, Nagaland- 797 106

An experiment was conducted at I.C.A.R. Research Complex for N.E.H. Region, Medziphema, Nagaland during 2008 to study the influences of leaf extracts of *Gmelina arborea*, *Michelia champaca*, *M. oblonga* and *Trema orientalis* on cereals- *Oryza sativa* (cv. Ranjit) and *Zea mays* (cv. Vijay Composite); legumes- *Vigna*



radiata (cv. SG-1) and *V. umbellata* (cv. Naga Local); and oilseeds- *Arachis hypogaeae* (cv. ICGS 76) and *Brassica campestris* (cv. TS-38). The results of the experiment revealed that germination, growth and dry matter production of test crops was significantly ($P = 0.05$) reduced by the leaf extracts. On average, there was 11.0, 21.5 and 25.3% reduction, respectively, in germination, root-shoot length and dry matter yield, irrespective of tree species and test crops. Magnitude of toxicity was recorded highest due to *G. arborea* (11.5, 25.0 and 26.0%, respectively, to germination, root-shoot length and dry matter production, irrespective of test crops). Among various test crops, *A. hypogaeae* was found most susceptible being reduction by 25.84, 31.61 and 36.69%, respectively, in germination, root-shoot length and dry matter yield. *O. sativa* ranked second in order of sensitivity to toxic accumulation of tree-crops. *V. umbellata* was, however, found resistant to phytotoxic influence of tree species to some extent.

11-19

INFLUENCE OF ROOT BIOMASS ON NET PHOTOSYNTHESIS AND ASSOCIATED PHYSIOLOGICAL TRAITS IN ROBUSTA COFFEE UNDER SOIL MOISTURE STRESS CONDITIONS

Mallikarjun G. Awati, C. G. Anand,* G. F. D'souza,* B. S. Tambat,** N. S. Renuka Swamy* and M. Udaya Kumar**

Regional Coffee Research Station, Thandigudi - 624 216, Dindigul District, Tamil Nadu

*Central Coffee Research Institute, C R S(Post) - 577 117, Chikmagalur District, Karnataka

**Department of Crop Physiology, University of Agricultural Sciences, GKVK, Bangalore-560 065
dsouzagfcri@yahoo.co.in

Root system plays a major role in sustaining the growth and productivity of plants by absorbing water and mineral nutrients from the soil. In general, rooting capacity is an important drought avoidance trait in determining the response of plants to drought. A study was initiated with an objective to assess the influence of root biomass on photosynthetic efficiency of plants under water stress conditions in robusta coffee seedlings. Total 31 accessions of *Coffea canephora* were maintained under 70% agro-shade net with two levels of moisture regimes i.e. 80 and 60 % of field capacity respectively as control and water stress conditions for 175 days. Initial and final observations were recorded on root and shoot biomass, total dry matter production, whole plant level net assimilation rate (NAR), leaf area duration (LAD), mean transpiration rate (MTR) and single leaf level gas exchange parameters i.e. net photosynthesis (P_n), stomatal conductance (g_s), transpiration rate (E) etc. under non-stress and moisture stress conditions. The study revealed that, some of the accessions namely S.4045, S.4042, BR.9, BR.12, S.3311, S.3332, CxR showed moisture stress induced increase in root dry weight, total biomass and root to shoot ratio compared to non-stress conditions. Similarly, increase in the root to shoot ratio (4.5 to 5%) with less reduction of root biomass (2.5 to 3%) and high decrease in shoot growth (9.5 to 10%) observed under moisture stress conditions. A significant ($p < 0.01$) positive correlation between root biomass and net photosynthesis was observed under both control and moisture stress conditions. However, strong positive relationship was observed under moisture stress ($r = 0.65$) compared to control ($r = 0.41$) condition in robusta. A significant ($p < 0.05$) positive correlation between root weight and E ($r = 0.47$) under control and no relationship existed between root weight and E in moisture stress conditions. Similarly, strong positive association between shoot biomass and P_n ($r = 0.66$), total biomass and P_n ($r = 0.66$) and whole plant NAR and P_n ($r = 0.58$), LAD and P_n ($r = 0.64$) observed under stress condition. However, no relationship noticed with above parameters under non-stress condition. Also, strong significant ($p < 0.01$) negative correlation between root weight and C_i/g_s ratio (mesophyll efficiency) observed under moisture stress ($r = -0.51$) than compared to control ($r = -0.42$) condition. The significant positive relationship between root dry weight, shoot dry weight, total dry matter production, NAR and LAD with net photosynthesis and negative association between root weight and C_i/g_s ratio together with stomatal control and also increase of drought induced root to shoot ratio signifies the importance of root system on growth and development in robusta coffee especially under long run and acclimatized moisture stress conditions.



11-20

DIAGNOSIS AND RECOMMENDATION INTEGRATED SYSTEM (DRIS) USING LEAF NUTRIENT NORMS FOR ROBUSTA COFFEE (*Coffea canephora pierre ex. Froehner*)

N.S. Renukaswamy, G.F. D'Souza, M.G. Awati, C.G. Anand and Jayarama

Central Coffee Research Institute, Coffee Research Station Post-577 117, Chickmagalur Dist, Karnataka
dsouzagfcri@yahoo.co.in

Nutrients play an important role in plant metabolism and leaf is the principal site of metabolism which determines the productivity of the plant and coffee is not an exception. The Diagnosis and Recommendation Integrated System (DRIS) was used for developing diagnostic norms for robusta coffee. Nutritional survey was conducted at Koppa liaison zone in Chikmagalur district of Karnataka state by selecting sixty four representing high and low yielding estates of robusta coffee. The major leaf nutrient level of N, P, K, Mg and S ranged from 2.97 to 3.56, 0.16 to 0.18, 1.35 to 2.07, 0.24 to 0.46 and 0.14 to 0.31 per cent and micronutrient levels of Fe, Zn, B and Mn ranged from 270 to 400, 28.83 to 43.66, 43.34 to 74.64 and 28.14 to 48.48 ppm respectively during pre monsoon period. Similarly, during post monsoon period these nutrient levels ranged from 3.22 to 3.99%, 0.14 to 0.21%, and 1.57 to 2.06%, 0.19 to 0.39%, 0.09 to 0.28%, 175 to 322 ppm, 12.7 to 36.31 ppm, 41.09 to 70.56 ppm and 40.47 to 57.13 ppm respectively. The physiological components such as total carbohydrates and C/N ratio also showed the seasonal variation and ranged from 2.36 to 5.90 & 2.63 to 7.11% and 0.71 to 1.95 and 0.63 to 1.96% during pre & post monsoon periods respectively. The results of DRIS indices and nutrient diagnosis of low yielding estates, indicated most often more than one nutrient was limiting the productivity. In majority of the estates, N, P, Mg, Fe, Zn & B during pre monsoon period and N, P, Fe, Zn & S contents during post monsoon period were the major limiting factors for crop production in robusta coffee. The low yielding estates also have shown high nutrient imbalance index (NII). Besides application of optimum level of macronutrients, feeding of micronutrients such as S, Zn and B could be useful to improve the crop yield of robusta coffee.

11-21

INTERACTION EFFECTS OF ROOTSTOCK SCION COMBINATIONS ON COMPATIBILITY & MORPHOLOGICAL TRAITS IN COFFEE

G.F.D' Souza¹, N Rajeswari², H.N. Ramesh Babu², N.S. Renuka swamy¹, B. Lamani¹, C.G. Anand¹ and Jayarama¹

¹Central Coffee Research Institute, Coffee Research Station -577 117 Chickmagalur Dist, Karnataka

²Dept of Botany and Seed Technology, Sahyadri Science College, Shimoga - 577 203, Karnataka
dsouzagfcri@yahoo.co.in

An experiment was conducted using coffee seedlings to generate information on grafting compatibility and rootstock scion interactions on morphological traits. Scions of three commercially important arabica cultivars such as S.795, Sln.10 and S.4202 were grafted with drought tolerant root stocks of three arabica such as Sln.9, Sln.5 (B) and Sln.11 and two high vigor robusta cultivars S.274 and CxR. The interaction effects were compared with pure line seedlings of scion materials. Among the combinations cent percent compatibility was obtained in arabica/arabica graft combinations compared to robusta/arabica combinations. Among the combinations arabica/arabica grafts recorded higher seedling height (8.56%), number of nodes (10.34%), number of leaves (25.0%), leaf area (49.25%) and internodal length (40.74%) compared to robusta/arabica grafts. The robusta root stocks being diploid species ($2n = 22$) significantly reduced the growth traits of tetraploid ($2n = 44$) arabica scion materials. The higher vigour in arabica/arabica combinations compared to robusta/arabica and self graft combinations might have been due to the influence of genetically divergent root stocks of same species. The S.795 scion on Sln.9, Sln.5 (B) and Sln.11 rootstocks were found to be high growth types. The identified high growth type root stock scion combinations could be further evaluated for field performance.



11-22

CHEMICAL LAND ORGANOLAPTIC PROPERTIES OF TEA AS AFFECTED BY ORGANIC CULTURE

G.K. Saikia, A. Deka and A.C. Barbora

Department of Tea Husbandry and Technology, AAU, Jorhat-785 013, Assam

Effects of organic culture on chemical and organolaptic properties of tea were evaluated in the department of Tea Husbandry and Technology, Assam Agricultural University, Jorhat 785013, Assam during 2002-2003. Organic culture had no effect on some characters of made tea viz. total colour and brightness. However, organically produced tea had lower caffeine content compared to tea produced by inorganic methods. Organolaptically, organically produced tea had better quality and tea tasters scored higher valuation for it. TF : TR ratio of tea produced both in organic and inorganic ways was within desirable limit.

11-23

SEASONAL FLUCTUATIONS IN CONSUMPTIVE WATER USE IN FIVE TREE SPECIES IN ARID ZONES OF NORTH-WEST INDIA

R. Angrish, K.S. Datta, O.P. Toky*, S. Madan, C. Rani and V. Arora**

*Dept. of Botany and Plant Physiol., *Dept. of Forestry, CCS Haryana Agricultural University, Hisar 125 004
**angrish@hau.ernet.in*

We studied consumptive water use or 'bio-drainage potential' of five tree species i.e. *Casurina equisetifolia*, *Eucalyptus teriticornis* clone 10, *Melia azadirach*, *Prosopisjuliflora* and *Terminalia arjuna* in specially designed soil-embedded lysimeters at Hisar (aridity index 80%). It was observed that in the dry summer months of end April through early June *C. equisetifolia*, *E. teriticornis* and *P.juliflora* could transpire up to 80 L day⁻¹. But in winter months transpiration potential of trees decreased considerably. Even in species like *E. teriticornis* and *C. equisitifolia*, Which are evergreen and maintain high leaf area values in winter, the bio-drainage capacity was as low as 10-16 L day⁻¹. Intermediate response was observed during wet months of end July through August. Our studies suggest that consumptive water use was maximum towards April-early June when high temperatures coupled with low relative humidity is reflected as 8-10 mm day⁻¹ of pan evaporation values. Conversely, in December-January, when pan evaporation values were 1.5-2 mm day⁻¹, the transpiration loss was also minimal. The significance of knowledge of bio-drainage potential of the tree species in irrigated arid agro ecosystem shall be discussed.

11-24

AGROFORESTRY INTERVENTIONS IN BAMBOO (*Bambusa* spp.) PLANTATION TO SUSTAIN PRODUCTIVITY OF FRAGILE AGRO-ECOSYSTEM

T. Vanlalngurjauva¹, P.K. Dhara², H. Banerjee^{3*} and D. Mazumdar⁴

^{1&2}Department of Soil and Water Conservation, ³Department of Agronomy, ⁴Department of Agricultural Statistics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal

Agroforestry is a land use system which offers viable potential to farmers for diversifying their income and to increase farm production. It plays vital role in livelihood by providing basic requirements like food, fuel, fodder, fibre etc. Taking cognizance of above facts, the present study was initiated during October 2007 at Research Farm of BCKV, Jhargram, West Bengal to study the potentiality of bamboo based agroforestry system in rainfed upland situation under red & laterite zone of West Bengal. Culm cuttings of two bamboo species, namely *Bambusa tulda* and *Bambusa balcooa* were planted under two spacing, viz. 10 x 10m (100 clumps/ha) and 12 x 10m (84 clumps/ha). The experiments were laid out in a 3 factor factorial RCBD with 3 factors as system of cropping, species and spacing replicated thrice. Each plot contains 12 clumps (3 x 4, rows x clumps) and altogether 12 such plots have been maintained in the experiment. Four arable crops viz. paddy, groundnut,



pigeon pea and turmeric were cultivated during rainy (kharif) season. Results indicated that survival rate of both the bamboo species was 100%. Though all the growth parameters of both the bamboo species were higher when grown under intercropping situation than sole plantation, but no significant difference was observed when planted at closer and wider spacing (under both sole and intercropping situation). Yield of intercrops was slightly higher in sole cropping than intercropping system. Further yield difference (of intercrops) among two bamboo plantations was also negligible. But yield of all intercrops was higher in wider spacing (12 x 10m) as compared to closer spacing (10 x 10m). It is noteworthy to mention that bamboo based agroforestry system has immense potentiality for providing livelihood security to the poor farmers of western part of West Bengal through self employment and higher income. Future studies should be conducted towards exploration and selection of economically and socially acceptable bamboo species compatible with intercrops under appropriate agroforestry based model.

11-25

KHIRNI FOR SAPOTA AND MAYFAL FOR NUTMEG ARE THE BEST ROOTSTOCKS FOR PLANTING MATERIAL PRODUCTION

M.P. Kandalkar, B.R. Salvi, S.A. Chavan and N.V. Dalvi
Regional Fruit Research Station, Vengurle, Dist. Sindhudurg, Maharashtra

Traditionally Sapota was propagated by air layering or approach grafting. Nutmeg was cultivated by raising seedling or by grafting on same rootstock. However the research carried out during last 10 years at Regional fruit research station vengurle have produced promising results. Khirni (*Manilkara hexandra* L.) and Mayfal (*Myrestica jumbotina* L.) are the plants which are found in the forests of Thane and Sindhudurg districts respectively; are found to be the promising rootstocks which are unexploited for planting materials production. This has immense potential for commercial use. The details of the observations recorded are given in is research paper. The research trial was conducted at Regional Fruit Research Station, Vengurle during the year 2006-2009. The seeds of Khirni and Mayfal were sown on raised beds. After germination Khirni seedlings of 9- 12 months age were used for Sapota grafting with variety Kalipatti. Mayfal seedlings were used for grafting at the age of 45-60 days for Nutmeg with variety Konkan Sugandha. During this research trial observations related to seed germination, growth parameters, seed viability, root system and grafting success were recorded. The results of this trial have shown that it takes 15 days for Khirni and 45 days for Mayfal to germinate. Both the seeds germinate to the tune of 70 – 75 %. Seed viability of Mayfal is for one month and Khirni remains viable for three months. The nursery techniques standardized for commercial production of nutmeg and Sapota grafts have shown that Khirni seed need to be soaked for 24 hours before sowing; where as Mayfal seed need to be sown immediately after harvest to avoid loss of viability. The grafting season of Sapota on Khirni is August to October and March to May whereas the Nutmeg grafts success is best during July, August and September months. The best growth of Mayfal for grafting Nutmeg is more than 15 cm height and for Khirni it is in the range of 30- 45 cm for Sapota grafting. The minimum number of leaves on seedling should be 8 for Mayfal and 14 for Khirni. The success percentage of Sapota on Khirni rootstock is 70% and that of Nutmeg on Mayfal is 80%. The present findings indicate that the unexploited rootstock Khirni and Mayfal are best suited for commercial production of Sapota and Nutmeg planting material respectively.

11-26

MANGO CULTIVARS FOR COMMERCIAL PRODUCTION IN KONKAN REGION OF MAHARASHTRA

N.V. Dalvi, B.R. Salvi, M.P. Kandalkar, S.A. Chavan and A.Y. Munj
Regional Fruit Research Station, Vengurle, Sindhudurg, Maharashtra

Mango the commercially grown and main fruit crop of konkan region in Maharashtra. So far mango is being cultivated in this region on 1,64,000ha; with 95% area is under sole variety Alphonso. Alphonso is a alternate bearing variety with low yield (3.0MT/ha) and having spongy tissue malady. Efforts were made to



collect the germplasm and maintain at this centre. Regional Fruit Research Station, Vengurle has so far collected and maintained 279 Mango germplasm. All these collections are being evaluated regularly every year for their growth, flowering, fruiting and physico-chemical properties. Every year 120-130 germplasm flowers and give fruits. Over the years the yield data recorded since 1975 have shown that Alphonso, Payri, Keshar, Goa mankur, Neelam and Totapuri are traditionally being cultivated by the farmers. During last two decades several hybrids have been evolved nationwide. Among these hybrids, Ratna, Amrapali, Mallika and Sindhu are performing very well. Thirteen exotic mango collection have been maintained at this centre. Among these Kensington, Lilly, Tommyatkins and Ostin are performing well at Regional Fruit Research Station, Vengurle. The yield data and physico-chemical properties related to traditionally grown six mango cultivars, four improved mango hybrids and four exotic cultivars are presented and discussed in this research paper. Among the traditionally grown various cultivars Alphonso tops the table; due to its best quality. Alphonso has unique quality due to its typical sugar acid blend having 19-21° B TSS and 0.23-0.30% acidity. The pulp is 74 %, 14% Peel weight and 12% seed weight. The fruits shelf life 17-21 days under ambient temperature. Due to its long lasting shelf life and excellent taste it fetches premium price in the market. The flowering and fruiting of Alphonso is the earliest among various mango cultivars. The remaining five percent area of the konkan region is covered by the cultivars like Payri, Keshar, Goa mankur, Neelam and Totapuri. All these cultivars come up very well under konkan region. Payri and Goa mankur are alternate bearing while Keshar, Neelam and Totapuri are regular bearer. Quality of all these varieties is also good but price fetch in the market by these varieties is next to Alphonso. For improving the mango yield and getting good tonnage per unit area the improved hybrids tested at this centre have given good results. Among the hybrids Ratna stands first due to its excellent quality large size fruits. Out of thirteen exotic mango hybrids tested Lilly stands first due to its higher yield, large size fruits, good attractive colour and excellent taste followed by Kensington, Ostin and Tommy atkins. At Regional Fruit Research Station, Vengurle out of 279 mango germplasm maintain and evaluated 165 germplasm have started giving fruits. The fourteen good, elite varieties that are being discussed here have shown promising results due to their higher yield, good keeping quality, excellent taste and commercial importance.

11-27

GENERATION OF EXPRESSED SEQUENCE TAGS (ESTs) FROM BLISTER BLIGHT TOLERANT CLONES OF TEA PLANT (*Camellia sinensis*)

Richa Namdev, Diganta Deka, Munmi Phukon, M.K. Modi, and P. Sen

Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat-785 013

Tea possesses a great value due to its popularity as a drink and also as a source of secondary metabolite products. Blister Blight disease caused by the fungus *Exobasidium vexans* is the major disease affecting the tender harvestable shoots of tea resulting in enormous crop loss. Up to now, the genomic information and gene expression patterns of tea plant (*Camellia sinensis*) have not been studied in detail. To understand the genetics of blister blight tolerance, Expressed Sequence Tags (ESTs) are generated and analysed. ESTs are short and single pass sequence reads from mRNA (cDNA) representing snapshot of genes. Analysis of these ESTs shall greatly help us to understand the genes involved in response to pathogen attack and environmental stress. Isolation of nucleic acids from tea is cumbersome due to the presence of high concentration of polyphenols and polysaccharides etc. In the present study Total RNA was isolated from Blister Blight tolerant clone of *Camellia sinensis* (SMP-1) by using Guanidine-HCl without liquid Nitrogen. This is the first report of isolation of RNA from a highly polyphenolic plant like tea without liquid nitrogen. The mRNA was purified from the total RNA followed by double stranded cDNA synthesis. cDNA fragments were fractionated and fragments more than 400 bp were ligated to Lambda Triplex2 vector. The Vector-cDNA ligation mixture was packaged and library screening and amplification was performed. The plasmids with inserts were isolated using tooth-pick method and then were sequenced and analysed. A total of 350 cDNA clones were sequenced and analysed in which a total of 124 high quality EST sequences were generated, among which, 103 ESTs had significant homology with sequences in NCBI non-redundant protein database by BLASTx analysis. The matched ESTs were classified into putative cellular roles like transcription, protein synthesis and energy related category. This study provides an overview of mRNA expression profile and a diverse genetic resource for tea plant research. Further generation and analysis of ESTs and construction of subtractive library is under progress.



Young Scientist Session



01

CLIMATIC VARIABILITY IN THE RAIN-FED FARMING ECOSYSTEMS IN INDIA

Abhishek Chandra^{1*}, Pallavi Saxena² and Rakesh Verma¹

¹Dept. of Environmental Sci. & Engineering, Guru Jambheshwar Unvi. of Sci. & Tech., Hisar-125001

²Centre for Environ. Management of Degraded Ecosystems (CEMDE), Univ. of Delhi, Delhi-110007

* ac.india@gmail.com

Rain-fed agriculture will remain the dominant source of staple food production and the livelihood foundation of the majority of the rural poor in Indian village ecosystem. Greatly enhanced investment in agriculture by a broad range of stakeholders will be required if this sector is to meet the food security requirements of tomorrow's India. However, production uncertainty associated with between and within season rainfall variability remains a fundamental constraint to many investors who often overestimate the negative impacts of climate induced uncertainty. Climate change is likely to make matters worse with increases in rainfall variability being predicted. The ability of agricultural communities and agricultural stakeholders in India to cope better with the constraints and opportunities of current climate variability must first be enhanced for them to be able to adapt to climate change and the predicted future increase in climate variability. Present investigations were carried out in Central Himalayan village ecosystem with special emphasis on change in cropping pattern and for a better understanding, characterization and mapping of the agricultural implications of climate variability and the development of climate risk management strategies specifically tailored to the needs of the cultivators. Agrobiodiversity present in this agro-ecosystem has a high probability of bio-physical and economic success in the context of climate variability.

02

DIFFERENT NUTRITIONAL VARIATION OF SELECTED INDIAN BANANA CULTIVARS

R. Dhandapani, Ajay Arora, V.P. Singh, Neera Singh

Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

Ultimate goal of agriculture research is to increase productivity and in turn ensure food security to the nation. Next to food security, nutritional security is the major area of concern for agricultural research. Vitamin A deficiency (VAD) and malnutrition are the serious health problem in many developing countries. Beta carotene is the most potent precursor of vitamin A, found abundantly in fruits like Banana. Moreover, India is the largest producer of Banana in the world and it provides livelihood security to thousands of people as "poor man's apple". So, screening the genetic diversity of major Indian banana cultivars that contain various valuable bioactive compounds, such as carotenoids (specifically β -carotene), carbohydrates and protein as well as mineral nutrients in the fruit may offer a potential food source for alleviating vitamin A deficiency and malnutrition. The high performance liquid chromatography analysis of twelve selected banana cultivars shows peels are the good source of β -carotene. Among them, peels of 'Red banana' (781 $\mu\text{g}/100\text{g}$ peel) and 'Karpooravalli' (737 $\mu\text{g}/100\text{g}$ peel) shows highest β -carotene on the basis of fresh weight. 'Red banana' also shows highest β -carotene in pulp (303 $\mu\text{g}/100\text{g}$ pulps). 'Cavendish' cultivar found to hold second highest β -carotene in pulp (255 $\mu\text{g}/100\text{g}$ pulps). However, plantains such as 'Nendran', 'Mondan' contains the highest β -carotene content in pulp (1362 $\mu\text{g}/100\text{g}$ pulp) and peel (1129 $\mu\text{g}/100\text{g}$ pulp) respectively. Phytoene synthase, the gene present in the upstream of the carotenoid biosynthetic pathway as rate limiting candidate is also identified and molecular characterized. The estimated protein content also follows the same trend as banana peel contains more protein than in pulp. But, plantain like 'Mondan' contains 2442 μg protein in one gram of pulp. 'Red banana' contains the highest starch content in peel (82 $\mu\text{g}/\text{g}$ peel) and pulp (269 $\mu\text{g}/\text{g}$ pulp). Next to Red banana, 'Mondan' contain more starch in pulp (212 $\mu\text{g}/\text{g}$ pulp). Mineral nutrients like Mg^{+2} , Fe^{+2} , Zn^{+2} and Mn^{+2} also found to present more in peel than pulp. Thus, banana cultivars like 'Red banana', 'Karpooravalli' and plantain cultivars like 'Nendran', 'Mondan' can be regularly exploited for their bioactive compounds.



03

ISOLATION AND CHARACTERIZATION OF ABIOTIC STRESS RESPONSIVE MUTANTS OF *ARABIDOPSIS*

Puja Rai, Viswanathan, C., Ajay Arora, K. C. Bansal, Monika, Abhay Kumar

Division of Plant Physiology, IARI, New Delhi-110012

pujaiari@gmail.com

Abiotic stresses cause depreciation in crop yield up to 70%. Development of abiotic stress resistant crops is necessary to sustain the agricultural production. Hence, in this study *Arabidopsis* was chosen as model system for T-DNA mutagenesis mediated forward genetic analysis of salt stress response mechanisms in plants. Putative abiotic stress responsive T-DNA insertion mutant lines of *Arabidopsis thaliana* (L.) Heynh. ecotype Columbia, were screened to isolate mutants impaired in salt (NaCl) stress response *in vitro*. Secondary screening in T3 generation of T-DNA lines lead to the identification of two salt stress hypersensitive mutants namely *salt overly sensitive 101* (*sos101*) and *sos102*, and four salt tolerant mutants namely *salt stress resistant 1* (*sst1*), *sst2*, *sst3* and *sst4*. Characterization of these mutants in T4 generation under photoautotrophic salt stress conditions, also confirmed their impaired salt stress response. Studies on ABA, glucose and oxidative stress responses revealed that *sst* mutants isolated in this study are not impaired in ABA signaling pathways and are non-allelic to previously known salt resistant mutants. Genomic location of T-DNA insertion in the mutants was mapped by using TAIL-PCR, and further confirmed by diagnostic PCR using *Arabidopsis* specific and T-DNA specific primer pairs. *sos101* mutation is caused by T-DNA insertion in the promoter region of *SOS101* (AT1G64610), which encodes a WD-40 repeat family protein. Salt stress up regulation of *SOS101* suggests that *SOS101* is a positive regulator of plant salt tolerance. The *sst3* knock-down mutation is caused by T-DNA insertion in the 3' UTR region of *SST3* (At2G30210), which encodes a putative laccase (*LACCASE 3*, *LAC3*). A constitutively low level of *SST3* probably contributed to the enhanced tolerance. In *sst4* mutant, T-DNA insertion is at 1087 bases upstream to the initiation codon of *SST4a* (At3G48770) and -1189 bases 5' to the transcription start site of *SST4b* (At3G48780) genes. *SST4a* encodes an ATP-binding/DNA binding protein, while *SST4b* encodes a serine C-palmitoyltransferase probably involved in sphingolipid biosynthesis.

04

RECENT TRENDS IN SHIFTING CULTIVATION (Jhum) PRACTICES AMONG THE GAROS OF MEGHALAYA: A CASE STUDY

Dhrubajyoti Bordoloi, Pawan K Kaushik, Vishavjit Kumar and P.K. Verma

Shifting Cultivation Division, Rain Forest Research Institute, Jorhat, Assam

Shifting cultivation popularly known as jhum in North East India is the oldest form of agricultural land use system in Meghalaya alike other states in the region. The East, West and South Garo hill districts of Meghalaya are predominantly inhabited by Garos tribes. Traditionally, Garos are food gatherer and indigenous shifting cultivators as the Jhum is their main agricultural land use system. Garos have a vast wealth of traditional ecological knowledge through which they manage their landscape by integrating agriculture and forestry efficiently. They grow cereals (rice, maize, finger millet), tuber crops (tapioca, dioscorea), vegetables, spices (ginger, turmeric) and NTFPs on same plot. As a result of reduced fallow period, jhum plot area per household, crop diversity, crop yield, soil fertility in jhum lands traditional shifting cultivators are facing difficulty in meeting their livelihood requirements. As a result they are taking up horticultural and other plantation crops on their jhum fallows. This present paper analyses the existing system of Jhum in relation to its transformation with time aiming to identify future research needs.



05

IMPROVING REPRODUCTIVE EFFICIENCY Zn DENSITY AND SEED YIELD OF GREEN GRAM THROUGH FOLIAR APPLICATION OF Zn AT EARLY REPRODUCTIVE PHASE

Girish Chandra Pathak, Bhavana Gupta and Nalini Pandey

Department of Botany, Lucknow University, Lucknow, Lucknow-226007, UP

To study the involvement of Zn in plant reproductive development plants of Green gram (*Vigna radiata* L.) were grown in refined sand culture with sufficient (1 μ M) and marginally deficient (0.2 μ M) supply of Zn under glass house conditions. At the onset of the reproductive phase, 0.1% ZnSO₄ was applied as foliar spray to both zinc sufficient (S) and zinc deficient (D) plants and these treatments were referred as sufficient foliar (SF) and deficient foliar (DF) respectively. The effect of the Zn treatments was studied on pollen and stigma structure, its involvement in fertilization seed Zn and seed yield. The plants grown with deficient supply of Zn reduced the size of anthers, pollen producing capacity, the size and viability of pollen grains. *In vitro* germination of pollen grains was reduced and a large number of pollen grains of Zn deficient plants failed to produce pollen tubes. Zinc status of plants affected the activities of acid phosphatase and esterase enzymes in stigma and pollen grains. Zinc deficiency reduced the setting of seeds and their size. In conclusion alleviation of Zn deficiency by foliar application of Zn as ZnSO₄ to deficient plants prior to initiation of flowering minimized the severity of Zn deficiency effect on pollen- stigma morphology, pollen fertility and greatly enhanced seed yield of plants but normalcy was not restored. Foliar application of Zn imposed not only the boldness and vigor of seeds but also the Zn content in seed. Improving the zinc content in seeds due to foliar application being beneficial for human would also acts as starter fertilization for an early establishment of the crop on low zinc soils

06

GAMMA IRRADIATION FOR POST HARVEST PRESERVATION: SUCCESSES, LIMITATIONS AND SOCIO-ECONOMIC FEASIBILITY OF THE TECHNOLOGY

Mahesh Kumar and Bhupinder Singh

Division of Plant Physiology, Indian Agricultural research Institute, New Delhi-110 012

India is second largest producer of fruits and vegetables. It produces 49 mt of vegetables and 101 mt of fruits, which is more than sufficient to meet the nutritional requirement of its population. However, about 25 to 40 % of our fruit and vegetable production is wasted due to poor post harvest management and insufficient storage infrastructure and technologies. Even globally the post harvest losses of agricultural produce are as high as 30%. Known storage option are only available and used by a handful of resource rich farmers. Gamma irradiation (also called cold pasteurization) is one of the most promising emerging technology for improving the shelf life and post harvest storage and quality of the produce. Gamma irradiation is a physical and non chemical process which leaves no residue. It is a relatively low cost, broad spectrum technology and a low energy alternative to freezing, refrigeration etc. The acceptability and popularity of the technology is however, marred by high costs of Installation, trained manpower availability and awareness in the farming community about its safe use and dose-application relationship. Irradiation proved to be extremely beneficial in terms of prolonging the fruit and vegetable shelf life by 3–5 times. Our results reveal an extension in shelf life of tomatoes (at red stage) by 7 days and for mangoes by 11 days as against mean average of 4 days in unirradiated treatment. Irradiated moonbeam and wheat could be stored for more than 1 year with only 5% seed loss as against 95% loss in unirradiated control. No loss of seed protein and nutrient quality was observed in irradiated treatment even after 18 months of storage at room temperature. These results will be discussed.



07

EFFECT OF ARSENIC ON SOME PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF BORO RICE DURING SEEDLING GROWTH

M. Begum, P. Dutta and S. Mondal

*Dept. of Plant Physiology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741 252, W.B.
minsura_08@rediffmail.com*

Arsenic is a potential contaminant of groundwater as well as soil in many parts of the world. The objective of the study was 1) to study the effect of different forms of arsenic on photosynthetic parameters, 2) to study the oxidative stress induced by arsenic stress and anti-oxidative responses of rice plant. Seedlings, grown in hydroponic culture with half strength Hoagland nutrient solution were treated with 0, 5, 10, 15 and 20 mg/L as Na_3AsO_4 and As_2O_3 . Arsenic significantly enhanced lipid peroxidation, whereas catalase activity, net photosynthetic rate, transpiration intensity and stomatal conductance decreased in response to arsenic, which is a typical reaction of the plants to a presence of oxidative stress. Arsenite was found to be more toxic than arsenate. Increase of lipid peroxidation and decrease of catalase activity, photosynthetic parameters caused by arsenite was higher than that of arsenate. The rates of physiological processes were more seriously affected in arsenite treated plants where plants did not survive for five days at the concentration of 15 ppm and/or beyond.

08

IN VITRO SCREENING OF RICE GENOTYPES FOR DROUGHT TOLERANCE BY POLYETHYLENE GLYCOL INDUCED STRESS

Rohit Joshi*, Alok Shukla* and R.K. Sairam#

**Department of Plant Physiology, College of Basic Sciences and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand-263145*

#Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

The aim of the present investigation was to develop a regeneration protocol and also to screen calli for drought stress tolerance using mature embryos as explants. Mature embryos of four rice (*Oryza sativa* L.) cultivars, viz. Pusa Basmati 1, Pant Sugandh Dhan 17, Taraori Basmati and Narendra 359 were used for developing callus on Murashige and Skoog medium supplemented with 2, 4-D (2.0 mg l⁻¹ for Narendra 359 and 2.5 mg l⁻¹ for Pusa Basmati 1, Taraori Basmati and Pant Sugandh Dhan 17). Highest somatic embryogenesis was observed in Taraori Basmati and lowest in Pusa Basmati 1. Screening of calli was done by sub culturing calli for 15 days on Murashige and Skoog basal medium supplemented with different concentrations of polyethylene glycol-6000 (70, 50, 40, 30, 20 and 10 g l⁻¹) as chemical drought inducer. After 15 d of PEG induced osmotic stress the results revealed that callus volume decreased and free proline content significantly increased with increase in PEG concentration in the culture medium. Rice variety Taraori Basmati showed best response in terms of callus growth at 70 g l⁻¹ of PEG. The positive correlation of proline level with the degree of tolerance to water stress suggests that proline accumulation accompanies survival and growth in drought environment. Selected calli were transferred to regeneration medium where addition of NAA (0.1 mg l⁻¹) and 2, 4-D (2.0 mg l⁻¹) was found to be effective for shooting and rooting (94%), respectively. Regenerated plants were hardened with 98% efficiency in soil in a growth chamber. Plants were successfully transferred to greenhouse and subsequently established in the pots. It was observed that the selected lines accumulated more proline under water stress; produce more tiller attained more height and showed increase chlorophyll content than non-selected lines.



09

IN VITRO CONSERVATION OF STRAWBERRY (*Fragaria* × *ananassa* Duch cv. Chandler) WITH GENETIC PURITY

Saikat Gantait^{1*}, Nirmal Mandal¹, Somnath Bhattacharyya² and Prakash Kanti Das²

¹Department of Biotechnology, Instrumentation and Environmental Science, ²Department of Genetics, Bidhan Chandra Krishi Viswavidyalaya., Mohanpur, W.B. 741252

*saikatgantait@yahoo.com

Strawberry (*Fragaria* × *ananassa* Duch.), a perennial stoloniferous herb of family *Rosaceae* is very popular as delicious fruits for its aroma, taste as well as fresh use and processing. It is also well adapted in all kinds of climates including temperate, Mediterranean, subtropical and taiga zones. Conventional strawberry cultivation is labour intensive and propagated by runners. As strawberry is a small herb, it requires 20,000 runners to plant an acre and propagation through runners results transmission of viral disease. Therefore, *in vitro* mass multiplication through tissue culture technique promises as the best alternative to traditional runner production resulting high yield and obtaining disease free plant materials. To facilitate the mass production at commercial level constant supply of quality propagules can be possible through conservation of propagules *in vitro*. The present study is thus concerned with *in vitro* conservation of multiple shoot culture of strawberry to achieve unbroken supply of propagules maintaining their genetic purity. Runner tip explants, collected from the 30 day old plantlet were passed through systematic surface sterilization before inoculation in MS supplemented with 0.1 mg l⁻¹ NAA and 1.0 mg l⁻¹ BAP. From each explant a maximum of 5 shoot buds appeared within 18 days after inoculation. Separated shoot buds, transferred on MS with 2.0 mg l⁻¹ KIN, produced 10 multiple shoots per inoculant after 50 days resulting a total of 50 (5 × 10) shoots from a single explant. *In vitro* generated shoots were subcultured for further multiple shoot proliferation in a sustainable manner. Five subcultures were performed at an extended 4 month interval over a period of 20 months in the same medium. The performance of these subcultures was assessed on the basis of response as well as the number and the length of multiple shoots. Plantlets regenerated from 1st and 5th subcultures showed no significant difference in their response to shoot multiplication as well as in number and length of multiple shoots, confirmed by DMRT. No phenotypic variation was detected within the *in vitro* generated clones and they were as good as their mother plant. Genetic integrity of *in vitro* clones was tested using 10 ISSR primers; of which 3 markers produced a total number of 77 distinct and scorable bands with an average of 2.33 bands per primer. All the monomorphic bands in the ISSR assay, both for primary culture as well long term culture *in vitro*, confirmed their genetic purity to a great extent through their partial genetic coverage.

10

NITROUS OXIDE EMISSION AS AFFECTED BY APPLICATION OF ORGANIC MANURES WITH DIFFERENT C: N RATIO

Manoshi Goswami and K. K. Baruah

Dept. of Environmental Science, Tezpur University, Assam

Emission of nitrous oxide from agricultural fields depends on various factors associated with soil, and application of fertilizers as well as organic manures. Studies conducted on upland rice crop during the summer season of 2009 in North Bank Plains Zone of Assam has showed differential emission from fields applied with different organic manures varying in C: N ratio. Nitrous oxide emission was measured in rice variety Luit grown under rainfed upland condition. Five different treatments were given namely T1 (normal fertilizer schedule prescribed by AAU), T2 (Only Cow-dung), T3 (Cow dung + Paddy Straw), T4 (Poultry Manure) and T5 (Poultry



Manure + Paddy Straw) which differ in terms of their C: N ratio. Nitrous oxide samples were collected and analyzed by following standard protocol and analyzed in GC with ECD. Seasonal integrated flux (Esif) of nitrous oxide from different treatments ranged from 128.69 mg N₂O –N m⁻² to 255.72 mg N₂O –N m⁻² depending on the treatment. Highest emission was reported from T1 (Normal fertilizer). Addition of paddy straw to cow dung and poultry manure resulted in lower emission which can be attributed to the higher C: N ratio of the paddy straw. Significant positive correlation was observed between nitrous oxide flux and soil organic carbon. Soil moisture content as well as harvest index of crop grown under different treatments was found to be negatively correlated with respective nitrous oxide emission. This study reveals the potentiality of organic manures with higher carbon-nitrogen ratio as a suitable eco-friendly biological mitigation option for nitrous oxide emission.

11

EFFECT OF SEASONAL VARIATION ON THE RATE OF DECOMPOSITION OF LEAF LITTER ON POPULATION OF MICROFUNGI IN *DIPTEROCARP* FORESTS IN MANIPUR; NORTH EAST INDIA

Debu Moni Baruah*, Rajesh Kumar and Ashwani Tapwal

Forest Protection Division, Rain Forest Research Institute, Jorhat-785001, Assam

* *debu03baruah@gmail.com*

The earth's climate has been changing throughout the planet's 3.5 billion year history which indicates that the present climate may not remain constant. Climate is the key factor which determines the decomposition or preservation of organic matter and change in it may affect the rate of leaf litter decomposition. is a very important factor as it largely determines the productivity of forest ecosystems. Furthermore, the existing litter layer the diversity of micro-fungi and other soil organisms. A study was conducted to determine the rate of decomposition of leaf litter of *Dipterocarpus tuberculatus* in the forests of Manipur; India April 2008 to 2009. The impact of seasonal variation on the rate of leaf litter decomposition evaluated using litter bag technique. The loss of leaf was found to be maximum during the rainy season and comparatively lower in winter. Variation in the micro-fungal quantity in different seasons was studied using serial dilution and agar plate methods. The number of fungal colonies per gram of decomposed leaf litter was found to be maximum in the rainy season and minimum in late spring and early rainy season. The long term objective of the present was to systematically carry out a detailed investigation on impact of climate change on leaf litter decomposition of *Dipterocarpus sp.* and also on the mycoflora present in the decomposed leaves by comparing the findings with earlier studies.

12

EXTENSION OF SHELF LIFE OF ORGANIC TOMATO USING KMnO₄ AS ETHYLENE ABSORBENT

Bandita Bagchi*, Amit Nath and Bidyut C. Deka

Division of Horticulture, ICAR Research Complex for NEH Region, Umiam-793103, Meghalaya

Ethylene absorbents play an important role in increasing the shelf life of fruits and vegetables since they scavenge away ethylene hormone, responsible for fruit ripening. Such a technique can be used in increasing the shelf life of ripe tomato, which is one of the most popular vegetables in India. Tomatoes are rich in nutrient content and contain lycopene, a natural antioxidant that has numerous health benefits. However, the shelf life of ripe tomato is very poor compared to many vegetables. Therefore, there is a need to extend the shelf life of ripe tomato by post harvest treatments. Organically cultivated ripe tomatoes were packed in polypropylene (200 gauge) packets with (0.002%) and without perforation. Chalks treated with different concentrations of KMnO₄ (1500 ppm-2500 ppm) were kept inside the polypropylene packets as ethylene absorbent along with the tomatoes.



Tomatoes packed in perforated (0.002%) polypropylene (200 gauge) packets with 2500 ppm KMnO_4 treated chalks had the shelf life of 28 days in cold storage ($04 \pm 2^\circ\text{C}$ and 85% RH) and 14 days in room temperature storage ($24 \pm 5^\circ\text{C}$ and 70% RH). Chemical analysis of the samples were carried out and it was found that the gradual change in the TSS, acidity, lycopene, ascorbic acid, etc related to senescence was slow in the samples packed with 2500 ppm of KMnO_4 .

13

IMPACT OF ELEVATED CARBON DIOXIDE CONCENTRATION ON SEED YIELD AND QUALITY IN SUNFLOWER GENOTYPES

Sunil Kumar Pandey, Anjali Anand, Madan Pal Singh, Sangeeta Khetarpal and Shantha Nagarajan
Division of Plant Physiology, IARI, New Delhi-110012
sunilbhu123@gmail.com

Global climate changes are unique research challenges to the present day agriculture. Increasing atmospheric carbon dioxide and simultaneous rise in temperature may influence the world's vegetation because they are important factors for plant growth, development and function. The carbon dioxide concentration in the atmosphere was in steady state at $280 \mu\text{mol mol}^{-1}$ till the pre-industrial period and is rising since then at the rate of 1.5 to $1.8 \mu\text{mol mol}^{-1}$ per year. It is expected to reach nearly $570 \mu\text{mol mol}^{-1}$ during this century (IPCC, 2007). The rising atmospheric CO_2 concentration may influence the productivity of the crop plants as it is the main substrate of photosynthetic process. A study was thus undertaken to assess the impact of elevated CO_2 on yield and quality of sunflower hybrid (DRSH-1) and cultivar (DRSF-113) grown inside open top chambers (OTCs) and exposed to ambient ($\text{CA } 370 \pm 20 \text{ ml l}^{-1}$) and elevated ($\text{CE, } 550 \pm 50 \text{ ml l}^{-1}$) CO_2 from germination to maturity of the crop. The plants exposed to elevated CO_2 showed increase in biomass and seed yield per plant. Hundred seed weight of elevated CO_2 grown plants was significantly higher compared to ambient conditions. Seed constituent analysis showed an increase of 5 and 15% in oil content in DRSH-1 and DRSF-113 respectively, whereas protein content decreased by 3% in both genotypes under elevated CO_2 condition. Protein content was adversely affected due to change in C/N ratio under high CO_2 conditions. Nutrient composition (macro and micronutrients) of sunflower seeds significantly decreased under elevated CO_2 compared to ambient CO_2 conditions. This study suggests that rising atmospheric CO_2 in future might have a positive effect on seed yield and quality of sunflower in terms of oil content.

14

EFFECT OF HERBICIDES ON MORPHO-PHYSIOLOGICAL TRAITS AND YIELD IN CABBAGE

L. Jagadish, B.B. Channappagoudar, M.B. Chetti and Lalit meena
Department of crop physiology, University of Agricultural Sciences, Dharwad-580 005

Field study was conducted on Black clayey soil at Main Agricultural research station, University of Agricultural Sciences, Dharwad during Rabi, to study the effect of herbicides on weed control efficiency, phytotoxicity rating, weed biomass, morpho physiological traits and yield in cabbage under irrigated condition. Pre-emergence application of pendimethalin @ $1.0 \text{ kg ai ha}^{-1}$ significantly reduced the weed biomass and increased the morpho-physiological traits without any phytotoxicity on cabbage crop where as clomozone @ $0.75 \text{ kg ai ha}^{-1}$ has been found phytotoxic to cabbage. The important morpho-physiological parameters viz., leaf area



index, AGR, CGR, NAR, SLW, LAD, BMD were significantly higher in herbicidal treatment pendimethalin @ 1.0 kg ai ha⁻¹ was very effective and increased all these growth parameters to a greater extent. However, the parameters viz., RGR, SLA and LAR were found to be more in unweeded control as compared to other treatments. The photosynthetic rate and chlorophyll content recorded highest in weed free check followed by pendimethalin treatment. The head yield of cabbage revealed significant differences among the treatments. Application of pendimethalin @ 1.0 kg ai ha⁻¹ (61.08 kg ha⁻¹) and trifluralin @ 1.5 kg ai ha⁻¹ (54.10 kg ha⁻¹) recorded significantly higher yield when compare to the unweeded control (29.77 kg ha⁻¹). It has been found economic and hence pre-emergent application of pendimethalin @ 1.0 kg ai ha⁻¹ can be recommended for controlling weeds in cabbage crop.

15

COMPARATIVE ANALYSIS OF SALINITY-INDUCED EFFECTS ON REDOX BIOLOGY AND ENERGETICS OF A GLYCOPHYTE (*Brassica juncea* L.) AND HALOPHYTE (*Sesuvium portulacastrum* (L.)

Vinayak H. Lokhande^{1; 2; #}, Ashish Kumar Srivastava^{1; #}, Sudhakar Srivastava^{1; #}, T.D. Nikam² and Penna Suprasanna^{1*}

¹ Functional Plant Biology Section, Nuclear Agriculture & Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400 085, Maharashtra

² Department of Botany, University of Pune, Pune- 411 007, Maharashtra

Salinity is a major environmental stress and a constraint to realizing crop productivity due to imposition of hyperionic and hyperosmotic stresses. To understand how salinity affects the redox biology and energy status of plants, a comparative analysis was performed using a glycophyte (*Brassica juncea* L.) and a halophyte (*Sesuvium portulacastrum* (L.) L.) system upon exposure to NaCl for 2 - 8 d. *Sesuvium* experienced a lower increase in oxidative stress parameters as compared to that observed in *Brassica*. The activities of various antioxidant enzymes, in general, significantly increased in *Sesuvium* but showed significant decline in *Brassica*. These negative effects in *Brassica* might be related to an improper signaling of the stress. To this end, NADPH oxidase activity, an important player in oxidative stress signaling, was not altered in *Sesuvium*, whereas, it declined significantly in *Brassica*. The level of proline in *Sesuvium* showed a significant increase only at 1000 mM NaCl and, total phenolics and carotenoids were not altered significantly, while these metabolites increased significantly on all durations in *Brassica*. This might be due to differential oxidative and osmotic stresses experienced by the two plant systems. The ATP/ADP and NAD/NADH ratios declined significantly in *Sesuvium* but showed an increase in *Brassica* indicating that energy metabolism was significantly altered in *Sesuvium* in the process of salinity tolerance. Further, in *Sesuvium*, reduced glutathione (GSH) and reduced to oxidized glutathione (GSH/GSSG) ratio declined after 8 d suggesting that the consumption of GSH increased significantly. In contrast, *Brassica* demonstrated an increase in GSH and GSH/GSSG ratio at 8 d indicating that tolerance mechanisms were stimulated but were not being utilized efficiently. In conclusion, maintenance of redox biology and coordinated energetic alterations seem to be crucial aspects of salinity.



16

EFFECT OF MOISTURE STRESS ON THE PHYSIOLOGICAL PROCESSES OF AHU RICE

Priti Banndana Konwar, Ranjan Das, Prakash Kalita

Department of Crop Physiology, AAU, Jorhat-13

An experiment was conducted during Ahu season of 2007 at the departmental field of Crop Physiology, Assam Agricultural University, Jorhat to assess the responses to moisture stress of some selected Ahu rice germplasms namely ARC-10372, Lachit, Bandana, Maibee and Kopilee. Moisture stress was created by withholding the irrigation. Results obtained during the investigation revealed that moisture stress had significant influence on various physiological processes. Moisture stress resulted in significant increases in the activities of Antioxidative enzymes namely Superoxide dismutase, Catalase, Ascorbate peroxidase, Peroxidase and Glutathione reductase in all the varieties to various extents. It was found that moisture stress caused reduction in the rate of photosynthesis, respiration, intercellular CO₂ and stomatal conductance. The reductions in these parameters were lowest in the varieties viz., ARC-10372 and Maibee whereas highest reduction was observed in the variety Lachit. Antioxidative enzymes activities were significantly increased in ARC-10372, Maibee and Bandana compared to other varieties