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# **Session 01**

**Photosynthesis, Plant Nutrition and  
Crop Productivity**





01-01

### EVALUATION OF REDGRAM VARIETIES FOR PHYSIOLOGICAL EFFICIENCY IN RABI SEASON

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A field experiment was conducted during *Rabi* season of 2009-2010 to study the growth analysis and yield of redgram varieties. Redgram is mostly preferred during *kharif* season but frequent failure of south west monsoon during *kharif* cause reduction in yield. There is a need to develop production technology for *rabi* redgram cultivation with physiological behaviour of plant growth and growth analysis for *rabi* redgram. Treatment consist of 10 varieties *viz.*, Early maturing varieties (6): ICPL 85063, ICPL 87119, LRG 30, Piler local, TRG 21, TRG 7; Late maturing varieties (4): ICPL 8863, PRG 148, LRG 41, TRG 22. The results revealed that among early maturing varieties were tested, Piler local recorded highest LAI (0.859), LAD (13.34 cm<sup>2</sup> day<sup>-1</sup>), RGR (0.043g g<sup>-1</sup> day<sup>-1</sup>), NAR (1.33 mg dm<sup>-2</sup> day<sup>-1</sup>), SLA (138 cm<sup>2</sup> g<sup>-1</sup>), SCMR (51.9) and yield (1672 kg ha<sup>-1</sup>) compared to other varieties at 90 DAS. Among late duration varieties, LRG 41 recorded highest leaf area index (0.938), leaf area duration (13.82 cm<sup>2</sup> day<sup>-1</sup>), SCMR (55.6) and seed yield (1862 kg ha<sup>-1</sup>) compared to other varieties.

01-02

### KINETIC PARAMETERS AND GENE EXPRESSION ANALYSIS OF HIGH-AFFINITY PHOSPHATE TRANSPORTER IN RESPONSE TO ELEVATED CO<sub>2</sub> AND PHOSPHORUS NUTRITION

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Experiments were conducted to study the response of three wheat species, bread wheat (*Triticum aestivum*), durum (*Triticum durum*) and rye (*Secale cereale*) to the interaction between the two phosphorus (P) levels (2 and 500 μM) and two CO<sub>2</sub> concentrations (380 and 700 μmol mol<sup>-1</sup>) in terms of alteration in uptake kinetics and expression of high affinity phosphate transporter (HAPT) gene. Among the wheat species, durum recorded highest P concentration in root and shoot tissues. Doubling of CO<sub>2</sub> resulted in significantly higher total dry matter accumulation under sufficient P supply in all the species. Rye accumulated higher <sup>32</sup>P at 20 minutes compared to durum and bread wheat at eCO<sub>2</sub>. A sharp increase in uptake was observed in durum, under aCO<sub>2</sub>, from 20 to 40 minutes and a second peak was obtained between 40 to 80 minutes. A dip in the curve obtained at 100 minutes, indicated there was efflux rather than influx. In bread wheat, the V<sub>max</sub> value increased significantly from 18.1 μmol P g<sup>-1</sup> root FW h<sup>-1</sup> at aCO<sub>2</sub> to 21.5 μmol P g<sup>-1</sup> root FW h<sup>-1</sup> at eCO<sub>2</sub>. The increase in rate of P uptake was 14.1% with a corresponding decrease in K<sub>m</sub> value by 34.7%. A similar trend was shown by rye, which obtained 14.5% higher V<sub>max</sub> value under eCO<sub>2</sub> over aCO<sub>2</sub> and a 49.0% decrease in K<sub>m</sub>. The expression of HAPT gene in ambient and elevated CO<sub>2</sub> grown plants showed that at low P concentration, the level of expression of high affinity phosphate transporter was higher at 20 min under eCO<sub>2</sub> compared to aCO<sub>2</sub> in all the three wheat species. Moreover, bread wheat and durum showed more intense bands than rye under eCO<sub>2</sub> indicating higher level of transcripts. A similar trend was obtained in seedlings incubated for 2h in P solution. However, as the concentration of P increased from 50 to 100 μM, the level of expression of HAPT was reduced at both the incubation periods. Thus, this study indicates that the HAPT gene is not expressed when plants are subjected to high phosphate concentrations and incubated for longer duration.



01-03

### ENHANCING PRODUCTIVITY AND CLIMATE RESILIENT CROPS THROUGH SYSTEM OF RICE INTENSIFICATION (SRI)

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Enhancing food production sustainably under changing climate and water scarce situation to feed growing world population is a major challenge in agriculture. Rice (*Oryza sativa* L.) is a major staple food for the world's population and is the largest water consumer in agricultural sector, which will suffer most due to shortage of water. System of rice Intensification (SRI), a climate-smart agriculture is opening up possibilities that more output can be achieved with reduced input. It not only increases the crop and water productivity and resilience of crops, but is also environment-friendly. Experiments conducted at Bhubaneswar showed significant improvement in rice plant's morphology and physiological performance than conventional method of rice cultivation. With SRI practices, grain yield was increased by 48% in these trials at the same time, there was average water saving of 22% compared with inundated TP rice. Water productivity with SRI management practices was almost doubled ( $0.68 \text{ g l}^{-1}$ ) compared to TP ( $0.36 \text{ g l}^{-1}$ ). SRI plants have stronger stems and deeper root systems that are more resistant to flooding, storm damage and drought compared to those grown using conventional practices. Beyond increasing yields, SRI also offers benefits that have significant climate implications if applied on a large-scale, i.e. reduction in water use, emission of GHG, use of chemical fertilizers and groundwater pollution risks. However, to exploit the full potential of these promising methods, investments are needed to promote and fine-tune them and do further research to improve the practices. For achieving this purpose, agricultural institutions, governments, aid agencies, and civil society should join hands together to help farmers to adapt this agro-ecological alternative for food security and sustainable development.

01-04

### ASSESSMENT OF PHYSIOLOGICAL AND MORPHOLOGICAL VARIABILITY IN PRE-BRED SUNFLOWER LINES

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Twenty-two pre-bred sunflower lines developed by crossing wild and cultivated sunflower species in different combinations were evaluated along with two checks (KBSH1 and Morden) to assess the physiological and morphological variability present in the pre-bred sunflower lines. The analyses of variance revealed the presence of sufficient variability among the breeding material for all the parameters. The mean days to maturity among the lines ranged from 86.5 (PS4003) to 100 days (DSC12) and the yield per plant ranged from 6.71 g (PS 4047) to 39.85 g (DSC 60). Among the lines, PS2003, PS4067 and DSC60 were found to be early in flowering, while PS2003, PS3014 and PS4056 were observed to have early maturity. PS1091, PS2036, PS2048, PS4003 and PS5017 showed medium plant height and the lines which showed medium plant height also recorded medium duration of growth. Increase in leaf area with increase in petiole length was noticed in PET-2-89A, PS1059, KBSH1 and Morden and these lines showed moderate vertical distribution of leaf area and percentage of light perception. High variability was observed among the lines for leaf area index (LAI). The lines viz., PET-2-89A, PS4056 and DSC60 exhibited an overall high LAI. Morden recorded high LAI at 60 days after sowing (DAS) whereas KBSH1 recorded high LAI at 75 DAS. The lines PET-2-89A and PS4056 showed  $3934.5 \text{ cm}^2$  and  $3440.7 \text{ cm}^2$  leaf area per plant, respectively at 75 DAS. Distribution of leaf area with respect to height was more



in PS4056 (58.74 cm<sup>2</sup>/cm) compared to PET-2-89A (34.20 cm<sup>2</sup>/cm). The line PET-2-89A also exhibited mean tilt angle of 68 and percentage light interception of 24.85. Among the lines, PS5022, PET-2-89A, DSC12 and PS1091 recorded high CGR, while high NAR values were obtained by PS2003, PS4056 and PS4067. Maximum RGR was noticed in PS1079 and PS4096. PS2003 and PS1079 recorded moderate yields due to poor partitioning of assimilates to the economic part. PS 2003 recorded low CGR values. This indicates that there is still scope for the improvement of yield in these lines by increasing the CGR values. High variability was observed for total dry matter production (TDMP) and harvest index (HI). TDMP was maximum in PET-2-89A (151.2 g) and minimum in PS4047 (41.9 g). Among these two lines, PS4047 took more time for maturity (97 days) compared to PET-2-89A (94 days). The minimum TDMP in PS4047 might be due to its short stature, which might be linked to poor grain set. Highest capitulum diameter was recorded by PS1059, PS5022 and DSC12. The lines DSC60, DSC12, PS1059, PS5022 and KBSH1 recorded highest test weight, while DSC60, KBSH1, PET-2-89A, PS4003 and PS2003 recorded higher seed yield plant<sup>-1</sup>. Thus the present investigation revealed the presence of sufficient variability in physiological and morphological traits among the pre-bred lines. This variability can be used to improve seed yield by conventional breeding and biotechnological approaches.

#### 01-05

#### EFFECT OF SEED SIZE ON CROP GROWTH DEVELOPMENT AND PRODUCTIVITY IN GROUND NUT (*ARACHIS HYPOGAEAE* L.) GENOTYPES

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Groundnut is one of the important oilseed crops in India. It occupies an area of 6.4 million hectares with an annual production of 9.1 million tones and with a productivity of 1432 kg/ha. In Andhra Pradesh, it occupies an area of 1.7 million ha with an annual production of 2.6 million tones and with a productivity of 1451 kg/ha. The seed replacement rate is very less (17%) in India and moderate (50%) in A.P. In order to bring awareness on usage of quality seed and its significance for enhancing the crop productivity to the extent of 2500 kgs/ha. A field experiment was conducted to study the effect of seed size on crop growth development and productivity in groundnut at Regional Agricultural Research Station, Lam farm, Guntur A.P, India during 2009-2010 duly adopting Factorial Randomized Block *Design* with two factors F<sub>1</sub> (Varieties - JL-24, K6, Narayani) F<sub>2</sub>: Seed sizes (Large -22/64, Medium - 20/64/, Small-18/64, shrivelled seeds -16/64) and ungraded seed (mixtures of all sizes) replicated thrice. The plants established from large sized seed (22/64) exhibited higher growth parameters (field emergence, number of primary branches, leaf area, total dry matter) and yield attributes (pods per plant, 100 seed weight, shelling percentage, sound mature kernel recovery percentage, oil content) yield (per plant and hectare) as compared to plants established from medium - 20/64/, Small-18/64, shrivelled seeds -16/64 and ungraded seeds. Such growth parameters and yield attributes gradually decreased with decrease of seed sizes in all varieties especially in Naryani. This might be due to the fact that the plants from small seed were not able to supply the required metabolites for better pod development because of low vigour through out the growth stages. The early vigour, higher leaf area and dry matter production in plants from large seed might have increased the number of filled pods. The higher photosynthetic efficiently coupled with translocation of metabolites might have resulted in proper filling of pods in plant from large size seed. Plants established from shrivelled seed and small size seed recorded lesser growth parameters, yield components as a result of low reserve food material in seed, less seed initial vigour, slow growth rate of seedlings and plants which inturn resulted in reduction of yield and yield attributes. Thus it was recommended that usage of large size seed is always beneficial for obtaining maximum productivity and monetary returns to the farmer



01-06

**NITROGEN ASSIMILATION AND MOBILIZATION OF NITROGEN IN WHEAT GENOTYPES UNDER RISING ATMOSPHERIC CARBON DIOXIDE**

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The exponential rise in the atmospheric CO<sub>2</sub> is one of the important parameter of global climate change that influences growth, development and productivity of C<sub>3</sub> crops. In the present experiment, an attempt was made to study the effect of elevated CO<sub>2</sub> on nitrogen (N) assimilation and mobilization in wheat plants. Wheat (var. PBW 343) plants were grown in free-air carbon dioxide enrichment (FACE) (EC, 550 ± 50 µL/L) and at ambient CO<sub>2</sub> (AC). The activities and expression of enzymes nitrate reductase (NR), glutamine synthetase (GS) and total N content were recorded in flag leaves and at milk and dough stages during grain development. The activities of enzymes NR and GS were lower in the main shoot flag leaves of EC grown plants initially but, during grain development there was a significant increase in the activities of these enzymes in flag leaves of CO<sub>2</sub> enriched plants as compared to AC grown plants. The increased enzyme activity corresponded with the higher levels of gene expression of NR, GS2 and GS1 in the flag leaves and the pedicels of EC grown plants at milk and dough stages. The N content of flag leaves of EC grown plants at harvest was lower than the AC grown plants. However, the sugar concentration increased by 30-40% in EC grown plants which is reported to increase GS activity as there is a close correlation between N and carbon metabolism. Thus, the higher expression level of GS1 at the later stages of flag leaf development under EC may enhance the recovery of N during senescence.

01-07

**PHOTOSYNTHETIC MODULATION OF CELL WALL CATABOLISM: DECLINE IN PHOTOSYNTHESIS, A SIGNAL FOR INDUCTION OF CELL WALL HYDROLASES DURING LEAF SENESCENCE OF *Arabidopsis thaliana***

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Leaf senescence is considered as an adaptation of green plants for nutrient recycling and energy conservation. The process is very complex and involves expression of several senescence associated genes (SAGs). These SAGs express temporally with a definite pattern of expression, some express early and some at late phase of senescence. The signalings regulating temporal expression of genes are not clearly understood. During last several years, we are working on the involvement of senescence induced loss in photosynthesis as a signal for induction of SAGs possibly through a complex sugar signaling cascade. A severe loss in photosynthesis during late phase of senescence in *Arabidopsis* leaves is demonstrated for induction of SAGs including *din 2* gene that codes for α-glucosidase. Senescence induced enhancement in the activity of α-glucosidase and α-glucanase, the two cell wall hydrolases are observed to express when the photosynthetic capacity of senescing leaves is drastically reduced at late phase. The experimental data generated in my laboratory suggest a possible link between loss in photosynthesis and induction of cell wall hydrolases. It is possible that the cell wall is the last target of senescence process that breaks down polysaccharides associated with the wall as the source of energy and nutrients in sugar starved senescing cells. Senescence induced loss in photosynthesis as a signal for induction of cell wall hydrolases is confirmed with further stimulation of the activity of hydrolases when the senescing leaves experience water stress that causes more loss in net photosynthesis. Photosynthetic involvement in signaling system associated with the activity of the hydrolases is supported with the observation that the withdrawal of stress leads to recovery of photosynthesis with concomitant suppression of the enzyme activity.



01-08

### LINKING PRE-ANTHESIS ASSIMILATE MOBILIZATION TO DROUGHT TOLERANCE IN UPLAND RICE USING PHYSIOLOGICAL AND YIELD ATTRIBUTING TRAITS

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Rice yields are most susceptible to reduction by stress at flowering. Drought at flowering causes irreversible loss of leaf area and reduced photosynthesis, which in turn increases the proportion of unfilled spikelets. When rice suffers flowering stage drought, grain growth is largely supported by reserve materials (carbohydrate) accumulated in culm and leaf sheath before stress and remobilized during stress. The effect of stress on physiological and yield determinants was studied in rice genotypes grown during 2005-06 *kharif* season. The number of tillers was recorded highest in MTU 1010, in both (control and stress) environments, under rainfed condition. Due to stress, maximum reduction was recorded in Swarna. Flag leaf area was maximum in Dagad *Desi*, PSBRC-9 and Poornima x Azucinal. The stability in flag leaf area contributes to photosynthetic efficiency and consequently resulting more stable yield under irrigated condition. At flowering, relative water content was higher in Mahamaya, Dagad *Desi* and Swarna/IR. Relative water content (RWC) and leaf water status decreased as drought progress from 90 DAS onwards under rainfed conditions. The variety Swarna, Poornima x Azucina, Dagad *Desi* and PSBRC-9 showed higher value of chlorophyll under both the conditions, respectively, Swarna/IR exhibited higher apparent translocation rate (ATR), under stress condition, Swarna/IR, MTU 1010, NDR 1045 possessed greater ATR. Maximum delay in flowering was recorded in Mahamaya and ARB-6 under rainfed condition. A negative association was observed between delay in flowering and grain yield. In stress imposed condition (leaf removal) maximum panicle length was recorded in NDR 1045 under rainfed condition and in PSBRC-9 under irrigated condition. Number of filled grains plant<sup>-1</sup> due to stress imposed were found highest and lowest in Dagad *Desi* and Swarna, respectively under rainfed condition, while number of unfilled grains plant<sup>-1</sup> under stress condition was found highest in Swarna/IR and lowest in ABR-6. Grain yield was found higher in Dagad *Desi* and Mahamaya under both the (irrigated and rainfed) condition, respectively. Dagad *Desi* and Swarna/IR recorded highest yield under stress condition.

01-09

### INFLUENCE OF ORGANICS ON GROWTH AND MORPHO - PHYSIOLOGICAL CHARACTERS OF MAIZE

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A field experiment was conducted under rainfed condition during *kharif* season of 2011-2012 to study the influence of organics (FYM, Vermicompost, Sheep manure and Poultry manure) on growth and morpho-physiological characters of maize at Main Agricultural Research Station UAS Dharwad. The experiment was laid out in randomized block design with fourteen treatments comprising different combinations of organics and chemical fertilizers with three replications. Among the treatments highest grain yield was recorded in poultry manure + 100% RDF. The effect of combinations of organic and inorganic fertilizers was influenced mainly by yield components like cob length, test weight, number of grain rows / cob, number of grains/ cob and grain weight/ cob. The highest yield in poultry manure + 100% RDF treatment was attributed to higher number of green leaves, LAI, TDM, its accumulation different plant parts, photosynthetic rate, chlorophyll content and nitrate reductase activity. The application of organics alone recorded lower grain yield than the combination of organics and inorganic fertilizers treatments. The nutrient uptake studies were also indicated the highest uptake of N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O in poultry manure + 100% RDF treatment combination.



01-10

**SCREENING OF WHEAT GENOTYPES FOR MORPHO-PHYSIOLOGICAL TRAITS IN RELATION TO YIELD ATTRIBUTES AND YIELD UNDER TIMELY SOWN AND LATE SOWN CONDITIONS**

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Wheat is grown in a wide range of environments, many of which are often featured by various abiotic stresses that limit the productivity. Out of these heat stress plays an important role as high temperature stress affect various metabolic and physiological processes. An experiment was conducted to screen 25 wheat genotypes for morpho-physiological traits in relation to yield attributes and yield under timely sown (15.11.2011) and late sown (10.12.2011) conditions to expose the crop to normal and high temperature environments, respectively. Under timely sown conditions, the yield attributes viz. grain no. /spike, grain wt./spike, grain yield and test weight were significantly higher in varieties viz., HD 3095, HI 1563, HUW 234 and MP 3353; whereas under late sown conditions, HI 8703, NIAW 1689, UAS 320 and WH 1123 were promising. The varieties HI 1571, HD 2864, GW 431 and GW 433 performed good for grain yield under both the growing conditions. Canopy temperature depression (CTD) values were found to be higher in high yielding varieties. HD 3095, HUW 234 and HI 1571 exhibited high CTD under both the growing conditions at the stages of anthesis, 7 DAA and 15 DAA substantiating that high CTD helped in reducing the evapo-transpirational losses and thereby contribute to increased grain yield. The chlorophyll content was higher in high yielding varieties particularly under timely sown conditions. It was noticed that GW 431 and HD 2864 showed high chlorophyll content at the stage of anthesis and 15 DAA under both the growing conditions; while HI 1571 sustained stay green trait at later stage i.e. 15 DAA under late sown conditions indicating its potential to combat the late heat stress.

01-11

**VARIABILITY, CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS FOR PHYSIOLOGICAL TRAITS IN RICE**

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Rice is an extensively consumed cereal crop, which serves as a major source of carbohydrate in human diet. The knowledge on the variability, character association and path analysis of physiological traits is of great importance in formulating efficient selection criteria for improvement of yield. Seven rice varieties viz, Samba mahsuri, Polasa prabha, Jagtial samba, Nellore mahsuri, Indra, Vijetha and Prabhat were crossed in diallel mating design (without reciprocals). Five physiological characters viz., chlorophyll content, specific leaf weight, harvest index, biological yield and flag leaf nitrogen content along with yield was assessed in 21 F<sub>1</sub>'s. Analysis of variance revealed significant differences among the genotypes for all the traits. Heritability in broad sense was found high for all the characters except chlorophyll content and harvest index. High genetic advance along with high heritability were found for biological yield and Grain yield /plant indicating presence of additive gene action for controlling these traits and selection for the improvement of these characters might be rewarding. Correlation studies indicated that the biological yield and flag leaf Nitrogen content upon which emphasis may given during selection. biological yield and flag leaf nitrogen content showed positive correlation with grain yield along with positive direct effects might be considered in developing breeding strategy for yield improvement.



01-12

## NEW IDEOTYPES FOR INCREASING GENETIC YIELD POTENTIAL OF BLACKGRAM

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Blackgram is one of the most important crop of India and also Andhra Pradesh and is grown in different seasons and cropping systems. Being a legume blackgram plays an important role in sustainable agriculture. The area and production under blackgram is decreasing year after year due to lack of efficient ideotype / plant types that can give high and stable yields under different situations apart from tolerance to stresses (YMV, PM, leaf spots, stemfly, *Maruca*, drought etc.). Blackgram cultivation is under threat due to various stresses and more competitive crops. It is not possible to import blackgram from other countries to meet domestic needs. The present day blackgram ideotype / plant type is not inferior to cereals in physiological efficiency but they are inferior in genetic yield potential. Hence, there is a need to understand the genetic architecture of yield and yield components and reconstruct ideotypes / plant types for increasing the genetic yield potential of blackgram to achieve quantum jumps in yields. In blackgram, number of pods per plant, number of clusters per plant and number of pods per cluster are positively correlated with grain yield. In ANGRAU, Breeding programmes aimed to reconstruct the plant architecture has lead to the development of two new plant types (sympodial and main stem bearing types) capable of producing more number of pods / plant, and release of varieties, WBG-26 (T9/Line-400 from Warangal) having sympodial bearing plant type (increase in number of pods/cluster, increase in number of clusters with short peduncle thereby increase in total number of pods). LBG-685 [LBG-402 x (Nethimumu/Chikkuduminumu) from Lam] having main stem bearing plant type (more number of pods per node with axillary pods coupled with normal cluster there by more number of pods/plant). WBG-26 is photo- insensitive with dull seed and LBG-685 is photo sensitive with shining seed. Screening of germplasm for identification of suitable traits for restructuring the plant type in black gram, breeding strategies and development of varieties have been discussed. Future strategies for increasing yields through incorporation of biotic and abiotic stress tolerance with available sources of resistance / identification of new sources of resistance for obtaining stable yields in black gram have been dealt to achieve self sufficiency in black gram production.

01-13

## MORPHO PHYSIOLOGICAL BASIS OF GROWTH AND YIELD VARIATION IN RABI SORGHUM GENOTYPES

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Field experiments were conducted to study the Physiological indices for higher productivity under receding soil moisture situation on various morpho-physiological, biophysical and yield and yield components. Among the genotypes RSLG-262, Phule Yashodha, PBS-2 and CRS-4 recorded maximum total dry matter at all growth stages and these genotypes also recorded higher photosynthetic rate, Relative water content and low transpiration rate which indicated their drought tolerance nature. The various biochemical parameters viz. chlorophyll content, NRA, Proline and sugar content was higher in genotypes RSLG-262, Phule Yashodha, PBS-2 and CRS-4 compared to all other genotypes. Yield and yield components viz, panicle weight, 1000 grain weight and number of grain per panicle, were significantly higher in genotypes RSLG-262, Phule Yashodha, PBS-2 and CRS-4 compared to Sigali Local and Barasi Zoot.



01-14

**STRATEGY FOR PHENOTYPING PHYSIOLOGICAL TRAITS IN MANGO (*Mangifera indica* L.) FOR THE DEVELOPMENT OF ABIOTIC STRESS TOLERANT VARIETIES**

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Abiotic stresses such as drought, heat and cold waves, nutrition stress and soil salinity are threats for mango cultivation in the subtropical climatic regions of India. This demands development of abiotic stress tolerant varieties by focussed breeding programmes involving identification and characterisation of tolerant traits in germplasm which were evolved as adaptive strategies. In India, establishment of automated high throughput infrastructure which allows plants to be exposed to various stresses and to evaluate and characterise physiological and morphological traits is in the progress. Till that infrastructure is in place, phenotyping for abiotic stress tolerant traits which are heritable and constitutive like waxes, stomatal index; induced or acquired traits like osmolytes, scavenging enzymes, abscisic acid content and gas exchange; secondary traits like relative water content, water potential, canopy temperature, leaf senescence could be evaluated at the field/lab level. The advanced techniques like oxygen isotope ratio ( $^{18}\text{O}/^{16}\text{O}$ ), carbon isotope discrimination ( $^{13}\text{C}$ ), chlorophyll fluorescence, state of PSII (Fv/Fm) and SPAD chlorophyll meter readings could also be employed as techniques for assessing stress and screening the germplasm for stress tolerance. Salinity tolerance is more in polyembryonic than in monoembryonic genotypes of mango. The characteristics like lower leaf concentration of  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{Mg}^+$  and  $\text{Na}^+$  exclusion in shoots and accumulation in root cell vacuoles could be candidates for phenotyping for rootstocks. All these tools and techniques when aligned with the proper phenological stages using modified BBCH scale of mango would help in standardization of stage for phenotyping for the development of climate resilient mango varieties.

01-14

**VARIATION IN PHOTOSYNTHESIS AND GROWTH OF MUSTARD CULTIVARS: ROLE OF ETHYLENE SENSITIVITY**

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Ethylene is involved in various aspects of plant growth and development. We studied ethylene sensitivity in four mustard (*Brassica juncea* L. Czern and Coss.) cultivars, Pusa Jai Kisan, Alankar, Basanti and SS2 using chemicals that modify ethylene production and examined its role in determining photosynthesis and growth. Pusa Jai Kisan showed maximum sensitivity to ethylene and was more responsive to ethylene modulators than SS2, which exhibited minimum sensitivity to ethylene. In the presence of ethephon (ethylene-source), Pusa Jai Kisan exhibited greatest increase in growth and the activity of ribulose-1,5-bisphosphate carboxylase (Rubisco), net photosynthesis, stomatal conductance and intercellular  $\text{CO}_2$  concentration, and maximal decrease in these characteristics with ethylene action inhibitor, norbornadiene (NBD). Glucose treatment did not inhibit Rubisco activity, net photosynthesis and growth in ethylene-sensitive plants, but these characteristics were maximally inhibited in ethylene-insensitive plants. Our results show that ethylene sensitivity has a role in determining photosynthesis and growth of mustard plants. The selection of an ethylene-sensitive mustard type would help in augmenting photosynthesis and growth and also provide new insight into the ethylene-mediated physiological responses.



01-16

### GENETIC DIVERGENCE BASED ON PHYSIOLOGICAL TRAITS IN PIGEONPEA [*Cajanus cajan* (L.) Millsp.]

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An investigation on genetic divergence in pigeonpea was carried out during *khari*f, 2009-2010 at Regional Agricultural Research Station, Lam, Guntur with 45 genotypes of pigeonpea [*Cajanus cajan* (L.) Millsp.] to elicit the information on nature and extent of the genetic variability, character association and genetic divergence. Observations were recorded on twelve characters, viz., days to 50% flowering, days to maturity, seed yield per plant (g), harvest index, LAI at vegetative stage, LAI at flowering stage, SLA at vegetative stage (cm<sup>2</sup>/g), SLA at flowering stage (cm<sup>2</sup>/g), SLW at vegetative stage (mg/cm<sup>2</sup>), SLW at flowering stage (mg/cm<sup>2</sup>), RWC at vegetative stage (%) and RWC at flowering stage (%). The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficients of variation indicating the effect of the environment. The correlation study indicated that the days to 50% flowering, harvest index, SLA at vegetative stage and SLA at flowering stage had significant positive association with seed yield and simultaneous improvement of these characters along with seed yield is possible. The results of multivariate analysis revealed the presence of considerable genetic divergence among the 45 genotypes studied and grouped into seven clusters as per D<sup>2</sup> analysis and also in case of cluster analysis. The grouping of genotypes into clusters was at random, which suggested that geographical isolation might not be the only factor causing genetic diversity. Out of 12 characters studied, the character seed yield per plant contributed maximum towards divergence followed by relative water content at flowering stage, relative water content at vegetative stage and specific leaf weight at flowering stage. The genotypes LRG-69, JSA-66, LRG-73, TAT 9629 and 11969 showed maximum inter-cluster distance and wide genetic distance in all the three divergence methods with each other. So they can be exploited in hybridization programme for identification of *desirable* segregants.

01-17

### PHYSIOLOGICAL BASIS OF YIELD VARIATION IN RICE GENOTYPES

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A field experiment was conducted during 2010 with 10 traditional *ahu* rice genotypes belonging to varying yield potentials under rainfed condition in the research field of B N College of Agriculture, AAU, Biswanath Chariali, Assam. The genotypes selected for the study were: Banglami, Rongadoria, Betguti, Bihari ahu, Pahari Dusura, Maghi ahu, Bhaluai, Budumoni, Guni and Nilajee. The soil of the experimental plot is sandy loam with medium available N and K<sub>2</sub>O and low P<sub>2</sub>O<sub>5</sub> content. The experiment was laid out in a randomized block design with three replications. The crops were cultivated following the recommended package of practices including adoption of timely plant protection measures. The genotypes differed significantly with respect to the physiological traits analysed at different stages of growth. Significant variation of grain yield was also found among the genotypes. The genotype Rongadoria recorded higher grain yield. The same genotype also recorded higher stomatal frequency, stomatal conductance, photosynthetic rate, transpiration rate and total leaf chlorophyll content. Therefore, these physiological traits may be used as indices for higher productivity in rice, particularly under upland rainfed condition of Assam.



01-18

### PHYSIOLOGICAL BASIS TO ENHANCE THE ASSIMILATE PARTITIONING AND ECONOMIC YIELD IN SCENTED RICE

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The field experiment was carried out during *kharif* season 2009-2010 at Instructional farm, IGKV, Raipur (CG) in the department of Crop Physiology and Agricultural Biochemistry to explicit the effectiveness of nitrogen levels on assimilate partitioning, growth and yield attributes of aromatic short slender rice genotypes for efficient partitioning and nitrogen use efficiency to enhance the productivity. The experiment was conducted in split plot design replicated thrice by using five aromatic short slender rice genotypes i.e., IET19713, IET 20477, Kalanamak, Badshahbhog and Dubraj at three levels of nitrogen  $N_1$  50% N of recommended dose (30 kg N/ha),  $N_2$  100% N of recommended dose (60 kg N/ha) and  $N_3$  150%N of recommended dose (90 kg N/ha). Two plants were transplanted per hill with the distance 20x10 cm. The morpho-physiological, growth and yield attributes were taken at various phenological stages of growth to find out the efficient partitioning towards the economic sink to achieve the high yield. It was observed that the increased levels of nitrogen increased the vegetative growth of scented rice genotypes i.e., plant height, number of leaves, leaf area leaf area index, LAR, LWR, CGR, RGR, NAR and SLA might be due to increased use of nitrogen. The increasing levels of nitrogen also enhanced the phenological stages of crop i.e., days to panicle initiation, flower initiation, 50%flowering, grain filling stage and days to maturity due to high persistence of vegetative growth and increased levels of chlorophyll and ultimately improved the biological yield of the crop. The grain yield was improved but the enhancement was not significant at high dose of nitrogen in scented rice genotypes, However, genotypes Kalanamak, Badshahbhog and Dubraj were respond better in terms of biological and economic yield at higher doses of nitrogen.

01-19

### PERFORMANCE OF MAIZE HYBRIDS TO INCREASED LEVELS OF FERTILIZATION

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A field experiment was conducted during 2012 *kharif* season in medium deep black soil to study the potential performance of popular maize hybrids through increasing the nutrient levels than the recommended dose and to study the relationship with bio physical parameters under rainfed situation. The experiment was laid out in randomized block design, includes ten treatments with three replications. The nutrient level applied was 50% higher (150:75:37.5 Kg NPK/ha) than the recommended dose (100.50:25 kg NPK/ha). The observation on plant height, leaf area, photosynthetic rate and SPAD readings were recorded at 50% silking stage. The yield and yield attribution were recorded at physiological maturity of the crop. The highest plant height was recorded in Pinnacle (92.6cm) followed by NK-6240 (91.3 cm) and 900 M Gold (89.5 cm). The photosynthetic rate was highest in 900 M Gold which was significantly superior over other hybrids. The hybrids NK-6240 and CP 818 were also recorded higher photosynthetic rate. The higher SPAD readings were recorded in Pinnacle followed by 900 M Gold, N K-6240 and CP 818. The highest grain yield was recorded in 900 M Gold (142.7 kg/ha) which was significantly superior over all other hybrids. However, the hybrids NK-6240, CP-818 and PAC 7401 recorded higher and on par grain yield (132.2 kg/ha, 129.6 kg/ha and 128.9 kg/ha respectively). The higher grain yield in 900M Gold can be attributed to higher test weight and higher cob length with better partitioning efficiency.



01-20

**MORPHOLOGICAL AND MOLECULAR CHARACTERIZATION OF SHOOT AND ROOT TRAITS IN A ROOT STUDY STRUCTURE IN CASTOR (*Ricinus communis* L.)**

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Castor in Andhra Pradesh chiefly grown under rainfed conditions suffers from lack of soil moisture. Identification of integrated multi gene avoidance secondary traits like roots, contribute to drought tolerance and improved productivity. Elevated root study structure 5 ½ feet high, 25 m length and 4 m wide was constructed to screen for shoot and root traits. Thirty five genotypes were sown in *rabi* 2012, with spacing of 60 x 45 cm. Irrigation was scheduled to induce drought stress and genotypic expression of roots. Hundred DAS root structure was dismantled, roots washed and characterized for eight characters. The data recorded for root parameters varied in length (50 – 230 cm), volume (15 – 185 ml), total root length (400 – 1600 cm), tertiaries diameter (0.2 – 1.0 cm), angle (40° – 170°), number of forks (2 - 30), root dry weight (3 – 40 g) and branching orders per each root (1-4). Observations on shoot varied for photosynthetic rate (13 – 21.6 m mol m<sup>-2</sup> s<sup>-1</sup>), SCMR (40.9 – 49.9), relative water content (61.4 – 78.8%), fluorescence (0.46-0.74), specific leaf area (121 – 136 cm<sup>-2</sup> g<sup>-1</sup>) and biomass at harvest (27.8 – 133.8 g plant<sup>-1</sup>). Genotypes viz., Kranthi, Haritha and DPC 9 for shoot, PCS 252, SKI 215, RG 48 and Kranthi for root showed superior performance. DNA was extracted from sixteen selected genotypes and ten primers were used to understand the polymorphism. Variation among the character could be explained by Polymorphism Information Content (PIC) value of 72.5%. A maximum of three alleles were recorded to control the variation. Dendrogram with coefficient of 0.71 revealed two major clusters. Correlation of phenotype with the genotype for any character needs development of suitable mapping population for which further experimentation becomes essential.

01-21

**EFFECT OF WATER LOGGING ON GROWTH AND SEED YIELD OF MUNGBEAN (*Vigna radiate* L.)**

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An experiment was conducted in pot culture with three varieties of mungbean (TM 96-2, LGG 40, and LGG 460) in Randomized block design with factorial concept to evaluate the effects of water logging at three different stages of crop growth (Water logging during – Vegetative stage, Flowering stage and pod development stage) during *kharif*, 2012. The experimental results reveal that the effect of water logging during flowering stage was more deleterious than stress at other stages. Varieties were affected to a lesser extent by water logging during pod development stage than during flowering and vegetative stages. Variety TM 96-2 accumulated lowest dry matter per plant under all stages of water logging treatments. Variety LGG 460 had maximum accumulation of dry matter followed by LGG 407. The growth parameters like plant height, plant dry weight, root volume, leaf area and number of pods per plant and final seed yield decreased due to water-logging. The activity of anti oxidant enzymes (peroxidase and SOD) increased during water logging and total chlorophyll content decreased in all the treatments.



01-22

### CROSS RESISTANCE AGAINST ACETOLACTATE SYNTHASE INHIBITORS IN *PHALARIS MINOR* RETZ

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*Phalaris minor* Retz. 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 coenzyme A inhibitors (ACCase) and acetolactate synthase inhibitors (ALS) were recommended for the management of this weed in 1998. Evolution of cross resistance against ACCase inhibitors has been reported earlier. This investigation provides information for cross resistance against ALS inhibiting herbicides in this weed. Twenty populations of *P. minor* were collected from different locations of Haryana in April 2010. These were tested for efficacy of sulfosulfuron (25g/ha), ready mix formulation of sulfosulfuron + metsulfuron (‘Total’, 40 g/ha), ready mix formulation of mesosulfuron + iodosulfuron (‘Atlantis’ 14.4 g/ha). Out of 20 populations, 12 showed resistance to sulfosulfuron and 8 were found to be medium resistant to this herbicide. Similar results were obtained with ‘Total’ and ‘Atlantis’. Physiological and biochemical indicators confirm this. A decline in total chlorophyll and carotenoid content was observed in medium resistant populations and no change was observed in the most resistant population. Ion efflux increased in all populations and a parallel increase in malondialdehyde content was also observed. An increase in proline content was also observed more so in medium resistant populations at a higher dose. An increase in peroxidase activity was observed in all populations. Catalase activity increased in resistant populations and decreased in medium resistant populations. Superoxide dismutase activity increased significantly in the most resistant population.

01-23

### BABY CORN YIELD AND FODDER PRODUCTION POTENTIAL OF MAIZE CULTIVARS

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In Indian agriculture maize crop has special significance due to its wide diversity as food crop and as an animal feed. Maize is cultivated in 7.83 lakh hectares with a production of 27.6 lakh tonnes in Andhra Pradesh during 2009-10 (Statistical Abstracts-A.P, 2010). Besides replacing pulses in rice fallows it has also gained immense popularity in its new use pattern i.e. baby corn. However, it is also an unique crop which can be ideally used as fodder in whatever stage it is harvested. Use of baby corn is increasingly gaining popularity owing to its use in urban cuisine. A study was conducted to evaluate the baby corn and green fodder production potential of various maize cultivars and the quality of green fodder at harvest of baby corn. About fifteen cultivars of maize viz., Vivek-9, Vivek-11, Vivek-15, Vivek-17, HIM-129, Baby corn-1, Bioseed-1, HQPM-1, Maduri, Harsha, Varun, Ashwini, BH-2187, African Tall and J-1006 were grown under irrigation during *kharif* season. The baby corn yields were highest in varieties Vivek-17, Vivek-11, Him-129 and Harsha ranging between 63.04 to 68.96 q ha<sup>-1</sup>, respectively. However earliest baby corn was harvested from African tall while highest number of baby cobs of four were harvested from two varieties i.e., Vivek-17 and Ashwini while varieties Vivek- 11, Baby corn-1, Bioseed-1, Vivek-9, Maduri, Harsha, African Tall and J-1006 yielded three cobs, respectively. The green fodder yield was highest in African tall and J-1006 followed by Vivek-17, 11 and Him-129. The crude protein content of green fodder at harvest of baby corn indicated ranges between 4.81 to 13.13%, nevertheless the CP% reduced in stalks with harvest of each cob. On an average the CP% reduced from 9.62% at harvest of I<sup>st</sup> cob to 7.76 at harvest of second cob and further fell to 7.07% at harvest of third cob. Among all the varieties studied Vivek-17 is ideal with respect to baby cob yield, number of cobs produced and commendable green fodder yield.



01-24

### STUDIES ON TERMO-TOLERANCE IN RICE GENOTYPES: 1. PHYSIOLOGICAL CHARACTERIZATION FOR INTRINSIC TOLERANCE TO DROUGHT

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For characterizing the physiological basis of rice genotypes to drought tolerance to fit into aerobic method of conditions, about 100 rice germplasm lines were procured and evaluated for their thermo tolerance using a novel technique Thermo Induced Tolerance (TIR) during 2010-2012. Significant genotypic variability for thermo tolerance via per cent survival of seedlings, per cent reduction in root and shoot growth respectively were observed among genotypes. The per cent survival of seedlings varied from 0 to 100 per cent with a mean of 80%, the reduction in root growth varied from 0 to 73 % with a mean of 21 per cent while the reduction in shoot growth varied from 0 to 66 % with a mean of 21.74 per cent. Among the 100 genotypes, 30 genotypes were identified to possess high level of thermo tolerance based on seedling growth. All the 30 selected lines based on TIR techniques were evaluated for moisture stress tolerance, physiological efficiency and yield components in a pot culture study. Moisture stress was imposed seven days before and after anthesis. Significant genotypic variability was observed between two main treatments i.e. non stress and moisture stress in terms of all the physiological parameters studied. Among the genotypes, NLR 3010, NLR 40059, NLR 34242, NLR 33671 maintained significantly higher values of SPAD Chlorophyll Meter Readings (SCMR), Relative Water Content, Photochemical Efficiency of Photosystem II (Chlorophyll Fluorescence Ratio, Fv/Fm), root miming abilities (root length and root volume) and lower percent of relative injury. These genotypes also maintained low spikelet sterility, high grain yield and its attributes. Hence, these genotypes are considered as drought tolerant as they possess both moisture stress as well as thermo tolerance.

01-25

### PHENOLOGICAL AND YIELD RESPONSES OF CHICKPEA GENOTYPES IN NORMAL AND LATE SOWN CONDITIONS

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Chickpea is an important pulse crop of India and Madhya Pradesh is most prominent state in its production. The raised atmospheric temperature due to change in climatic conditions directly influences the reproductive phase of chickpea crop. The experiment was conducted in *Rabi* season on University farm and thirty genotypes were grown under normal (mid November) and late sown (1<sup>st</sup> week of January) conditions. Phenological observations were recorded at 1<sup>st</sup> flower initiation (FI), 1<sup>st</sup> pod initiation and corresponding temperature in both the conditions i.e. normal and late sown in all the thirty chickpea genotypes studied. Genotype K-850 was observed to have early flower and pod initiation in normal as well as late sown conditions. Biomass was recorded under different temperature regimes i.e. 32°C-35°C, more than 35°C and at final harvesting stage. Genotypes IPC-98-12 and K-850 were found to have enhanced grain yield under normal sown (10.88 g/ha and 10.57 g/ha) and late sown (6.13 g/ha and 5.87 g/ha) conditions respectively.



01-26

### INCREASING THE YIELD POTENTIAL IN IRRIGATED RICE - MANIPULATING SOURCE AND SINKS

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A study was conducted on rice source sink relationship in high yielding varieties (early, medium and late) and hybrids, by manipulating source and sink sizes. Based on 3 years of study, the results revealed that source and sink size increased with increasing nitrogen levels from 0-200 kg ha<sup>-1</sup>. Among the varieties, source size and sink capacity was highest in hybrids as compared to high yielding varieties (HYV). Leaf area index (LAI) of 6-7 was found to be optimum for attaining a yield of 8-9 tons ha<sup>-1</sup> where as the growth analysis data revealed that crop growth rate (CGR) increased with increase in Nitrogen levels and hybrids had better CGR than HYV. Physiological parameters measured by Licor-6400 revealed that Photosynthetic rate, stomatal conductance and transpiration rate increased with increase in nitrogen levels. Photosynthetic rate and transpiration rate were high in hybrids as compared to high yielding varieties, among hybrids PHB-71 had the highest photosynthetic rate and transpiration rate, among high yielding varieties Akshayadhan had high photosynthetic rate. Varadhan had high water use efficiency when measured by Licor 6400 in terms of A/T and IWEU ratios. A/Ci ratio i.e., Corboxylation efficiency or activity of RUBP carboxylase was found to be higher in hybrids as compared to high yielding varieties. Correlation analysis was carried out for yield and yield influencing attributes. Significant correlation was observed for yield with TDM and spikelets per panicle. It was found that yield levels can be improved in irrigated ecology by improving the Bio-mass (Total Dry Matter) and sink size (spikelets per panicle) in HYV and Hybrids. Based on the study, it was found that source was limiting in early duration HYV and sink was limiting in late duration HYV. In Hybrids, there is an optimum source and sink relationship for achieving yield of 8-9 tons ha<sup>-1</sup>.

01-27

### INFLUENCE OF CROP AGE ON JUICE QUALITY OF SUGARCANE (*Saccharum officinarum* L.)

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Seven promising mid late maturing sugarcane clones in the main yield trial were studied for their tolerance for delayed harvest. Juice quality parameters viz., brix, sucrose (%), CCS (%) and reducing sugars were estimated at monthly intervals from November(12<sup>th</sup> month age) to March (16<sup>th</sup> month age). Brix (%) increased with increase in crop in all the clones. However, decline in per cent juice sucrose was observed in all the clones with increase of crop age i.e., from November to March. The rate of reduction in juice sucrose was low in 2006T34, Co 86032 and 2006 T10. Similar trend was observed for CCS% whereas reducing sugars increased with increase in crop age. Among all test clones tested for their tolerance to delayed harvest. The clones 2006T34, Co 86032 and 2006 T10 recorded low reducing sugars even at 14<sup>th</sup> months (March) of crop age The magnitude of loss in juice quality was found low in these clones. Based on the results of present investigation, it is evident that the clones 2006T34, Co 86032 and 2006 T10 found to possess tolerance deterioration and hence can be recommended for delayed harvest.



01-28

### EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF CASTOR IN PONGAMIA BASED AGRISILVI SYSTEM

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One of the major thrusts in oilseeds research programmes has been the development of location specific agro production technologies including cropping systems and integrated nutrient management to maximize the productivity of oilseed crops. *Pongamia pinnata* is best suited tree for energy plantation and since the gestation period is high in *Pongamia* and because of wider spacing between the trees the interspaces can be effectively used for intercropping. Castor (*Ricinus communis* L.) one of the important non edible oil seed crop of the region which is largely cultivated under rainfed condition is tried as an intercrop under five year old *Pongamia* trees. Keeping this in view an experiment was conducted during *kharif* 2009 in a randomized block design with nine treatments which comprises mainly combination of inorganic (urea) and organic sources (FYM and Neemcake) in three different ratios i.e. a 100 % inorganic and 75 % inorganic with 25 % and 12.5 % organic sources. The results reveal that all growth characters of castor such as plant height, dry matter production, leaf area, number of branches and crop growth rate were maximum with the application of 75% N through urea (inorganic) + 12.5% N through FYM (organic) + 12.5% N through neem cake (organic) over the other treatments at all stages of crop growth. Yield and yield attributes like spike length, number of spikes per plant and test weight were also maximum in this treatment due to better crop growth. Thus it can be concluded that when inorganic fertilisers were substituted with organic sources like FYM and Neem cake castor can be grown successfully under *Pongamia* alleys.

01-29

### FAST CHLOROPHYLL FLUORESCENCE TRANSIENT OF WHEAT CULTIVARS SOWN UNDER TIMELY AND LATE SOWN CONDITIONS

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Development of high temperature tolerant wheat genotypes is one of the major mandates of wheat improvement programmes across the country. This is mainly because wheat is exposed to temperature above optimum that affects productivity particularly when sowing is delayed due to delayed harvesting of previous crops such as rice and sugarcane in Indo- Gangetic plains. Therefore, twenty one genotypes of wheat (*Triticum aestivum* L.) viz. WH-147, WH-416, WH-542, WH-711, WH-730, WH-1021, WH-1100, WH-1111, DBW-14, DBW-16, DBW-17, HD-2687, HD-2932, HD-2967, PBW-343, PBW-373, PBW-550, PBW-590, MP-4010, Raj-3765 and SONALIKA were evaluated for Chlorophyll (Chl a fluorescence under two environments (Timely and Late sown) at 10 days after anthesis. Chlorophyll a fluorescence is very useful and provides information about the photosynthetic capability and vitality of the plants. The fluorescent transient was measured by handy plant efficiency analyzer (PEA). Fast chlorophyll (Chlorophyll) fluorescence transient data analysis showed that structure function index of the plants SFI(abs) and driving force for photosynthesis (DF) were highest in the heat tolerant cultivar WH 730 followed by WH 1021. The grain yield was significantly and positively correlated with the density of reaction centres ABS/CS<sub>0</sub> (0.65), TR<sub>0</sub>/CS<sub>0</sub> (0.63) and ETo/CS<sub>0</sub> (0.74) and negatively correlated with dV/dt<sub>0</sub>, excited cross section of leaf. Fast Chl a fluorescence measurement can be used as a model system to assess the heat tolerance in wheat cultivars.



01-30

**INFLUENCE OF SOWING AND TRANSPLANTING DATES ON PHYSIOLOGICAL PARAMETERS OF DIFFERENT SUMMER RICE (*Oryza sativa* L.) VARIETIES**

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The present investigation was carried out at the Main Paddy Research Centre (N.A.R.P.), Navsari Agriculture University, Navsari, Gujarat during *rabi*-summer season of 2010-2011 to examine various aspects of effect of different sowing dates on growth and yield of summer rice crop. The treatments comprised six dates of sowing viz., 1<sup>st</sup> December, 8<sup>th</sup> December, 15<sup>th</sup> December, 22<sup>th</sup> December, 29<sup>th</sup> December 2010 and 5<sup>th</sup> January 2011 (sowing and transplanting was done at an interval of 7 days and 21 days respectively, starting from 1<sup>st</sup> December 2010 to 26<sup>th</sup> January 2011) with two varieties NAUR-1 and Gujarat. The experiment was conducted in a Factorial Completely Randomized Design (FCRD) with three replications in rice variety NAUR-1 and Gurjari. Significant differences were observed due to the different sowing dates in the case of germination percentage, number vigour index, fresh weight of seedling at T.P., plant height, number of tillers, leaf area, days to flag leaf initiation, days to 50 per cent flowering, number of panicles, number of filled grains, number of unfilled grains, test weight, grain yield, straw yield, biological yield, and harvest index were significantly higher in 1<sup>st</sup> December (D<sub>1</sub>) than the other delayed sowing dates, D<sub>3</sub>, D<sub>4</sub>, D<sub>5</sub> and D<sub>6</sub>. Crops sown during 1<sup>st</sup> December (D<sub>1</sub>) to 8<sup>th</sup> December (D<sub>2</sub>) were able to produce higher yield resulting in greater values of thermal and radiation use efficiencies. Reproductive and ripening phases of rice were found to be most sensitive phases. Daily mean temperature, daily thermal units, daily heliothermal units, growing degree days (GDD) and heliothermal units (HTU) between two successive growth phases as well as in the complete growth period of the crop, sown at different sowing dates were calculated. Correlation between these atmospheric variables with the duration of particular phase revealed that the temperature is the major and dominating atmospheric factor to control it. On the basis of present investigation, it can be concluded that reduction in yield under late sown condition was associated with reduction in germination per cent, vigour index, plant height, number of tillers/plant, leaf area (cm<sup>2</sup>), days to 50 % flowering, days to flag leaf initiation, Biological yield/plant (g), number of panicle, length of panicle (cm), number of filled grain/panicle, grain yield (g), harvest index (%) and dry matter efficiency DME %.

01-31

**PHYSIOLOGICAL IMPACT OF INCREASING PLANT POPULATION LEVELS WITH REDUCING SOIL MOISTURE REGIMES IN MAIZE**

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Soil water deficit is the major future problem to the forthcoming generation. Study conducted in Coimbatore, India during *kharif* season of 2009. Maize (COH(M)5) as a test crop, cultivated with three soil moisture levels, 100% irrigation water (0.8 IW/CPE ratio), 75% irrigation water (0.6 IW/CPE ratio) and 50 % irrigation water (0.4 IW/CPE ratio) and three plant population levels, normal spacing (60x20 cm), narrow spacing (45x20 cm) and reduced narrow spacing (30x30 cm). From the experimental study, 100% irrigation water level (0.8 IW/CPE ratio), narrow spacing (45x20 cm) showed a significant difference in functional leaf area (LAI) (9.06), maximum leaf thickness (SLW) (5.7 mg cm<sup>-2</sup>), and crop growth rate (CGR) (53.8 g m<sup>-2</sup> day<sup>-1</sup>) compare with other treatments at. The maximum kernel yield obtained in interaction of 100% irrigation water level (0.8 IW/CPE ratio) with narrow spacing (45x20 cm) (6477.5 kg ha<sup>-1</sup>) and also individually.



01-32

### EFFECT OF PHOSPHORUS DEFICIENCY ON PHOTOSYNTHESIS, PHOSPHATASES AND YIELD IN WHEAT GENOTYPES

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Twelve genotypes of wheat were raised in pot culture house with three levels of phosphorus (P): P<sub>1</sub> (100% P), P<sub>2</sub> (50% P) and P<sub>3</sub> (15% P) as per Hoagland nutrient solution. Phosphatase and phytase enzymes activity in root extracts showed an inverse relationship with decreasing P levels. Maximum activity of alkaline phosphatase (ALP) was observed in genotypes WH1107, LOK-1 and PBW343 at 15% P- level at heading stage. Acid phosphatase (ACP) in treatment P<sub>3</sub> was found to be highest in genotypes WH1080, LOK-1 and WH1094. Highest activity of phytase at heading stage was observed in WH1021, WH1080 and WH1107. Photosynthetic rate was adversely affected by decreasing P-levels, however WH1080, WH1081 and WH1094 showed highest photosynthetic rate in P- deficient soil. No significant difference of P- supply was observed on chlorophyll fluorescence. Maximum number of productive tillers was observed in WH1080, WH147 and PBW343 in P<sub>1</sub> and in WH1080, WH147 and WH1094 in P<sub>3</sub> treatment. Genotypes WH1080, WH1081 and WH1094 performed well in terms of yield under P- deficiency, these genotypes also showed maximum yield under 100% P levels. On the basis of present study, WH1080 and WH1094 were P- efficient genotypes as they performed better in terms of phosphatase and phytase activity, photosynthetic rate, number of productive tillers and grain yield.

01-33

### BIO-EFFICACY OF NANO BASED ZNO ON SEEDLING GROWTH IN RICE AND GREEN GRAM

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Micronutrients play an important role in plant metabolism and growth. However, the bioavailability and mobility of these micronutrients in the plant system is often restricted due to their bigger size and low surface area. Hence nutrient use efficiency of micro nutrients was reported to be poor in most of the crops. Nano particles of size below 100 nm fall in the transition zone between individual molecules and the corresponding bulk materials, which generate both positive and negative biological effects in living cell. The smaller size, higher specific surface area and reactivity of nano sized micronutrients may affect solubility, diffusion compared to bulk particles and hence become more available to biological cells. However, the unique properties of nano particles that make them useful as sources of nutrients could also pose biological risks. Hence the present investigation was carried out to know the bio-efficacy of metal based nano sized zinc oxide on seedling growth. Zinc is an essential micronutrient for humans, animals and plants. Higher plants generally absorb Zn as a divalent cation (Zn<sup>2+</sup>), which acts either as the metal component of enzymes or as a functional structural or a regulatory co-factor of a large number of enzymes. Nanocrystalline zinc oxide of (25nm) has been prepared by using the oxalate decomposition technique. Both bulk ZnSO<sub>4</sub> and nano scale ZnO solutions were prepared at concentrations of 100, 500, 1000, 2000 and 4000 ppm. Forty seeds of Rice (BPT-5204) and Green gram(LGG-460) were soaked in 100 ml of these solutions of both bulk ZnSO<sub>4</sub> and nano scale ZnO for three hours. The seeds were germinated on petriplates with four replications and data on seed germination and seedling vigour was recorded. The data revealed that nano ZnO recorded higher seedling root and shoot growth in both the crops compared to bulk ZnSO<sub>4</sub> and control. It is worth reporting that nano ZnO was only effective in lower concentrations i.e. 500ppm. To ascertain biological risks and optimize toxicity levels of nano based ZnO particles in cells, toxicity studies were also conducted using plasmid DNA.



01-34

**EFFECT OF NITROGEN AND LEAF POSITION ON QUALITY CONSTITUENTS OF LANKA TOBACCO (*Nicotiana tabacum* L.) GROWN IN ANDHRA PRADESH**

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*Lanka* tobacco, an indigenous air-cured tobacco used for cheroot making, is famous for its characteristic pungent taste and strong aroma and is cultivated on alluvial flood plains of Godavari River in East and West Godavari, and Khammam districts of Andhra Pradesh. A field experiment was conducted during 2010-11 in Rekhapalli, Khammam district, Andhra Pradesh to study the effect of nitrogen levels (Recommended practice; N1=300 kg/ha and farmers practice; N2=1000 kg/ha) and leaf position (bottom, middle and top) on biochemical quality constituents in *lanka* tobacco. Nicotine, reducing sugars (RS), starch, proline, petroleum ether extractives (PEE) and acid value (positively related to quality) were decreased whereas chlorophyll a, chlorogenic acid, rutin and nitrate nitrogen (negatively related to quality) were increased with an increase in nitrogen level from N1 to N2. Nicotine, RS, chlorogenic acid, PEE, starch, nitrate nitrogen and proline contents increased whereas rutin content decreased with increase in leaf position from bottom to top. Nicotine content decreased by 10.9% in the top leaves with increase in nitrogen levels from N1 to N2. Reducing sugar content varied from 0.46 to 1.41% among the leaf position and nitrogen levels. RS and proline contents decreased significantly by 14.39% and 79% respectively, whereas Chlorogenic acid content increased by 17.68% with increased levels of nitrogen from N1 to N2. The chlorogenic acid content in the top leaves was 36.79 and 40% higher than the middle and bottom leaves, respectively. The maximum content of nitrate nitrogen (4.06 mg/g) was in the top position leaves under N2 level. Nitrate nitrogen content increased by 82.53, 48.16 and 129.45% in top, middle and bottom position leaves respectively, with increase in N levels from N1 to N2. Results revealed that tobacco from top followed by middle position showed maximum accumulation of quality constituents at 300 kg N/ha. The recommendation of 300 kg N/ha for *lanka* tobacco was found to be optimum for higher yields with balanced quality constituents for its pungent taste and strong aroma compared to farmer's practice (1000 kg N/ha).

01-35

**STUDIES ON ROOT TRAITS, ANTIOXIDANT ACTIVITY IN RELATION TO LOW PHOSPHORUS SUPPLY IN RICE (*Oryza sativa* L.) GENOTYPES**

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Six genotypes viz., IET 20710, IET 20894, IET 20716, MTU 1010, IET 20744 and SWARNA grown with modified Hoagland solution with low phosphorus: 1.6  $\mu$ M (LP) as well as normal phosphorus: 200  $\mu$ M (NP). Morphological, physiological and biochemical parameters in root and shoot were evaluated in the rice genotypes in response to phosphorus supply. Results indicated that the root attributes such as root length, root volume, root dry weight and higher root/shoot ratio in rice genotypes viz., IET 20710, SWARNA and IET 20716 contributed to greater adaptation to low P availability. These genotypes also had higher antioxidant activity (SOD, POD and CAT) with reduced oxidative injury (MDA content) in root and shoot under grown under low P indicative of their tolerance to P deficiency. In contrast, rice genotypes viz., IET 20744 and IET 20894 exhibited reduction in all the above traits indicative of susceptibility.



01-36

### PHYTOSIDEROPHORES ARE ALSO RESPONSIBLE FOR ZINC BIO-FORTIFICATION

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The goal of the proposed program is to improve the health of poor people by breeding staple food crops by biofortification of food grains either by developing crop cultivars with high concentration of Zn in grains or by adequate Zn fertilization of crops grown. The Zn content of the grain has shown the wide variability in the Zn content among the 15 varieties each of sorghum and finger millet by conducting an experiment in our IISS farm through agronomic measure. Among the sorghum the CSV 1955 and pant chari 3 has highest zinc content with the values of 35–40 ppm (control 29 & 35 ppm). Similarly, the variety Paiyur-1 showed the highest value of zinc with 32ppm (control 27.47ppm) in the finger millet. Among the treatment, the foliar application was found to enhance the Zn content in grain in finger millet, while soil and foliar combine application enhances in the Sorghum by over 10%. By analyzing the Zn content, the varieties with low, medium and high Zn content in the sorghum are PC 5, Pant chari series and CSV216R, respectively. Similarly, in the raagi, though the variation was not high, the varieties are HR 911, GPU 28 and Paiyur 1, respectively. The higher zinc content have shown the positive correlation with thiol group (-SH), higher amino acids secretion, but not with phenolic content in phytosiderophores exudates, implying the binding capability of these compound for zinc (or other micronutrient).

01-37

### SCREENING OF AROMATIC RICE FOR NUE AND INFLUENCE OF DIFFERENT NITROGEN LEVELS ON SCAVENGING ENZYME ACTIVITY IN RICE (*Oryza sativa* L.)

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Nitrogen (N) stress may also enhance the antioxidative enzyme activity to protect the plants. The objective of this study was to examine the role of antioxidant enzymes under two different N levels at vegetative and reproductive stages. The Response of antioxidant enzymes such as superoxide dismutase (SOD), peroxidase (POD) catalase (CAT) and Lipid peroxidise are the systems considered to minimize the Reactive oxygen species (ROS) i.e., superoxide anion ( $O_2^{\cdot-}$ ) and hydrogen peroxide ( $H_2O_2$ ). During *kharif* and *rabi* 2011-12, around 138 aromatic rice genotypes were screened under different N-0 and N-100 levels, Parameters such as Leaf temperature, leaf thickness, grain yield and its components were recorded from these 138 genotypes. Based on the overall physiological performance and yield, the genotypes such as Basmati 370, Ranbhir basmati, Dehradun basmati and Krishnajoha were found to be high yielding, while Kolajoha-3 and Ratnasundari were taken as low yielding. In these selected genotypes the antioxidant enzymes such as, SOD, POD, CAT and Lipid peroxidation activity were studied in young leaves at full expansion. Significant differences were observed between genotypes and treatments. The results suggested that the maximum SOD, POD activities were observed in stress (N-0) than control (N-100) at both vegetative and reproductive stages, while the variety Kolajoha -3 was shown more SOD, POD activity under N-100 level at reproductive stage. The maximum CAT activity was observed in N-100 level as compared to N-0 at both stages except in Ratnasundari. The lipid peroxidation activity was more in N-0 level compared to N-100 at both stages. Like in abiotic stress nitrogen levels also influence the antioxidant enzyme in evident, and the genotypes varied significantly in relation to nitrogen nutrition, which will be useful in identifying interaction between, N use efficiency and stress tolerance.



01-38

### GENOTYPIC DIVERSITY IN WHEAT CULTIVARS IN RELATION TO NITROGEN USE EFFICIENCY

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Nitrogen (N) is one of the most important nutrients required for plant growth. Crop productions all over the world are limited by nitrogen deficiency. The understanding of variation and mechanism of N uptake can be helpful for genetic analysis and molecular approaches to make crop plants more N-efficient. Total 110 wheat genotypes were sown in the field with and without N-application. The recommended dose of fertilizer were applied @120:60:40:: N:P:K kg/ha (N 120) and 0:60:40:: N:P:K kg/ha (N 0). Genotypic variability was recorded in terms of total above ground biomass, grain yield and 1000 seed weight and computed harvest index. The relative change in shoot dry matter at N0 over N120 was maximum in PBW-347 (126%) and Stretton (125%) while Bevy-1 (Med) produced the lowest shoot dry matter. In terms of relative change in grain yield at N0 over N120, Lira recorded maximum (98.8%) while Bevy-1 (Med) (31.3 %) recorded the minimum grain yield. Nyabing (133%) has recorded maximum relative 1000 seed weight and PDW-233 (74%) recorded minimum among 110 genotypes at N0 over N120. Triticale Tahara (139.9 %) has recorded maximum relative HI and Stretton (49.5%) recorded minimum at N0 over N120. Relative total chlorophyll content (mg g<sup>-1</sup> fr wt) was recorded maximum by Raj 4102 (127.52 %) and minimum by Excaliber (24.4 %) at N0 over N120. On the basis of biomass and grain yield PBW-347 and Stretton were categorized as N-efficient cultivars and Bevy-1 (Med) and Culiacant as N-inefficient cultivars.

01-39

### PHYSIOLOGICAL EFFECTS OF SOLUBLE FERTILIZERS UNDER DRIP FERTIGATION IN OKRA (*Abelmoschus esculentus* (L.) Moench)

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Field experiment was conducted at Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during 2010-2011, with the objective to study the physiological effects of soluble fertilizers under drip fertigation on morphological, biochemical, physiological, growth characters, yield components and yield in okra. The treatments included the application of soluble fertilizers under drip fertigation @ 300 kg ha<sup>-1</sup>, 200 kg ha<sup>-1</sup>, 150 kg ha<sup>-1</sup> and conventional fertilizers (control). Among the various treatments imposed, soluble fertilizers @ 300 kg ha<sup>-1</sup> under drip fertigation with an interval of 5, 10, 20, 30 and 60 days after sowing was found more effective in all the growth stages viz., vegetative, flowering and maturity. The observations on morphological parameters viz., plant height, number of leaves, number of nodes and internodal length of the crop were significantly influenced by application of soluble fertilizers @ 300 kg ha<sup>-1</sup>. The biochemical constituents such as chlorophyll content, soluble protein, nitrate reductase and peroxidase activities were also substantially increased due to the application of soluble fertilizers @ 300 kg ha<sup>-1</sup> under drip fertigation. The drip fertigation of soluble fertilizers @ 300 kg ha<sup>-1</sup> had positive influence on yield components viz., number of flowers, number of pods, pod girth, pod length, pod weight, and 100 seed weight. The significant influence of soluble fertilizers under drip fertigation ultimately resulted in yield increase up to 23.9 per cent over control.



01-40

### EVALUATION OF SWEET SORGHUM GENOTYPES FOR BIOMASS (CANE YIELD), JUICE PARAMETERS AND SUGAR LEVELS

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Sweet Sorghum has been identified as a preferred biomass crop for fermentation into methanol and ethanol fuel. The adaptation of sweet sorghum to sub-humid and semiarid climates has extended biomass production into large regions than other warm cereals. Sweet Sorghum cane is containing sugars equivalent to that of sugarcane and is very good alternative source for bio-ethanol production. A field experiment was conducted during *kharif* season at research farms of Directorate of Sorghum Research, Rajendranagar, Hyderabad to assess the potentiality of Sweet Sorghum genotypes for biomass, green cane and leaf area etc., in addition to juice parameters like juice extractability, total sugars and sucrose levels. Eleven Sweet Sorghum genotypes were evaluated at four stages of growth. The genotypes Wray, Urja, SSV-74 and CSH-22SS registered significantly higher brix value, % Total Soluble Sugars (%TSS) and % Sucrose at physiological maturity. Brix value, % TSS and % Sucrose in juice increased from boot leaf to physiological maturity whereas, reducing sugars decreased. At boot leaf stage, genotype SSV-74 and CSH-22SS recorded higher % reducing sugars. The genotypes CSH-22SS and SSV-74 registered highest biomass, juice volume and leaf area at milky stage as compared to other genotypes as well as grain and forage sorghum cultivars. Highest chlorophyll content (SPAD meter reading) was recorded in Wray and Urja cultivars at milky stage.

01-41

### RESPONSE OF WHEAT GENOTYPES FOR PHOSPHORUS USE EFFICIENCY BASED ON ROOT MORPHO-PHYSIOLOGICAL TRAITS

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Root system geometry is essential to improve nutrient use efficiency in plants. A common response to Phosphorus (P) deficiency is an increase in root to shoot dry weight ratio. Low soil P availability also changes the distribution of growth among various root types. Another common adaptation to low P is the stimulation of root hair growth in terms of root hair number, root length and density. P is a common yield limiting nutrient for wheat. Adequate P nutrition is essential for tillers and root development of wheat. Genotypic variation and tolerance to P deficiency in wheat have been reported by many workers. Genotypes having the same yield potential may behave differently with respect to their P deficiency stress tolerance. Different approaches to enhance P uptake through root traits have been listed in literature. The objectives of present investigation were to identify the root morpho-physiological traits associated with efficient P uptake. Ten wheat genotypes, namely- WH-147, Raj-4083, WH-1021, WH-1022, WH-1025, PBW343, PBW550, C306, LOK-1 and NW-2030 differing in response to P application were evaluated with recommended dose of P (100%), half of recommended dose (50%) and one fifth of recommended dose (20%) for root characteristics, viz. root length, no. of roots, root/shoot ratio, acid and alkaline phosphatase activity of root and root exudates. Varieties WH-147, Raj-4083, WH-1022, C306, LOK-1 and NW-2030 showed significant difference in root characteristics at 20% P dose as compared to different doses of P(50% and 100%). Acid and alkaline phosphatase activities were significant higher in genotypes WH-147, Raj-4083 and C306. Therefore, these genotypes may be used for incorporation P uptake efficiency in the plant breeding programme of wheat genotypes for improving phosphorus.



01-42

### EFFECT OF BALANCED AND IMBALANCED NUTRITION ON THE YIELDS OF RICE-RICE CROPPING SYSTEM

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The effect of balanced and imbalanced nutrition on the rice-rice cropping system was studied in the AICRP on Long Term Fertilizer Experiments (ICAR) in rice-rice cropping system at Regional Agricultural Research Station, Jagtial. The experiment is being conducted since 2000-01 in a clay soil. The soil was low in available nitrogen, medium in available phosphorus, high available potassium and the micronutrient cations and sulphur were above critical limits. In control plots, low grain yields (10 years average yield of 3017 and 2525 kg ha<sup>-1</sup> in *kharif* and *rabi*, respectively) were obtained. Application of only nitrogen (120 kg N ha<sup>-1</sup>) (imbalanced nutrition) increased the yields by only 41.3% (1246 kg ha<sup>-1</sup>) in *kharif* and 34.9% (881 kg ha<sup>-1</sup>) in *rabi* over control. However, when balanced nutrient application was done i.e., NPK were applied (120-60-40 kg ha<sup>-1</sup>), yields increased considerably. Application of NPK increased the yields by 73.8% over control and 23.8% over only N application in *kharif*. The increase was 92.8% over control and 42.9% over N-alone in *rabi*. When nitrogen alone was applied at recommended level (120 kg ha<sup>-1</sup>), low grain yields (4263 and 3406 kg ha<sup>-1</sup> in *kharif* and *rabi*) were recorded. Balanced application of recommended NPK (120-60-40 kg ha<sup>-1</sup>) resulted in higher yields of 5245 kg ha<sup>-1</sup> in *kharif* and 4867 kg ha<sup>-1</sup> in *rabi*. Further, balanced application of NPK at only 50% recommended NPK (60-30-20 kg ha<sup>-1</sup>) resulted in grain yield of 4401 kg ha<sup>-1</sup> in *kharif* and 3783 kg ha<sup>-1</sup> in *rabi*, which were higher than imbalanced application (only N at recommended level). These results show the advantage of balanced nutrient application (i.e. application of N, P and K together) over imbalanced nutrient application.

01-43

### PERFORMANCE OF SOME BLACKGRAM GENOTYPES IN RELATION TO PHYSIO-CHEMICAL, ROOT PARAMETERS AND YIELD AS INFLUENCE BY FOLIAR FEEDING WITH BORON

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A field study was carried out during summer season with the objective to assess the physio-chemical and root parameters of seven blackgram genotypes under rainfed situation as influence by foliar feeding with boron. There were three treatment combinations comprising of control (T<sub>1</sub>), foliar application of 100 ppm boron at 20 DAS (T<sub>2</sub>) and foliar application of 100 ppm boron at 20 and 35 DAS (T<sub>3</sub>). Significant variations in root parameters and physiological and biochemical parameters were recorded in all the genotypes except the leaf temperature. Genotype USJD-113 followed by SB-121-36 was recorded to be the best genotypes in terms of physiological parameters like Photosynthetic rate, chlorophyll contents, leaf nitrogen content and root characters. Foliar applied boron caused significant alteration in root parameters and physiological and biochemical parameters of all the genotypes. Foliar application of 100 ppm boron at 20 and 35 days after sowing was found to be more effective in enhancing all the parameters as compared to 100 ppm boron applied at 20 days after sowing. Genotypes USJD-113 and SB-121-36 were found to be more responsive towards foliar applied boron.



01-44

**EFFECT OF DATES OF SOWING AND FERTILIZER LEVELS ON GROWTH, PHYSIOLOGICAL PARAMETERS AND YIELD OF GARDEN CRESS (*Lepidium sativum* L.)**

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An investigation was carried out to study the effect of dates of sowing and fertilizer levels on growth, yield and quality of garden cress, at Kittur Rani Channamma College of Horticulture, Arabhavi, during October 2010 to February 2011, with 3 dates of sowing as main plot treatment and 5 fertilizer levels as sub plot treatment in split plot design with three replications. Maximum growth and yield were recorded with crop sown on 1<sup>st</sup> November among the different dates of sowing and with the application of 80:80:30 kg of NPK/ha among the fertilizer levels. The treatment combination of 1<sup>st</sup> November sowing and 80:80:30 kg of NPK/ha recorded maximum plant height, number of branches, number of leaves, dry matter accumulation per plant and per hectare, physiological parameters like absolute growth rate, relative growth rate, cumulative growth rate, seed yield per plant and per hectare (47.75 q/ha), oil yield and uptake of NPK. While, oil content was maximum in treatment combination with 15<sup>th</sup> November sowing and 40:40:30 kg of NPK/ha. Higher net returns of Rs. 2,07,145/- and benefit: cost ratio of 6.55:1 was observed when the crop was sown on 1<sup>st</sup> November and supplied with 80:80:30 kg of NPK/ha, under northern dry zone of Karnataka.

01-45

**BIOCHEMICAL AND MOLECULAR CHARACTERIZATION OF MAIZE (*Zea mays* L.) GENOTYPES FOR HIGH IRON CONTENT**

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Biofortification is development of the micronutrient dense staple food crop using the best traditional breeding practices and biotechnology. The present study was conceptualized and executed for screening maize genotypes for iron content and identification of SSR markers closely associated with micronutrient content in maize genotypes. Fourteen maize genotypes were obtained from the Maize Research Centre, ARI, ANGRAU, Hyderabad. The powdered samples were analyzed for grain iron content by Atomic Absorption Spectrophotometry. Based on iron content, the maize genotypes were grouped under high, medium and low categories. The iron content of the maize genotypes ranged from 9.81 to 80.47 mg / kg of grain. Four genotypes had high iron content, six genotypes possessed medium iron content and four genotypes exhibited low iron content. A total of eighty SSR markers distributed over the ten chromosomes of maize were used for PCR amplification, for identifying the primers closely linked with the genomic regions associated with micronutrient content. Among the eighty markers used, only fifty markers showed amplified bands, out of which, the markers umc1982, umc1353, umc1008 and umc1349 showed polymorphism between four maize genotypes having high iron and the three genotypes with low iron content. The four markers were then used to confirm whether polymorphism between fourteen maize genotypes was due to iron content. Definite trend of polymorphism that could be attributable to high and low iron content in the grains, clearly differentiating the genotypes with high and low iron content, was exhibited by the SSR marker umc1008, located on chromosome 4.



01-46

### INFLUENCE OF MICRONUTRIENTS ON GROWTH CHARACTERISTICS AND SEED YIELD OF KASTURI BHENDI (*ABELMOSCHUS MOSCHATUS* L.)

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A field experiment was conducted on the field of Department of Agricultural Botany, College of Agriculture, Marathwada Krishi Vidhyapeeth, Parbhani (MS) during *kharif* season of 2010-2011 in Randomized Block Design with three replications and nine treatments. The investigation was therefore undertaken to study the effect of foliar sprays of zinc, boron and iron on growth parameters of Ambrette. The micronutrients were sprayed at 60 and 90 days after sowing. The treatment T8 (0.5%  $ZnSO_4$  + 0.2% borax) recorded overall better performance than all other treatments in respect of yield and yield contributing characters. The treatment with foliar spray of 0.5%  $ZnSO_4$  + 0.2% borax (T8) proved to be the tallest of all through growth period. Its more plant height might be due to boron which is associated with the development of cell wall and cell differentiation and helps in root elongation and shoot growth of plant. The same treatment gave the highest seed yield and maximum fruit length. Girth of fruit and thousand seed weight were not influence by any of the treatments. The oil content was maximum in treatment with foliar spray of 0.5  $ZnSO_4$  in combination with 0.2% borax (T8) among all other treatments.

01-47

### EVALUATION OF FLUE-CURED TOBACCO GENOTYPES FOR NITROGEN-USE EFFICIENCY

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Tobacco is very sensitive to nitrogen fertilization. In tobacco, leaf being the economic product, nitrogen plays a key role in realizing optimum yields and quality. At present recommended rate of N for tobacco on irrigated Alfisols is 120 kg/ha. But Nitrogen use efficiency (NUE) in this area seldom exceeds 50%. Identification and use of genotypes with higher NUE may be a promising strategy to reduce the use of N fertilizer and in turn environmental pollution. A Field experiment was conducted at CTRI Research Station, Jeelugumilli to evaluate the flue-cured tobacco genotypes for nitrogen use efficiency using eighteen flue-cured tobacco genotypes 16/103, Mc Nair-12, CM-12, Kanchan, TOBIOS-2, RT-31-1, RT-40-1, RT-42-1, RT-46-1, RT-51-2, RT-52-3, RT-57-1, RT-62-1, RT-102-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1 with and without 120 kg N ha<sup>-1</sup> in three replications using recommended package of practices. After attaining maturity leaves were harvested, cured in barn and the yield recorded. The leaf and stem samples were processed and analysed for nitrogen. From the data nutrient uptake and use efficiencies were computed. Genotypes showed differential response to applied nitrogen. The biomass production of genotypes without N application ranged from 786 to 1244 kg ha<sup>-1</sup> with an average of 1066 kg ha<sup>-1</sup>. The biomass production of 18 genotypes grown with N varied between 1606 to 2722 kg ha<sup>-1</sup> with an average of 2370 kg ha<sup>-1</sup>. The reduction in biomass in the absence of N application ranged from 41 to 70%. Nitrogen uptake increased due to nitrogen application and it ranged from 50.83 kg ha<sup>-1</sup> to 88.5 kg ha<sup>-1</sup> and 15.34 to 26.6 kg ha<sup>-1</sup> with and without N, respectively. Genotypes viz., RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1, RT-62-1, ABL-10-1, TOBIOS-2, RT-102-1 and RT-31-1 have high yield potential. The NUE of the genotypes varied between 5.74 to 15.14 kg cured leaf kg<sup>-1</sup> nitrogen applied with an average of 11.48 kg kg<sup>-1</sup>. The genotypes viz., RT-42-1, RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-46-1, RT-102-1, TOBIOS-2, RT-46-1,



ABL-49-1 and RT-62-1 have higher NUE. Based on biomass production and NUE, the genotypes which recorded higher yield and greater NUE were categorized as efficient genotypes with high yield potential. Among the 18 flue-cured tobacco genotypes evaluated, RT-57-1, RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1, RT-62-1, TOBIOS-2, RT-102-1 recorded greater NUE coupled with high yield potential. These genotypes can be regarded as NUE varieties and also may be used in future breeding programs to produce cultivars with high NUE and high yield potential.

**01-48**

### **PHYSIOLOGICAL INVESTIGATIONS IN TO THE PRODUCTIVITY OF MAIZE HYBRIDS**

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A field experiment was conducted to know the productivity of popular hybrids in Karnataka. Totally ten hybrids were selected based on the area covered in the State. The experiment was laid out in randomized block design with 10 treatments replicated thrice. The fertilizer (100:50:25 hg/ha N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O kg/ha.) was applied as per the recommendation made to agro-climatic zone (Zone 8) under rainfed conditions. The observations on leaf area, plant height, and photosynthetic rate and SPAD readings were taken at 50% silking stage whereas yield and yield attributes were recorded at physiological maturity. Among the hybrids NK-6240 recorded highest photosynthetic rate (42.6 μm/m<sup>2</sup>/s), closely followed by 900 M Gold (39.5 μm/m<sup>2</sup>/s). The highest leaf area index [LAI] was recorded in NK-6240 followed by 900 M Gold and CP 818, however, the SPAD reading was maximum in 900 M Gold. The highest grain yield was recorded in 900 M Gold (116.7 q/ha) followed by NK-6240 (112.2 q/ha) and CP-818 (110.0 q/ha). The higher yield in 900 M Gold may be attributed to its higher photosynthetic rate, chlorophyll content, cob girth (174cm), higher number of seed rows per cob (16) and test weight (38.9 g) while, the higher yield in NK-6240 may be due to higher photosynthetic rate, chlorophyll content, cob length (18.5 cm), cob girth (16.7 cm), higher number of seed rows per cob and number of seeds per cob. The higher partitioning efficiency (52%) was also noticed in 900 M Gold.

**01-49**

### **IMPACT OF ZEOLITE FORTIFIED NITROGEN FERTILIZER ON MAIZE GROWTH AND YIELD**

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Zeolite is a hydrated aluminasilicate having three dimensional rigid crystalline networks that are 10<sup>-9</sup> m in size used as a carrier material in fortification of fertilizer. Nitrogen is one of the major nutrients in crop. Nitrogen (N) supply is to delay the leaf senescence and prolongation of vegetative growth. Mostly, the N fertilizer is unavailable to plant due to volatilization, leaching and denitrification. The soluble form of N (NO<sub>3</sub>) reaches beyond the plant root zone; thereby inhibiting the availability of nitrogen to plants. By curtailing the nitrification process by slow release of N fertilizer through zeolite fortified N fertilizer, uptake of nitrogen by plants can be improved. The urea is loaded in to zeolite (carrier material) it causes the slow release of fertilizer and to minimizing the conversion of NH<sub>4</sub> to NO<sub>3</sub>. An experiment was conducted to study the impact of Nano nitrogen fertilizer on maize crop. Maize was grown under pot culture with the treatment of conventional and zeolite fortified N fertilizer. When compared to conventional N fertilizer, zeolite fortified fertilizer applied maize crop showed more leaf area, increased total chlorophyll content, higher SPAD value and higher yield.



01-50

### OPTIMIZATION OF NITROGEN UPTAKE LEVELS OF FINGER MILLET THROUGH HYDROPONIC CULTURE

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The optimum nitrogen requirement of Finger millet (*Eleusine coracana*) for obtaining plants of a high phenotypical quality and good physiological parameters were studied in this research using hydroponic culture. Plants were subjected to four treatments of nitrate concentrations. Plants grown in 0.5 mM nitrate conc. attained more height compared to other low nitrogen treatments. Similarly plants of 0.5 mM nitrate treatments possessed more number of lateral roots, more surface area of leaves, more dry weight of plants and more chlorophyll contents compared to other low nitrogen treatments. Specific activity of nitrate reductase in plants treated with 0.5 mM concentration was found more than 3 times higher than that of control plants; similarly specific activity of nitrite reductase in 0.5 mM treated plants was more followed by 0.1 mM, 0.05 mM and control treatments. From the results of these different physiological parameters of plants we concluded that 0.5 mM nitrate is optimum nitrogen concentration for the growth of finger millet.

01-51

### STUDIES ON TERMO-TOLERANCE IN RICE GENOTYPES: 2. FIELD EVALUATION OF SELECTED GENOTYPES IN AEROBIC CULTIVATION AND MARKER VALIDATION

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Selected eleven rice genotypes with contrasting tolerance to moisture stress (highly tolerant, moderately tolerant and susceptible) from an earlier pot culture study were further validated for their field performance under aerobic conditions as well as with selected markers. The cultivars NLR 3010, NLR 40059, NLR 34242 and NLR 33671 recorded high SCMR and low SLA values compared to other genotypes denoting their higher WUE nature. These genotypes also possessed high Photosystem II efficiency (higher Fv/Fm ratios). NLR 3010, which maintained higher WUE, incidentally possess high thermo tolerance in terms of significantly low membrane injury (37%) compared to all other entries. NLR 40059, NLR 34242, MTU 1010, NLR 145 maintained membrane injury (lesser than 50% up to 105 day after sowing). Physiological indices viz. CGR, LAI and LAD varied significantly among the rice genotypes. NLR 3010 recorded significantly higher CGR, LAI and LAD followed by NLR 34242, NLR 40059, NLR 33671 compared to all other cultivars. Yield and yield components significantly varied among the genotypes. NLR 34242 recorded maximum number of tillers and NLR 3010 recorded more number of productive tillers than other genotypes followed by NLR 40059, NLR 34242, NLR 145, NLR 33671 and MTU 1010. Among the genotypes tested, NLR 3010 recorded the highest HI of 43 % followed by NLR 40059 (42%), NLR 33671 and NLR 34242 (41%). NLR 3010 also recorded the highest seed yield of 241 g m<sup>-2</sup> followed by NLR 40059 (235 g m<sup>-2</sup>) NLR 33671 (228 g m<sup>-2</sup>) and NLR 34242 (224 g m<sup>-2</sup>). MTU 1010 and NLR 145 recorded moderate seed yields of 210 and 188 g m<sup>-2</sup> respectively. The higher seed in the above genotypes was due to lower spikelet sterility indicative of drought tolerance. Validation with four SSR markers (RM1221, RM53, RM6970 and RM340) in selected contrast rice lines showed positive amplification linked to known WUE



traits (carbon isotope discrimination) and QTLs such as root length and root dry weight traits in NLR 3010, NLR 40059, NLR 33671, NLR 34242. It is concluded that the genotypes NLR 3010, NLR 40059, NLR 33671, NLR 34242, MTU 1010 and NLR 145 with high thermo-tolerance traits can be either recommended to aerobic cultivation based on their geographical adoptability or used as donor source in breeding programmes for development of rice genotypes for aerobic cultivation.

01-52

### EFFECT OF NITROGEN DEFICIENCY ON CHLOROPHYLL CONTENT AND YIELD IN WHEAT GENOTYPES

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Twelve genotypes of wheat (WH711, WH1081, PBW343, WH1025, WH1021, WH147, WH1080, PBW 621, LOK1, C306, WH 1107 and WH 1111) were raised in the field with nitrogen (150 kg N/hectare (+N), and without nitrogen (-N). A 10 to 30 % decline in chlorophyll content was observed in the -N treatment at heading stage, which showed a further decline of 3-10% per week. The chlorophyll fluorescence also decreased in the -N treatment (2-7%) although the decline was much smaller than chlorophyll content. The genotypes which performed well in terms of chlorophyll content and chlorophyll fluorescence under -N treatments were WH1080, WH711 and PBW 343. A 60 to 70 % decline in plant biomass at harvest stage in -N treatment was observed. The genotypes which performed well in terms of plant biomass were WH1080, WH1021 and WH 1111. A 40 to 60% decline in grain yield was observed in -N treatments. The genotypes which performed well in terms of grain yield were WH1111 and WH 1080. No significant effect of treatment was observed on grain test weight.

01-53

### EFFECT OF BORON SPRAY ON YIELD AND YIELD COMPONENTS OF RICE

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Boron deficiency is one of the plausible reasons for spikelet sterility. Rice grown on a wide range of soils suffers from boron deficiency. Unavailability of soil Boron and its immobile nature in plant tissues limits growth and development. Hence, foliar spray was given at anthesis as 0.2, 0.4, 0.8 ppm and control to seven varieties viz., IET 20979, IET 21007, IET 21106, IET 21114, IET 21519, IET 21540 and Rasi or IET 1444. Initial B level in soil was 0.327 ppm. Boron content (ppm) was estimated in leaf, stem and grain. IET 20979 showed maximum B content (3.63) followed by IET 21114 (3.10) with 0.8 ppm and IET 21007 (3.08) IET 21106 (3.00) with 0.4 ppm spray in grains. Leaf and stem B contents also high in these four varieties irrespective of treatment effect. IET 20979, IET 21106 and IET 21519 recorded more number of panicles gave high yields. IET 21519 possessed highest number of filled grains at 0.8 ppm (173) and 0.4 ppm (157). Rasi recorded low plant B levels and high yield, owing to high pollen viability and stigma receptivity. IET 21007 recorded low pollen viability and less grain number. IET 21540 with low Boron showed low spikelet fertility. The study revealed that IET 20979, IET 21106 and IET 21114 which recorded high number of filled grains and pollen viability possessed high B content within, which possibly resulted in high yields with 0.4 ppm spray.



01-54

**INFLUENCE OF PHOSPHORUS SOLUBLIZING INOCULANTS TO REDUCE THE PHOSPHORUS STARVATION STRESS IN SEEDLING AND ACTIVE TILLERING STAGE OF RICE**

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Phosphorous is a major limiting factor, because it often make complex with cations and become unavailable to plants. Phosphorus plays a significant role in several physiological and biochemical activities. Therefore, an experiment was conducted to examine the efficiency of phosphate solubilising inoculants on morpho-physiological changes and amelioration of phosphorus starvation stress in seedling and active tillering stage of rice. Five seed treatments viz., control (S<sub>1</sub>), Azophos 20g/kg of seed (S<sub>2</sub>), three different microbial population of *Penicillium billai* (JumpStart) 160 mg/kg of seed (S<sub>3</sub>, S<sub>4</sub>, S<sub>5</sub>) under 0, 50, 100 per cent phosphorus level were employed. At seedling stage, *Penicillium billai* treatment showed a reduction in acid phosphatase activity and carbohydrate content in roots with enhanced root growth and total chlorophyll content. In active tillering stage, *Penicillium billai* treated plants exhibited higher  $F_v/F_m$  value, increase in proliferation of lateral roots and root width than other treatments. Thus, the above results conclude that the seed treatment with (*Penicillium billai* 160 mg/kg of seed) + 100 percent P level stimulated the growth of rice at seedling and active tillering stages.

# **Session 02**

**Abiotic stress management (water,  
temperature, salinity, pollutants,  
light, etc.)**





02-01

### EFFECT OF HEAVY METAL AND MYCORRHIZAL TREATMENTS ON OXIDATIVE METABOLISM IN *JATROPHA CURCAS* LEAVES

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*Jatropha* seedlings were raised in germination trays in laboratory and transferred to the earthen pots containing soil treated with heavy metals in the following concentrations: (i) Control (ii) Cd 5 ppm (iii) Cd 10 ppm (iv) Cr 5 ppm (v) Cr 10 ppm (vi) Ni 50 ppm (vii) Ni 100 ppm (viii) Pb 50 ppm (ix) Pb 100 ppm (x) Control + Mycorrhizal culture (xi) Cd 5ppm + Mycorrhizal culture (xii) Cd 10 ppm + Mycorrhizal culture (xiii) Cr 5 ppm + Mycorrhizal culture (xiv) Cr 10 ppm + Mycorrhizal culture (xv) Ni 50 ppm + Mycorrhizal culture (xvi) Ni 100 ppm + Mycorrhizal culture (xvii) Pb 50 ppm + Mycorrhizal culture (xviii) Pb 100 ppm + Mycorrhizal culture. Heavy metal treatments (5 ppm Cd, 10 ppm Cd, 5 ppm Cr, 10 ppm Cr, 50 ppm Pb, 100 ppm Pb, 50 ppm Ni and 100 ppm Ni) increased the ROS and H<sub>2</sub>O<sub>2</sub> content significantly in *Jatropha curcas* leaves. Maximum increase was found with 100 ppm Pb (67%). H<sub>2</sub>O<sub>2</sub> content increased to 2 fold with 100 ppm Ni. The increased ROS and H<sub>2</sub>O<sub>2</sub> content adversely affected the membranes resulting in increased membrane injury and MDA content. Maximum increase in membrane injury was observed with Cr 10 ppm (55%). MDA content also increased maximum to 82% with Ni 100 ppm. Heavy metal treatments decreased the chlorophyll content and chlorophyll fluorescence. Heavy metal treatments induced the antioxidant system as was evident from increased activities of antioxidant enzymes catalase, ascorbate peroxidase, peroxidase, glutathione reductase, dehydroascorbate reductase and Monodehydroascobate reductase. Mycorrhizal treatments showed a positive effect by reducing the toxic effects of heavy metals as was evident from reduced ROS, H<sub>2</sub>O<sub>2</sub>, MI (%) and MDA content. Mycorrhizal treatments further increased the activities of antioxidant enzymes with heavy metal stress.

02-02

### LIGHT REGULATION OF CD UPTAKE IN *Oryza sativa* SEEDLINGS

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Light is essential for plant growth and development. Red and blue light wavelengths are noticed to have role in physiological process such as photosynthesis and stomatal opening respectively. Both these process influences mineral uptake in plants by modulating redox potential and transpiration stream. Thus uptake of elements is indirectly related to wavelength of light. A study on cadmium (Cd) uptake in rice is of importance because of ability of rice plants to accumulate this toxic trace element. In the present study; *Oryza sativa* cv MTU 7029 was subjected to Cd under red, blue and white wavelengths of light. It was found that red and blue light at lower intensity cause reduction in Cd uptake especially in leaf and enhance photosystem II mediated reactions. Antioxidant defense system mediates by both enzymatic and non enzymatic components are implicated as mediators that prevent loss of function of metabolic process under Cd stress. It is found that reactive oxygen species production varied between the light treatments and the variation pronounce in presence of Cd. NADPH dependant superoxide production is elucidated as a major route of free radical production. Metal chelators such as thiol derivatives and organic acids also find to have significant role in dynamics in Cd translocation under varying wavelengths of light. Thus light regulation plays significant role in reduction of Cd uptake in rice.



02-03

### MORPHOPHYSIOLOGICAL PARAMETERS ASSOCIATED WITH DROUGHT TOLERANCE IN HIGH YIELDING CLONES OF RAINFED SUGARCANE

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Sugarcane cultivation under rainfed conditions with limited irrigation facilities are completely depending on monsoon rains is predominant particularly in north coastal districts of Andhra Pradesh which accounts for more than 30% of sugarcane cultivated area. The crop raised under rainfed conditions usually suffer from moisture stress specifically grand growth stage resulting in poor cane yields. Earlier field experiments conducted at Anakapalle from 1980 to 1993 indicated that CO 6907, 84A 125, 81A 99, 87A 298, COT 8201, CO 7219, 86A 146 performed well under rainfed situation and gave higher cane yields than others tested. Eleven genotypes of sugarcane were tested under rainfed conditions with June planting at Regional Agricultural Research Station, Anakapalle-531001, Andhra Pradesh during 2010 and 2011 to identify morpho-physiological parameters associated with drought tolerance in high yielding genotypes of sugarcane under rainfed conditions. Among the genotypes 93145 (80.3 t ha<sup>-1</sup>), 2000A 56 (78.2 t ha<sup>-1</sup>), 2001A 63 (73.5 t ha<sup>-1</sup>), 97A 85 (82.8 t ha<sup>-1</sup>), COC 01061 (83.2 t ha<sup>-1</sup>), 98A 160 (78.8 t ha<sup>-1</sup>) and 2000A 226 (80.4 t ha<sup>-1</sup>) recorded higher cane yield and juice sucrose percent. Shoot population at 120 DAP, stalk population at harvest, root depth and root spread area were high in high yielding genotypes. Sheath moisture percent was also high in high yielding genotypes compared to moderate and low yielder. Specific leaf area was low in these clones which denotes more dry matter accumulation per unit leaf area. Positive and significant association of root depth, root spread area and length of millable canes with cane yield was observed. Sheath moisture percent and shoot population had positive but not significant association with cane yield. Regarding physiological parameters like leaf chlorophyll content, SPAD (SCMR) values, specific leaf area, leaf proline content and SOD values at grand growth stage registered significant and positive correlation with cane yield. The root characters (root depth and root spread area), millable canes under morphological characters and SPAD values, SLA, leaf proline content, SOD activity associated with drought tolerance activity under physiological parameters. This was confirmed with more WUE by values of d13C at grand growth stage.

02-04

### THE COORDINATED ROLE OF ETHYLENE AND GLUCOSE IN SULFUR-MEDIATED PROTECTION OF PHOTOSYNTHETIC INHIBITION BY CADMIUM

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Ethylene control photosynthesis and induces tolerance of plants to metal stress. However, little is known about the interaction between ethylene, photosynthesis and sulfur (S) availability under cadmium (Cd) stress. Recently, we reported that ethylene controls photosynthesis by increasing glutathione (GSH) synthesis with sufficient-S availability under Cd stress. Plants treated with Cd were less sensitive to ethylene and showed photosynthetic inhibition. Ethylene sensitivity of plants was increased with exogenously-sourced ethylene or with sufficient-S application resulting in induced GSH synthesis and alleviation of photosynthetic inhibition by Cd. In this article, we present some additional data indicating that ethylene regulates photosynthesis by reducing glucose (Glc) sensitivity, thus reducing the Glc-mediated photosynthetic repression.



02-05

### GROWTH AND REGENERATION CAPACITY OF RICE GENOTYPES TOWARDS SUBMERGENCE STRESS UNDER LOWLAND FLOOD PRONE ECOSYSTEM

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Fifteen genotypes of rice including submergence tolerant cultivar FR-13A were subjected to submergence stress at seedling stage for 15 days in low land flood prone ecosystem of Bihar. Plant growth and yield contributing parameters viz. plant height, tiller number, leaf weight, stem weight, total biomass after re-emergence, total biomass at flowering, total biomass at harvest and grain yield were observed among the genotypes towards tolerance to submergence stress and regeneration capacity after 15 days of complete submergence at 30DAS. More than 200% increase in leaf weight and 82% elongation in plant height was observed in land race FR13A followed by JRS5 (81%). However Swarna sub1, IR64 sub1 and Samba Mahsuri sub1 exhibited lower elongation in plant height when compared to other cultivars. Leaf weight increased from 73% to 265% of their pre submergence level among the cultivars after submergence. However stem weight increased to a lesser extent of 8% to 51% of their pre submergence level among the cultivars after submergence. The total dry matter after re-emergence from submergence stress and at flowering stage was more in IR64 sub1, FR13A, swarna sub1, samba mashuri sub1, Atiranga and Gangasuli. Maximum grain yield was observed in Swarna sub1 followed by Samba mahsuri sub1, Accession 37887 and FR13A. The growth pattern analyzed indicated that lower elongation during submergence and less utilization of stem reserves during the stress might have contributed towards greater regeneration capacity of the genotypes, which ultimately contribute towards higher yield in rainfed lowland flood prone ecosystem.

02-06

### IS VARIATION IN LEAF MORPHOLOGY OF LUCERNE AN INDICATOR OF DROUGHT ADAPTATION?

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In a composite population of lucerne cv. RL-88, a national check, heterogenous plants with varied leaf morphology are observed. An attempt was made to understand whether plants with different leaf morphology during vegetative stage have adaptation to drought. The plants with different leaf morphology (Orbicular {3x1.5cm}, Obcordate {3x 1 cm} and Ovate {3x0.5 cm}) were clonally selected from different fields and planted in pots. It was observed that orbicular leaved plants were shorter with less number of branches and invested more dry matter in leaves. Whereas, obcordate leaved plants invested more in stem dry matter. More number of stomatas was present on orbicular and ovate leaves compared to obcordate leaves. When leaves were subjected to water loss under laboratory conditions, orbicular leaves lost water more compared to obcordate and ovate leaves. After subjecting plants to stress, parameters like relative water content (RWC), cell membrane stability (CMS), conductance (g), chlorophyll fluorescence, A/Ci curves, and osmotic potential were studied. Drought avoidance strategy through stomatal regulation and drought tolerance mechanism through osmotic adjustment were noticed in leaves with varying leaf morphology. Stomatal and non-stomatal limitations under water deficit conditions were discussed *vis-a-vis* CO<sub>2</sub> fixation. These results indicate that morphological expression is one of the criterions to assess plants adaptation to drought stress. This may contribute to identify useful physiological traits for breeding programs concerning drought adaptation in *Medicago sativa* L.



02-07

**BIOMASS ACCUMULATION AND SEED YIELD OF LATE PLANTING CHICKPEA (*Cicerarietinum* L.) GOVERNED BY LOW TEMPERATURE AT DELHI CONDITIONS**

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Chickpea is a cool-season legume crop sensitive to temperature at its different developmental stages. A field study was conducted during 2010-11 with three staggered sowings viz. S1 (early November), S2 (late November) and S3 (mid December) with fourteen chickpea genotypes to determine the effect of temperature on biomass and seed yield. Genotypes sown under S2 and S3 experienced low temperature during the vegetative stage (~13.4°C mean temperature) compared with S1 (~17.1°C mean temperature). On the other hand, average daily mean temperature at mid-flowering to podding stage ranged between ~14.6 to 21.2 °C and ~20.4 to 25.1 °C, respectively for S2 and S3 sown crops. Poor vegetative growth in late sown crops resulted in production of lower plant dry weight and seed yield per plant compared with normal sown crop. Yield reductions were ~27% and ~53% in S2 and S3 sowings, respectively compared with S1 in all the genotypes. Pearson correlation coefficients for vegetative stage temperature and seed yield varied ( $r = 0.687$  to  $0.995$ ) amongst different genotypes suggesting differences in low temperature sensitivity. Although, there was strong negative correlation of yield with high temperature during flowering and podding stages, but lower biomass assimilation suggests that low temperature during vegetative and early flowering stage, which governs the biomass allocation in chickpea genotypes under late sown conditions. The study concludes that late sown chickpea crop is more vulnerable to low temperature during vegetative and early flowering stage apart from high temperature during flowering and podding stages under late sown Delhi condition.

02-08

**POLYAMINE MEDIATED RECOVERY OF OXIDATIVE DAMAGES IN *Marsilea* (*Marsilea minuta* Linn.)**

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In a study where one of the aquatic fern *Marsilea minuta* Linn. was taken as an useful material for hyper accumulation of cadmium. A significant accumulation of cadmium (Cd) was recorded in dose-dependent manner in the tissues as detected in SEM and EDXS study. In response to Cd accumulation, plants significantly recorded the generation of reactive oxygen species (ROS) in terms of superoxide, hydrogen peroxide and hydroxyl radicals. With this, a significant variation of non-enzymatic and enzymatic antioxidation pathway have also been studied. Most importantly, phenolic contents, anthocyanin and total flavonoids were increased according to concentration of Cd doses. In response to enzymatic antioxidation pathway, superoxide dismutase, peroxidases like guaiacol peroxidase (GPX), and ascorbate peroxidase (APX) were assayed. The activities of those enzymes were upregulated but the activities were less when spermidine was applied. On the contrary, the catalase activity was downregulated under the condition of Cd which was up regulated with spermidine application. The DNA disintegration as detected by comet assay also done which was under the condition of spermidine was down regulated. Therefore, in the present study, spermidine could be used as effective alleviator for Cd induced oxidative damages.



02-09

**EFFECT OF SALICYLIC ACID ON SOME PLANT METABOLITES AND MEMBRANE STABILITY IN *Citrullus lanatus* UNDER MOISTURE STRESS**

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In arid region of Rajasthan moisture stress is one of the most important manifestations of abiotic stress in plants. The present study was conducted to evaluate the interaction effects of SA (salicylic acid) and moisture stress (induced by 7.5 and 15 % of Poly Ethylene Glycol or PEG-6000) on protein, proline, total soluble sugars content, chlorophyll stability index (CSI) and membrane stability index (MSI) in *Citrullus lanatus* (Thunb.) Matsumura & Nakai plants grown *In-vitro*. *C. lanatus* locally known as watermelon belongs to family Cucurbitaceae which is an important fruit crop grown in arid region of Rajasthan. *In-vitro* grown seeds were treated with distilled water (control) and respective treatment solutions Viz. 7.5 and 15% of PEG, 7.5 and 15% of PEG + SA (0.25 mM) and SA (0.25 mM) alone. After 7 DAS (Day after Sowing) seedlings were used for estimation of different parameters. Results showed that moisture stress decreased protein, stability of chlorophyll and membrane while increased proline and total soluble sugars content with increase in PEG concentration. Seedlings treated with SA showed higher proline, protein and soluble sugars content and percentage of CSI and MSI compared to control plant. SA along with 7.5 and 15 % of PEG 6000 showed higher CSI % and MSI % as compared to respective control however, these values were lower than control of unstressed plant. Treatment of salicylic acid with combination of both concentration of PEG alleviates the adverse effect of moisture stress by increasing osmolytes content and percentage of CSI and MSI.

02-10

**EFFECT OF BRASSINOLIDE ON PHYSIOLOGICAL ASPECTS OF FENUGREEK (*Trigonella foenum graecum* Linn) UNDER DROUGHT CONDITION**

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A pot experiment was conducted at S.K.N. College of Agriculture, Jobner during *Rabi* season, 2011 to study the Effect of brassinolide on physiological aspects of fenugreek (*Trigonella foenum graecum* Linn) under drought condition. Four fenugreek cultivars namely RMt-1, RMt-361, RMt-305 and Hissar Sonali were grown in ceramic pot under normal conditions till vegetative stage and then plants were sprayed with brassinolide concentration (0.0, 0.25, 0.50, 0.75 and 1.00 ppm), then half the plant were subjected to water stress by withholding irrigation for 8 days. The non-stressed plants were irrigated as frequently as needed and observation was recorded at 7-days after first (pre-flowering) spray and 17-days after first spray of brassinolides. The effect of Brassinolide was found to increase significantly the relative water content, chlorophyll stability index, photosynthetic and transpiration rate, stomatal conductance in all cultivars under non-stress and water stress conditions. The 1.0 ppm concentration of brassinolide was found most effective under both non-stress and water stress condition. Number of seeds per pod, number of pods per plant, seed yield per plant (g) and biological yield were significantly increased on account of brassinolide treatment under non-stress and water stress conditions in all cultivars. Most of the physiological parameters are positively and highly correlated with seed yield. It may be concluded that between the cultivars studied, RMt-305 was drought tolerant and tolerance was mediated by physiological characteristics. Brassinolide increased productivity by reducing the adverse effect of drought stress on growth and yield attributes.



02-11

**IN SILICO TARGETED GENOME MINING, COMPARATIVE MODELLING AND PROTEIN STRUCTURAL MOTIFS STUDIES OF RESPIRATORY BURST OXIDASE HOMOLOGUES (RBOHS) IN MAIZE**

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One of the chief concerns of climate change is an escalation in the frequency and severity of abiotic stresses. Computational biology is an important tool to evolve climate ready cultivars with tolerance to drought and other stresses. Respiratory Burst Oxidase Homologues (RBOHs) are integral plasma membrane proteins belonging to a multigenic family. RBOH proteins are important components of signalling pathways and play a role in abiotic stress tolerance. We hypothesize that it will be possible to associate candidate genes discovered in model species such as *Arabidopsis thaliana*, with corresponding loci in maize. We took up a detailed analysis of the complete maize genome for the similarity/presence of either DNA, mRNA or protein product of At RBOH. We conducted i) BLASTN - nucleotide query to maize nucleotide database; ii) TBLASTX – translated nucleotide query sequence into protein sequences in all six reading frames compared to maize nucleotide database translated on all six reading frames; and iii) TBLASTN - protein query to translated six frames maize nucleotide database. RBOH like proteins were classified in maize genome and phylogenetic trees were constructed. A homology model was built according to the positive match protein sequence. A comprehensive search for templates was done in all pdb structures. InterPro scan was done with other known protein families, domains, regions, repeats, and sites for identifiable features found in known proteins to be applied to the target protein sequence. The resultant putative RBOH was subjected to detailed bioinformatics analysis to ascertain structural and functional similarity to known RBOH.

02-12

**MANAGEMENT OF LOW TEMPERATURE STRESS IN WINTER RICE**

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Abiotic and biotic stresses influence the physiological processes of rice grown under different ecologies and seasons which have direct impact on yield. Rice grows optimally at 20°C to 32°C. Greater frequency of extreme low / high temperature and its influence on germination to spikelet sterility and decrease in rice productivity a cause of concern due to climate change. Changing climate requires better genotypes with good germinability as it is an important trait for plant establishment. Winter rice grown in India, particularly Andhra Pradesh (Northern Telangana, Central Telangana, Southern Telangana and High Altitude and Tribal Zones) suffers from low temperature (5°C – 16°C) stress leading to low germination, stunted growth, yellowing of leaves reduction in tillering during vegetative phase and partial to complete sterility during reproductive phase apart from protracted flowering and prolongation in duration of the crop leading to greater reduction in the yield and sometimes total failure of crop. In parts of South and South East Asia, around 7 m.ha cannot be planted due to low temperature stress. Hence, there is a need to develop different strategies to manage the low temperature effects in winter rice to realize optimum yields. Research conducted at Regional Agricultural Research Station, Warangal to



overcome the low temperature effects on winter rice has lead to identification of sources of resistance development of high yielding low temperature / cold tolerant rice varieties. Among the different strategies, breeding approach has been found to be stable and long lasting than the other agronomic management strategies. Based on leaf yellowing, root and shoot growth, Erramallelu, Tellahamsa, Chaitanya, NLR-145, Lumisree, BPT-5204, WGL-14377 etc., were found to be low temperature/cold tolerant. The tolerant lines have also shown high degree of pre potency by throwing tolerant seggregants in the crosses involving tolerant parents. High yielding cold tolerant varieties having good cooking quality have been developed by using the identified cold tolerant parental lines viz., WGL-283 (Chaitanya / Tellahamsa) WGL-347 (NLR 145/Kavya) and WGL-32183 (Divya/BPT-5204). 22 genes were found to be associated with cold tolerance. Among the newly developed lines WGL-283 was released in the name of ‘Sheethal’ for cultivation in winter season in Andhra Pradesh by State Varietal Release Sub-Committee (SVRC) during 2012 and WGL-347 and WGL-32183 completed all stages of testing and ready for release. This paper deals with identification of new lines (WGL-44, WGL-14, Co-5, Radhakrishna, Krishna Hamsa, HRR-2143, VD-62, Satya, RNR-2458, WGL-580, WGL-623 etc.) for low temperature / cold tolerance, development of cold tolerant high yielding rice cultures with acceptable grain quality and other agronomic practices (growing nursery in low level tunnels covered with polythin sheet, shift in date of sowing, additional fertilizer application etc.) to overcome the low temperature effects in winter rice.

## 02-13

### A NAC FAMILY GENE OF HORSEGRAM *MuNAC4*, IMPROVES DROUGHT STRESS TOLERANCE IN TRANSGENIC GROUNDNUT (*Arachis hypogaea* L.)

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The NAC gene family encodes plant specific transcription factors which are involved in various processes of plant growth, development and stress response. In our previous work, a stress responsive gene, *MuNAC4* protein was identified and characterized from horsegram. The over-expression of *MuNAC4* confers stress tolerance in *E. coli*. The *MuNAC4* protein was found to be localized in the nucleus where it activated transcription. Groundnut (*Arachis hypogaea* L), is an important oilseed crop in semi arid regions of the world. In this study we standardized *in vitro* plant regeneration and transformation for groundnut crop using *MuNAC4* as a candidate gene using *Agrobacterium* mediated gene transfer method to develop transgenics for drought and salt tolerance. The cotyledonary node was cultivated with *Agrobacterium* carrying binary vector pCAMBIA2301 contains *MuNAC4* gene, *nptII*, GUS reporter gene driven by CaMV 35S promoter. The co-cultivated cotyledonary nodes were regenerated in half strength MS media with 0.5 mg/L BAP, 3.0 mg/L, NAA and kanamycin antibiotic supplemented with acetosyringone (100 µg/L), a potent inducer of virulence genes. Successful transformation was initially confirmed by GUS histo-chemical assay. By PCR amplification genomic DNA of putative transformed cotyledonary nodes and regenerated transgenic plants showed positive for *nptII* and gene specific (*MuNAC4*) primers. The transgenic lines exhibited tolerance to drought stress. Under water stress condition significantly higher root growth was observed in transgenics than in wild type groundnut lines. A detailed characterization of groundnut transgenic plants revealed that overexpression of the *MuNAC4* gene can improve drought stress tolerance of groundnut plants. It was also found that overexpression of *MuNAC4* resulted in altered expression levels of some drought stress-responsive genes and changes in several physiological indices, which allow groundnut plants to overcome adverse conditions. These results indicate that the *MuNAC4* plays important roles in plant stress tolerance, and modification of its expression may improve drought stress tolerance in crop plants.



02-14

### EVALUATION OF PROMISING SINGLE CROSS MAIZE HYBRIDS FOR HEAT-STRESS TOLERANCE

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Heat stress due to high ambient temperatures is considered as a serious threat to agriculture in a changing global climate. Developing resilient high yielding crop varieties/ hybrids is an important goal towards adaptation strategy to tackle climate change. For this purpose, a systematic screening of existing germplasm for thermotolerance trait, understanding of physiological responses of plants to high temperature, and deciphering the mechanism of heat stress adaptation is required. High temperature tolerant maize germplasm is essential to enable intensification of cropping systems in which maize is grown as a third crop, and/or in situations in which drought is likely to affect the crop during flowering or grain filling stage. Maize improvement for high temperature tolerance requires reliable evaluation maize germplasm of diverse origin. We have screened 34 single cross maize hybrids during summer 2012 for high temperature tolerance. The crop was planted in field during mid March to coincide its flowering stage to extreme summer of New Delhi. The maximum temperature ranged from 31.4°C to 44.5°C during crop life cycle and specifically from 39.5°C to 44.5°C during flowering. The plants were phenotyped by using Green Seeker Optical Sensor, SPAD chlorophyll meter, Leaf Colour chart, biometric measurement of plant morphology, canopy temperature, tassel blasting, leaf firing, anthesis-silking-interval (ASI), root biomass, grain yield and its attributes, *etc.* Most of the hybrids tested could survive during early growth stage (seedling and knee high) at high temperature but there was a significant decrease in plant growth and physiological efficiency as compared to their performance in preceding *kharif* season. The flowering stage showed symptoms of heat-stress sensitivity of hybrids in terms of increased anthesis-silking interval with tassel blasting and leaf firing resulting in barrenness. Overall 16 hybrids exhibited tolerance to high temperature, while 6 hybrids were highly sensitive. The tolerant hybrids which recorded grain yield in the range of 4.20-18.1 q/ha exhibited heat-stress adaptive traits like more fertile cobs, low ASI ( $e^{25.0}$ ), less tassel blasting, higher root biomass, *etc.* These hybrids can not only serve as a source material for deriving heat-stress tolerant inbred lines but also provide an alternative planting material in summer season.

02-15

### TOXICITY OF CADMIUM ON GROWTH, PROLINE AND TOTAL CARBOHYDRATE CONTENT IN *Plantago ovata* Forsk

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The present study was designed to examine the toxicological effects of different concentrations of cadmium (Cd) on the growth and biochemical parameters in isabgol. The endpoints of isabgol seedlings, including seed germination percentage, mean germination time ( $D_{50}$ ), seedling dry weight, root length and shoot height, all decreased along with increasing the Cd concentrations on the contrary, showed an increase in Proline and carbohydrate when compared to control. General observation in this study can conclude that, Cd had an obvious toxic effect on the seed germination percentage and time, seedling dry weight, root length, shoot height and ratio of shoot height to root length, as well as Proline and Carbohydrate content.



02-16

**LEAD INDUCED OXIDATIVE STRESS CAUSED ALTERATIONS IN ANTIOXIDANT EFFICACY AND PROTEOME RESPONSES IN GROUNDNUT (*Arachis hypogaea* L. cv. K6)**

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Metal contamination of soils has become a world wide problem and great environmental threat, as these metals accumulate in soils and plants in excess, and entered into food chain. One of the major sources of soil contamination with lead is the automobile exhausts. The concentration of Pb in soils near highways has been related to the distance from the road and most of the Pb accumulation is within 200 to 500 ft of highways. Crops growing near the highways are prone to be affected by lead stress and growth of the such crops closed related to the lead contamination and lead concentration in the soil especially near the highways. Increased lead (Pb) uptake from contaminated soils leads to altered plant metabolism and limits the crop productivity. Groundnut, *Arachis hypogaea* L. is an important oil seed crop, widely grown in Rayalaseema regions of Andhra Pradesh. An experiment was conducted to examine the effect of different concentrations of Pb (0, 100, 200, 400, 800 ppm) on the performance of groundnut. Concentration dependent reduction in root, shoot growth and fresh, dry weight was observed at all concentrations tested. There was a significant reduction on root dry weight and leaf area at all concentrations tested. *In vivo* histochemical assay indicated that Pb stress caused a significant accumulation of H<sub>2</sub>O<sub>2</sub> and O<sub>2</sub><sup>-</sup> in leaves under lead stress conditions. Activity of ascorbate peroxidase (APX) increased with increasing Pb concentrations, while activity of superoxide dismutase (SOD) decreased at higher Pb concentrations (800 ppm). SDS-PAGE analysis revealed that two polypeptides with apparent molecular weight 57.5 and 58 kDa were significantly up-regulated with increasing Pb concentrations. 2DE analysis showed changes in several proteins which are involved in metal toxicity, ion homeostasis and several metal binding organic compounds and enzymes. These results suggest that Pb toxicity causes oxidative stress in plants and the antioxidative enzymes SOD, POX and APX and the proteins involved in metal tolerance mechanisms could play a pivotal role against Pb induced oxidative injury.

02-17

**ALLEVIATION OF ANTAGONISTIC EFFECTS OF NaCl SALT STRESS IN MUNGBEAN PLANTS BY GLYCINE-BETAINE AND CHOLINE**

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A glasshouse experiment was conducted to investigate the antagonistic effects of NaCl salt stress in mungbean plants. As compared to control, the length of root and shoot, fresh and dry weights of shoot, leaf structure, chlorophyll contents and K<sup>+</sup> ion concentration was found to decrease whereas, Na<sup>+</sup> ion concentration increased due to salt stress. Highest level of salt stress (12 mS cm<sup>-1</sup>) proved most deleterious. Pre-soaking of mungbean seeds in betaine or choline overcome the antagonistic effects of salt stress partially. While low level of salt stress (4 mS cm<sup>-1</sup>) brought about an increase in the thickness of leaf blade and midrib bundle dimensions, the moderate and high regimes revealed a remarkable decrease in these attributes. Betaine as well as choline pre-soakings mitigated the adverse effects of this abiotic stress.



02-18

**THE PROTECTIVE ROLE OF DIFFERENT OSMOLYTES ON PHOTOSYSTEM I & II EXPOSED TO NaCl IN ECOTYPICALLY VARYING MEMBERS OF ACANTHACEAE**

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The effects of varying osmolytes viz. proline, sucrose, mannitol and sorbitol on short-term NaCl stress on the activity of the photosystem (PS) I and PSII were examined in *Thunbergia erecta* and its salt-tolerant close relative *Avicennia officinalis*. Isolated thylakoids from both the plants were treated with different concentrations of NaCl for different time intervals. In general, *T. erecta* (a glycophyte), showed a much higher sensitivity to NaCl than *A. officinalis* (a halophyte). The activity of PS I and PS II (at room temperature) declined below 50% in *T. erecta* and *A. officinalis* within a time period of 2.15 h & 3.30 h and 1.15 h and 1.40 h respectively. In the above time period, the additional presence of NaCl resulted in the decline of PS I and PS II below 20%. This decline happened in the presence of 2.25 M and 8 M NaCl in the case of PS I activity in *T. erecta* and *A. officinalis* respectively. The decline in the case of PS II activity happened in the the presence of 1.75 M and 6 M NaCl in *T. erecta* and *A. officinalis* respectively. All the osmolytes studied had a protective function on both PS I and PS II activity, but the extend of protection varied between one another. In *A. officinalis* mannitol (1.5 M and 1.75 M for PS I and PS II respectively) had the maximum protective role for both PS I and II, whereas in the case of *T. erecta* PS II and PS I was maximally protected by sucrose (1.5 M) and proline (1.25 M) respectively. Further studies are underway for analyzing the molecular level of protection imparted by these osmolytes to PS I and PS II of both *T. erecta* and *A. officinalis*.

02-19

**24-EPIBRASSINOLIDE AND/OR PUTRESCINE APPLICATION TRIGGER PHYSIOLOGICAL AND BIOCHEMICAL STRATEGIES FOR THE MITIGATION OF SALT STRESS IN *Cucumis sativus* L.**

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Brassinosteroids (BRs) and polyamines (PAs) are well-established growth regulators playing key roles in abiotic stress managements in plants. In our present study, an attempt has been to explore the role of 24-epibrassinolide (EBL, an active BR) and/or putrescine (Put) on the salt induced changes in cucumber and to modulate the over production of oxidative stress under salt stress. The 15 d old plants were exposed to salt stress (100mM NaCl) for three days and were given exogenous treatment of EBL and/or Put at 25 and/or 30 d stage respectively. The salt stress significantly reduced the plant growth, gas exchange parameters but increased proline content and electrolyte leakage in the leaves. Toxic effects induced by salinity stress were completely overcome by the combination of EBL and Put at 35 d stage of growth. Treatments of EBL and/or Put improved the growth and photosynthetic parameters of NaCl-stressed plants and up regulated the activities of enzymes, more specifically that of the antioxidant enzymes like catalase, peroxidase, superoxide dismutase and the content of proline under salt stress. Co-applications of EBL and Put together are more effective than their individual treatments are more effective in alleviation of NaCl-stress. Mitigation of salt stress by EBL and Put generated synergistic response due to the modulation in the activities of antioxidant enzymes (peroxidase, catalase and superoxide dismutase), membrane stability as evident from electrolyte leakage and the values for photosynthetic pigments more remarkably in salt-stressed plants than their individual applications.



02-20

**IDENTIFICATION OF THERMOTOLERANT FINGER MILLET (*Eleusine coracana* (L.) Gaertn.) GENOTYPES THROUGH THERMO INDUCTION RESPONSE TECHNIQUE**

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The Fingermillet (*Eleusine coracana* (L) Gaertn.) is a C<sub>4</sub> crop and one of the important millet crops of India. It is a short duration crop of arid and semi-arid climates grown mostly under rain fed conditions with high temperatures. Impact of global warming on crops was predicted to be high for crops which are already growing in high temperature areas in low-latitude regions even moderate temperature increases (1-2°C,) are likely to have negative impacts on yield of major cereals Thus, climate change may impair food production, particularly in developing countries, most of which are located in tropical regions with warmer baseline climates. Therefore, identification of genotypes with high temperature stress tolerance will help in stabilizing yields. Furthermore, since distinct varieties seem to respond differently to elevated temperatures in terms of harvestable yield, future research should be also directed towards selecting promising genotypes for a changing global climate. Hence present investigation was carried out to identify high temperature stress tolerant finger millet genotypes using a novel method “Thermo induction Response (TIR) technique”. The technique involve exposing germinating seedlings to Gradual (Sub-lethal) temperatures followed by challenging (Lethal) temperatures. The protocol was standardized, where finger millet 2 days old seedlings were exposed to gradual temperatures of 34°C to 54°C for 5 hours followed by challenging temperatures of 57°C for 2 hours. Hundred finger millet germplasm were screened and results revealed that there are significant differences among the germplasm for germination percent, percent loss of shoot growth and percent loss of root growth. Among them ten entries showed to be thermo tolerance in terms of high germination percent with loss of root and shoot growth.

02-21

**CLONING AND SEQUENCE CHARACTERIZATION OF GENE CODING FOR INSULIN IN BITTER MELON (*Momordica charantia* L.)**

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*Diabetes mellitus* is a serious chronic metabolic disorder that has a significant effect on the health, quality of life, and life expectancy of the human being. Diabetes has become a worldwide epidemic and the current diabetic population is estimated to be at 143 million people, which is a fivefold increase from estimates made in the 1990s. This number will probably double by 2030 and India is the one of the major sufferer. Bitter melon (*Momordica charantia* L.) has been traditionally used as a hypoglycemic agent with a long history in Asia, Africa and south america. In this respect bitter melon cultivars Taiwan white and CBM10 were grown in glass house facility of Clemson University for isolation of insulin gene. Genes coding for insulin were amplified using insulin specific primers from the DNA of bitter melon and eluted. The eluted DNA fragment were ligated and transformed into *E. coli* using pGEMT vector. Transformed cells containing plasmids were selected in LB medium containing ampicillin. Plasmid DNA was isolated following mini-prep and digested with EcoRI to separate the DNA insert. The isolated DNA insert was sequence characterized at Clemson University Genome Initiative (CUGI). The gene sequences characterized were further analyzed for blast alignments with human form of insulin. It was found to be significantly similar to *Homo sapiens* insulin. This indicates that bitter melon can be used as a good source of insulin for human being. However further work is needed to ascertain the pharmacological property of the isolated gene in animal model system before using it as a medicine for diabetes.



02-22

### **EFFECT OF SIMULATED MOISTURE STRESS AT DIFFERENT STAGES OF CROP GROWTH ON YIELD OF GROUNDNUT VARIETIES**

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Rainfed groundnut crop in Southern zone experiences regular moisture stress at different plant growth stages due to erratic monsoons. During the time, assessing the yield loss for different groundnut varieties is the research priority. An experiment was conducted during *rabi* season with 3 main treatments viz., control, mid season moisture stress (25-55 DAS) and end of season moisture stress (55-85 DAS) and 6 groundnut varieties as sub treatments viz., TPT-4, Narayani, Abhaya, Greeshma and Dharani were laid in field to assess the yield loss at different moisture stress treatments in different groundnut varieties. The results revealed that, among the moisture stress treatments, there was 28 per cent and 52.6 per cent reduction in groundnut yields under mid season and end of season moisture stress conditions respectively. Among the groundnut varieties, the per cent reduction in yield was low in Greeshma followed by Dharani under both mid season and end of season moisture stress conditions. Hence, it can be concluded that, groundnut crop at 55-85 DAS (peak flowering to pod filling period) is most sensitive to moisture stress. Among the groundnut varieties released in Andhra Pradesh, Abhaya was tolerant to mid season stress and Greeshma, Dharani were moderately tolerant at both stages of growth.

02-23

### **EFFECT OF ARSENATE AND ARSENITE ON GERMINATION AND EARLY SEEDLING GROWTH OF RICE**

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Presence of arsenic in ground water is a great concern now as it is used for drinking and crop irrigation. Arsenic load of soil in the areas of arsenic contamination ground water is gradually increasing as more than 95% of such contaminated ground water is used for crop irrigation particularly for irrigation of *boro* (summer) rice. An experiment was conducted to study the effect of two inorganic arsenic species, arsenate and arsenite, on germination and early seedling growth of a popular rice variety shatabdi. Rice seeds were exposed to water contaminated with different concentrations (control, 2, 4, 6, 8 and 10 ppm) of arsenate and arsenite during germination and seedling growth. Observations were taken on germination at 24 hour interval after 48 hours of setting the seeds for germination up to seven days. Root and shoot length, fresh and dry weight of seedlings were also recorded. Germination percentage under arsenate @ 2 and 4 ppm and under arsenite @ 2 ppm was interestingly at par with that under uncontaminated control treatment. At further higher concentrations of arsenate and arsenite, germination reduced progressively with increase in their concentrations at all temporal counts and final count also. The speed of germination under arsenate @ 2 and 4 ppm was at par with the control treatment and under further higher concentration of arsenate and in all concentrations of arsenite it was lower than the control treatment. Length of root and shoot, fresh and dry weight of seedlings were found to decrease with increase in concentration of arsenic. Such decrease was higher in arsenite than arsenate. The results indicate that arsenate beyond 4 ppm and arsenite beyond 2 ppm only affected germination. But seedling growth was very sensitive to arsenic and was affected at all concentrations of arsenate and arsenite. Arsenite appeared to be more toxic than arsenate.



02-24

**PHYSIOLOGICAL EVALUATION OF RICE (*Oryza sativa* L.) GENOTYPES FOR DROUGHT TOLERANT AND YIELD CHARACTERS UNDER RAINFED UPLAND ECOSYSTEM**

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Agricultural drought is a major environmental stress that effects the crop growth and development and ultimately productively Global climate change may caused more drought and growing water shortage. Upland rice is more vulnerable to drought as rice eco-system is depending on erratic rainfall regimes. As the drought tolerance is a complex phenomenon, and there is a need to know the specific mechanisms associated with resistance though the mechanism of drought tolerance at vegetative stage is different form reproductive stage. Therefore, this experiment was design to know the drought tolerance characters under rainfed condition in 14 rice genotypes including three check varieties Anjali, Sahabhadhan and Tulasi during *kharif* 2011. A parallel irrigated treatment was also conducted to facilitate the comparison of genotypes for computation of drought tolerant indices. Specific leaf area was 14% higher under rainfed treatment and IET-22020 had highest SLA while, SLW of genotypes was 50.5% less in rainfed ecosystem. LAI at flowering was 26% less in rainfed treatment with superior LAI (3.37) in IET-22051. Stem weight at flowering and maturity was 23% and 7 % less in rainfed treatment than irrigated one. Mean RWC at two dry spell was 87.6 and 85.9% between PI to flowering with superior RWC in cv IET-22051 followed by 21620 and Sahabhadhan. TDM at flowering and maturity reduced by 31 and 27% respectively under rainfed condition in comparison with the irrigated control. Reduction in number of filled grain panicle<sup>-1</sup> was 29% in rainfed than irrigated while; less reduction 4.6% in 1000 grain weight was noted in rainfed crop in comparison to irrigated. The mean grain yield was reduced by 46% under rainfed treatment with respect to irrigated treatment. Highest grain yield was produced by IET 22051 (375g<sup>-1</sup> m<sup>2</sup>) followed by IET-21620, Sahabhadhan and IET 20859 under rainfed ecosystem. Drought stress index (DSI) varied between 0.305 and 1.336%. IET- 20589, IET-22038 and Sahabhadhan were having DSI<1.0 indicating relative tolerance. Similarly yield stability index (YSI) varied between 38.4 to 74.8%. Genotype IET-21638, IET-22020, IET- 22032 and Tulasi was found YSI>50% indicating relative tolerance to drought under rainfed ecosystem.

02-25

**STUDIES ON PHYSIOLOGICAL AND BIOCHEMICAL MARKERS OF RICE GENOTYPES (*Oryza sativa* L.) UNDER WATER INDUCED WATER STRESS**

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With objective of identifying the tolerant genotype for water stress and to ascertain the physiological and biochemical markers of water stress rice genotypes *viz.*, Tulasi, Rajendra, Tellahamsa and BPT 5204 were tested under field conditions, *ex-vitro* and *in vitro* conditions. Biometric data *viz.*, plant height, relative water content, leaf area index days to 50% flowering, number of tillers, number of productive tillers and *in vitro* observations on seed germination were recorded. Among the genotypes, Tulasi was found significantly superior over all other genotypes and equally followed by Rajendra. These two genotypes even germinated at -20 bars water potential. Increased water stress significantly decreases plant height, leaf index area, number of tillers number of productive tillers, number of grains / panicle and germination percentage, also significantly increased number of days to flowering



and spikelet sterility. Increased water stress enhanced Trehalose and Glutathione. S-transferase accumulation in 21 day old seedlings more in Tulasi followed by Rajendra while they were the least with Tellahamsa and BPT 5204. The superior growth performance of Tulasi and equally followed by Rajendra in field experiment *ex vitro* and *in vitro* studies identify the basis for drought tolerance. By knowing the isozymic pattern of trehalose, enzyme glutathione S-Transferase and profiles of total proline, different pathways for drought tolerance can be identified, established and exploited. Since each genetically determined isoenzyme sub-unit type is the result of a different gene and hence isozymes sub-unit is a marker of its own gene. Therefore, the present investigation shows possibilities of induction of genes for water stress which are not found in native plants. Secondly, our results encourage the mechanism of putative gene synthesis by simulating abiotic stresses in field *in vitro* and *ex vitro* conditions. Hence, the present investigation concludes that both lab results and field results are on par and relatively similar.

02-26

### PHYSIOLOGICAL BASIS OF DROUGHT TOLERANCE IN *Bt* COTTON GENOTYPES (*Gossypium hirsutum* L.)

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The field experiment was conducted during *kharif* 2009-10 and 2010-11 at Agricultural College Farm, Bapatla. The experiment was laid out in strip plot design replicated thrice. There are two main treatments i.e. no stress (irrigation is given as per irrigation schedule) and stress (rainfed condition) and twelve sub treatments (*Bt* cotton genotypes). The results revealed that significant differences were observed between water stress treatments and genotypes and their interactions. Among morphological parameters, plant height, number of sympodia plant<sup>-1</sup> and leaf area significantly decreased under rainfed condition over irrigated condition in both the years of study. Among the drought tolerant traits used to evaluate cotton hybrids, WUE traits specific leaf area (SLA), SPAD chlorophyll meter readings (SCMR) and relative water content (RWC) were significantly reduced under moisture stress (rainfed) conditions compared to irrigated condition in both the years. A significant positive correlation between SCMR and WUE and a negative correlation between SCMR and SLA which were considered as good drought tolerant traits. In the present study also, an inverse relationship was observed between SLA and SCMR, SLA and seed cotton yield and positive correlation between SCMR and seed cotton yield in both the years at boll development stage. Among the *Bt* cotton hybrids, Tulasi 9 BG-II, Tulasi 9 BG-I and Bunny BG-I recorded lower SLA and high RWC and SCMR. Whereas, JK Durga BG-I, Rasi Early BG-I and Rasi Early BG-II recorded higher SLA and low RWC and SCMR values in both the years. At boll development stage, membrane injury index was increased by 43.77 and 41.40 per cent under rainfed condition compared to irrigated condition during 2009-10 and 2010-11 respectively. A protein of 25 to 35 KD (larger band) observed to be expressed under rainfed condition by Tulasi 9 BG-II, Tulasi 9 BG-I and Bunny BG-I hybrids which might help in osmoregulation function to with stand moisture stress. Yield components viz., number of bolls plant<sup>-1</sup>, boll weight, seed index, lint index, ginning out turn and seed cotton yield were significantly decreased in moisture stress (rainfed) condition. Tulasi 9 BG-II, Tulasi 9 BG-I and Bunny BG-I recorded higher yield and its components, whereas JK Durga BG-I, Rasi Early BG-I and Rasi Early BG-II recorded lower seed cotton yield both under irrigated and moisture stress (rainfed) condition in both the years of study. These results revealed that the *Bt* cotton hybrids Tulasi 9 BG-II, Tulasi 9 BG-I and Bunny BG-I are highly suitable to the Agro-Climatic Zone-III both under irrigated as well as rainfed conditions, whereas JK Durga BG-I, Rasi Early BG-I and Rasi Early BG-II showed poor performance in all respects. The other hybrids recorded moderate growth, yield and yield attributes.



02-27

### STUDIES ON HEAT TOLERANCE USING CELLULAR MEMBRANE THERMOSTABILITY AND ENZYME VIABILITY IN COTTON

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Cotton is being grown in both the tropical and temperate regions of the world and is greatly influenced by climatic factors. Cotton has an optimal thermal kinetic window of 23 to 32°C for efficient metabolic activity. The changes in CO<sub>2</sub> and other greenhouse gases are predicted to increase surface mean temperature in the range of 1.4-5.8°C. Preferential selection for heat tolerant cultivars may delay the onset of heat stress in the plant throughout the season, thereby minimizing the yield loss whilst maintaining fibre quality in a hot year. The present investigation was carried out with 40 genotypes of cotton (*Gossypium hirsutum* L.) at Agricultural College Farm, Bapatla to elicit information on heat tolerance using cellular membrane thermostability and enzyme viability. The mean relative electrical conductivity values showed gradual increase from 32.06 at 25°C to 84.15 at 50°C indicating higher temperatures had direct effect on the leakage of fluids from the cells and higher levels of cell injury. The dehydrogenase enzyme viability was reduced with the increase in the temperature from 30°C and 50°C. The genotypes L788, RAH 912 and Pee Dee 0113 showed high levels of heat tolerance in both the experiments at 50°C and these genotypes can be exploited in the breeding programmes for heat tolerance. Genotypic differences for cellular membrane thermostability and enzyme viability were observed. The genotypic and phenotypic coefficients of variation were moderate while heritability coupled with high genetic advance as per cent of mean was high for these characters. This study also indicated the importance of these parameters as easy screening tools for heat tolerance in cotton.

02-28

### DROUGHT TOLERANCE OF SUNFLOWER GENOTYPES WITH CONTRASTING ROOT TRAITS

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14 genotypes possessing good root traits along with 4 genotypes with poor root traits were evaluated for their drought tolerance at Narkhoda farm of Directorate of Oilseeds Research, Hyderabad, during summer 2010 in a split plot design following spacing of 60 x 30 cm, with 3 replications. Stress treatments were assigned to main plot and genotypes to subplot. Crop was subjected to water stress by withholding irrigation during flowering, the most sensitive stage for water stress, for 30 days (35-65DAS). Observations on growth and soil moisture were recorded before imposing and before relieving stress and at harvest. Water stress affected different parameters significantly, and the most affected was leaf area expansion followed by dry matter production and the least affected was leaf number. Based on the drought susceptibility index, PS 1040, 136R, LDM 02, EC 512679, NDR 71, PS 2029, KBSH 1 were identified as tolerant genotypes. Poor root types were low yielders with poor growth and susceptible to drought. Among these only KBSH 1 and NDR 71 recorded >20g/plant seed yield in stress. PAC 1091 and PS 1059 also recorded > 20g/pl seed yield under water stress though they are relatively more susceptible to water stress. These genotypes, KBSH 1, NDR 71, PAC 1091 and PS 1059 recorded higher yield under stress due to high seedling vigour, good crop growth rate during stress and recovery, membrane stability and proline accumulation than other genotypes.



02-29

**MITIGATION OF MOISTURE STRESS THROUGH PRODUCTION OF PIGEONPEA UNDER TRANSPLANTED CONDITIONS IN THE TELANGANA TRACT OF ANDHRA PRADESH, INDIA**

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Majority of pigeonpea varieties grown in the telangana tract of Andhra Pradesh are of medium to long duration and grown under rainfed situations. Unimodal condition of monsoon invariably makes the crop vulnerable to vagaries of nature and stress conditions. Flowering and pod formation stages of the crop generally coincides with cessation period of the monsoon and gets affected by the terminal drought. Hence there is a need to evolve a package where sowing periods can be advanced with minimum water requirement and with optimum maintenance of plant population. Transplanting pigeonpea is a viable option which would allow the crop to be sown at optimum time with minimum management practices. The varieties that perform well under transplanted conditions also need to be evaluated. Three promising pigeonpea varieties LRG-41, Asha and BSMR-736 were evaluated in a field trial under transplanted (planting on 1<sup>st</sup> week of June and 1<sup>st</sup> week of July) and direct sown (sowing on June 15<sup>th</sup> and July 15<sup>th</sup>) conditions under varied dates of sowing during *Kharif* 2011. The trial was laid out in a strip plot design with 3 main plots (varieties) and 4 subplots (dates & methods of sowing) replicated thrice with an individual plot size of 5m x 5m. The results indicated that among the varieties, Asha (14.2 q/ha) significantly out yielded LRG 41(11.5 q/ha) and BSMR-736 (12.8 q/ha). With reference to the date and method of sowing, transplanting during 1<sup>st</sup> week of June gave significantly higher yields of 14.5 q/ha than other treatments. Direct sowing of pigeonpea on July 15<sup>th</sup> resulted in significantly lower yield (8.5 q/ha). Our results indicated that under the conditions evaluated, transplanting pigeonpea during 1<sup>st</sup> week of June is a viable option under late onset of monsoon over delayed direct sowing.

02-30

**SULFUR SUPPLEMENTATION IMPROVES PHOTOSYNTHETIC FUNCTIONS IN MUSTARD (*Brassica juncea* L.) UNDER SALT STRESS**

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Salt stress affected areas are increasing significantly all over the world leading to adverse effects on plant metabolism and development through the formation of reactive oxygen species. The management of salt stress can be done modulating the nutrition status of the plant particularly sulfur mechanism. In our study mustard (*Brassica juncea* var Varuna) were grown in the S levels and exposed to 100 mM soil. The results showed that adequate S (100 mg kg<sup>-1</sup> soil) protected mustard plants by alleviating the salt induced oxidative stress on photosynthetic functions. Sufficient S proved more effective than excess S (200 mg kg<sup>-1</sup> soil), under optimal (without salt stress), while excess S proved more capable than sufficient S in alleviating salt stress under stressful conditions. In order to allow adjustment of the cellular redox state or the harmful hazards of ROS, our findings can provide the opportunity to develop an agronomic practice to reduce the negative impact of soil salinization.



02-31

### ROLE OF SALICYLIC ACID IN IMPARTING SALT STRESS TOLERANCE ON WHEAT

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An experiment was conducted to study the effect of salicylic acid on the growth and metabolism of wheat exposed to two different levels of salinity. Four wheat genotypes were raised in earthen pots of uniform size (30 × 30 cm) lined with two layers of polyethylene bags and filled with 10 kg of air-dried soil and farm yard manure in 3:1 ratio. One month old seedlings were given salinity treatment with 2.5 litres water (control) and saline solutions, [S1 100 mM NaCl), S2 (200mM NaCl). Actual salinity levels are expressed as electrical conductivity, ECe determined at vegetative (30 days after sowing and anthesis are 1.21, 8.43 and 13.04 respectively. Salicylic acid treatment (concentrations 0.5, 1 and 2mM) was given at anthesis stage as foliar spray, in both control as well as salinity stressed plants. SA treated plants showed increase in relative water content, membrane stability index, plant height, dry mass, grain yield and total chlorophyll content. SA treatment, under salinity stress, protected and maintained nitrate reductase (NR) activity. Positive effect of salicylic acid treatment was more pronounced in salinity stressed plants as compared to non stressed plants. Results signify the role of SA in regulating the salinity stress response of plants and suggest that SA could be used as a potential growth regulator, for improving plant growth under salinity stress condition.

02-32

### USE OF BIO- INOCULATES TO ALLEVIATE TERMINAL HIGH TEMPERATURE STRESS IN WHEAT

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The field experiment was conducted at CCS Haryana Agricultural University, Hisar on potential effects of AM fungi upon the growth, yield components and quality of wheat, which might be a great importance for advancement of wheat productivity and its sustainability in the region. The fungi strain, *Glomus mosseae* was introduced in the soil, and the crop seeds were also inoculated with the fungi before seeding. Four treatments including seeding with dry or unprimed seed (DS), primed seed (PS, soaked in water overnight) and inoculation of unprimed seed with AM (DS + VAM) and primed seed with AM (PS + VAM) were replicated three times in a randomized block design. The mycorrhizal application improved yield attributes, yields and grain quality, and the effect was compounded when fungal inoculation was preceded by seed priming (soaking of seed overnight in water). The yield gains were mainly due to early seedling emergence, more number of spikes and higher biomass and improved physiological traits like canopy temperature depression and higher photosynthetic and stomatal conductance rates of flag leaf during anthesis. The yield-attributes, number of spikes/m<sup>2</sup> and grains/spike were increased by 38.1 and 54.7% in variety PBW 343 and 43.4 and 65.8% in variety WH 1021, respectively due to fungal inoculation of primed seed over unprimed seed without inoculum. The respective yield gain was 25.8 and 19.1% in variety PBW 343 and WH 1021. The protein content and wet gluten in the grains was improved significantly with fungi inoculation. After the harvest, the percent mycorrhizal infection on the roots of the variety WH 1021 was estimated to be increased by more than two fold when primed seeds inoculated with fungi as compared to unprimed seeds.



02-33

**PROLINE ACCUMULATION AND STRESS INDUCED P5CS GENE EXPRESSION AS DETERMINANTS OF SALINITY STRESS TOLERANCE IN DIFFERENT WHEAT GENOTYPES**

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The response of four wheat genotypes viz., Kharchia 65, HD 2009, HD 2687 and WL 711 to long term salinity stress was investigated at vegetative, and anthesis stages at 1.21 (control), 8.43 (S1) and 13.04(S2) dS m<sup>-1</sup> salinity levels, achieved by adding water, 100 and 200 mM NaCl solution. Kharchia was relatively tolerant to salinity stress and performed better than WL711 and HD 2687. HD 2009 showed moderate salinity tolerance in terms of maintenance of leaf area, relative water content (RWC) and membrane stability index (MSI). Proline content increased in all the genotypes under salinity stress, but the magnitude of increase was more or less similar in all the genotypes, except in genotype WL 711 where comparatively less increase in proline content was observed under stress treatment. Studies on enzyme activity and transcript abundance of  $\Delta^1$ -pyrroline-5-carboxylate synthetase (*P5CS*) involved in proline biosynthesis showed that salinity stress induced transcription level changes resulting in increased enzyme activity, ultimately leading to increased accumulation proline. PCR band products were cloned and sequenced, and partial cDNAs of *P5CS* from different wheat genotypes were obtained. Results suggests that in wheat, proline accumulation serves as a potent mechanism of osmotic adjustment under salinity stress, though the degree of tolerance of different genotypes are not governed solely by the level of proline accumulation. Varietal-specific differences in proline metabolism may be due to the link of proline metabolism with redox buffering i.e., maintaining a favorable NADP/NADPH ratio or as source of energy under salinity stress.

02-34

**POTENTIAL INDIAN SORGHUM LANDRACES FOR BIOTIC RESISTANT AND ABIOTIC TOLERANCE**

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Landraces are the varieties nurtured and cultivated by the farmers through traditional method of selection over the decades. An autochthonous landrace is a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and an intermediate yield level under a low input agricultural system. Since 2000, DSR has collected and conserved 1194 landraces. In the sorghum landraces collection, some potential landraces showed resistant/tolerant to stresses viz., drought tolerant (42 acc.), salinity tolerant (23 acc.), stay-green plant (35 acc.), cold tolerant (31 acc.), and water logging tolerant (1 acc.). Some landraces were subjected to control screening and resistant sources were identified viz., grain mould resistant (8 acc.), shoot fly resistant (13 acc.), and stem borer resistant (19 acc.). Majority of these drought tolerant lines were collected from arid regions of the country. The salinity tolerant accessions were collected from coastal regions of Gujarat. The cold tolerant accessions were collected from higher altitudinal regions of Himalayas. Among these landraces, some accessions were high grain yielding (6 acc.), very early maturity (1 acc.), twin seeded (33 acc.), fodder type (192 acc.), and dual purposes (39 acc.). These potential landraces has to be utilized for trait specific breeding material development to develop resistant varieties to withstand in the adverse climatic conditions.



02-35

### SOYBEAN GROWTH AND YIELD AS AFFECTED BY VARYING TEMPERATURES AND MOISTURE STRESS

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Occurrence of drought, growth stage at which the drought occurs and ambient temperature are the major factors influencing rainfed soybean yields in India. To reduce the adverse impact of these factors, it is necessary to understand their impacts individually as well as their interaction on growth and yield. Soybean variety JS 97-52 was planted in four green houses maintained at day/night temperatures of 30/22, 34/24, 38/26 and 42/28 °C with an average temperatures of 26, 29, 32 and 35 °C, respectively. At each temperature, pots were divided into three sets, one set was control (non-stressed) while second and third set were subjected to water stress at vegetative and beginning seed fill (R5) stage, respectively. In both the stress treatments, the plants were subjected to moisture stress to about -30 bars after which the stress was released. Increasing temperatures and imposition of water stress significantly reduced the dry matter accumulation, root growth, rate of photosynthesis, seed yield and yield attributing characters. Averaged over all the water stress treatments, the highest yield (14.3 g/pl) was observed at 26 °C, which was significantly reduced by 21, 44 and 72% at 29, 32 and 35 °C, respectively. When averaged over all the temperatures highest yield was observed in unstressed plants (15.1 g/pl) and showed a mild reduction in plants stressed at vegetative stage (27%) and a severe reduction in plants stressed at reproductive stage (87%). Significant temperature x water stress interaction was observed for seed yield and other attributes indicating that prevailing ambient temperatures differentially affected the growth and yield in unstressed plants and plants subjected to water stress at vegetative and reproductive stages.

02-36

### INFLUENCE OF COMPOSITE EDIBLE COATINGS ALONG WITH SOME PHENOLIC COMPOUNDS ON SHELF LIFE AND QUALITY OF GRAPES (*Vitis vinifera*)

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The present investigation is aimed to examine the influence of the composite edible coating based on Xanthan gum (0.3%) and Olive oil (0.1%) enriched with phenolic compounds like Gallic acid (0.1%) and Ferulic acid (0.1%) and Ascorbic acid (0.1%) as an antibrowning agent on the postharvest storability and nutritional quality of Green Grapes. All the treated as well as untreated grapes were stored separately in the plastic boxes and kept at 10±5 °C. The stored fruit were subjected for physico chemical and biochemical parameters like pH, total soluble solids (TSS), total sugars, total phenols, total antioxidant activity and ascorbic acid analyses at regular interval of 6 days till 24 days of storage. Significant results were obtained in the treated fruit than that of the untreated fruit. Uncoated grapes decayed completely at 12<sup>th</sup> day of storage period where as the shelf life of the coated grapes could be extended by 12 days. The use of edible coating helped in reducing the weight loss, decay percentage, respiration rate and metabolism of the coated fruit with as compared to control fruit. Incorporation of phenolic compounds helped in enhancing the level of phenolics and maintained antioxidant activity throughout the storage period.



02-37

**PHYSIOLOGICAL EFFECTS OF WATER STRESS IN TOMATO GENOTYPES (*Lycopersicon esculentum* Mill)**

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Field Experiment was carried out in the Department of Crop Physiology, Tamil Nadu Agricultural University, during 2010 and 2011 to study the effect of water stress at different growth stages of tomato genotypes on their growth and yield. Eight tomato genotypes were evaluated under water stress condition in order to bring out the adverse impact of water stress on the morpho-physiological, biochemical and yield characters. The impact of stress on these characters at vegetative and flowering stage varied significantly among the genotypes. However, the tolerant genotypes maintained higher expression of these characters at all stages of water stress. The traits which are associated with drought tolerance namely relative water content, leaf area index, chlorophyll content and proline to be useful indices for screening of drought tolerance under field condition. The genotypes, CLN 2123, LCR 2, TOPURA, LE13 and LE315 showed higher expression in respect of the above characters than the other genotypes. The drastic reductions in yield were brought out significant decreases in plant height, leaf area, CGR and NAR. Eco-physiological attributes such as transpiration rate, stomatal conductance and photosynthetic rate were also suffered to a greater extend under stress. The result of the field investigation revealed that the stress imposed at flowering stage was more detrimental than the vegetative stage from the point of view of yield reduction. Mean yield reduction due to water stress at flowering stage was to the tune of 22.60 percent over the vegetative stage.

02-38

**MODULATION OF ANTIOXIDANT SYSTEMS BY ETHYLENE LEADS TO PROTECTION OF PHOTOSYNTHESIS AND GROWTH OF MUSTARD CULTIVARS AGAINST NICKEL STRESS**

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The unrestricted developmental activities such as industrialization and urbanization carried out during the past few years have given rise to serious problems of environmental contamination and plants survival in the field. Contamination of soils with heavy metals is both an environmental problem as well as a risk to human health. Present study was undertaken to evaluate the role of ethylene sensitivity under nickel (Ni) stress and found that it plays a significant role in alleviation of Ni stress. Application of Ni (200 mg Kg<sup>-1</sup> soil) on Type 59 (ethylene sensitive cultivar) and Anmol 555 (ethylene insensitive cultivar) resulted in decreased gas exchange parameters, chlorophyll content and growth parameters of plants whereas application of ethephon (200 µL L<sup>-1</sup> and 400 µL L<sup>-1</sup>) reversed the adverse effects of Ni stress in Type 59 maximally whereas Anmol 555 showed little alleviation in Ni stress. The cultivar Type 59 showed greater enhancement of antioxidants system and led to increased tolerance under nickel stress than Anmol 555. It is concluded that Type 59 showed more sensitivity to ethylene and tolerance to Ni stress. Thus, the differential response of cultivars to ethylene and plants responses to Ni tolerance is attributed to ethylene sensitivity.



02-39

**INFLUENCE OF SIMULATED POST-ANTHESIS WATER STRESS INDUCED BY FOLIAR APPLICATION OF POTASSIUM IODIDE ON STEM DRY MATTER REMOBILIZATION, YIELD AND YIELD COMPONENTS IN RICE VARIETIES**

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A field experiment was conducted to study the influence of Potassium Iodide (KI) foliar application to simulate post-anthesis water stress on stem dry matter remobilization and yield. KI sprays had significantly reduced total chlorophyll content in all tested varieties and significant varietal differences were observed. KI spray had no significant influence on number of spikelets per panicle or number of spikelets/m<sup>2</sup>. However, the interaction between treatment and variety was found to be significant. The number of grains/panicle were reduced by KI spray. Varietal difference was significant. Maximum no. of grains/panicle was recorded by WGL-4 under control followed by DRR Dhan-39 in KI spray. KI application had resulted in significant reduction in mean grain yield. The reduction in grain yield was highest in PA-6129, Swarna and Akshayadhan and the reduction is comparatively less in Sampada, WGL-14, PA-6201 and PA-6444 indicating better carbon remobilization in these varieties. The mean remobilization efficiency was increased by KI application. The increase in remobilization efficiency was higher in WGL-14, PA-6201, Sampada and PA-6444 which incidentally produced higher yields under KI treatment due to increased remobilization of carbon from the vegetative organs which replenished the carbon lost due to impaired photosynthesis. Our results indicate that KI application can be effectively used to identify rice varieties with high remobilization capacity and yield stability under post-anthesis water stress.

02-40

**HIGH TEMPERATURE TOLERANCE DURING REPRODUCTIVE PHASE OF *Cicer arietinum* L. – PHYSIOLOGICAL AND REPRODUCTIVE BEHAVIOR**

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High temperature (>35°C) is considered to be a major physiological constraint limiting production and productivity particularly during pod filling stage of chickpea in North-Western region of the country. With this aim, two chickpea genotypes i.e. HC-5 and ICCV-92944 were screened for their tolerance against high temperature. High temperature stress was given by manipulation of sowing dates i.e. under normal (10 November, 2010) and late sown conditions (14 December, 2010). At temperature >35°C, highest relative stress injury (RSI %) was evident in HC-5 (1.34%) followed by ICCV-92944 (1.18%). Relative water content (RWC %) differed much between these two genotypes, being maximum (23.85%) in HC-5 and minimum (8.12%) in ICCV-92944. A decline in 13.54% and 8.03% in total chlorophyll content was observed in HC-5 and ICCV-92944, respectively. A significant decline i.e. 56.07% and 48.84 % in chlorophyll stability index (CSI %) observed in HC-5 and ICCV-92944 respectively over control. The per cent decline in pollen viability found in HC-5 and ICCV 92944 was 35.88% and 22.54% respectively. The high temperature reduced pod set by reducing pollen viability in both genotypes ranged from 42% to 49% as compared to normal temperature. The other stages of reproductive development and function were also affected by high temperature, including pollen germination, and the stigma. The decline in grain yield was 20.65% in HC-5 and 14.80% in ICCV-92944 under high temperature. Based on above physiological parameters and reproductive behavior, genotype ICCV-92944 was identified as high temperature tolerant and can be used further for crop improvement programme of plant breeding.



02-41

**EXOGENOUS APPLICATION OF SULPHYDRYL COMPOUNDS INFLUENCES LIPID-PEROXIDATION, ANTIOXIDANT ENZYMES, LEAF GAS EXCHANGES AND YIELD OF CLUSTERBEAN (*Cyamopsis tetragonoloba*) UNDER WATER STRESS CONDITION**

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Drought is an important abiotic stress inhibiting photosynthesis and decreasing growth and productivity of plants. Drought is known to inhibit photosynthetic activity in tissues due to an imbalance between light capture and its utilization. Reactive oxygen species (ROS) attack the biological macromolecules in cells to impair their functions. Plant cells possess both enzymatic and non-enzymatic defense systems to maintain the cellular redox state, and to mitigate the damage caused by oxidative stress. The sulphhydryl compounds have the ability to modulate plant growth and development events and to improve the crop tolerance to water deficit stress. In present study, effects of exogenously applied sulphhydryl compounds in alleviating the detrimental effects of water deficit stress in clusterbean (*Cyamopsis tetragonoloba* L. Taub) were evaluated. Field experiment was conducted during Kharif 2011 at CAZRI, RRS, Bikaner, Rajasthan to assess the efficacy of two sulphhydryl compounds i.e. thioglycollic acid (TGA) and thiourea (TU) on water relation, lipid peroxidation, antioxidant enzymes, leaf gas exchange and yield of clusterbean under water deficit stress. The experiment was laid out in randomized block design with three replications. The three concentrations of TGA (200, 300, and 400 ppm) and TU (500, 750, and 1000 ppm) were applied via foliar application. Application of sulphhydryl compounds showed significant ( $P < 0.05$ ) influence on relative water content (RWC), water potential ( $\Psi_w$ ), membrane stability index (MSI), photosynthetic pigments (Chl and Car content), lipid-peroxidation (LPO) and antioxidant enzymes viz. catalase (CAT), ascorbate peroxidase (APOX), guaiacol peroxidase (GPOX), superoxide dismutase (SOD) and glutathione reductase (GR) in leaves of clusterbean at 50 DAS. The highest improvement in RWC,  $\Psi_w$ , and MSI was recorded with the application of 400 ppm TGA followed by 1000 ppm TU. The highest increase in total Chl content was found with 1000 ppm TU (25.1 %) followed by 400 ppm TGA (24.2 %). The lowest accumulation of LPO was observed with 400 ppm TGA (18.9 %) followed by 1000 ppm TU (17.5 %) compared to control. The highest increase in activities of CAT, APOX and GPOX was recorded with application of TGA @ 400 ppm. Highest activities of SOD and GR were recorded with application of TU 1000 ppm, followed by 400 ppm TGA, 300 ppm TGA and 750 ppm TU. The respective increase in activity of SOD was in order of 42.2, 35.0, 29.7, and 27.2 % over control. The application of -SH compounds brought significant ( $P < 0.05$ ) improvement in net photosynthetic rate (Pn) and stomatal conductance (gs) at flowering and post flowering stages. The highest Pn was recorded with 400 ppm TGA followed by 1000 ppm TU at both stages. The application of TGA and TU significantly ( $P < 0.05$ ) improved yield attributes and yield. The highest improvement in number of pods per plant and seed yield was found in order of 400 ppm TGA > 1000 ppm TU > 300 ppm TGA > 750 ppm TU as compared to control. Exogenous application of sulphhydryl compounds-induced promotion in physiological and metabolic activities were mediated through maintenance of tissue water potential and activities of antioxidant enzymes lowering the lipid peroxidation under water limiting condition.



02-42

## HYDROGEN PEROXIDE AND SALICYLIC ACID MODULATE THE EXPRESSION OF MITOCHONDRIAL SOD (mtSOD) GENE IN WHEAT (*Triticum aestivum*) UNDER HEAT STRESS

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Superoxide dismutase plays very important role among the network of various antioxidant enzymes in enhancing the tolerance mechanism of the plants against abiotic stresses. In this study, full length cDNA of 733bp encoding superoxide dismutase, designated as *TaSOD*, was isolated and characterized from wheat (*Triticum aestivum*). A manganese iron-binding domain was observed in the sequence using CD search tool of NCBI. Quantitative transcript profiling of SOD showed 1.3, 1.8, 1.9 fold increase in thermotolerant genotype (HDR77), 1.1, 1.3, 1.5 fold increase in thermosusceptible (PBW343) at pollination, milky dough and seed hardening stages respectively in leaves because of diurnal changes in environmental temperature. Abundance of *TaSOD* transcript and high SOD activity, total antioxidant capacity and cell membrane stability index were observed in HDR77 in response to the exogenous application of H<sub>2</sub>O<sub>2</sub> (10mmole L<sup>-1</sup>) compared to that of salicylic acid (5mmole L<sup>-1</sup>) under differential heat shock. Isoenzymes analysis of SOD showed expression of three prominent isoenzymes in HDR77 and only two in PBW343 under the heat stress, with maximum activity at pollination and seed-hardening stages in both the cultivars. Thermotolerance capacity was analyzed using cell membrane stability and total antioxidant capacity; both the parameters were high in thermotolerant (HDR77) where abundance of SOD transcript was observed as compared to thermosusceptible (PBW343). Superoxide dismutase regulates the expression of various heat stress associated genes through balancing the accumulation of H<sub>2</sub>O<sub>2</sub> inside cells, which also act as signaling molecules.

02-43

## SCREENING CASTOR GENOTYPES FOR WATER USE EFFICIENCY (WUE) AND ROOT TRAITS

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Castor is mostly grown in rainfed situations with poor agronomic management. Only in Gujarat and southern parts of Rajasthan, it is cultivated with irrigation. Due to erratic rainfall distribution there is wide variation in productivity between irrigated and rainfed crops. Though it has higher realizable yield, it shows high percent reduction under stress. There is scope to increase realizable yield by increasing the drought tolerance capacity of the crop. Among many traits associated with drought tolerance, root characters play a major role for water acquisition from the soil. Improving this trait along with total dry matter (TDM) and other water use efficiency (WUE) traits helps in improving the productivity in water limited environments. Hence, a study was conducted to identify genotypes with high WUE, root traits and TDM. Sixty four genotypes including germplasm lines and advanced varietal/hybrid trial (AVT/AVHT) entries along with checks (48-1 and GCH-5) were sown during 2008-09 in two specially constructed root structures (32 in each structure) replicating twice with four plants per replication. Data on root (length, volume, dry weight), shoot (LAI, TDM, stem girth) and WUE traits (SPAD chlorophyll meter reading, specific leaf area, <sup>13</sup>C, <sup>18</sup>O) were recorded at 90 DAS. Among the material screened, ten genotypes were selected based on index using principal component analysis (PCA) as best genotypes for root and shoot growth and WUE traits. These genotypes include RG 1437, RG 1463, RG 1494, RG 1614, RG 1645, RG 1941, RG 2058, RG 2113, RG 2127 and RG 2139.



02-44

### ROLE OF ANTIOXIDANT ENZYMES AGAINST HEAT STRESS IN SOME CHICKPEA GENOTYPES

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In arid to semiarid environments, annual crops are often grown under high temperature stress during their reproductive growth which drastically reduces their yield. However plants protect its cellular and subcellular systems from cytotoxic effects of the reactive oxygen species (ROS) using antioxidant enzymes. A Phytotron experiment was therefore conducted with five selected chickpea genotypes differing in their sensitivity to high temperature stress, so as to know the protective role of antioxidant enzymes against heat stress in them. The plants were maintained at 18/23°C (control) and 25/35°C (temperature stress) night/day temperature after maximum tillering. In all chickpea genotypes high temperature stress increased membrane injury index (MII), activity of superoxide dismutase (SOD) and ascorbate peroxidase (APX), malic acid and slightly decreased the activity of glutathione reductase (GR), relative water content (RWC), chlorophyll and carotenoid contents. Under the HT stress, the tolerant genotypes Pusa-1103 and BGD-72 exhibited higher RWC (in BGD-72 average decline was 14.21% and in Pusa-1103 it was 6.0% while RSG-991 showed highest decline 18.99% in RWC as compared to control), higher chlorophyll and carotenoid contents, increase activity of SOD, APX, GR and less decrease in MII as compared to susceptible genotypes Pusa-256 and RSG-991. Under HT condition also malic acid content increased by 110% in BGD-72, Pusa-1103 93% showed highest malic acid content compared to susceptible genotypes under HT condition. Besides this antioxidant enzymes showed positive correlation (*r*) with chlorophyll content, RWC and negative with MII under high temperature stress. From the results it is apparent that the antioxidant defense mechanism plays an important role in heat stress tolerance of chickpea genotypes.

02-45

### PHYSIOLOGICAL PARAMETERS IN RELATION TO DROUGHT TOLERANCE IN CHICKPEA

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An experiment was conducted with 9 chickpea genotypes during three successive *rabi* seasons of 2007, 2008 and 2009 at Regional Agricultural Research Station, Nandyal to identify chickpea genotypes tolerant to drought with higher yield. Pooled analysis of variance indicated highly significant differences among the genotypes. The highest mean seed yield was recorded in Vijay (1011 kg/ha) followed by JAKI-9218 (977 kg/ha) and JG-11 (968 kg/ha). Genotype JAKI-9218 (63%) and JG-11 (62%) also recorded higher Relative Water Content. The proline content was the highest in pod filling stage than that at flowering stage. At pod filling stage the highest proline content was recorded in JGK-2 (4.13  $\mu$  mol per g tissue) followed by Annegiri (3.29  $\mu$  mol per g tissue) and JAKI-9218 (3.13  $\mu$  mol per g tissue). Higher SPAD chlorophyll Meter values 60 DAS were recorded in JAKI-9218 (45) and Vihar (45). JAKI-9218 also recorded higher value of SPAD chlorophyll Meter reading at 30 DAS and comparatively higher proline content (3.13  $\mu$  mol per g tissue). Thus these promising genotypes identified for various drought tolerance and yield attributes can be further exploited in breeding programme to develop high yielding drought tolerant chickpea genotypes.



02-46

## GENETIC VARIABILITY FOR HEAT TOLERANCE IN CHICKPEA

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High temperature (<30 °C) particularly during pod filling stage is a major factor affecting plant growth, development and productivity of chickpea in northern-western region of the country under late sown conditions and proved detrimental to seed filling. With this objective, an experiment was conducted with 15 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 11, 2011) and late (December 16, 2011) sown conditions. Observations for days to flowering, maturity, pod setting, quantum yield (the ratio between variable fluorescence to maximum fluorescence Fv/Fm), relative stress injury (RSI %), canopy temperature depression (CTD °C), pollen viability, seed yield attributes were recorded above 30 °C. Under late sown condition, 50 % flowering commenced in 78 days in H05-24 genotype and H-208 took 128 days to physiological maturity. Results indicated that high temperature caused hastening of flowering by 10 days and physiological maturity by 24 days in late sown as compared to normal sown conditions in chickpea. A significant variation in the quantum yield (Fv/Fm) was observed among the tested genotypes. The values for Fv/Fm ranged from 0.624 to 0.725 and 0.521 to 0.615 under normal and late sown conditions, respectively. Fv/Fm was maximum in H07-03 (0.615) followed by H 07-120 (0.605) and minimum in HK06-171 (0.521) under late sown conditions. Relative stress injury (RSI %) of leaves varied from 18.7 to 32.1 % under late sown conditions. RSI was considerably high in kabuli genotypes HK 06 -171 (32.1 %) and low in desi genotypes H 07-03 and H-208 (18.7 %). The canopy temperature depression revealed significant differences among the tested genotypes. Under late sown conditions, CTD values ranged from -3.2 (H07-157) to -6.2 °C (H 07-03 and H06-63), whereas, from -4.5 (H04-75) to -5.9 °C (H07-3) under normal sown conditions. Pollen viability was found to be in the range of 53 to 75 % under late sown conditions and was the highest in the genotypes H04-75, H07-03, H-208 (75 %) and lowest in H05-24 (53 %). Heat susceptibility index (HSI) computed to test the sensitivity of genotypes to high temperature stress ranged from 0.62 (H07-03) to 1.56 (HK06-171) and value less than was recorded in H07-03 (0.62), H 05-10 (0.67), H07-120 (0.71), HC-5 (0.74), H-208 (0.81) and H06-63 (0.95). Chickpea genotypes H07-03, H05-10, H07-120, H-208, HC-5 and H04-75 were identified thermo-insensitive and showed the maximum tolerance against high temperature stress with least variation for seed yield and the value of heat susceptibility index (HSI) was less than one. These genotypes were also found to have high values of percentage pollen viability, quantum yield (Fv/Fm), but low values of relative stress injury (RSI %) and maintained the cooler canopy temperature.

02-47

## PHYSIOLOGICAL INDICES FOR DROUGHT TOLERANCE IN CHICKPEA (*Cicer arietinum* L.)

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An investigation on “Physiological indices for drought tolerance in chickpea (*Cicer arietinum* L.)” was carried out during *rabi* 2011-2012 at pulses improvement project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). Fourteen genotypes were evaluated in Randomized Block Design with two replication in two separate experiments one under water stress and another under irrigated condition. The studies revealed



that the water stress had a strong influence on the growth, yield and physiological character of chickpea genotypes under study. Significant differences were observed amongst the genotypes for mean values of phenological observation, post harvest observations including number of pods per plant, number of seeds per plant, 100 grain weight, harvest index, grain protein content, grain yield per plant, grain yield per hectare, etc. and physiological parameters *viz.*, relative leaf water content, membrane injury index, chlorophyll index, proline accumulation, chlorophyll stability index, protein content, drought susceptibility index and drought tolerance efficiency, etc. under irrigated and moisture stress conditions. The genotypes Phule G 09103, Phule G 2008-74, DigVijay, Phule G 0302-26 exhibited least yield reduction due to moisture stress and as such found to be stable. RLWC, MII, chlorophyll content, chlorophyll stability index, and proline accumulation and nitrate reductase activity were found to be the most useful parameters while selecting genotypes for drought tolerance. The genotypes Phule G 6102, Vijay exhibited highest drought tolerance efficiency by virtue of high relative leaf water content while genotypes Phule G 6102 and Vijay recorded maximum drought tolerance value by virtue of high membrane injury index. The genotypes Phule G 09103, Phule G 2008-74, DigVijay exhibited higher values for drought tolerance efficiency, drought tolerance behavior. Therefore, these genotypes can be used as sources of drought tolerance in further breeding programme for evolving the drought tolerant genotypes in chickpea.

02-48

#### COMPARATIVE SEMI QUANTITATIVE EXPRESSION ANALYSIS STUDY OF HEAT INDUCED ESTs IN MOTHBEAN (*Vigna aconitifolia*)

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Moth bean (*Vigna aconitifolia* (Jacq.) Marechal) is an important grain-legume crop grown, in rain fed areas of hot desert regions of Thar, under scorching sun rays with minimum supplementation of water. SSH cDNA library was generated from leaf tissues of moth genotype RMO-40 (heat tolerant) exposed to elevated temperature of 42°C for 5 min induce signaling genes and 30 min to induce transcription factors and heat shock proteins. A total of 488 unigenes (114 contigs and 374 singletons), were derived by cluster assembly and sequence alignment of 738 ESTs; Out of these, 206 ESTs (28%) were found to be unknown proteins and 160 ESTs (14%) were novel to moth bean. Further, 578 ESTs (78%) showed significant BLASTX similarity (<1E-06) in the NCBI non-redundant database. Gene ontology functional classification terms, were retrieved for 479 (65%) sequences, and 339 sequences were annotated with 165 EC codes and were mapped to 68 different KEGG pathways. 452 ESTs were further annotated with Inter Pro Scan (IPS) and no IPS were assigned to 153 ESTs. On the basis of putative function of these 738 ESTs 27 ESTs were selected for semi quantitative expressive analysis. For this, PCR primers were designed using NCBI's Primer-BLAST (<http://www.ncbi.nlm.nih.gov/tools/primer-blast/>). RMO-40 (5 min) heat induced genotype was used to see the expression level of these ESTs in both control and treatment condition. Out of these 21 ESTs were up regulated and 6 showed down regulations under heat stress conditions. In another set of experiment, moth genotypes RMO-40 (heat tolerant) and CZM – 105 (heat susceptible) were exposed to 42 C for 5 min and 30 min and 10 ESTs were checked for their expression level and calculated through Alpha Imager EC Gel Documentation system. Actin was used as an internal standard. One step RT-PCR was conducted using Qiagen one step RT-PCR kit. Expression analysis indicate that mannose-o phosphate isomerase, global transcription factor, prlll-interacting factor G, and ribulose bis phosphate were overexpressed at 30 min treatment in tolerant genotype. Expression of jumongi box was of almost same intensity in both the genotypes under control and heat treated condition. Gigentia expressed better in CZM -105 at 30 min treatment. Work on 50 more ESTs is in progress to make a final conclusion.



02-49

## EVALUATION OF CHICKPEA GENOTYPES FOR DROUGHT TOLERANCE

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The field experiment entitled above was carried at Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahamednagar of state Maharashtra to evaluate the effect of chickpea genotypes for drought tolerance. Fifteen genotypes were evaluated in Randomized Block Design under water stress as well as under irrigated condition. Significant differences were observed amongst the genotypes for mean values of phenological observations, post harvest observations including number of pods per plant, number of seeds per plant, number of seed per pod, 100 grain weight, harvest index, grain protein content, grain yield per plant, grain yield per hectare etc. and physiological parameters viz., relative leaf water content, membrane injury index, chlorophyll content (Chl-a, Chl-b and Total Chl content), proline accumulation, chlorophyll stability index, protein content, drought susceptibility index and drought tolerance efficiency etc., under irrigated and moisture stress conditions. Under irrigated conditions the genotypes PG-95333, JG-315, JG-03110-1, Vijay found promising for yield and yield contributing characters. PG-95333 as found superior in respect of morpho-physiological yield and yield contributing characters. The genotypes Vijay, Vishal, Phule G-03110-1 found have indicated less yield reduction due to moisture stress and as such found to be stable. RLWC, MII, Chlorophyll content, chlorophyll stability index, drought tolerance efficiency and proline accumulation were found to be the most useful parameters for screening genotypes for drought tolerance. The genotypes Phule G-95333, Vijay, JG-315 exhibited higher value for drought tolerance efficiency, proline content, chlorophyll content and lower values for drought susceptibility index, membrane injury index indicating their drought tolerance behavior. Therefore, these genotypes can be used as sources of drought tolerance in further breeding programme for evolving the drought tolerant genotypes in chickpea.

02-50

## DEVELOPMENT OF DROUGHT TOLERANT GROUNDNUT GENOTYPES BY TRAIT BASED APPROACH – A SUCCESS STORY

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Groundnut (*Arachis hypogaea* L.) is a multi purpose crop provides cooking oil and vegetable protein. National productivity of the crop is low as 70 per cent of production comes from seasonally rainfed areas, prone for moisture and temperature stress. Screening of germplasm for desired traits is the core in any breeding programme. Empirical method (direct selection) is usually followed by breeders, where screening of lines will be done based on final yield. In the present study physiological method, trait method approach (indirect selection) was used for genetic enhancement of drought tolerance in groundnut. The physiological traits used in the selection of donor parents as well as segregating population are water use efficiency (WUE) traits. For screening high WUE types, indirect methods viz., SPAD Chlorophyll Meter Readings (SCMR), Specific Leaf Area (SLA) and Carbon Isotope Discrimination (CID) were used. However, donor parents and selected progenies were revalidated for real WUE using gravimetric technique. The breeding programmes were initiated with modified pedigree method and successfully developed three drought tolerant and high yielding groundnut varieties and released in Andhra Pradesh viz., Abhaya (2006), Rohini (2009) and Dharani (2012). Among the three genotypes, Dharani is becoming popular in Andhra Pradesh for its tolerance and stable performance.



02-51

## ARSENIC TOXICITY: A THREAT TO SUSTAINABLE RICE CULTIVATION IN WEST BENGAL

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Rice (*Oryza sativa*) grown under anaerobic environment condition shows higher efficiency in uptake of arsenic. With this background, experiments were carried out to investigate the effect of inorganic arsenic on rice genotypes was taken as test crop. Pot experiment result showed that Arsenite (As-III) caused disturbance in the process of flowering. As-III @ 20ppm appeared to fatal for Lalat, PNR-546 and GB-1. As-III @ 20ppm caused severe disturbance in reproductive development resulting in non appearance panicles in Triguna, IR-36, PNR-519 and Heera with complete shedding of grain in genotype Siddhanta. Among 17 rice genotypes, As concentration of grain decrease markedly in the order at 20 ppm As-V, Lalat > PNR-519 > Heera > Triguna > Annada > IR-64 > Nidhi > IR-36 > Anjaly > IET-4094 > Ratna > PNR-546 > Provat > Gontra bidhan-1 > Krishna hamsa > Siddhanta > IET-4786. Field experiment result showed that Arsenic load in flag leaf and grain of rice increased continuously from flowering to harvest. Flag leaf regulates the transport pattern of arsenic in to the grain. Hydroponic experiment result showed that the nitrogen and phosphorus reduces uptake of As-V and As-III while Bo and Si influence the uptake of As-III. Sulphur nutrient plays an important role in regulating As translocation from root to leaves. Lab experiment results showed that the activity of enzyme decreased when the seedlings were exposed against both As-V and As-III solution. Both As-V and As-III were found to be toxic for rice seedling vigor at the concentration range of 2.5 to 15 ppm. As-V significantly increased the speed of germination (SG) up to its concentration of 7.5 ppm, consistently showing higher percentage of germination up to seven days. As-III caused significant reduction in the germination percentage and SG with increased concentrations.

02-52

## DIFFERENTIAL SENSITIVITY OF CHICKPEA GENOTYPES TO SALICYLIC ACID AND DROUGHT STRESS DURING PRE-ANTHESIS: EFFECTS ON TOTAL CHLOROPHYLL, PHENOLICS, SEED PROTEIN AND PROTEIN PROFILING

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The work was conducted with the purpose to evaluate the effect of salicylic acid (SA) under drought stress on chlorophyll pigment, phenol seed protein and protein profile in four chickpea (*Cicer arietinum* L.) genotypes (i.e., Tyson, ICC 4958, JG 315 and DCP92-3). The experiment was carried out in a complete randomized design with three replications. Drought stress was imposed during the pre-anthesis phase. Reduction in relative injury was observed in plants treated with SA at the threshold level of 1.5 mM. Drought stress reduced the total chlorophyll and percentage of seed storage protein, whereas increases the level of total phenolics content were observed under drought stress, and this was further induced by SA. The genotype ICC4958 perform better than Tyson, JG 315 and DCP 92-3 under drought stress with SA treatment. Moreover, it is also noteworthy that drought did not change significantly the 1-D protein profile of chickpea genotypes. This suggests that chickpea could be induced to tolerate drought using 1.5 mM of SA.



02-53

## INDUCING DROUGHT TOLERANCE IN CROPS THROUGH BREEDING AND GENOMICS

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Drought is one of the prime abiotic stresses in the world. Crop yield losses due to drought stress are 24 per cent of global yield losses. Conventional breeding led to development of drought resistant cultivars in different crops, this shows that it has played a considerable role during last century in for drought tolerance crop improvement. However empirical breeding is a highly time consuming, cost, labor intensive approach and to achieve desired gain a high number of selection and breeding cycles may be required. Two major genomic approaches could be used, firstly identification of QTLs (Quantitative trait loci), development of molecular markers for the desired trait and use in marker assisted breeding. And QTL mapping for drought tolerance have been done in different crops, but limited work has been done in introgression of identified QTLs to desired background through marker assisted backcross breeding. And to achieve MAS efficiency a strategy *i.e* “Mapping As You Go” which involves repeated re-estimation and validation of QTL effects throughout the breeding programme can be utilized. Advanced backcross QTL analysis is another approach, in which QTL analysis is delayed until BC2 or BC3 generation, which helps in simultaneous discovery and transfer of QTLs from unadapted line to elite germplasm. Second genomic approach is to identify drought related genes through transcriptome profiling using microarray technology which was in practice in model species like *Arabidopsis* and rice. Currently another approach called “Genetical Genomics” has been developed based on gene expression profiling and marker based fingerprinting of related lines or individuals in a segregating population to delineate a trait related genetic network. Apart from these genomic approaches, transgenic approach can also be effectively used. However, successful breeding for stable high yield under drought conditions will only be possible when a true integration of traditional breeding with genomics assisted breeding and genetic engineering is achieved. Thus, to face drought stress and to achieve sufficient yield in future, requires a multidisciplinary approached breeding based on genetics and genomics.

02-54

## ACCUMULATION OF NUTRIENTS WITHIN RICE CROP SYSTEM UNDER ARSENIC TOXIC CONDITION: A HYDROPONIC STUDY

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A hydroponic experiment was conducted in Directorate of Research, B.C.K.V., Mohanpur to observe the effect of arsenic concentration on accumulation of minerals within rice seedlings. Seedlings were treated with 0.6, 1.2 and 1.8 ppm arsenic (As) concentration along with full Hoagland solution (1940) for 14 days in net house condition. Our experiment result indicates that arsenic was mostly concentrated in roots and a little amount was moved to shoots, indicating that arsenic was not easily translocated to shoots of rice seedlings. Accumulation of P, K, Fe, Ca, Mg, Mn, Zn and Cu content decreased in leaves significantly with the arsenic treatments, indicating that rice seedlings are As-sensitive and As-toxicity depends on the arsenic concentration in the rooting medium. In root, accumulation of P, K and Mn decreased but accumulation of Ca and Cu increased with increasing arsenic concentration. Mg accumulation increased in root at 0.6 ppm arsenic concentration and decreasing in root at high arsenic concentration (1.2 ppm and 1.8 ppm). Fe and Zn accumulation increased with increasing arsenic concentration and at high concentration of arsenic (1.8 ppm) accumulation of Fe and Zn decreased.



02-55

**EXOGENOUSLY APPLIED ASCORBIC ACID AND SALICYLIC ACID ALLEVIATE  
OXIDATIVE STRESS IN MAIZE BY BIOCHEMICAL REPROGRAMMING OF CELLULAR  
ANTI-OXIDANT SYSTEM**

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One of the most important physiological manifestations of drought stress in plants is oxidative burst of Reactive Oxygen Species (ROS), which severely damages cell structure and function. It is proposed that under normal conditions, there exists a fine homeostasis between ROS production and its scavenging which is dys-regulated and reprogrammed during stress. The degree and nature of this cellular reprogramming and its effects in modulating adaptation response to stress still remain to be unravelled completely. Here we show that, phyto-active chemicals like, ascorbic acid and salicylic acid are capable of favourably perturbing the ROS homeostasis to promote stress adaptation. A high degree of oxidative stress was induced in field grown maize single cross hybrid *HQPM1* at flowering stage (most stress sensitive crop growth stage in maize) by application of methyl viologen. The plants were either pre-treated with a graded concentration (0.5 mM, 1.0 mM and 1.5mM) of salicylic acid or ascorbic acid or a combination thereof. The plants were phenotyped for stress tolerance and the cellular physiology was monitored by measuring electrolyte leakage, total soluble protein levels, and activities of three key ROS scavenging enzymes *viz.*, Superoxide dismutase (SOD), Catalase (CAT) and Peroxidases (POX). Upon induction of stress, levels of SOD and POX were found to be increased, while the levels of CAT were decreased, in a dose dependent manner. There was a significant and consistent increase in the levels of SOD in ascorbic acid and salicylic acid treated plants only and not in unstressed plants. We hypothesize that ascorbic acid and salicylic acid and not ROS trigger transcription factors which up regulate SOD gene. Presently, we are studying transcriptional dynamics of SOD and other genes in these plants. A complete understanding of factors modulating redox rebalancing and adaptation under stress would lead to identification of candidate genes that could be used to engineer climate ready crops.

02-56

**HIGH TEMPERATURE STRESS INDUCED PROTEINS IN RICE (*Oryza sativa* L.) LEAVES  
AND SPIKELETS**

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Changes in rice leaves and spikelets proteome in response to high temperature stress at flowering were investigated. Plants of high temperature stress tolerant rice cultivar N22 were subjected to temperatures of 28°C (control) and 42°C (high temperature stress) at flowering stage. Leaf and spikelet samples were collected at 24h after the temperature treatment. Increased relative ion leakage and antioxidant enzyme activities suggested that high temperature stress affected the metabolic processes in rice leaves and spikelets. Two dimensional gel electrophoresis (2-DE), coupled with Mass Spectrometry (MS), was used to identify high temperature stress-responsive proteins in rice. Protein extracts were separated by 2-DE, and visualized by staining with coomassie brilliant blue. Approximately 800 protein spots were reproducibly detected on each gel, wherein 120 proteins were differentially expressed between the two temperature regimes. Among the differentially expressed proteins,



a total of 75 and 55 protein spots were found in the control and high temperature stressed leaf samples, respectively. Using MALDI-TOF MS in conjunction with the MASCOT protein database search, 25 of the proteins that appeared only in the high temperature stressed plants were positively identified. According to putative physiological functions, the identified proteins were grouped mainly into five categories (Fig 1B): (i) Growth (ii) Heat shock proteins (HSPs) (iii) Regulatory proteins (iv) Redox homeostasis proteins and (v) Energy & metabolism related proteins. The largest functional category was that of energy and metabolism proteins (38.46%) followed by regulatory proteins (26.93%), growth (15.38%), redox homeostasis (11.53%) and HSPs (7.69%). Which suggest that, energy & metabolism and regulatory proteins may play a pivotal role in protecting the cellular damage under high temperature stress. Since the 3D structure of many of these differentially expressed proteins were not known, their 3D structures were predicted from the amino acid sequences identified using MALDI-TOF MS with the PYRE-2 software. Two of these differentially expressed proteins were of HSPs: heat stress transcription factor A-2b and 26.2 kDa heat shock protein. These are located in nucleus and mitochondria, respectively and they function as sequence-specific DNA binding transcription factor and stress response factor, respectively. Similarly four proteins (spot nos. 71, 74, 84 and 99) were identified as B3 domain-containing protein, fructose-bisphosphate aldolase, alpha-amylase isozyme 2A, and putative potassium transporter 8; they were categorized as regulatory proteins. These proteins are actively involved in various functions like potassium ion transporter activity, enzymatic activity and DNA binding. The non-symbiotic hemoglobin and probable protein phosphatase grouped under redox homeostasis proteins are involved in oxygen binding and metal ion binding, respectively. Proteins of spots 43, 82, and 112 were involved in energy metabolism with various functions like metal ion binding, ATP dependent and lipid binding. Thus, the results of the present study suggest that plants cope with high temperature stress in a complex manner, where not only the HSPs but many other functional proteins play important role in the complex cellular network. Although the present study is an initial proteomic investigation on the response of rice leaves to high temperature stress, it provides a good starting point in understanding the overall thermal response of plants. Further studies involving many high temperature stress treatments and comparative analyses are necessary to gain a better understanding of the thermal response of plants.

02-57

### EVALUATION OF WATER DEFICIT STRESS TOLERANCE IN RICE (*Oryza sativa* L.) GENOTYPES

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Rice is the most important food crop of the world and is a model cereal species. About 45% of the rice cultivated area in India is under rainfed area. Rainfed rice system faces intermittent drought stress which leads to severe yield loss. The impact of drought stress on crop yield depends on different factors like weather characteristics of target environment, duration and degree of stress and the stage of growth at which the crop is exposed to stress. In this present study, a total of 21 upland and lowland indica rice genotypes were evaluated under pot and field conditions. Drought stress was imposed at booting stage. Soil moisture status was monitored by using tensiometer and also recorded by gravimetric method. Various changes in physiological parameters such as relative water content, chlorophyll stability index, canopy temperature, spikelet fertility, leaf area, and yield and yield components were recorded. Drought susceptibility index (DSI) was used to rank the genotypes for overall drought tolerance. There were high variations in drought susceptibility index and relative yield values between genotypes. The genotypes were Nagina 22, Vandana, Shabhagidhan, Vanaprava, Rasi, CR 143-2-2, CR262-4, Nerica-L-44 showed better tolerance in terms of RWC, spikelet fertility and yield as compared with other genotypes under drought stress.



02-58

**IDENTIFICATION OF GROUNDNUT GENOTYPES FOR THERMOTOLERANCE, WATER USE EFFICIENCY AND ROOT MINING TRAITS**

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Groundnut is predominantly grown under rainfed conditions in *kharif* season in southern zone of Andhra Pradesh and yields were limited by drought stress. The use of drought resistant varieties is an important strategy to combat the problem and to achieve higher yields. As drought is coupled with moisture and high temperature stresses, it is essential to develop varieties which can tolerate both situations. Development of drought tolerant varieties is the prime option to sustain the productivity under these water limited conditions. Among the several physiological approaches, identification of ideal types with high WUE, thermotolerance, deep root system with high pod yield is need of the day. The present study is taken up at Regional Agricultural Research Station, Tirupati to identify donor source with high drought tolerant traits during *Kharif*, 2010.. Field experiment was conducted and evaluated with 15 groundnut (Spanish bunch) genotypes for morphological, physiological, water use efficiency, thermotolerance characters at 60 days after sowing of crop growth. WUE was measured by surrogate methods (SPAD meter and SLA) at 60 DAS. The genotypes TCGS-991, TCGS-969, TCGS-1043 and TCGS-894 recorded low SLA and high SCMR and thus were found to be of high WUE types. It is imperative to note that above genotypes have also maintained high cell membrane integrity in terms of low relative injury percent when exposed to high temperatures (52°C) and revealed their intrinsic abilities to tolerate high temperatures. These genotypes also recorded moderate root length and higher root dry weight. Among the pre-release genotypes, TCGS-991, TCGS-969, TCGS-1043 and TCGS-894 also recorded higher shelling percentage and pod yield apart from high WUE traits, thermotolerance and moderate root mining abilities compared to other entries. These genotypes can be used as donor source in drought resistance breeding or can be promoted to multi-location testing in rainfed areas for further exploitation. The identified genotype TCGS-1043 was released as Dharani in 2012. The genotype is becoming popular among the drought prone areas of Andhra Pradesh.

02-59

**ANTIOXIDATIVE ENZYME PROFILE IN SOME UPLAND SUMMER RICE GENOTYPES AS INFLUENCED BY MOISTURE STRESS**

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Studies were carried out during *Ahu* (summer) seasons at departmental field of Crop Physiology, Assam Agricultural University, Jorhat to assess the response of some selected *Ahu* rice varieties namely ARC-10372, Lachit, Bandana, Maibee and Kopilee towards moisture stress. The moisture stress was created by withholding the irrigation. Results obtained during the investigation revealed that moisture stress had significant influence on various biochemical parameters. 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. Significantly higher content of proline and activities of antioxidative enzymes were recorded in ARC-10372, Maibee and Bandana. Nitrate reductase activity in leaf was found to decrease due to moisture stress.



02-60

**CONSEQUENCES OF POST-ANTHESIS HIGH TEMPERATURE STRESS ON DRY MATTER DISTRIBUTION AND BIOCHEMICAL CHANGES IN DEVELOPING GRAINS UNDER DIFFERENT DATES OF SOWING IN WHEAT (*Triticum aestivum* L.)**

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High temperature stress is a major environmental stress limiting crop productivity worldwide. In Indian condition the problem of late sowing of wheat is influenced by elevated atmospheric temperature during reproductive phase. In this connection a field experiment was carried out in the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi in *rabi* season during 2009-10 and 2010-11. To evaluate the effect of high temperature stress on total plant dry matter distribution, biochemical changes in developing grains and yield components of wheat were studied in two wheat genotypes *HUW-510* (Heat tolerant) and *HUW-468* (Heat sensitive) under three dates of sowing (DOS) viz., 20<sup>th</sup> November (normal sowing date), 10<sup>th</sup> December (late sowing date) and 30<sup>th</sup> December (very late sowing date). The results showed that normal sowing date significantly increased total plant dry weight, number of ears, grain yield, test weight and harvest index in heat tolerant genotype as compared to heat sensitive genotype. Genotypic differences were significantly noticed for protein, starch and sugar content at different intervals after anthesis in developing grains. At 21 days after anthesis (DAA), *HUW-468* showed higher protein content under very late sowing compared to *HUW-510*. The higher starch content was observed in *HUW-468* in developing grains under normal sown condition compared to *HUW-510*. Starch content significantly decreased under high temperature, which limited the potential sink size for dry matter deposition in the grain, whereas higher soluble sugar content was observed in *HUW-510* under very late sown condition compared to *HUW-468*. It is concluded that the quality of wheat grains and yield were dependent on genotypic and environmental conditions. High temperature reduced the photosynthetic assimilating efficiency of the flag leaf and inhibited the dry matter distribution, by which grain weight decreased significantly. Results showed that the highest grain yield was obtained in *HUW-510* compared to *HUW-468* under normal sowing date and there was a reduction in grain yield under late and very late sowing dates in all genotypes.

02-61

**MOLECULAR CHARACTERIZATION AND CLONING OF PROLINE RICH REGION IN LENTIL (*Lens culinaris* Medik)**

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Plants are subjected to a range of abiotic and biotic stresses that affect their growth and development. These stresses have been estimated to cause depreciation in crop yield up to 70% when compared to the yield under favorable conditions. In particular, it is predicted that water deficit will continue to be a major abiotic factor affecting global crop yields. The crops respond to dehydration and low temperature by accumulating various proteins and smaller molecules including sugars, proline and glycine betaine. Its involves complex physiological changes resulting in reduction of growth, water content, transient increase in ABA, changes in membrane composition and also accumulation of osmolytes. These osmolytes required for the osmotic adjustment which is



considered as an important physiological mechanism of drought adaptation in many plants. Proline is one of the important osmolytes which accumulates during moisture stress condition. It helps to maintain turgor and promotes continued growth in low water potential soils. It has been observed that proline accumulation under drought condition is a good indicator of drought resistance capacity of plants. In this view present study was done for the identification of a novel proline rich region in lentil by using EST database. Soybean proline rich protein sequence was taken as query sequence for the analysis. Primer pairs were designed and amplification was done with selective *Lens culinaris* cultivars in thermocycler. The amplified gene was 250bp in size. The 250bp gene was cloned in pTZ57R/T vector and sequencing was done. This proline rich gene was submitted to NCBI with accession number JX564851. The gene was analyzed by bioinformatics tool, BLAST. blastx result has shown 90% similarity with chickpea EST sequence (Accession no. GR398344). Blastn results of the lentil sequence have been shown 85% similarity with soybean proline rich protein (NM001251664). *Pisum sativum* (AJ233399), *Gossypium hirsutum* (AF044205) and *Phaseolus vulgaris* (AM158278) have also shown considerable similarity with *Lens culinaris* proline rich gene.

## 02-62

### EFFECTIVE USE OF WATER (EUW) IS CRUCIAL DURING POD DEVELOPMENT STAGE IN GROUNDNUT (*Arachis hypogaea* L.) under intermittent drought stress

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Intermittent drought, which varies in intensity, severely limits groundnut (*Arachis hypogaea* L.) yields. Assessment were made of root development, water uptake, transpiration efficiency, yield components and their relationships, in groundnut genotypes under well watered (WW), and mild (DS-1), medium (DS-2) and severe (DS-3) intermittent stress. Pod yield decreased 70%, 55% and 35% under severe, medium and mild stress, respectively. Pod yield varied among genotypes, and showed significant genotype-by-treatment effects. Root length density (RLD) varied among genotypes before and after stress, although RLD did not discriminate tolerant from sensitive lines. Total water uptake and RLD under water stress had a weakly significant relationship. Water extraction from the soil profile was highest under severe stress. Water uptake varied among genotypes in all water regimes, but correlated with pod yield under WW conditions. The relative harvest index (HI) (*i.e.* the ratio of the HI under stress to HI under WW conditions) was closely related to the pod yield in all three intermittent stresses ( $R^2 = 0.68$  in DS-1;  $R^2 = 0.65$  in DS-2;  $R^2 = 0.86$  in DS-3) and was used as an index of stress tolerance. Under medium and severe stresses, the relative HI was negatively related to plant leaf weight ( $R^2 = 0.79$  in DS-2;  $R^2 = 0.53$  in DS-3), but less so under mild stress ( $R^2 = 0.31$ ). The results suggest that under intermittent stress, genotypes with a lower leaf area may use water more sparingly during the drying cycle with less damaging consequences for reproduction and pod. Our major finding was that water uptake was critical for pod yield during a stage that corresponded broadly with the pod filling period. The genotypes differed in how much water was taken up during that stage, and this was negatively related to amount of water taken up soon after stress imposition and had a direct positive bearing on pod weight. TE also appears to be the other most important component of yield architecture and contributed approximately 30% to yield under intermittent drought. Tolerance to drought was mostly explained by the capacity to maintain a high HI under drought in the tolerant genotypes, indicating that, at least under the medium and severe water stress, the reproductive processes were affected. This effect on reproduction in sensitive lines under DS-2 and DS-3 was probably a consequence of having a larger leaf canopy. Our interpretation is that a larger leaf canopy would lead to higher water use during drying cycles and then more damaging consequences on the reproductive processes in the sensitive lines.



02-63

**SALINITY-INDUCED MORPHO-PHYSIOLOGICAL CHANGES IN TOLERANT AND SUSCEPTIBLE GENOTYPES OF MUNGBEAN [*Vigna Radiata* (L.) Wilczek] aT EARLY SEEDLING STAGE**

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Salinity is one of the most severe abiotic stresses affecting production of crops worldwide. Salt tolerance in plants is conferred by multiple traits. The present experiment was envisaged to group 21 genotypes of mungbean into different clusters on the basis of salt tolerance and to prioritize the selection markers for tolerance. The results indicated that all the 21 genotypes showed significant reduction in root and shoot length when treated with salinity level of 100 mM NaCl. Few genotypes registered increased biomass accumulation in root but the shoot biomass reduced significantly in all the cases. The genotypes Sukumar, Samrat, RMG-26, Mung-45-9 and Bireswar were identified as 5 top ranking tolerant genotypes, while Mung-44-9, Mung 31-6, HUM 12, Sel 42-17 and Local Sel were identified as most susceptible genotypes. These 10 genotypes were further subjected to physiological studies under salinity stress. The data indicated that the susceptible genotypes showed higher reduction of relative leaf water content but higher extent of membrane damage under salinity stress over control as compared to that of the tolerant ones. The 5 tolerant genotypes showed higher increase in proline under salt stress as compared to the susceptible ones. The tolerant genotypes also showed increase in superoxide dismutase activity and guaiacol peroxidase activity in their leaves under salinity stress. In the present study, salt response index (SRI) of leaf proline and phenol content as well as the activities of SOD and GPX showed highly significant positive correlation with salt tolerance index, while lipid peroxidation and leaf membrane electrolyte leakage (EL) showed highly significant negative correlation with STI. Thus, selection for elevated levels of leaf proline and phenol content along with superoxide dismutase activity would improve the salt tolerance in the genotypes of mungbean at early seedling stage. The findings in the present experiment will provide important guidelines for distinguishing the salt tolerant germplasm and breeding for tolerant cultivars in mungbean.

02-64

**BIOREMEDIATION EFFECT OF ORGANIC MATTERS ON GROWTH OF *Trigonella foenum graecum* L. IN RELATION TO TOXICITY OF CADMIUM**

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Application of organic matter effectively reduced the toxic effect of heavy metals like Cadmium from the environment. Cadmium is a non-essential heavy metal that does not have any metabolic use and can be harmful to the growth and productivity of crops even at low concentrations. Fenugreek (*Trigonella foenum-graecum* L.) is an important pulse crop grown in India to eradicate the malnutrition and hunger from developing country like India. Plants were grown in pots treated with 50 mg Cd kg<sup>-1</sup> soil as CdCl<sub>2</sub> caused significant damage to the growth parameters. The toxicity of Cd was significantly reduced when these plants treated with organic matters like sunflower cake and groundnut cake. Significant improvement was observed in growth parameters such as plant height, fresh as well as dry weights, percent pollen fertility, number of pods per plant, total chlorophyll content and nitrate reductase activity. The highest improvement was noted in those plants treated with organic matters, while the minimum in those plants treated with Cd alone and Cd+organic matters, respectively. Sunflower cake was found more effective than groundnut cake for reducing the toxic effect of Cadmium.



02-65

### ISOLATION AND CHARACTERIZATION OF HIGH AFFINITY NITRATE TRANSPORTER GENE FROM *Brassica juncea* ROOTS GROWN UNDER LOW NITRATE SUPPLY

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Plants have developed different transport systems to adapt in variable soil nitrate concentration, designated as high and low affinity nitrate transporter (HATS and LATS, respectively). Experiments were conducted to study growth, nitrate uptake kinetics and expression of high affinity nitrate transporter gene in *Brassica juncea* cv. 'Pusa bold'. Further, isolation of full length cDNA of high affinity nitrate transporter (*BjNRT2.1*) and its sequence analysis were carried out. Plants were raised in hydroponics with different nitrate concentrations i.e. 0.01, 0.05 and 5.0 mM. The root traits including root length, volume, surface area, root tips per plant were higher in plants grown at low nitrate. Nitrate reductase activity measured in leaves was higher in plants grown at 5 mM nitrate as compared to those grown at low nitrate concentrations. The  $V_{max}$  and  $K_m$  of uptake system was 116.36  $\mu\text{mol g}^{-1} \text{FW h}^{-1}$  and 0.950  $\mu\text{M}$ , respectively suggesting induction of high-affinity nitrate transporter. This was further confirmed by reverse transcriptase-polymerase chain reaction (RT-PCR) of *BjNRT2.1* which showed expression only at 0.01 mM nitrate. Full length coding sequence was obtained by performing 5'RACE-PCR, cloned and sequenced. The sequence analysis of *BjNRT2.1* showed 97.2% homology with *BnNRT2* from *B. napus* and the difference between the two species was only for 15 amino acids. Hydropathy plot of *BjNRT2.1* predicted 11 transmembrane domains and a conserved protein kinase recognition motif. The reliability of this model was also supported by the presence of MFS (major facilitator superfamily) sequences and NNP (nitrate-nitrite porter) motifs associated with NRT2 transporter followed by the presence of two conserved arginine residues. The homology model of high affinity nitrate transporter *BjNRT2.1* in the present study was orthologue of *AtNRT2.1* in the NRT phylogenetic tree.

02-66

### INCREASING THE AMYLOSE CONTENT OF MAIZE BY SILENCING OF *SBE2A* GENES WITH RNAi TECHNOLOGY

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Improved amylose content in maize has been achieved by reducing the starch branching enzyme (SBE) activity via transgenic maize inbred line transformed by a high-efficient RNAi expression vector, which may provide the foundation for maize quality improvement. The sense and anti-sense fragments of maize SBE gene *sbe2a* were cloned by reverse transcript PCR and high efficient RNAi expression vector was constructed based on plant expression plasmid pCAMBIA1301. Then the reconstruct was introduced into maize inbred line Tie7922 by pollen tube pathway transformation. Four transgenic plants were obtained. The integration of interest gene *sbe2a* into maize genome has been confirmed by PCR amplification and Southern hybridization. The *sbe2a* transcription was suppressed obviously by the analyses of RT-PCR, SBE activity and amylase content on the four transgenic plants. The SBE activity was significantly less than that of wild type maize, and was at most reduced by 77.9%; the amylose content was at most increased by 87.8%. In conclusion, RNAi expression vector pRSBE2a containing *sbe2a* gene was successfully constructed. Through genetic transformation, RNAi technique efficiently silences endogenous *sbe2a* gene to reduce the SBE activity, and high-amylose maize lines are obtained.



02-67

**ELECTROLYTE AND PHENOLIC LEAKAGE AND THEIR RELATION WITH PHYSIOLOGICAL ATTRIBUTES AT LOW TEMPERATURE STRESS IN SUGARCANE**

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Ten sugarcane (*Saccharum* spp, hybrids) varieties were evaluated for low temperature stress tolerance based on electrolyte and phenolic leakage contents. Electrolyte leakage (EL) was comparatively high (30.8 to 51.8%) at -10°C compared to that at 25°C (21.7 to 28.4%). Phenolic leakage (PL) varied from 15.0 to 26.2% at -10°C compared to 8.6 to 16.6% at 25°C. Highest EL (51.8%) and PL (26.2%) was observed in CoLk 8102 and CoLk 9617 varieties, respectively. Anthocyanin, malondialdehyde (MDA), chlorophyll and carotenoids contents and activity of antioxidant enzymes namely catalase (CAT, EC 1.11.1.6), peroxidase (POX, EC 1.11.1.7) and superoxide dismutase (SOD, EC 1.15.1.1) were determined during winter season (in the month of January) for all the varieties tested. Anthocyanin content ranged from 0.24 to 0.99 µg per 100 cm<sup>2</sup>, while MDA ranged from 7.18 to 15.44 µg per g fwt. Catalase activity ranged from 72 (CoJ 64) to 309 (CoS 97264) µmol H<sub>2</sub>O<sub>2</sub> decomposed per mg protein, while peroxidase from 5.97 (CoLk 8102) to 9.39 (CoS 95255) change in OD per mg protein. SOD activity was ranged from 19.6 (CoLk 8001) to 30.6 (CoS 95255) units per mg protein. Variety CoJ 64 exhibited lowest chlorophyll a, b and carotenoids contents. Electrolyte and phenolic leakage showed negative correlation with chlorophyll, carotenoids and activity of antioxidant enzymes. High correlation coefficient as observed with EL indicated its usefulness in selection of varieties suitable for low temperature stress. Variety BO 91 showed least leaf injury suggesting higher membrane stability and tolerance to low temperature stress in contrast to variety CoJ 64 which showed highest membrane damage among other varieties tested.

02-68

**EFFECT OF SALICYLIC ACID ON GROWTH, TOTAL CHLOROPHYLL, PROLINE ACCUMULATION, NITRATE REDUCTASE ACTIVITY, SUGAR ACCUMULATION, ANTIOXIDANT ENZYMES ACTIVITY AND YIELD OF FIELD PEA (*Pisum sativum* L.) UNDER SALINITY STRESS**

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Field pea (*Pisum sativum* L.) is one of the most popular vegetable crops, which is highly sensitive to salinity stress. In the present investigation, soil induced salinity stress @ 50 mM, 100 mM and 150 mM NaCl was found to adversely affect the seedling growth, physiological and biochemical parameters including antioxidant enzymes activity at different growth stages followed by yield attributes of two field pea genotypes, viz., DDR 61, HUDP 15. However, it was evaluated that salicylic acid treated plants at the threshold level of @ 1.0 mM significantly mitigated the deleterious effect of salinity in both the genotypes and enhanced the germination percentage, seedling growth, total dry matter, biochemical parameters, viz., total chlorophyll, proline accumulation, nitrate reductase activity, sugar accumulation, superoxide dismutase, ascorbate peroxidase and catalase enzyme activity. In accordance to altered morpho-physiological, biochemical and antioxidant enzymes activity at different levels of NaCl and its combination with salicylic acid it was observed critically that yield attributes such as pod plant<sup>1</sup>, seed yield plant<sup>-1</sup> and test weight were found improved with salicylic acid under salinity. This obviously emphasizes the role of salicylic acid in maintenance of physiological and biochemical status of plants under salinity stress through improved proline status and antioxidant enzymes activity. The physiological significance of salicylic acid will be discussed.



02-69

## PHYSIOLOGICAL AND BIOCHEMICAL STUDIES ON EFFECT OF PERCHLORATE STRESS ON EUCALYPTUS PLANT

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Perchlorates are the salts of perchloric acid ( $\text{HClO}_4$ ) and are the most oxygenated compound of chlorine and oxygen. Perchlorate contamination occur due to common industrial processes, manufacture and uses of explosives, fireworks, highway, railroad, and marine safety flares also as the initiator component of air bag inflators and laboratory reagent. Perchlorate is not easily degraded & can be highly toxic once enter in ecosystem. The present studies are undertaken to find out the effect of perchlorate stress on growth of Eucalyptus sp. Physiological and Biochemical parameters are undertaken to study the effect on growth of Eucalyptus plant under stress conditions. Plants were treated with varying concentrations of perchlorate (control, 0.1%, 0.2%, 0.5%, and 1.0%). Growth parameters used for the studies include height of plant, branching, no. of leaves and chlorosis. Gradual decrease in plant height and no. of branches, number of leaves was observed with increasing concentration of perchlorate. Plant under 1.0% perchlorate treatment showed arrested growth after one week. There observed to be decrease in chlorophyll content with increasing concentration of perchlorate. (Total Chl in control 1.23 mg/gm & 1.0% treatment 0.90 mg/gm). Whereas protein and proline content has been increased in plant tissue with increasing perchlorate concentration. Activity of Guaiacol Peroxidase enzyme also showed increase with increasing concentration of perchlorate (control- 142.19 units/l & 1.0% - 248.83 units/l).

02-70

## PHYSIOLOGICAL RESPONSES OF TRANSGENIC *INDICA* RICE TO SEVERE DROUGHT STRESS

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The impact of drought stress on rice plants is manifested in morphological (growth and yield) and physiological responses. Physiological parameters include photosynthetic efficiency, transpiration rate, chlorophyll content, water relations like RWC, leaf water potential, Osmotic adjustment and osmolyte accumulation. We developed the transgenic indica rice cv. Samba Mahsuri by introducing the *AtDREB1a* transcription factor, which has been reported to confer water stress tolerance, through *Agrobacterium* mediated transformation. Genotyping of the transgenic rice plants was confirmed by PCR, Southern and RT-PCR analyses. Drought phenotyping of homozygous transgenic rice lines included the severe water stress treatment for 21 days combined with the determination of physiological parameters at regular intervals among transgenic and non transgenic controls. At the peak stage of water deficit condition, chlorophyll SPAD values of transgenic lines showed very high values in the range 40-45 where as non-transformed controls showed very least values 35-36. Higher RWC (70%) of transgenic lines over controls (54%) suggested the water withholding capacity inside the leaves. EC value, the direct index of ion leakage determined the cell membrane stability in transgenic lines, was more intact than controls. Proline estimation results showed two to three fold accumulation in transgenic lines than control plants which could be the reason for drought tolerance of transgenics. During drought stress, transgenic plants were very healthy, greenish without wilting where as controls dried up within 7 days. Comparison of transgenic lines with drought tolerant controls for determination of photosynthetic parameters in response to water stress is being studied.



02-71

**PHYSIOLOGICAL CHARACTERIZATION OF RICE GERMPLASM FOR DROUGHT TOLERANCE AND YIELD REGULATING MECHANISM UNDER DIFFERENT WATER REGIMES**

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Drought is the major constraint to rice production in rainfed areas across Asia and sub-Saharan Africa. In the context of current and predicted water scarcity, increasing irrigation is generally not a viable option of for alleviating drought problems in rainfed rice-growing systems. It is therefore critical that genetic management along with physiological strategies for drought focus on maximum extraction of available soil moisture and its efficient use in crop establishment and growth to maximize biomass and yield. Extensive genetic variation for drought tolerance exists in rice germplasm. The objectives of this study was to identify the reliable indices as a selection criterion for tolerance to water deficit and also to determine the physiological traits contributing to the tolerance for water stress in target environment. The physiological (relative water content, photosynthetic rate, transpiration rate and apparent translocation rate), morphological (leaf area, plant height and number of tillers), phenological (days to panicle initiation, 50% flowering and days to maturity) root characteristics, anatomical root study and biochemical (praline content, membrane stability index and chlorophyll content) traits were recorded at various growth stages. In rainfed condition, genotype tends to delay the flowering which seems to be a key cause of yield reduction of the genotypes. Findings clearly conferred that the genotypes viz. Lakhokunwar, Bhatagurmatia and Uraibuta have expressed better root mining ability through deeper root system and adequate root growth desirable for efficient water uptake. Studies clearly revealed that the remarkable differences do exist in anatomical features (ground tissues and vascular bundles) in genotypes (Lakhokunwar, Uraibuta, Bhatagurmatia, Banspor, Luchai and Kanakchudi) in irrigated and rainfed site can be related with maintenance of high leaf water status, less delay in spikelet, photosynthetic stability, high apparent translocation rate and extended photosynthetic traits indicated that yield can be regulated either by extended photosynthetic traits or by partitioning of biomass to the grains. Mobilization of assimilates under rainfed condition was triggered coupled with higher translocation rate from shoot to grains in these genotypes. Leaf rolling and reduced leaf area are the major indicators exhibiting the cultivars ability to maintain a favourable water status under stress. The maintenance of plant water status and sustained metabolic function after stress are the key components of drought stress. Based on the result, the grain yield reduction in rainfed condition was approximately estimated 34.19 percent over the control. On the basis of association analysis studies in irrigated condition, the grain growth rate, chlorophyll stability index and harvest index determines the assimilate partitioning while in rainfed condition the relative water content, membrane stability index and apparent translocation rate were found to be the key traits for grain yield. Studies clearly indicated that production of grain yield during drought depends on action and interaction of different morphological (earliness, reduced leaf area, leaf rolling, efficient rooting system, reduced tillering and yield stability), physiological (reduced transpiration, higher plant water status and stomatal closure) and biochemical (accumulation of praline) traits.



02-72

### EFFECT OF SEED COATING WITH SYNTHETIC POLYMERS ON SEED VIABILITY OF SORGHUM DURING STORAGE

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Sorghum is adapted to tropical and subtropical climates but the greater part of the area of the crop falls in drought-prone, semi-arid tropical regions of the world. In these areas, it is usually grown with limited inputs in conditions of sparse rainfall and low soil fertility. As a result, the yields are poor. In fact, the yield potential of sorghum is quite high. However, a majority of the subsistence farmers who typically cultivate this crop are unable to take advantage of this potential because they have limited options for improving their management practices. Hence, improvements in sorghum production are more readily achieved through seed-based technologies. Sorghum is a poor storer and loose viability and vigour rapidly in storage. The success of seedling establishment at the field level largely depends on the initial quality of the seed. In recent times various quality enhancement treatments are given to the seed as a presowing treatment. Seed coating is a presenting technique. Polymer is film coating chemical normally applied over seeds. This type of polymers form a flexible film that prevent dusting off and loss of fungicide during handling and are readily soluble in water (hydrophilic), so as not to impede with normal germination in view of this. An experiment was conducted at Seed Technology Research Unit, NSP (crops) Mahatma Phule Krishi Vidyapeeth, Rahuri during 2007-08 to 2009-10 to study the effect of seed coating with synthetic polymers, fungicides, insecticides & their combinations and stored in gunny bag and polylined gunny bag. Seed coating with vitavax (polycot containing thiram, carboxin dye and filler) @ 2g/kg of seeds ( $T_3$ ) maintained the sorghum seed germination (83 %) above the minimum seed certification standard upto 6 months, root shoot length (35.72cm), seedling dry weight (0.24g), electrical conductivity ( $0.45 \text{ dsm}^{-1}$ ), vigour index (20.38), field emergence (91%), final plant stand (86%) and seed yield (35.47 q/ha). The decline in germination percentage may be attributed to ageing effect leading to the depletion of food reserve and decline in synthetic activity of embryo apart from death of seed because of fungal invasion, insect damage and storage condition. Thiram acts as a protective agent against seed deterioration due to fungal invasion and physiological ageing as results of which the seed viability was maintained for a comparatively longer period of time. The filer formed around the seed act as a physical barrier, which has been reported to reduce leaching of inhibitors from the seed covering may restrict oxygen diffusion to the embryo. The higher germination percentage can be seen in polymer coated seeds. It is due to increase in the rate of imbibitions where the particles in the coating act as moisture attractive material which perhaps improve germination.

02-73

### EVALUATION OF SACCHARUM GERMPLASM FOR DROUGHT TOLERANCE WITH SPAD

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*Saccharum* germplasm was screened for traits contributing to high water use efficiency (WUE) and temperature tolerance in a field experiment by imposing moisture stress at formative phase i.e. 40 DAP to 120 DAP (days after planting). WUE was measured using surrogate methods viz., SPAD chlorophyll meter readings (SCMR), pecific leaf area (SLA) and thermostability was quantified by measuring membrane relative injury percentage on 20 days (60 DAP) and 80 days (120 DAP) after imposing moisture stress (DAIS). Among the 150 genotypes, four genotypes viz., 97 R 129, 92 V 104, CO (O) 061 and CO 6907 showed low SLA and higher SCMR values, which indicates higher water use efficiency. However, higher thermostability was recorded in 92 V 104 and CO 907 genotypes only. Hence, the 92 V 104 and CO 6907 genotypes having both WUE and temperature tolerance traits can be used as donar parents in breeding programmes. SCMR, SLA, relarive injury per cent can be used as surrogate methods for measurement of WUE and temperature tolerance in sugarcane and can be used as selection traits in breeding programme for developing drought tolerant genotypes.



02-74

**ISOLATION, CLONING AND CHARACTERIZATION OF TRYPSIN INHIBITOR GENE FROM *Dolichos biflorus* CULTIVAR HPK4**

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Trypsin inhibitor gene (309bp) was amplified from cDNA of *Dolichos biflorus* HPK4 cultivar seeds (60 DAF) using a pair of designed primers. The amplified PCR product was cloned and sequenced. Sequence analysis of cDNA clone of HPK4 revealed 100% homology with bowman–birk inhibitor of *Dolichos biflorus*, 92% homology with bowman–birk inhibitor of *Phaseolus glabellus* and 84% homology with bowman–birk inhibitors of *Glycine soja*, *Glycine max*, *Glycine microphylla*, *Phaseolus vulgaris* and Soybean clone JCVI-FLGm-1K8. The predicted amino acid sequence of protein product of isolated trypsin inhibitor gene was deduced from nucleotide sequence using ‘ExpASy’ translate tool (<http://us.expasy.org/tools/dna.html>). Amino acid sequence analysis using BLASTP showed 100% homology with *Dolichos biflorus* clone pHGI-3 and 84% homology with amino acid sequences of double headed trypsin inhibitors from *Phaseolus hintonii*, *Lablab purpureus*, *Phaseolus microcarpus*, *Phaseolus microcarpus*, *Phaseolus zimapanensis* and *Phaseolus lunatus*. Sequence of *Dolichos biflorus* HPK4 cultivar trypsin inhibitor gene has been submitted to NCBI with Accession No. JQ259858. The gene isolated during present studies will broaden the pool of plant defense genes for development of transgenic crops resistant to insect pests.

02-75

**TRAIT INTROGRESSION BREEDING TO IMPROVE WATER USE EFFICIENCY IN RICE (*Oryza sativa* L.)**

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With the receding water availability, saving water and improving rice productivity under upland conditions is essential. It is clear that a trait introgression breeding would be the most plausible approach for achieving this goal. Among several traits, water acquisition and its efficient use for biomass production have paramount significance in improving productivity. Being multigenic in inheritance, a comprehensive molecular breeding program is therefore essential. A set of diverse rice germplasm were screened for variability in WUE based  $^{13}\text{C}$  and other physiological traits. Contrasts were identified and most consistent lines were crossed to develop trait specific mapping population segregating for WUE. The  $F_2$  lines (495) were phenotyped and a large variability was noticed. These progenies were advanced by SSD method to  $F_4$  generation and extensively phenotyped. A set of 188 progeny lines representing the entire range of phenotypic variability was chosen for molecular characterization. Initially the parental lines were screened with 100 SSR markers and 8 primer combinations of AFLP. Polymorphic markers were used to screen the  $F_4$  mapping population. A total of 109 markers were added to the linkage map constructed using MAPMAKER EXP 3.0. A marker trait association was carried out by both SMA and CIM strategies. QTL were discovered for traits such as TDM, TLA, Yield etc. Markers RM110 & TA\_CAA8 were found to be associated by both SMA and CIM to TDM and TLA respectively. Saturation of these QTL regions would be necessary before using these markers for marker assisted selection. From among the transgressivesegregants a few promising lines such as  $F_4$  SSD125,  $F_4$  SSD295 and  $F_4$  SSD313 are being tested in AICRP Rice Trials.



02-76

### PHYSIOLOGICAL AND METABOLIC INDICES FOR HEAT TOLERANCE IN MAIZE

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Seasonal aberrations leading to high temperature during crop growth is a major determinant of agricultural production throughout the world which affects plants right from seed germination to final yield harvested. High temperature stress adversely affects various morphological, physiological and biochemical characteristics of crop plants predominantly during reproductive stage. Better understanding of the mechanism involved in stress tolerance would facilitate speedy development of thermo-tolerant varieties to stabilize crop productivity under fragile environments. Thirty two maize genotypes received from DMR, NBPGR and CIMMYT were raised during off-season by staggered sowing in January and February 2012 so as to expose the reproductive phase of the crop to high temperatures of April and May. Observations were recorded for various traits viz., leaf rolling, membrane stability, chlorophyll content, chlorophyll fluorescence, canopy temperature, stomatal conductance, photosynthetic rate, tasseling, anthesis, silking, lipid peroxidation, important metabolites and changes in activities of some enzymes related to sucrose and anti-oxidative stress metabolism. Tasseling, anthesis and silking intervals varied across thirty two genotypes studied leading to variable ASI values. The genotypes identified with low ASI values were HKI-325-17AN; RJR-068; NSJ-285; NSJ221; PSRJ-13086 and PSRJ-13038), while, HKI-3-4-8-6ER, Z93-194, Z-40-183; Z59-11; NSJ-189; RJR-163; PSRJ-13099 and PSRJ-13247 possessed higher ASI values. The contents of ascorbate and malondialdehyde (MDA), phenols, free amino acids declined while glucose, fructose and starch increased in the high ASI genotypes as compared to low ASI ones. Activities of the enzymes related to anti-oxidative stress tolerance viz., superoxide dismutase, peroxidase and catalase were lower while important sucrose metabolizing enzyme sucrose phosphate synthase was higher in the high ASI genotypes.

02-77

### STUDIES ON THE GROWTH AND YIELDS RESPONSE OF FOUR BRASSICA CULTIVARS UNDER THE EFFECT OF FLYASH, WASTEWATER AND NPK FERTILIZATION

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A pot experiment was conducted in the net house of the Botany Department, Plant Physiology and Environmental Section, to observe the effect of various combination of flyash (FA), wastewater (WW) and NPK fertilizers on four various *Brassica* cultivars namely *Brassica campestris* cv. Pusa Gold, *Brassica juncea* cv. Pusa Bold, *Brassica napus* cv. GSL-1, *Brassica nigra* cv. IC247. The number of treatments was 13 each with *Brassica* cultivars separately. The treatments include one control, three doses of NPK & two doses of FA. The NPK (kg/ha) @ (i) 80, 45 & 45 (ii) 60, 30 & 30 (iii) 40, 15 & 15 respectively was applied each with the FA @ 10 & 20 kg/ha. These treatments supplied with ground water (GW) and wastewater (WW) irrigation separately and compare together. The result showed that solid and liquid waste i.e FA and WW may prove as feasible option for local farmers to use in their field to increase the productivity of *Brassica* crops. The plant irrigated with WW was superior over the plant irrigated with GW. Among the various treatments the combination of FA<sub>20</sub> + N<sub>80</sub> P<sub>45</sub> K<sub>45</sub> was best to increase the growth parameters and yield of four brassica cultivars. FA<sub>20</sub> + N<sub>40</sub> P<sub>15</sub> K<sub>15</sub> were closely followed to this treatment. The physiochemical characteristics of FA and WW were under the permissible limit of FAO guidelines.



02-78

## IDENTIFICATION AND CHARACTERIZATION OF ABA RECEPTORS FROM RICE

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Abscisic Acid (ABA) plays crucial roles in development and stress responses of plants. ABA receptor (ABAR) family in *Arabidopsis* consists of 14 members. The molecular details of signaling mechanism and the core-components of ABA signaling pathway for all the members have been demonstrated in single cell protoplast system and *in vitro* system. However, the specific function of members of ABARs in developmental and stress responses needs to be understood. Hence, we initiated a study on identification and characterization of ABAR family genes in rice. Bioinformatic analyses led to the identification of eleven PYR/PYL homolog ABARs from rice. ABARs were identified based on the conservation of ABA-binding pocket, gate and latch residues in the primary structure. Phylogenetic analysis revealed three distinct subfamilies as in case of *Arabidopsis*. Expression analysis of ABARs in abiotic stress tolerant and sensitive genotypes of rice revealed significant differences in their tissue specificity and stress responses. To identify the specific functions of each receptor genes, some of the receptors were cloned in plant transformation vector for over-expression and RNAi mediated suppression of gene expression. Work is in progress to transform *Arabidopsis* and rice with these ABAR genes constructs. Characterization of ABARs will help engineer crops with stress specific ABARs and orthogonal receptors for improving abiotic stress tolerance of crops.

02-79

## ADDRESSING DROUGHT TOLERANCE IN RICE THROUGH A TRANSGENIC APPROACH

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Rice, the second most important crop in the world provides staple food for about 3 billion of the world population. It was estimated that 70% more production of rice, is required from less labor, less water and fewer chemicals by 2025 to meet the increasing number of rice consumers in India. Rice production is seriously hampered both by different biotic and abiotic stresses. Abiotic stresses like drought, submergence and salinity cause severe yield losses year after year as most of the rice area in India is rainfed where water control is not possible. Drought is a very serious problem effecting rice, and there is no immediate solution as the physiology of drought is controlled by combination of several genes. The estimated average loss in rice production during drought years in eastern India is 5.4 million tons. Enhancement of host plant resistance is one of the viable options to deal with various stresses and genetic engineering methods can help in transfer of specific resistant/tolerant genes into desired genotypes which can address these stresses effectively. Despite the best efforts through conventional approaches using the primary germplasm, the genetic enhancement in rice against drought is still not effective. In this scenario, introduction of novel genes from other sources might contribute significantly in the enhancement of tolerance to drought. Significant improvements in the area of transgenics by incorporation of several agronomic traits through various gene transfer technologies were made and reproducible results have been obtained in rice. The present study reports an attempt to enhance drought tolerance in rice through incorporation of novel DREB1A gene cloned from *Arabidopsis* and introduced into rice through *Agrobacterium* mediated gene transfer using the callus as the explants. PCR assays on the putative transgenics confirm the presence of the incorporated gene and transgenics were studied for their inheritance and stability over three generations. The results on the levels of drought tolerance in the transgenics and its implications will be discussed in detail.



02-80

### EFFECT OF HEAT, DROUGHT AND COMBINED STRESS ON DRYLAND SORGHUM DURING PRE-FLOWERING STAGE

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Sorghum (*Sorghum bicolor* (L.) Moench) is one of the important cereal crops grown for food, feed, fodder and bioenergy production around the world. Occurrence of drought & heat stress and their combination during pre- and post-flowering stages limits sorghum productivity. Further, future climate change and its variability are projected to reduce the sorghum yields. Experiment was conducted with an objective of quantifying the impact of drought (D), high temperature (HT) and combined stress (D\*HT) during preflowering stage. The experiment was conducted in controlled environmental facility which includes four growth chambers (Convicon Model CMP3244) at Kansas State University, Manhattan, KS, USA. The plant material is sorghum early maturing sorghum hybrid DKS-29-28. Seeds were planted in plastic pots (5 L cap.). The potting media used was a mixture of Metro mix 360 potting soil plus slow release fertilizer (@10g pot) Osmocote 19-6-12 [N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O]. The treatments imposed include 1) control [Irrigation+ Optimum temperature (OT) (32/22°C day and night time, resp.)]; 2) drought stress [drought for 20 days + OT (32/22°C)]; 3) HT stress [Irrigation+ HT (38/28°C)]; and 4) combined stress [drought+HT (38/28°C)]. Plants were initially grown at OT (32/22°C) from sowing to 21 days after sowing (DAS) in all treatments. Thereafter, stress treatments were imposed until 40DAS and stress relieved at 41DAS. Results indicated that plant leaf area decreased by 25% due to combined stress over OT, while, leaf number increased by 7% due to combined stress. Across days, plant height decreased by 7.4% due to HT and combined over OT. Mean leaf temperature had increased by 8.0, 5.0, 2.5% resp., in combined, HT and D over Optimal. Maximum root length and root-shoot ratio significantly increased by 11.0% due to combined stress over optimum. Stomatal conductance decreased by 8.0% due to combined stress over OT. Transpiration rate decreased by 5.6% and 10.0% in HT and combined resp. over OT. Photosynthesis rate did not differ among treatments. Interestingly, relative leaf water content (RLWC) decreased by 16.1% and 35.0% resp. in drought (D) and combined (D\*HT) over OT. The implication of these results is discussed for improving sorghum for climate change resilience dryland production system.

02-81

### COPPER INDUCED TOXIC RESPONSES ON THE GROWTH AND YIELD OF CHICKPEA (*Cicer arietinum* L.) CULTIVARS

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An attempt has been made to study the effect of differential levels of Cu (0, 100, 200, 300 mg Cu/kg soil as CuSO<sub>4</sub>.5H<sub>2</sub>O on growth, yield, chlorophyll, carotenoid, protein and ascorbic acid content in (*Cicer arietinum* L. cv. Pusa 312 and Pant G 114) planted under soil pot culture conditions. All the growth and yield attributes studied, viz. plant height, number of branches, number of pods per plant, biological yield, economic yield, harvest index, fresh weight and dry weight of shoot decreased with an increase in Cu supply. Biochemical studies indicated steady decline in chlorophyll a and b, carotenoid and soluble protein content with an increasing Cu dose in both the varieties. Ascorbic acid content was found high in Cu supplied plants. Results obtained indicated that high dosages variety Pusa 312 in terms of lower decrease in growth attributes.



02-82

**EFFECT OF WATER STRESS ON NITROGEN METABOLISM IN TWO HIGH YIELDING CULTIVARS OF GROUNDNUT (*Arachis hypogaea* L.) WITH CONTRASTING DROUGHT TOLERANCE**

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Water deficit is one of the most common environmental stresses that affects growth and development of plants. Two cultivars of groundnut differing in drought tolerance (cv. K-134 and cv. JL-24, drought tolerant and drought sensitive respectively) were evaluated for comparative study of nitrogen metabolism in response to water stress at different soil moisture levels for a duration for 12 days. The activities of nitrate reductase, protease, glutamine synthetase (GS), glutamate synthase (GOGAT), glutamate dehydrogenase (GDH) along with total protein content, free amino acid level and ammonia content were studied in leaves of both cultivars. The total protein content of the stressed plants declined with a progressive accumulation of free amino acids. Concurrently, the protease activity in the tissues was also increased. Percent of increase in amino acid pool was relatively more in K-134 than in JL-24. Nitrate reductase activity was decreased under stress conditions in both cultivars. However, the decrease was more in JL-24. Water stress resulted in a significant accumulation of free ammonia content in leaves of both cultivars with concomitant increase in GS, GOGAT and GDH. The results indicate that during water stress, ammonia accumulation may be due to enhanced proteolytic activity rather than nitrate reduction. The difference in the ammonia levels among the cultivars can be attributed to the difference exhibited in the reassimilation of ammonia by the activities of ammonia assimilating enzymes, where by the tolerant cultivar K-134 recorded a relatively better reassimilation capacity of ammonia than JL-24. The results possible suggest that drought tolerant cultivar K-134 seems to be associated atleast in part with its ability to maintain greater level of amino acids, higher metabolic activity coupled with more pronounced reassimilation of ammonia. The relative tolerance of these two cultivars is discussed.

02-83

**EVALUATION OF INDIAN AND AUSTRALIAN VARIETIES FOR WATERLOGGING TOLERANCE AND MICROELEMENT TOXICITIES IN SODIC SOIL**

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A study was conducted to evaluate the waterlogging tolerance of eleven Indian and Australian wheat varieties, KRL 3-4, KRL99, Kharchia 65, KRL 19, KRL 210, NW 1014, Brookton, Ducula-4, DBW 17, HD 2851 and HD 2009 in sodic soil (pH 8.9) under potculture condition during 2010-11 at the Crop Physiology Experiment Site, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.). The experiment consisted a total of 22 treatment combinations including 11 varieties and two conditions *viz.*, non waterlogging(NWL) and waterlogging(WL) for 10days at 30 days plant age (water depth 5-6 cm). For monitoring the waterlogging, redox potential was measured in both NWL and WL pots at every 2 days interval during and after waterlogging till redox potential in WL pots reached above anoxic limit (+350mV). The redox potential in WL pots dropped



rapidly from +402.8mV (before WL) to +96.4 mV (10d after WL). After WL termination, redox potential in WL pots increased gradually and it took 10 days to reach the anoxic limit. At the starting of WL treatment, NWL pots were lightly irrigated as a result redox potential in NWL pots after 2 days of WL period was +356.7 mV and at 10d it increased to the level of +437.3 mV. In general, waterlogging decreased plant height, shoot biomass, yield and yield traits of all varieties. The decrease in plant height and shoot biomass under WL treatment with respect to NWL at maturity was minimum in KRL3-4 followed by Kharchia 65, KRL 99, NW1014 and DBW 17, while highest decrease was observed in HD 2009. Waterlogging delayed the days to 50% flowering (5 to 14 d) and maturity duration (4 to 13 d) of all varieties. Yield traits like, EBT per plant, number of grains per panicle, panicle length and test weight were severely affected due to waterlogging which resulted to poor grain yield in all varieties. Relative grain yield index (WL/NWL) was highest in Kharchia 65 (0.77) followed by KRL 3-4, KRL 99 and NW-1014, while, HD 2009 had lowest (0.40) followed by HD2851 (0.42). ICP analysis of leaves showed tremendous increase in Fe (10 fold), Al (9 fold), Mn, and Na under WL relative to NWL. Tolerant varieties, KRL3-4, KRL99, Kharchia showed less increase in above elements as compared to sensitive HD2009 and HD2851. So, it may be concluded that under waterlogging, increase in Fe, Mn, Al and Na toxicities reduce the growth and yield of wheat. However, tolerant varieties have relatively less increase in element toxicities than susceptible ones, hence have less reduction in growth and yield.

## 02-84

### PHENOTYPIC AND MOLECULAR CHARACTERIZATION OF DROUGHT TOLERANCE IN NATIVE LAND RACES OF RICE

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Drought, one of the major worldwide problems on crops, differentially affects the physiological and molecular changes occurring on endogenous phytohormonal pathways. In rice, the effect of drought ranges from slight physiological changes to complete plant desiccation. The magnitude of grain yield losses depends on the duration of the drought, and the stage of crop growth. In an effort to assess the diversity for tolerance against drought, 134 native land races of rice were screened at morphological, physiological, and molecular levels against drought. The entries were direct seeded in the field and thirty days old seedlings were exposed to moisture stress and the experimental conditions include i. water table depth below 90 cm ii. Soil moisture content of 10-12% and iii. Soil moisture tension of 40-50 kPa at 30 cm soil depth during the stress period. Out of the 134 lines, 78 lines were recorded as tolerant with the SES score in the range of “0-3” (IRRI SES method, 1-9 scale) while the other 56 lines were noted as susceptible with “5-9” score. Of the 78 lines, 12 entries having a SES score ‘0’ were identified as excellent for vegetative stage drought while 18 entries had a SES score of ‘1’. The same set of entries was screened under artificial osmotic stress using PEG 6000 at germination and seedling stage and amplification of OsCDPK7 gene using gene specific primers was done using PCR assays. From the pooled data of the three experiments, it was observed that six genotypes showed high levels of tolerance for drought at field and physiological level. PCR results revealed that in fifteen genotypes polymorphism was observed. The sequence alignment of nucleotide and amino acids of the polymorphic variants indicate SNP variation at the 46<sup>th</sup> position of gene and it appears that a natural mutation in this region might be associated with varied levels of expression of tolerance in different genotypes. Extension of these genotyping and phenotyping studies further and their correlation analysis may lead to identification of novel genes/alleles in the gene(s)/QTL(s) associated drought tolerance in rice.



02-85

### EVALUATION OF SUGARCANE GENOTYPES FOR MOISTURE STRESS TOLERANCE

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Drought is one of the major limitations to plant productivity worldwide. Twenty sugarcane genotypes were screened for traits contributing to high water use efficiency (WUE) and temperature tolerance in a field experiment by imposing moisture stress at formative phase i.e. 60 DAP to 150 DAP (days after planting). WUE was measured using surrogate methods viz., SPAD chlorophyll meter readings (SCMR), canopy temperature and relative leaf water content (RLWC) on 45 days (105 DAP) and 90 days (150 DAP) after imposing moisture stress (DAIS). In general, LT of drought-stressed plants was higher than that of well-watered plants however, relative increase was greater in drought susceptible genotypes. Relative Water Content of water stressed plants had declined significantly in all genotypes compared to values at the onset of well-watered treatments at 90 DAIS. Among the twenty genotypes, eight genotypes viz. CoM 09057, CoM 0265, CoM 09029, Co 86032, CoM 09022, CoM 09060, CoM 09043 and CoM 09034 showed higher SCMR and RLWC values which indicates higher WUE. However relatively lower canopy temperature was recorded by the genotypes, CoM 09029, CoM 09057, CoM 0265, CoM 09034, CoM 09060, CoM 09022 and Co 86032. Hence the genotypes, CoM 0265, CoM 09022, CoM 09057, CoM 09029 and Co 86032 having both WUE and canopy temperature tolerance can be used for commercial planting or used as a donar parents in breeding programmes. The results are consistent with the tolerant susceptible classification of these genotypes and indicate that these tools can be reliable in screening for drought tolerance, SPAD index and canopy temperature having the added advantage of being nondestructive and easy and quick for assessment of sugarcane genotypes for water and high temperature stress.

02-86

### DIFFERENTIAL GROWTH RESPONSES OF *Vigna radiata* SEEDLINGS UNDER WATER STRESS: ROLE OF HORMONES AND THEIR INHIBITORS

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Plants are often subjected to environmental stresses, water stress being one of them. During studies on growth responses of *Vigna radiata* seedlings to water stress induced by PEG 6000 (-0.5MPa), we observed differential shoot and root response. Root growth promotion was more prominent in dark while shoot growth inhibition was more in light. Regarding the role of hormones in controlling growth, exogenous ABA (10 $\mu$ M) had no effect on stress-induced root growth; however, it promoted growth in non-stressed roots under dark condition. Under stress, Fluridone (ABA biosynthesis inhibitor) totally inhibited root growth in dark indicating the role of endogenous ABA in root growth. The inhibition could be slightly overcome by application of exogenous ABA. Exogenous GA (100 $\mu$ M) had a negative effect on stress-induced root growth. Treatment with CoCl<sub>2</sub> (10 $\mu$ M), an ethylene biosynthesis inhibitor, did not affect root growth under stress thus eliminating the role of ethylene. Stress-induced shoot growth responses under light were also studied under different treatments. Treatment with CoCl<sub>2</sub> again did not affect shoot growth, while Fluridone promoted such growth. The combined effect of CoCl<sub>2</sub> and Fluridone also showed the effect of Fluridone only. Thus, ABA plays an inhibitory role in shoot growth under water stress while ethylene has no role in the process. In non-stressed condition exogenous GA induced shoot growth; however, it did not show any change in stress condition. Moreover, GA could not overcome the effect of fluridone. It appears that stress-induced inhibition of shoot growth is not due to absence of GA.



02-87

## TRANSGENIC BREEDING APPROACH FOR DEVELOPMENT AND DEPLOYMENT OF RICE AGAINST WATER STRESS CONDITIONS

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Being a complex phenomenon, drought is the major abiotic factor that limits the productivity of rice crop and efforts to improve rice against water stress yielded limited success. Among the molecular tools, transgenic technology has been successfully demonstrated as one of the best tools to develop crop plants that are tolerant to water stress conditions. An array of genes /transcription factors are identified and transgenics are developed by over-expression or silencing of these genes which confer tolerance to water stress particularly drought condition. We developed transgenic rice in the back ground of indica cv. Samba Mahsuri through *Agrobacterium* method by using the binary vector *pCAMBIA1200* cloned with the *AtDREB1A* gene driven by stress inducible *rd29A* promoter. PCR, Southern and RT-PCR analysis confirmed the gene integration and expression in T<sub>0</sub> and three independent events were advanced to T<sub>4</sub> generations to get homozygous lines. All homozygous lines were subjected to drought stress evaluation in hydroponics and at vegetative and reproductive stages under bio-safety glass-house conditions. Most of the transgenic lines showed very high level of tolerance to water stress when compared to controls both in vegetative and reproductive stages. Physiological parameters such as chlorophyll content, proline and relative water content and ion leakage indicated relatively high levels of drought tolerance among most of the transgenic plants. Phenotypic observation on characters like pollen grains, spikelet fertility and quality confirmed the better performance of transgenic plants than control plants both in stressed and unstressed conditions. Further, all the relevant physiological and biochemical studies are in progress in selected lines to determine the factors that confer tolerance to drought stress. Selected lines are also promoted for event selection trials (EST) and for further biosafety trials.

02-88

## EVALUATION OF CHICKPEA GENOTYPES UNDER RAISED TEMPERATURE CONDITIONS

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Climate change widens the weather requirements as well as cultivation practices of crops. The present work emphasizes on identification of better performing chickpea genotypes under raised temperature conditions which is an essential requirement under M.P. climatic conditions. Chickpea crop is one of the most important pulse crops grown in *rabi* season. The short duration chickpea genotypes are required and preferred for being suitable to crop rotation practices or shifting of cultivation due to changed climatic conditions. Thirty genotypes were evaluated for normal sown (mid November) as well as late sown conditions (1<sup>st</sup> week of January) and parameters like crop reproductive duration, biomass, harvest index and filled pods, unfilled pods and HIS were recorded. Genotypes like Pusa-256, ICCV-92944, JG-218, JG-11 and K-850 were found to have close similarity in test weight (weight of 100 seeds) under late sown conditions. Pusa-240, JG-11 and Annagiri genotypes were recorded to have enhanced yield under raised temperature conditions.



02-89

### REMEDIATION OF CHROMIUM CONTAMINATED SOILS BY ORNAMENTAL XEROPHYTIC PLANTS

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One of the most common heavy metals affecting the soil quality is chromium which is introduced into the environment from industries such as leather tanning, electroplating and pigment production. The leather industry is the major source for the environmental influx of chromium. Presently there are 6000 tanneries out of which a sizable percentage is actively involved in the chrome tanning process. Several reports have shown that the values for Cr in tannery effluent are considerably higher than the safe limits prescribed by National and International standards. Cleaning up of the Cr contaminated sites is a challenging task. Phytoremediation is an emerging technology that can be considered for remediation of contaminated sites because of its cost effectiveness, aesthetic advantages, and long term applicability. Phytoremediation is well suited for use at very large field sites where other methods of remediation are not cost effective or practicable; at sites with low concentrations of contaminants, where treatment is required over long periods of time. However, there is a danger of contamination of the food chain if edible crops are used for phytoremediation. A viable and remunerative alternative could be cultivation of non-edible crops which will prevent the entry of heavy metals through food chain. Therefore, a study was undertaken to examine the response of some ornamental xerophytic plants i.e., *Euphorbia milli*, *Agave angustifolia*, *Furcaria gigantia* and succulent fern to different levels (0, 25, 50, 75, 100, 150 and 200 mg/kg soil) of chromium and their possible use for remediation of soils contaminated with chromium. Among the four plant species *Furcaria gigantia* was found to be more tolerant to Cr agave least tolerant. In *Furcaria*, up to 100 ppm of Cr, no toxic symptoms were observed whereas at 200 ppm there was either mortality or very negligible growth of plants. *Euphorbia milli*, could tolerate upto 75 ppm and beyond that there was mortality of the plants. In succulent fern and *Agave angustifolia* beyond 50 ppm there was a drastic reduction in growth of plants. The highest concentration of Cr was found in the roots and was followed by shoots.

02-90

### EVALUATION OF SUNFLOWER (*Helianthus annuus* L.) GENOTYPES FOR DROUGHT TOLERANT TRAITS BASED ON ROOT CHARACTERS, WATER USE EFFICIENCY AND YIELD STABILITY INDICES UNDER MOISTURE STRESS CONDITION

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To examine the relevance of the roots in sunflower under water limited condition, around 200 sunflower genotypes including CMS-lines, RHA lines, inbreds and some hybrids were evaluated over the years for better root system and high water use efficiency (WUE) in temporary cement root study structures. Among them, 32 promising genotypes were found promising and grown simultaneously both in temporary cement root study structures and field and the moisture stress was imposed for 20 days from star bud stage by withholding the irrigation. During the crop growth period all the physiological traits, morphological parameters, root characters and yield parameters were recorded and the results were compared with non stressed plants. Results showed a wide and significant genetic variability for all the parameters. In the plants grown in temporary cement root structures, days to 50% flowering was reduced by 3 days under stress. The mean chlorophyll content measured by SPAD chlorophyll



meter also reduced from 2 to 4%, indicating the effect of moisture stress on chlorophyll content. Plant height exhibited a wide variation and it was decreased during stress. Under stress, total leaf area was reduced from 27.57% in R-lines to 32.57% in inbreds. Total dry matter (TDM) was reduced drastically under stress. Though the mean values for root length was more in hybrids, maximum root length was observed in R-lines and inbreds. Stress affected the root dry weight severely. There was a genetic variability in  $\delta^{13}\text{C}$  values in all the selected genotypes both under stress and control condition. Field grown plants flowered 1 or 2 days earlier under stress compared to control. The mean grain yield was more in inbred. Stress affected the grain yield upto 50% in all the entries. The mean 100 seed weight was more in inbreds (6.35g) similar to the total grain yield. There was a reduction in oil content to an extent of 2.75% in hybrids to 4.72% inbreds under stress. Genotypic variations in  $\delta^{13}\text{C}$  values were significant. Yield stability indices viz., drought tolerant efficiency (DTE) and drought susceptibility index (DSI) were also determined. The value for DTE ranged from 24-63% and 0.71 to 1.48 for DSI values. Genotypes viz., IB-84, P-62-R, R-297, CMS-851A, CMS-343A, RCR-60-P, RES-834-1, IB-47, IB-60 and BGR-135-2 with high DTE and low DSI with minimum reduction in yield were identified as drought tolerant. Under stress condition, CMS-343A, CMS-851A, R-16, BGR-135-2, IB-97, IB-20 and EC-512690 exhibited better root dry weight while, CMS-343A, CMS-336A, R-16, R-297, BGR-135-2, IB-97, IB-46 and IB-20 showed high TDM and CMS-343A, CMS-336A, CMS-851A, RES-834-1, R-275, BGR-135-2, RCR-60-P, P-62R, IB-84, IB-47 and IB-60 recorded more grain yield. Further, these selected promising genotypes will be utilized to develop drought tolerant sunflower hybrids which can survive better under water limited conditions.

02-91

#### RELATIVE WATER CONTENT AS AN INDEX OF PERMANENT WILTING POINT IN GROUNDNUT UNDER PROGRESSIVE WATER DEFICIT STRESS

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The relationship between relative water content (RWC) and permanent wilting was studied in 21 Spanish groundnut varieties during summer season. Irrigation was with-held 30 DAE for 60 days. Observations on RWC of leaves and moisture content and temperature of soil were recorded at five progressive intervals. After 60 days of progressive stress (DPS), the soil moisture content decreased from 15.3% to 0.39% in 0-15 cm soil-layer and from 16.8% to 2.3% in 15-30 cm soil-layer. The day temperature of soil increased from 33.8°C to 38.0°C at 5 cm depth and decreased from 40.3°C to 38.3°C 15 cm depth during 60 DPS. The RWC in all varieties declined progressively with increasing intensity of water deficit stress with mean value of 92.4, 84.8, 77.2, 73.8 and 70.5% at 10, 25, 35, 50 and 60 DPS, respectively. Interestingly the RWC at 60 DPS was above 70% in 13 out of 21 groundnut varieties with the highest value in JAL 42 (73.4%) followed by DRG 12 (72.9%) while it was lowest in VG 9521 (67.3%) followed by GG 5 (67.5%). There were significant differences among the varieties for their fraction of plant population on the threshold of permanent wilting (TPWV) recorded visually at 60 DPS. The maximum value for TPWV was observed in GG 2 (42.1%) while the lowest in ICGV 86590 (5.1%). The fraction of plants showing permanent wilting (PWP) was lowest in TPG 41 (4.12%) and was closely followed by ICGV 86590 (4.25%). A strong inverse correlation was observed between RWC at 60 DPS and TPWV ( $r = -0.74$ ) and RWC at 60 DPS and PWP ( $r = -0.76$ ) indicating that RWC at the 60 DPS would be an appropriate tool for determining the possibility of mortality of plants under going moisture deficit stress. The lower limit of RWC in groundnut leaves causing permanent wilting, however, varied with cultivars. Most plants could survive moisture deficit up to 70% RWC and any further reduction would enhance the chances more than 60% of visibly wilted plants to become permanently wilted.



02-92

**PHYSIOLOGICAL BASIS OF CYTOKININ INDUCED DROUGHT TOLERANCE IN WHEAT  
(*Triticum aestivum* L.)**

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Wheat is one of the premier cereal crops of worldwide importance and water stress is the most serious environmental factor limiting the productivity of wheat. PGRs plays important role in plant response to water stress, cytokinins among them can induce water stress tolerance by delaying leaf senescence. The present study was conducted to determine the effect of cytokinin (6-Benzyl amino purine; 40  $\mu$ M) treatment under two different water regimes (Control and water stressed) in two contrasting cultivars, water stress tolerant and susceptible, C-306 and PBW-343 respectively. In water stressed plants significant reduction were observed in traits like RWC, MSI, chlorophyll and carotenoid content, photosynthesis rate, stomatal conductance, photochemical efficiency and total starch content. Cytokinin treated plants were observed with higher activity of all the parameters studied in relation to photosynthesis and related traits in both the wheat cultivars under moisture deficit condition. Application of cytokinin also enhanced activity of nitrate reductase and glutamine synthetase and further increased leaf nitrogen and protein content in both cultivars. Yield related attributes also enhanced due to application of cytokinin in both the cultivars under water stress conditions. Wheat cultivar C-306 drought tolerant performed better under water stress condition compared to PBW-343 drought susceptible. Highest level of Rubisco SSU expression was observed at anthesis stage and expression of desiccation tolerance genes was more under water stress condition and at later developmental stages as well as the expression of LEA-3 family was significantly high at water stress condition we concluded we can enhanced the drought tolerance by delaying in the leaf senescence.

02-93

**EXPRESSION OF HEAT RESPONSIVE TRANSCRIPTION FACTORS AND HEAT SHOCK  
PROTEINS IN MILKY WHEAT UNDER HEAT STRESS AND EFFECT ON STARCH  
GRANULE STRUCTURE**

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Heat responsive transcription factors (HSFs) regulates the expression of the majority of heat shock genes (HSPs) under heat stress. Here, we report the regulation of different HSPs genes by heat shock transcription factors at milky stage in wheat. We could observe an increase in the expression of heat shock protein (HSP17 and HSP70) with the increase in the expression of HSF3 and HSFA4a in milky tissues of wheat under heat stress. The increase in fold expression of HSP70 and HSP17 was 5.6, 3.9 (HD2985) and 2.4, 1.9 (NIAW) compared to 2.45, 2.34 (HD2985) and 1.45, 1.32 fold (NIAW) increase in the expression of HSFA4a and HSF3 under heat shock of 42°C for 4h. The increase in the expression of heat shock transcription factors was less compared to that of heat shock proteins, but then the regulation effect was observed more in milky wheat. Heat responsive transcription factors acts as a driver for the expression of stress associated genes like heat shock proteins and antioxidant enzymes and the expression of both HSFs and HSPs was observed more in tolerant cultivar compared to susceptible. Under heat stress, antioxidant enzymes like SOD and Catalase expression were observed high as compared to control in HD2985 cultivar of wheat at milky stage. Scanning electron microscopy study of starch granules showed a fragmented starch granules with pleated shape and less in number in both the cultivars and the damaging effect was more severe in case of NIAW compared to HD2985 (thermostable wheat cultivar).



02-94

### SEED METABOLISM IN MAGNETOPRIMED CHICKPEA SEEDS UNDER NaCl SALINITY

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Soil salinity is a major deterrent for sustainable crop production. Chickpea (*Cicer arietinum* L.) is one of the important legume crop conventionally cultivated in marginal areas and saline soils. Seed germination and early seedling growth are the critical stages sensitive to salinity stress. Salt and osmotic stresses are responsible for both inhibition or delayed seed germination and seedling establishment. At higher salt levels, crop yields are severely affected and cultivation is not economical without expensive measures like soil amendments. Selection and breeding of cultivars that can give a good economic yield under salinity offer a viable solution to minimize the losses incurred due to salinity, but is limited by very little genetic variability for salinity tolerance in chickpea. Seed priming is an alternative method of pre-sowing seed treatment that improves germination and vigour of seeds with poor germination capacity and under different stress conditions. Pre-sowing exposure of seeds of different crops to static magnetic field (SMF) called 'magnetopriming' is a non invasive dry seed priming treatment increases percentage of germination, rate of germination and seedling vigour of many crops. Chickpea seeds of Pusa 1053 (kabuli) and Pusa 256 (desi) magnetoprimed with 100 mT 1h static magnetic field were subjected to salinity stress to evaluate the metabolic changes associated with germination under saline conditions. Enhanced rate of germination and seedling growth parameters (root and shoot length and vigour indices) under different salinity levels indicated that magnetopriming was more effective in alleviating salinity stress at early seedling stage in Pusa 1053 compared to Pusa 256. Dynamics of seed water absorption in magnetoprimed seeds showed increased water uptake in Pusa 1053 under non saline conditions compared to salinity that could have resulted in faster hydration of enzymes in primed seeds leading to increased rate of germination. At the biochemical level, the total amylase, protease and dehydrogenase activity was higher in primed seeds compared to unprimed seeds under both non saline and saline condition. Production of superoxide radicals was enhanced in germinating seeds of both the genotypes under salinity irrespective of priming. Increased levels of hydrogen peroxide in germinating magnetoprimed seeds, under both the growing conditions, suggested its role as a signaling molecule for the germination of the seed. Thus, magnetopriming of dry seeds of chickpea can be effectively used as a pre-sowing treatment for mitigating adverse effects of salinity at the germination stage.

02-95

### PHYSIOLOGICAL RESPONSES TO SALINE IRRIGATION IN TWO SUMMER MUNGBEAN [*VIGNA RADIATA* (L.) WILCZEK] GENOTYPES

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Two mungbean genotypes i.e. MH-421 and SML-668 were grown in screen house experiment using dune sand (*Typic torrispammments*) to evaluate the effect of single chloride dominated saline irrigation (0, 2.5, 5.0, 7.5 dS m<sup>-1</sup>) given at flowering stage (30-35 DAS) after 7 and 14 after treatment (DAT). The aim of the present studies was to test the tolerance based upon plant water status, chlorophyll content, hydrogen peroxidation (H<sub>2</sub>O<sub>2</sub>) content, solute accumulation, membrane integrity, mineral distribution, reproductive behaviour and yield. The water potential ( $\phi_w$ ) of leaves and osmotic potential ( $\phi_s$ ) of leaves and roots significantly decreased in MH-421 and SML-668, respectively. Relative water content (RWC %) of leaves and roots reduced significantly, while a



sharp rise in proline and total soluble sugar (TSS) was observed. A marked increase in the contents of  $H_2O_2$  and thiobarbituric acid substances (TBRAS) was seen. The  $Na^+/K^+$  ratio in leaves and roots was enhanced significantly, being highest in roots. MH-421 exhibited a low value of  $Na^+/K^+$  ratio in aerial plant parts than SML-668.  $Cl^-$  content was significantly higher in SML-668 than MH-421. N-content of stem leaves and roots declined significantly more SML-668 than MH-421 after saline irrigation. Salinity also significantly reduced the number of pods, weight of pods, number of seeds and weight of seeds  $plant^{-1}$ ; number of seeds  $pod^{-1}$  and seed test weight. The pollen viability, *in vitro* pollen germination and pollen tube length decreased both in MH-421 and SML-668 with increasing the level of salinity. Based upon the various physiological traits i.e. better plant water status and reproductive behaviour and low content of  $Cl^-$ ,  $Na^+/K^+$  ratio and membrane injury in relation to yield potential, the genotype MH-421 was identified slightly better tolerant to saline irrigation than the genotype SML-668. These traits can further be used in crop improvement programme.

02-96

### SCREENING OF RICE (*Oryza sativa* L.) CULTIVARS AGAINST SALINITY FOR MORPHOLOGICAL AND PHYSIOLOGICAL TRAITS AT SEEDLING STAGE

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This experiment was taken up during June, 2010 at Directorate of Rice Research, Rajendranagar, Hyderabad with an objective was to classify the 24 rice genotypes for salt tolerance. Screening of rice genotypes was done at three concentrations of salinity (4, 8 and 12  $dS\ m^{-1}$  of electrical conductivity and distilled water as control) created by mixing 2.57, 5.14 and 7.70 g of sodium chloride per litre of water. Observations were recorded for length of seedlings, root dry weight, shoot dry weight,  $Na^+/K^+$  ratio in root,  $Na^+/K^+$  ratio in shoot and standard evaluation score (SES) for visual salt injury symptoms after inducing of 15 days of salt stress. The results revealed that the cultivars *viz.*, CSR-30, CSRC(S)2-1-7, CSR-4, Sampada and BPT-231 showed lower reduction in SVI (Less than 15%). However, the genotypes Santhi (93.31%), NLR-33892 (91.83%) and BPT-2231 (91.46%) expressed higher reduction in seedling vigour index (SVI) under induction of 12  $dS\ m^{-1}$  of salinity. The stress induced reduction in shoot dry weight was observed to be higher in Varadan (63.41%) followed by RPBio-226 (53.03%) and NLR-34449 (50.88%) at a higher salinity level of 12  $dS\ m^{-1}$ . In marked contrast, lower reduction in shoot dry weight was observed in CSR-4 (17.11%) followed by SR26-B (18.64%) and CSRC(S)5-2-2-5 (22.22%). Further, no significant differences between the treatmental effects were noticed among these cultivars, except at 12  $dS\ m^{-1}$  level of salinity. The 24 cultivars were categorized based on standard evaluation score (SES) for visual salt injury symptoms and  $Na^+/K^+$  ratio into three classes. The cultivars SR26B, CSRC(S)5-2-2-5 and CSRC(S)7-1-4 were found to be tolerant to salinity due to lower  $Na^+/K^+$  ratio in the shoot (less than 0.5), besides recording lower salinity score (less than 3) and it was noticed that tolerant genotypes were good excluders of  $Na^+$  ions with high  $K^+$  absorption. The genotypes *viz.*, CSR-27, CSR-30, CST7-1, CSRC(S)2-1-7, Santhi, NLR-33359, NLR-3041, NLR-33892 and NLR-34449 were found to be moderately tolerant by virtue of their salinity score of less than five and  $Na^+/K^+$  ratio less than one. Similarly, the cultivars *viz.*, RPBio-226, Swarna, Krishna Hamsa, Sampada, NLR-3042, NLR-145, BPT-5204, Varadan, BPT-2231, BPT-2270 and Dhanarasi were graded as susceptible as they showed higher salt injury score of more than five and exceeding the ratio of  $Na^+/K^+$  unity. The genotypes *viz.*, SR26B, CSRC(S)5-2-2-5 and CSRC(S)7-1-4 could be used as donors for salinity tolerance in the breeding programmes for boosting up rice production in salt affected soils.



02-97

### PHYSIOLOGICAL SCREENING OF CHICKPEA GENOTYPES UNDER DROUGHT STRESS

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Climate change situation arises abiotic stresses like drought, high temperature, salinity etc. In the present research work drought stress has been focused which influences growth and development of chickpea cultivars. Chickpea has been recognized as a valuable source of protein (25.2-28.9%), vitamins (mainly Vitamin C) and minerals (P and Ca) in the human diet and occupies a very important place in human nutrition in many developing countries. Chickpea is currently grown in about 9.21 mha area worldwide with production of 8.25 mt. and accounts for 16% of the world's pulses production. In India, it is being grown in 8.17 mha area with production and productivity of 7.48 mt. and 915 kg/ha respectively. Madhya Pradesh contributes 37% of India's total chickpea production covering an area of 3.12 mha with production and productivity of 2.68 mt and 931 kg/ha respectively. The thirty one chickpea genotypes were grown in rainfed conditions on University farm and tolerant genotypes were identified with the help of physiological parameters. Genotypes ICCV-10, PDG-84-16 and Pusa-362 were recorded to have higher photosynthetic rate, while stomatal conductance and transpiration rates were enhanced in Pusa-315 and BDG-72. The relative water content was observed to be increased in JG315 and Vishal genotypes. Water use efficiency (Intrinsic and Instantaneous) was higher in ICCV-10, PDG-84-16, ICC-4958 and JG11 genotypes under stress conditions.

02-98

### MORPHO-PHYSIOLOGICAL EVALUATION OF WHEAT ACCESSIONS FOR TERMINAL HEAT TOLERANCE

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India is the second largest producer and consumer of wheat in the world. Its productivity is only 27.3% of that in U.K. Late sown crop gets exposed to mean maximum temperature of about 35 °C during grain growth which causes yield reduction of 270 kg/ha/degree rise in temperature. In India, terminal heat stress is a common abiotic factor for reducing the yield in certain wheat growing areas. Keeping in view the above constraints, 125 wheat accessions were sown under natural field condition at NBPGR, Farm, IARI, New Delhi on 20.11.11 (normal planting) and 20.12.11 (late planting) to evaluate for terminal heat. The values of all morpho-physiological traits under late sown condition were lower as compared to normal sown due to high temperature stress. Details of promising accessions for various traits under late sown condition are as follows: days to heading IC536265, IC75212, IC443729, IC144904 (80 days); milk stage IC536265(93days) ; physiological maturity IC536265, IC443729, IC144904 (114 days); chlorophyll content index at anthesis stage IC445595 (64.6 %); membrane stability index at grain development stage IC565811 (62.05 %); relative water content at grain development stage IC443727 (79.57 %); canopy temperature at anthesis stage IC116274 (24.5 °C) ; number of tillers/plant IC75240 (7); spike length IC252927 (15.30 cm); number of seeds/spike IC128213 (70); biomass/plant IC75240 (25.35 g); seed yield/plant IC443725 (9.90 g); 1000 grain wt. IC443727 (50 g); seed protein content IC290230 (15.11%) and harvest index IC-75219 (51.0 %). Besides, erect plant type (15), long peduncle (5), leaf rolling (10), stay green colour (7), waxy coating peduncle (7), bold ears (6), good tillering germplasm (8) and tip sterility (5) were also observed. Therefore, these trait specific accessions can be used in breeding programme for improving tolerance to terminal heat.



02-99

**ISOLATION, CLONING AND CHARACTERIZATION OF DEHYDRIN (*DHN*) GENE FROM *Sorghum bicolor* L. Moench**

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Water-deficit stress is one of the major environmental conditions that adversely affects plant growth and crop yield. Dehydrins, a class of LEA proteins play an important role in desiccation tolerance during seed development, salinity and cold stress through maintenance of membrane structure, sequestration of ions and as molecular chaperones. Hence the present study was aimed at the isolation, cloning, characterization and expression analysis of dehydrin gene from *Sorghum bicolor*. Genomic DNA and total RNA isolated from the stressed seedlings of sorghum were used for PCR amplification of *dehydrin* gene. The PCR amplified products were cloned into pTZ57R/T vector and sequenced. Sequence analysis revealed that the isolated *DHN* genomic and cDNA sequences were 770bp and 638bp in length respectively. The difference in molecular weights indicated the presence of 132bp intervening region in the genomic sequence. Both genomic and cDNA sequences were deposited in the GeneBank with accession # GU137312.1 and HM243499. Blastn search revealed homology with dehydrin sequences of *S. bicolor* and other species. The ORF encoded a predicted polypeptide of 153 amino acid residues with a molecular mass of 15.7 kDa, pI of 8.81 containing two lysine-rich K-segments and a 7-serine residue S-segment, characteristic of SK<sub>2</sub>-type dehydrins. Semi-quantitative RT-PCR analysis revealed upregulated expression of *DHN* gene under different abiotic stresses. Bacterial expression of cDNA clone of *DHN* revealed the presence of 15.7 kDa protein. *E. Coli* cells expressing *DHN* gene showed enhanced tolerance to different concentrations of mannitol, PEG, NaCl and methyl viologen when compared to untransformed control.

02-100

**WONDER SIGNALLING MOLECULE – ROLE OF HYDROGEN PEROXIDE IN WHEAT THERMOTOLERANCE**

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Terminal heat stress causes an array of physiological, biochemical and morphological changes in plants, which affect plant growth and development. It has very severe effect on the pollen viability and seed setting in wheat. In the present investigation, an altered expression of H<sub>2</sub>O<sub>2</sub> (0.9 ig/g in C-306 and 0.75 ig/g in HD2329) was observed with the highest accumulation at seed hardening stage and against heat shock (HS) of 42°C for 2 h. With the increase in H<sub>2</sub>O<sub>2</sub> accumulation, an increase in the number of isoenzymes of superoxide dismutase and catalase were observed with high activities under differential heat shock. A decrease in the proline accumulation was observed under differential heat shock. Exogenous application of H<sub>2</sub>O<sub>2</sub> (10 mmole/L) leads to increase in the accumulation of intracellular H<sub>2</sub>O<sub>2</sub> and further an increase in the number of isoenzymes of superoxide dismutase (SOD) and catalase (CAT) was observed. The tolerant cultivar was more responsive to exogenous application of H<sub>2</sub>O<sub>2</sub> compared to susceptible cultivar. The percentage decrease in cell membrane stability under differential heat shock was low in H<sub>2</sub>O<sub>2</sub> treated plants compared to non-treated. The results from this study suggest a potential role for H<sub>2</sub>O<sub>2</sub> in regulating the activity of antioxidant enzymes and accumulation of proline inside cells and in turn influence the cell membrane stability under heat stress. All the defense associated genes were observed to be very responsive to intracellular H<sub>2</sub>O<sub>2</sub>, which gives inference that H<sub>2</sub>O<sub>2</sub> has regulatory role to play in controlling the expression and activities of these proteins under abiotic stresses.



02-101

### PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN Bt COTTON UNDER WATERLOGGED CONDITIONS

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Waterlogging stress causes plant growth as well as yield reduction in cotton (*Gossypium hirsutum* L.). A major component of waterlogging stress is the lack of oxygen available to submerged tissues. The effect of waterlogging on physiological and biochemical changes in Bt cotton was studied during *kharif*, 2012. Waterlogging caused significant reductions in stem elongation, shoot length, root length, leaf number and leaf area. Leaf samples were taken for the biochemical analysis of total proteins, carbohydrates, aminoacids (proline), total phenols, chlorophyll content and antioxidant enzymes (peroxidase & superoxide dismutase). In waterlogged plants there is a reduction in chlorophyll content and decreased in photosynthetic rate. The stomatal conductance is arrested and the translocation of photoassimilates is inhibited. The sugars enters the anaerobic respiratory pathway increases which results in decreased total phenol content, carbohydrate content and protein content. Antioxidant activity changes in response to oxidative stress. Peroxidase activity is increased during initial stages of waterlogging and gradually decreased on later stages where as superoxide dismutase activity increases with increased levels of oxidative stress. Proline is accumulated in plants in response to high concentrations of inorganic ions. Leaf proline content increased under waterlogged conditions. Our results stated that under oxidative stress (waterlogging) the plant produces reactive oxygen species, resulting in oxidative damages which can decrease photosynthetic rate, plant growth and yield.

02-102

### COMPARATIVE EFFECTS OF THREE DIFFERENT SALTS ON SEED GERMINATION, SEEDLING GROWTH AND BIOCHEMICAL PARAMETERS OF SORGHUM GENOTYPES

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Despite the fact that saline soils contain several types of soluble salts dominated by chlorides and sulfates of sodium, magnesium and calcium and to a lesser extent their carbonates with each salt having a different effect on plant growth, NaCl has received major attention and much of the research has been historically focused on NaCl- induced salt stress in the plants and the mechanisms adapted by them to alleviate its deleterious effects. Salt stress related effects on plants are both quantitative as well as qualitative and depends upon variables such as plant species, intra-specific genotypes, specific salt type, its composition, concentration and duration of exposure. The present investigation was therefore aimed to observe whether there is any differential behavior of two sorghum genotypes namely Phule Vasudha (PV) and Phule Revati (PR) under increasing levels of three different salts (two sodium dominant and two chloride dominant) viz. NaCl, MgCl<sub>2</sub> and Na<sub>2</sub>SO<sub>4</sub> (0 to 300 mM each) induced salinity stresses at germination and vegetative growth stages. Amongst three salts, Na<sub>2</sub>SO<sub>4</sub> showed comparably higher antagonistic effects on physiological parameters including seed germination, seedling growth, biomass production and relative water content. Both the cultivars performed differentially and PV showed better performance than the PR in terms of germination and biomass production. The salt tolerant nature of PV was manifested by lower decrease in chlorophyll content under high salt stress. The salt tolerant nature of the cultivar PV may further be attributed to the higher proline content both under non-saline as well as highest salinity levels (300 mM) irrespective of the nature of the salts used. Overall Phule Vasudha showed better performance in terms of physiological and biochemical parameters under a range of salts used.



02-103

**DEVELOPMENT OF SSR MARKERS IN BAMBARA GROUNDNUT (*Vigna subterranea* L. Verdc)**

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Bambara groundnut (*Vigna subterranea* L. Verdc) is a widely grown crop in marginal lands mainly in Sub Saharan Africa. Improvement of this crop has tremendous potential for its extension to other places including India. Though Bambara groundnut is a drought tolerant crop, from the agronomic point of view, drought tolerance should be linked with superior growth rates and productivity under water limited conditions. Improving its water acquisition traits and Water Use Efficiency (WUE) has been shown to be associated with increased productivity under water limited conditions. Marker Assisted Breeding is expected to enhance the speed and accuracy of achieving such improvements. However, lack of locus specific co-dominant marker systems in this crop is the major constraint for molecular breeding. Therefore, development of SSR (Simple Sequence Repeats) markers in Bambara groundnut that can be subsequently employed in identification of QTL (Quantitative Trait Locus) for specific physiological traits relevant for drought tolerance is the need of hour. A pre-cloning enrichment (selective hybridization) strategy was adopted to fish out the SSRs from Bambara groundnut genome to develop a microsatellite enriched library. This strategy involves the hybridization of digested genomic DNA with repeat oligomers, leading to selective enrichment. Based on this technique, we obtained 2239 microsatellite enriched clones, of which 734 clones were sequenced and analyzed for the presence of microsatellite repeat regions. Among these, clones revealed microsatellite regions with more than 15bp. Initially, primers were designed and synthesized for 143 SSR regions. These primers have been validated for their amplification using the genomic DNA of different land races. Of these, locus specific amplification was observed in 99 primer pairs. These validated SSR markers are being used for molecular characterization of different Bambara groundnut landraces.

02-104

**RESPONSE OF GROUNDNUT GENOTYPES TO TERMINAL DROUGHT RELATED TO DROUGHT TOLERANCE**

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The use of the surrogate traits with simple inheritance as selection criteria for drought tolerance should speed up the selection programs. The objective of this study is to investigate the response of peanut at the terminal drought, for traits related to drought tolerance at the beginning of pod filling stage. 13 peanut genotypes and two stages of stress were laid out in a RBD design with three replicates. The data were recorded for SPAD chlorophyll meter reading (SCMR), specific leaf weight (SLW), biomass, pod yield, number of matured pods. Drought increased SCMR and SLW and reduced biomass production, pod yield and numbers of pods per plant were not significantly affected. SCMR and SLW were well associated and they had high correlation with biomass. SCMR seemed to be more stable than SLW and it is recommended to be used as a surrogate trait for drought tolerance in peanut. TG 47 was identified as drought tolerant by SCMR and SLW and by pod yield.



02-105

### SOIL APPLICATION OF FLY ASH ON MORPHO-PHYSIOLOGICAL TRAITS AND YIELD IN GROUNDNUT [*Arachis hypogaea* (L.)]

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In the present investigation an attempt was made to ascertain the effect of treated fly ash from West Cost Paper Mill Ltd., Dandeli Uttar Kannada district of Karnataka State on morpho-physiological traits and yield of groundnut in clay soil of Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad, which is situated at 15° 26' N latitude and 75° 07' E longitude with an altitude of 678 m above mean sea level. Fly ash was applied at various levels (20,30 and 40 t/ha) to the soil prior to the sowing along with recommended dose of fertilizer (RDF) and 25 to 50% recommended gypsum, zinc and iron. The effect of fly ash treatments were compared with Bhoochetatana ((200 kg Gypsum + 55 kg of DAP + 20 kg MOP + 20kg ZnSO<sub>4</sub> + 2.5 kg Borax + 1.5 t FYM/ha). It was observed that significant influence on morpho-physiological traits such as plant height, number of branches, leaf area, leaf area index, SLW and total dry matter with the application of 40 t/ha fly ash along with recommended dose of NPK (RDNPk), 50% recommended dose of gypsum, Zn and Fe and these traits were significantly lower in Bhoochetatana treatment. Similar results were also recorded with total chlorophyll content, nitrate reductase activity and leaf water content. Significant difference in yield and yield attributing characters were also registered with fly ash combination treatments. Maximum pod yield of 3618 kg/ha was recorded with 40 t/ha fly ash along with RDNPk, 50% recommended dose (of gypsum, Zn and Fe compared to Bhoochetana (2995 kg/ha). The present study revealed that maximum yield could be obtained in groundnut, with the application of fly ash along with RDNPk and 50% recommended dose of gypsum, zinc and iron.

02-106

### ISOLATION AND CLONING OF *TPS1* GENE FROM *S. cerevisiae* AND VALIDATION IN TOBACCO

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Abiotic stress is the most limiting constraint for crop productivity and yield. One of the potential strategies for enhancing abiotic stress tolerance is genetic engineering of plants for overproduction of compatible solutes. Among the different osmoprotectants, trehalose is considered to be most effective since metabolic engineering for its production results in tolerance to multiple stresses such as drought, salinity and freezing tolerance. Therefore, the present study was aimed at isolation, cloning and characterization of *TPS1* gene from indigenous strain of *Saccharomyces cerevisiae*. The isolated *TPS1* gene was validated by genetic transformation of tobacco. The *TPS1* gene sequence isolated from Strain MTCC No. 174 (NCBI GeneBank accession # EF540748) was 1488bp in length. The PCR product was cloned into TA vector pTZ57R/T for sequencing. Sequence analysis of the *TPS1* gene isolated revealed homology with other *TPS1* sequences in the NCBI database. Amino acid sequence of the deduced *TPS1* protein showed similarity to the glycosyl transferase conserved domain that catalyses the synthesis of alpha,alpha-1,1-trehalose-6-phosphate from glucose-6-phosphate. The *TPS1* gene was cloned into expression vector pQE30UA and SDS-PAGE analysis of induced protein revealed a single protein band of 56.1kDa. Further, it was cloned into pRT100 for mobilization of promoter and terminator and then finally into binary vector pCAMBIA1303. The construct pCAMBIA1303TPS1 was used to transform tobacco by tissue culture based *Agrobacterium* mediated transformation method. Tobacco *TPS1* transgenics were successfully regenerated, rooted and acclimatized. Transient GUS expression and molecular characterization using PCR, RT-PCR and Southern analysis confirmed the integration and expression of the transgene.



02-107

**DIFFERENTIAL RESPONSE OF RICE (*Oryza sativa* L.) GENOTYPES TO TERMINAL HEAT STRESS**

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Influence of high temperature stress from panicle initiation until physiological maturity was examined in 25 rice genotypes. High temperature stress conditions crop duration was reduced where such reduction in grain filling was maximum in TRIGUNA, while it was least affected in IET 20944. Physiological traits viz. water potential; membrane thermo-stability and chlorophyll content (SPAD chlorophyll meter readings) and chlorophyll fluorescence were significantly affected by high temperature stress over control (normal temperature). Among the genotypes, IET 20915, IET 20893 and IET 21513 exhibited higher membrane thermo-stability and photosystem II efficiency (chlorophyll fluorescence:  $F_v/F_m$  ratios). Genotypes viz., JAYA, IET 20893 and IET 21510 exhibited less reduction in water potential with high temperature stress. Besides higher values of membrane thermo-stability, chlorophyll fluorescence and water potential, genotypes viz. IET 20907, IET 20915 also exhibited higher photosynthetic rates compared to other genotypes under high temperature stress conditions. Reproductive traits such as pollen viability, spikelet fertility were significantly affected by high temperature stress compared to control in all genotypes. Genotypes viz., JAYA, IET 20915 and IET 20926 exhibited higher spikelet fertility under high temperature stress compared to other genotypes due to higher pollen viability under high temperature stress conditions. The genotypes IET 21510, IET 21531, IET 21513 and IET 21519 were recorded greater translocation of stem reserves in terminal heat stress conditions. Panicle size, dry matter production, number of spikelets  $m^{-2}$ , 1000 grain weight, grain yield and harvest index were significantly reduced with high temperature stress. in all rice genotypes under high temperature stress. Genotypes with higher values of pollen viability, spikelet fertility and secondary branches in panicles recorded higher grain yield were IET 20926, IET 20893, JAYA, and IET 21510. It is concluded that superior performance of rice genotypes in terms of higher membrane thermo-stability, chlorophyll and photosynthetic characters together with higher values of pollen viability lead to higher fertility, and stem reserve mobilization resulted in higher grain yield under high temperature stress conditions which could be taken as traits for thermo-tolerance in rice. Based on the above traits, rice genotypes viz. JAYA, IET 20926, IET 20893, IET 208907, IET 20894 and IET 21510 were ranked as thermo-tolerant while TRIGUNA, IET 20744, IET 20925, IET 20935, IET 20923, and IET 21528 were ranked susceptible.



# **Session 03**

**Plant Growth Regulators,  
Agrochemicals, Allelopathy and  
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### 03-01

#### DISSIPATION OF HERBICIDES IN SOIL AND THEIR EFFECT ON SOIL ENZYME ACTIVITY

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Field experiment was conducted to study the persistence of pendimethalin and oxyfluorfen in soil and its residues in edible parts of raddish. At harvest in both the seasons more than 98% of initial deposit of pendimethalin was dissipated and observed half life in raddish field was 6.45 days and 10.03 days for pendimethalin applied @ 0.5 and 0.75 kg ha<sup>-1</sup> respectively. More than 60 per cent of the initial deposit of oxyfluorfen was dissipated at the time of harvest of crop and 6.96 days and 12.26 days of half life was observed at 0.1 and 0.15 kg ha<sup>-1</sup> of oxyfluorfen application respectively. In raddish tubers the detected residues of pendimethalin and oxyfluorfen were below maximum residue limits (MRL values). Effect of of pendimethalin and oxyfluorfen on soil enzyme activities in raddish crop were studied and there was significant differences existed between the herbicide treatments and periods of study and their interaction at 5 per cent level. In current study there was always a stimulation of enzyme level at active growth of the crop plants. Acid, alkaline phosphatase and dehydrogenase activity was found to increased in control from 0 days after application to 30 days after application (DAA) in the all the treatments showing a decrease there after at the time of harvest. In the two seasons of study, phosphatases and dehydrogenase showed maximum activity at 30 DAA. The interaction effect (treatments and DAA) showed that the acid,alkaline phosphatase and dehydrogenase level in the herbicide treated plots was significantly higher than the control among all the periods and also lower level of herbicide application increased enzyme activity as compared to higher dose of herbicide. Oxyfluorfen @ 0.15 kg a.i ha<sup>-1</sup> showed inhibitory effect on enzyme activity. Where as urease levels in the herbicide treated plots were significantly lower than the control for all the growth stages.

### 03-02

#### BENEFICIAL EFFECTS OF PLANT GROWTH PROMOTING RHIZOBACTERIA

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Rhizosphere region are the most nutrient rich niche among the soil environment that feeds the soil dwelling microorganisms. Bacteria that colonize near the vicinity of the root system and enhance the plant growth by various mechanisms can be known as “Plant Growth Promoting Rhizobacteria (PGPR). In the present study, forty rhizobacterial isolates were obtained from the rhizosphere soils of legume (Groundnut and Redgram) crops in Rangareddy district. All these bacterial isolates were observed for Plant growth promoting characters such as solubilization of Phosphorus, production of Indole Acetic Acid (IAA), HCN and siderophores. After that, these isolates were screened for *in vitro* biocontrol activity against three common soil borne fungal phytopathogens viz., *Rhizoctonia solani*, *Sclerotium rolfsii* and *Fusarium solani*. Further, these forty isolates were for tested for *in vitro* compatibility with commonly used agrochemicals (12) like Fungicides (4), Insecticides (4) and Herbicides (4). Majority of the bacterial isolates were observed positive for showing Plant growth promoting characters and also for inhibiting the mycelial growth against one or more of the pathogens. All these forty bacterial isolates were found to be compatible with most of the chemicals, under *in vitro* conditions except for few of tested. Finally all these bacterial isolates were characterized and identified as *Rhizobium* (10), *Pseudomonas* (15) and *Bacillus* sp. (15), based on their colony morphology, cell morphology and biochemical properties. Results suggested that, rhizosphere soils of these legume crops in Rangareddy district were proved to be a good source of Plant growth promoting rhizobacteria (PGPR).



03-03

### INFLUENCE OF PLANT GROWTH REGULATORS AND CHEMICALS ON BIOCHEMICAL PARAMETERS AND YIELD IN CHICKPEA (*Cicer arietinum* L.) GENOTYPES

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A field experiment was conducted during *rabi* season, 2010-11 at College of Agriculture, University of Agricultural Sciences, Dharwad to study the effect of Plant Growth Regulators and Chemicals on various biochemical and Yield in chick pea genotypes. The experiment was laid out in split plot design with two genotypes viz., BGD-103 and JG-11 and ten treatments in three replications. The treatments included three plant growth regulators and one chemicals in two concentration i.e. Progibb (20 and 40ppm), CCC (500 and 1000ppm), TIBA (100 and 200 ppm) and Salicylic acid (50 and 100ppm) as foliar spray at 30days after sowing. The foliar application of CCC (500ppm) enhanced the biochemical parameters viz., chlorophyll-a, chlorophyll-b, total chlorophyll and NRA activity while there is no significant difference were recorded in seed protein content in both genotypes of chick pea. While the result on various yield and yield attributes indicated that the entire yield contributing characters viz., number of pods/plant, number of grains/pods, seed yield per plant, 100-seed weight and harvest index were significantly higher with CCC (500 ppm) followed by TIBA (100 ppm) in both genotypes. From the economic point of view, CCC (500 ppm) was more profitable in terms of net returns compared to all other treatments.

03-04

### PHYSIOLOGICAL STUDIES ON WEED CONTROL EFFICIENCY IN TRANSPLANTED ONION

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Field study was carried out at University of Agriculture Sciences Dharwad to study the weed control efficiency of different herbicides and their combinations. The experiment was comprised of 11 treatments with 5 herbicides (alchlor, butachlor, pendimethalin, oxadiargyl, oxyfluorfen). The design of experiment was RBD with 3 applications. The major weed flora of the experimental plot was *Cyprus rotundus*, *cyanadon dactylon*, *amaranthus viridis*, *parthenium hysterophorus*, *phylanthus niruri*, *dinebra retroflexa*, *commmmelina benghalensis*, *cinotis* sp. Pre-emergence application of butacholar @ 1.0 kg a.i./ha + oxyfluorfen @ 0.25 kg a.i. /ha was found to be phytotoxic during early stage of crop and recovered later. Pre-emergence application of oxadiargyl @ 90 g a.i./ ha + post emergence application oxyfluorfen @ 0.25 kg a.i./ha at 40 days after transplanting recoded significantly lower weed count and weed biomass followed by pre emergence application of oxadiargyl @ 90 g a.i. /ha + 2 hand weeding at 40 and 60 days after transplanting (DAT) compared to other treatments except weed free check. The morpho-physiological traits like plant height, leaf dry weight, bulb dry weight, TDM, chlorophyll content were higher in weed free check followed by pre emergence application of oxadiargyl @ 90 g a.i./ ha + post emergence application of oxyfluorfen@ 0.25 kg a.i./ha and pre emergence application of oxadiargyl@90 g a.i./ha + 2 hand weeding at 40 and 60 days after transplanting. Significantly higher bulb yield was recorded in weed free check, pre emergence application of oxadiargyl @ 90 g a.i./ ha + post emergence application of oxyfluorfen @ 0.25 kg a.i./ha and pre emergence application of oxadiargyl @ 90 g a.i./ha + 2 hand weeding at 40 and 60 days after transplanting. The quality parameter like total soluble solid, sprouting percentage differ significantly due to weed management practices except unwedded control which has significantly lower percentage of rotting.



03-05

**EFFECT OF KINETIN AND HOMOBRASSINOLIDE ON SOME MORPHOLOGICAL, PHYSIOLOGICAL, BIOCHEMICAL CHARACTERS, YIELD AND YIELD ATTRIBUTES UNDER WATER STRESS IN CHICKPEA (*Cicer arietinum* L.)**

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Chickpea is the important food legume crop grown during *rabi* season in the SAT climate of India. Terminal drought stress important constraints decreasing chick pea yields. The objective of the current study was to assess the “effect of kinetin and homobrassinolide on some morphological, physiological, biochemical characters, yield and yield attributes under water stress in chickpea (*Cicer arietinum* L.). Field experiment was conducted in *rabi* 2008 and 2009 at Agricultural college Research Farm, Bapatla in a split-plot design with nine treatments replicated four times. The results indicated that morphological parameters, plant height, number of productive branches, root length, root volume, root shoot ratio, number and dry weight of nodules were significantly influenced by stress treatments and foliar sprays of kinetin @ 5 ppm and homobrassinolide @ 1 ppm. Stress from vegetative stage with homobrassinolide spray recorded maximum root volume (19.2%) and root to shoot ratio (13.5%) over the control. In physiological parameters, plants not subjected to stress recorded an increase in relative growth rate (17.5%), net assimilation rate (39.1%) and leaf moisture retention index (17.2%) over water stress from vegetative stage. Further, water stress from vegetative stage recorded more proline content (54.0%), more superoxide dismutase activity (98.2%) and catalase activity (43.5%) over no stress and it was further enhanced by the foliar spray of homobrassinolide. Water stress from vegetative stage with homobrassinolide spray recorded increased proline content, superoxide dismutase activity and catalase activity 114.8%, 166.4% and 179.7% respectively, over the control, followed by water stress from vegetative stage with kinetin spray. In case of seed yield, no water stress (irrigated at two times) recorded significantly higher seed yield (31.9%) over water stress from vegetative stage (unirrigated). Among foliar sprays, spray with homobrassinolide @ 1ppm resulted higher seed yield (20.9%) over no spray and it was on par with kinetin spray @ 5ppm. Seed yield has significant positive correlation with primary branches, specific leaf area, relative growth rate, net assimilation rate, SCMR and harvest index and significant negative correlation with membrane injury index. Hence, it can be concluded that homobrassinolide spray @1ppm would provides better, dry matter partitioning, biochemical regulation and ultimately produce potential seed yield under water stress (drought) conditions in chickpea particularly at coastal regions of Andhra Pradesh.

03-06

**PROGESTERONE MEDIATED RESPONSE ON GROWTH AND PHOTOSYNTHESIS IN *Brassica juncea***

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Steroids are most essential groups of compounds derived from the sterane skeleton and are present in almost all the living organisms. The presence of mammalian sex hormones-progesterone in plants was postulated in the early twentieth century but only proven with the use of modern analytical methods, developed recently. The aim of the present studies was to explore the role of progesterone (PROG) in the modulation of growth, photosynthesis and enzyme activities in *Brassica juncea*, and to establish the most effective concentration. The seedlings were raised in earthen pots and at 30 d stage of growth, progesterone was administered through foliar application. The findings of this study indicated that out of the various concentrations used,  $10^{-7}$  M proved most effective and increased growth characteristics, gas exchange parameters, carbonic anhydrase activity and protein content of plants at 45 d stage.



03-07

### EFFECT OF FOLIAR APPLICATION OF ETHREL AND BORON ON REPRODUCTIVE EFFICIENCY OF GROUNDNUT (*Arachis hypogaea* L.)

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A field experiment was conducted at Agricultural College Farm, Bapatla, during *kharif* 2011-12 to find out the effect of foliar application of ethrel and boron on reproductive efficiency of groundnut (*Arachis hypogaea* L.) Ten treatments consisting of application of Ethrel @ 400 ppm at 25 DAS (T1), Ethrel @ 400 ppm at 45 DAS (T2), Ethrel @ 400 ppm at 25 and 45 DAS (T3), Borax @ 0.25% at 25 DAS (T4), Borax @ 0.25% at 45 DAS (T5), Borax @ 0.25% at 25 and 45 DAS (T6), Ethrel @ 400 ppm + Borax @ 0.25% at 25 DAS (T7), Ethrel @ 400 ppm + Borax @ 0.25% at 45 DAS (T8), Ethrel @ 400 ppm + Borax @ 0.25% at 25 and 45 DAS (T9), Water spray (T10) were tried in Randomized Block Design with three replications. The findings of the experiment revealed that the growth parameters such as plant height, number of branches, number of leaves, leaf area and total dry matter measured at different intervals were significantly influenced by ethrel and boron treatments. Application of Ethrel + Borax at 25 and 45 DAS resulted in increase in plant height (78.9%), number of branches (37.8%), number of leaves (64.7%) and number of flowers (61.9%) over control. The spray of Ethrel + Borax at 25 and 45 DAS exhibited better performance in increasing leaf area by 94.0 per cent over control and by 36.7 to 76.8 per cent over the remaining treatments (T2, T3, T4, T5 and T6). The total dry matter increased by 73.3 per cent over control and by 21.1 to 56.3 per cent compared to remaining treatments. The results indicated that the growth characteristics like AGR, CGR, RGR and NAR increased with the spray of ethrel and boron due to increment in the leaf area and dry matter production. Biochemical parameters like chlorophyll a, chlorophyll b, carotenoids, total chlorophyll content and seed oil content in groundnut increased with the foliar spray of ethrel and boron. The highest total chlorophyll content was observed with the spray of Ethrel + Borax at 25 and 45 DAS. The variation in oil content of groundnut among treatments was on par. However, higher oil content was observed in Ethrel + Borax at 25 and 45 DAS (T9) and lower content was observed in control. Foliar spray of ethrel and boron significantly increased the yield and yield attributes. The number of pods plant<sup>-1</sup> (18.9%), pod weight plant<sup>-1</sup> (21.7 %), kernel weight plant<sup>-1</sup> (55.9%), test weight (37.6%), and the yield ha<sup>-1</sup> (36.3 %) were high with the spray of ethrel and boron at 25 and 45 DAS. Spray of Ethrel + Borax at 45 DAS (T8) increased the shelling percentage by 21.9 per cent over control and 8.6 to 16.4 percent compared to the remaining treatments. However spray of Ethrel + Borax at 25 and 45 DAS recorded higher net return of Rs. 51752 and proved superior to the rest of the treatments.

03-08

### 24-EPIBRASSINOLIDE AND 28-HOMOBRASSINOLIDE ON THE OXIDIZING AND HYDROLYZING ENZYMES OF RADISH PLANTS – A STUDY

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The effect of 24-epibrassinolide (24-EpiBL) and 28-homobrassinolide (28-HomoBL) on the activities of four oxidizing enzymes (catalase and peroxidase) and two hydrolyzing enzymes (ribonuclease and protease) of radish plants were studied. Both 24-EpiBL and 28-HomoBL stimulated the activity of the oxidizing enzyme, catalase of the radish plants. The activity of the other oxidizing enzyme peroxidase was decreased by the application of 24-EpiBL and 28-HomoBL. Brassinosteroid-treatment resulted in lowered protease as well as ribonuclease activity.



03-09

### EFFECT OF DIFFERENT GROWTH REGULATING COMPOUNDS ON BIOCHEMICAL AND QUALITY PARAMETERS IN GREENGRAM

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A field experiment was conducted in Greengram cv WGG-37 with two growth promoting (NAA and Brassinosteroid) and growth retarding substances (chlormequat chloride and mepiquat chloride sprayed at flower initiation stage during *Rabi* 2009-10. Among the growth regulators growth promoting substances NAA (20 ppm) recorded significantly higher values in biochemical parameters of photosynthetic rate and chlorophyll content. In the present study, the photosynthetic rate increased from flowering to pod setting stage and thereafter decreased. At flowering stage there was significant differences in photosynthetic rate between treatments. NAA (20 ppm) recorded significantly higher photosynthetic rate at pod setting stage ( $23.47 \mu \text{mol m}^{-2} \text{s}^{-1}$ ) and maturity stage ( $19.18 \mu \text{mol m}^{-2} \text{s}^{-1}$ ). SCMR values were maximum at flowering stage and declined thereafter. The application of chlormequat chloride ( $375.0 \text{ g a.i ha}^{-1}$ ), brassinosteroid (20ppm) and mepiquat chloride (5% AS) resulted significantly higher chlorophyll content. Higher SCMR values at maturity (32.13) were recorded by NAA 20 ppm. In quality parameters highest seed protein (%) content and highest NHI values were recorded with growth retarding substances chlormequat chloride ( $137.5 \text{ g a.i ha}^{-1}$ ) in greengram. The application of growth regulators showed significant effect on seed protein which indicated that, the applied growth regulators had marked effect on biosynthetic pathways related to protein synthesis. The maximum seed protein percentage (20.63%) and Nitrogen harvest index (17.31%) was recorded in chlormequat chloride ( $187.5 \text{ g a.i/ha}$ ).

03-10

### COMPARATIVE PERFORMANCE OF VARIOUS HERBICIDES AND EUCALYPTUS OIL FOR WEED MANAGEMENT IN RICE (*Oryza sativa* L.)

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The present investigation was conducted in the Norman E. Borlaug Crop Research Centre and the Department of Plant Physiology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, to evaluate the comparative performance of various herbicides and Eucalyptus oil for weed management in rice (*Oryza sativa* L.). The field experiment was conducted during rainy season, laid out in a Randomized Block Design with three replications. The treatments consisted of four herbicides, which include both pre- and post-emergence herbicides along with two doses of Eucalyptus oil (5% and 7.5%). Data on weed flora and biomass, tiller number and yield of rice were recorded at different growth stages of the crop. Among the weed species, *Alternanthera* was controlled by Bispyribac-Na while *Paspalum* was controlled by Eucalyptus oil (7.5%). *C. iria* and *E. crusgalli* were found to be controlled by almost all the herbicides but the degree of control was less with Bispyribac-Na. Higher weed dry weight was recorded with eucalyptus oil treatment (5%) as compared to the herbicides. Consequently, total biological yield and grain yield were lowest in the Eucalyptus oil treatment (5%) as compared to the herbicides used. Among all the treatments Penoxsulam recorded highest biological and grain yield.



03-11

### AFLATOXIN UPTAKE AND TRANSPORT IN GROUNDNUT PLANTS

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We have evaluated the natural occurrence of aflatoxins (AFs) in groundnut plants including agricultural soil and its AFs uptake ability. A survey was conducted among nine major groundnut growing regions of Karnataka state, 71 groundnut plant samples along with soil were collected. All the soil samples tested were found to be contaminated with aflatoxigenic fungi and AFs. Groundnut plants were also found to be contaminated with AFs. From the *in vitro* experiments it was proved that the groundnut plant roots were uptaking aflatoxin B<sub>1</sub> (AFB<sub>1</sub>) via the xylem and was transported to aerial parts. The uptake was found to be affected by various parameters such as duration of exposure, initial toxin concentration, pH of the medium, zinc concentration and competitively reduced in the presence of other aflatoxins such as AFB<sub>2</sub>, AFG<sub>1</sub> and AFG<sub>2</sub>. Later when aflatoxin uptake kinetics was studied it was found that uptake of AFs varied with water uptake in plants and found to be reduced with decreased rate of transpiration at higher relative humidity. From these results we can assume that major portion of AFs uptake is simple diffusion and involvement of active transport is yet to be confirmed. Crude root exudates of groundnut seedlings were found enhancing the conidial germination of *A. flavus* and subsequent aflatoxin production. From greenhouse experiment it was clear that rhizospheric environment was favoring *A. flavus* growth. When analyzed there was a gradual increase in the level of aflatoxin in both root and shoot up to 75<sup>th</sup> days of incubation. But towards the end of the experimental period the aflatoxin levels was significantly decreased in root.

03-12

### EFFECT OF PLANT GROWTH REGULATORS ON LEAF BIOCHEMICAL CHARACTERS AND FRUIT YIELD COMPONENTS OF BITTERGOURD (*Momordicacharantia* L.) cvs. MHBI-15 AND CHAMAN PLUS

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A study on the effect of plant growth regulators on biochemical characters and fruit yield components of bittergourd (*Momordicacharantia* L.) was carried out at Agricultural Research Station, University of Agricultural Sciences, Dharwad during *Rabi* 2007-08. The experiment consists of treatment combinations involving three plant growth regulators such as GA<sub>3</sub> (20, 40 and 60 ppm), NAA (50 ppm) and CCC (100 and 200 ppm) and control in two varieties of bittergourd such as MHBI – 15 and Chaman Plus. The treatments were imposed at 45 days after sowing (DAS) in both the varieties. And the experiment was laid out in factorial randomized block design with three replications. The results of the study reveals that there was a significant differences between the treatments and the varieties on chlorophyll, sugars, total phenols content and also on nitrate reductase activity. Foliar application of CCC (200 ppm) showed maximum total sugars (8.25 mg/g fresh weight), total phenols content (14.81 mg/g fresh weight) and also on nitrate reductase activity (156.3 n mol NO<sub>2</sub> g fr. Wt<sup>-1</sup>hr<sup>-1</sup>) and minimum was recorded in control. Among all the treatments application of GA<sub>3</sub> (20 ppm) recorded maximum chlorophyll content (1.211 mg/g fresh weight) with highest yield (1.310 kg/plant) followed by CCC (200 ppm) with 1.266 kg/plant as compared to other treatments and control in both the cvs.MHBI-15 and Chaman Plus.



03-13

**PHYSIOLOGICAL EFFECTS OF BIOSTIMULANT (*NovoBac*) ON CHILLI (*Capsicum annum L.*)**

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A field experiment was conducted to find out the changes in morpho-physiological, biochemical, nutritio-physiological and yield parameters of TNAU Chilli hybrid Co1 due to seed treatment and/ or soil drenching with a new biostimulant (*NovoBac*). *NovoBac* is a new biostimulant promoted by M/s. Novozymes South Asia, Bangalore which is a natural, soluble, beneficial microbial formulation containing several species of *Bacillus* amounting to a minimum of  $8.5 \times 10^9$  cfu/g. Seed treatment of chilli with *NovoBac* influenced the seedling characters viz., germination percentage, vigour index, root length, shoot length and total dry matter production. The treatment combination of biostimulant (*NovoBac*) seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 days after transplanting (DAT) showed significant increase in plant height, root volume, IAA oxidase, Phosphorous content, soil dehydrogenase activity, bacterial population and yield in chilli. *NovoBac* containing different *Bacillus* sp is found to improve plant growth by enhancing the tryptophan dependent IAA content in the plant. Increased accumulation of *Bacillus* sp. in the rhizosphere of soil resulted in enhanced nutrient uptake from the soil and an increase in green chilli yield due to application of *NovoBac*. It is concluded from the present study that *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT favoured for better growth and yield by recording high B: C ratio of 1: 2.07.

03-14

**IDENTIFICATION OF SSR MARKERS FOR HYBRIDITY AND GENETIC PURITY TESTING IN HYBRID MAIZE (*Zea mays L.*)**

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Assessment and maintenance of genetic purity of hybrids seed lots play an important role in successful popularization and adoption of hybrids. Conventionally, grow out test (GOT) is being done for estimation of seed purity, which is based on assessment of morphological and floral characters. This is a laborious and time consuming process. With objective of replacing the GOT with molecular based assays, the present investigation was carried out to identify suitable unique DNA marker associated with hybrid, their parental lines, off types and pollen shedders in female lines. About 12 informative microsatellite markers were employed for fingerprinting maize hybrid (DHM-117) and their parental lines. Out of which, maize hybrid DHM-117 was clearly distinguished by using SSR marker umc1600, and phi053, based on their banding pattern resolved on agarose gel (3%). The complementary banding pattern of both parents paved path towards the identification of the hybrid. The locus umc1600 amplified allele size at 180 bp was specific to female parent (BML-6) and 195 bp was specific to male parent (BML-7). These two bands of allele size 180 and 195 were found in hybrid DHM-117. The other SSR primer phi053 was able to distinguish the hybrid DHM-117 by amplifying allele size of 170 bp, a female specific (BML-6) and an amplicon size of 190 bp a male specific allele (BML-7). Thus, a simple procedure for detection of purity has been standardized in 10 day old seedlings of maize of hybrid (DHM-117) along with parental lines using unique microsatellite markers, umc1600 and phi053 without any ambiguity.



03-15

### UTILIZATION OF AGROCHEMICALS FOR AMELIORATION OF LEAF REDDENING IN Bt. COTTON

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Cotton is an important cash crop cultivated over an area of 54.2 m. ha in the country out of which 22 percent area is under Bt cotton. India ranks first in the world cotton area and fourth in production of cotton. The productivity of cotton in the country is low (502 kg/ha) compared to other cotton growing countries. A field experiment was conducted during 2008-09 and 2009-10 at Agricultural Research Station, Dharwad farm, University of Agricultural Sciences Dharwad. To study the effect of different nutrients for control of leaf reddening in Bt cotton. The experiment was laid out in RBD design with nine treatments and three replication. The treatment consist of (T1) MgSO<sub>4</sub> 20 kg/ha soil application (T2) Urea 2% at 90 & 110 days (T3) MgSO<sub>4</sub> 1% at 90 & 110 DAS (T4) MgSO<sub>4</sub> 1% at 70 and 90 DAS (T5) MgSO<sub>4</sub> soil application 30 kg/ha (T6) 125% N soil application (T7) urea 2% at 70 & 90 DAS (T8) Nutrient mixture (Ca + B) (T9) Control. Highest yield (2637 kg/ha) was recorded in mgso<sub>4</sub> 1% spray at 70 & 90 DAS and the least was recorded in control (2211 kg/ha). The leaf reddening was recorded less in MgSO<sub>4</sub> 1% at 70 and 90 DAS compared to all other treatments

03-16

### EXOGENOUSLY-APPLIED 28-HOMOBRASSINOLIDE MINIMIZES NICKEL INDUCED OXIDATIVE DAMAGE THROUGH OVER-EXPRESSION OF ANTIOXIDANT ENZYMES AND PROLINE IN *Vigna Radiata*

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28-homobrassinolide (HBL), a steroidal plant hormone is required for normal plant growth and development. The role of HBL in countering nickel induced oxidative damage through over expression of antioxidant enzymes and proline in *Vigna radiata* has been investigated. Two varieties of *Vigna radiata*, one sensitive to Ni (PDM-139) and other tolerant to Ni (T-44) were sown in the soil supplemented with different levels (0, 50, 100, or 150 mg kg<sup>-1</sup>) of Ni. The foliage of stressed and non-stressed plants was sprayed with deionized water (control), 10<sup>-10</sup>, 10<sup>-8</sup>, or 10<sup>-6</sup> M of HBL along with 0.5% surfactant Tween 20 at 29 d stage. The fresh and dry mass of plant, leghemoglobin, nitrogen and carbohydrate content in the nodules, leaf chlorophyll content, photosynthesis efficiency, leaf water potential, activities of nitrate reductase, carbonic anhydrase and nitrogenase decreased proportionately with the increasing concentrations of nickel whereas electrolyte leakage, various antioxidant enzymes viz. catalase, peroxidase and superoxide dismutase and accumulation of proline increased at 45 d stage. However, the exogenously applied HBL to the nickel stressed or non-stressed plants improved growth, nodulation, photosynthesis and further enhanced the various antioxidant enzymes viz. catalase, peroxidase and superoxide dismutase and accumulation of proline. The negative impact of Ni on the plants was concentration dependent where HBL applied to the foliage induced over expression of antioxidant enzyme and accumulation of proline (osmolyte) which could have conferred tolerance to Ni up to 100 mg kg<sup>-1</sup>, resulting in improved growth, nodulation, photosynthesis and yield attributes.



03-17

**PROPAGATION OF *Camellia assamica* L. TEA PLANTS OF ASSAM VALLEY, DURING THE PERIOD OF SPRING SEASON UNDER THE INFLUENCE OF GRAVITY COMPONENTS**

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For the propagation of tea plants of Assam Valley *Camellia assamica* L during the period of spring season a serious of investigation was performed, where the role of length of stem cuttings, apical bud, total number of leaves, growth regulators as well as role of gravity components on the vegetative propagation of stem cuttings i.e. Initiation of adventitious roots were investigated. From the investigation it was observed that stem cuttings with a length of 6cm most suitable for enhancing early root initiation (160h), production of maximum nos. of roots (14) and maximum average root length (6.4cm). Similarly, removing of the first leaf and presence of rest three leaves with apical bud showing early root initiation(152h) and production of maximum nos. of roots(15) and maximum average root length (6.5cm) in comparison to the absence of apical buds. Initiation of adventitious roots also enhanced when treated with various concentration of growth regulators. Among the concentration of growth regulators IBA at a concentration of 60ppm, IAA at 50ppm and Kinetin at 30ppm showing the best results for initiation of adventitious roots and their post development. Role of gravity components were also important for the enhancement of adventitious roots in stem cuttings of *Camellia assamica* L plants. As because when the stem cuttings were placed at various inclinations i.e., at 0°, 22.5°, 45°, 67.5°, and 90° in comparing with the soil surface, it was found that initiation of adventitious roots took less time (138h) when the stem cuttings cultured at 45° inclination, followed by 67.5°, 22.5° 90° and 0° respectively. From the investigations it was found that gravity components had a definite role on the initiation of adventitious roots and their post development on the stem cuttings of *Camellia assamica* L plants

03-18

**STUDIES ON THE *Rhizobium* INOCULATION, FOLIAR SPRAY OF KNO<sub>3</sub> AND GROWTH REGULATORS ON GROWTH AND YIELD OF MUNGBEAN (*Vigna radiate* L.)**

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A field experiment was carried out at the Student's Instructional farm of Narendra Dev University of Agriculture & Technology, Kumarganj Faizabad (U.P) during *kharif* season, 2010 to see the effect of seed priming in plant growth regulators and KNO<sub>3</sub> and their foliar application as well as inoculation of *Rhizobium* alongwith untreated control (distilled water) in randomized block design with three replications on mungbean (variety Narendra Mung-1). Spraying of NAA 30ppm, GA<sub>3</sub> 150ppm and KNO<sub>3</sub> 150ppm were done in alone and in combination at 25 and 40 DAS. Observations were recorded at 30, 40, 50 DAS and at maturity. The results revealed that inoculation of seed with *Rhizobium* culture, seed priming and foliar spray (GA<sub>3</sub> 150 ppm (seed soaking) + *Rhizobium*+ GA<sub>3</sub> 150 ppm foliar spray at 25 and 40 DAS) enhanced plant height, crop growth rate (CGR), relative growth rate (RGR). Seed inoculation with *Rhizobium* as well as foliar application of NAA (30ppm) at 25 and 40 days after sowing produced most effective response on dry matter production, number of nodules per plant, days to physiological maturity, pod cluster per plant, pod per plant, pod length, number of seed per plant and yield q/ha. This experiment showed importance of *Rhizobium* bacteria and growth regulators in mungbean.



03-19

### INFLUENCE OF PLANT GROWTH REGULATORS AND CHEMICALS ON PHYSIOLOGY AND YIELD IN CHICKPEA (*Cicer arietinum* L.) GENOTYPES

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A field experiment was conducted during *rabi* season, 2010-11 at College of Agriculture, University of Agricultural Sciences, Dharwad to study the effect of Plant Growth Regulators and Chemicals on Physiology and Yield in chick pea genotypes. The experiment was laid out in spilt plot design with two genotypes viz., BGD-103 and JG-11 and ten treatments in three replications. The treatments included three plant growth regulators and one chemicals in two concentration i.e. Prodigion (20 and 40ppm), CCC (500 and 1000ppm), TIBA (100 and 200ppm) and Salicylic acid (50 and 100ppm) as foliar spray at 30days after sowing. The PGR prodigion increased the plant height significantly, whereas the growth retardants viz., CCC and TIBA resulted in reduced plant height. The number of branches increased significantly with growth regulators viz., TIBA (100 and 200ppm) and CCC (500ppm). The application of prodigion (40ppm) hastened the days for flower initiation and 50% flowering. Significant in the dry weight of leaf, stem, reproductive parts and total dry weights were observed within in the application of plant growth regulators. The growth parameters viz., leaf area, LAI, LAD, SLW, BMD, CGR, AGR, RGR and NAR increased significantly with CCC (500 ppm) in the both genotypes of chick pea. While the result on various yield and yield attributes indicated that the entire yield contributing characters viz., number of pods/plant, number of seed/pods, seed yield per plant, 100-seed weight and harvest index were significantly higher with CCC (500 ppm) followed by TIBA (100 ppm) in both genotypes.

03-20

### EFFICACY OF AN HERBICIDE ON DRY MATTER PRODUCTION, LEAF AREA INDEX AND YIELD OF SOYBEAN (*Glycine max* L.)

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The aim of current study was to determine the effect of an herbicide on growth parameters like plant height, leaves per plant, branches per plant, crop biomass, leaf area index and yield during *kharif* season of 2011 at Breeder Seed Production Unit of JNKVV, Jabalpur in soybean (*Glycine max* L.). Eleven weed control treatments viz T<sub>1</sub> Odyssey @ 52.5 and 75 g ai/ha, T<sub>2</sub> Odyssey active @61.25 and 87.5 g ai/ha, T<sub>3</sub> Odyssey 70 and 100 g ai/ha, T<sub>4</sub> Odyssey @ 52.5 and 75 g ai/ha+1000 ml adjuvent, T<sub>5</sub> Odyssey @ 61.25 and 87.5 g ai/ha+1000 ml adjuvent, T<sub>6</sub> Odyssey @ 70 and 100 g ai/ha+1000 ml adjuvent, T<sub>7</sub> Imazethapyr @ 100 and 1000ml ai +1000ml adjuvent, T<sub>8</sub> Imazamox 42 and 350ml ai+1000 ml adjuvent, T<sub>9</sub> Chlorimuron ethyl 9.37 and 37.5 g ai/ha, T<sub>10</sub> Fenoxoprop-ethyl 67.5 and 750 ml ai, T<sub>11</sub> weedy check, were laid out in a randomized block design with three replication. The odyssey (imazethapyr + imazomox) is a new molecule which reportedly kills the post-emergence weeds in soybean. Growth parameters like plant height, leaves per plant, branches per plant, crop biomass, and leaf area index were significantly superior in treated plots than weedy check. Both seed and straw yields were significantly higher under all the plots receiving weed control measures than weedy check. Maximum seed yield of soybean was recorded under T<sub>6</sub> (odyssey + adjuvant 100 g + 1000 m/ha) and proved superior over all the herbicidal treatments. Among the herbicidal treatments, application of odyssey with adjuvant (100 g + 1000 ml/ha) was significantly superior and was at par to imazethapyr (1000 ml/ha) and imazamox (350 ml/ha).



03-21

**YIELD ENHANCING EFFECT OF BRASSINOSTEROIDS ON MORPHO-PHYSIOLOGICAL PARAMETERS IN BLACKGRAM (*Vigna mungo* L)**

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The present investigation comprised of foliar spray of brassinosteroids @ 0.025 ppm, 0.05 ppm, 0.075 ppm, 0.1 ppm at vegetative, pod development and vegetative + pod development stages, water spray as control in RBD with three replications. Application of 28-homobrassinolide @ 0.1 ppm at vegetative + pod development stage resulted maximum increase in plant height (35.3%) than control. Spraying of 28-homobrassinolide @ 0.1 ppm at vegetative + pod development stage resulted in increase of leaf area, LAI and SLW at the rate of 56.2, 82.5 and 14 per cent respectively. The plants which undergone HBL spray at various stages of crops showed increase in total dry matter, indicating its positive impact in accumulating dry matter. 28-homobrassinolide sprayed @ 0.1 ppm at both vegetative + pod development stage recorded 97 per cent increase of total dry matter over control. The results indicated that foliar sprays of brassinolide enhanced growth and development in black gram and particularly at vegetative and pod development stages. In these treatments, physiological parameters like AGR, CGR, RGR and NAR increased with the increment in the leaf area and dry matter production. Biochemical parameters like chlorophyll content and soluble protein content showed increase with foliar spray of brassinosteroids. The SCMR reading was observed higher in the treatment of spray of brassinosteroids @ 0.1 ppm at vegetative + pod development stage. This increased chlorophyll content to an extent of 20.3 per cent when compares with control. Soluble protein content increased significantly at each treatment compared to control. Maximum increase in soluble protein recorded was up to 17.4 % with spray of 28-homobrassinolide @ 0.1 ppm at vegetative + pod development stage. Foliar spray of HBL at both stages significantly increased the yield and yield attributes. The grain yield per plant, test weight and HI recorded higher with two sprays compared to one spray at vegetative or pod development stage. However spray of at 28-homobrassinolide @ 0.1 ppm at vegetative + pod development stage recorded highest net returns of Rs. 38,235.17 and C-B ratio (1:2.68) and proved superior to the rest of the treatments.

03-22

**EFFECT OF GROWTH SUBSTANCES ON GROWTH AND YIELD OF RICE (*Oryza sativa* L.) VARIETY NAUR-1 IN SUMMER SEASON**

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A field experiment was conducted during *rabi*-Summer season of 2010-11 at the Main Paddy Research Centre (N.A.R.P.), Navsari Agricultural University, Navsari. Fourteen treatments were taken in to investigation with four growth substances viz., GA<sub>3</sub> (25 mg/l), Thiourea (1000 mg/l), Salicylic acid (100 mg/l) and KNO<sub>3</sub> (1.5 %) as seed treatment, seedling spray and combination of both practices along with seed treatment with water and absolute control. The results revealed that the combination of seed treatment and seedling spray with Thiourea @ 1000 mg/l significantly improved morpho-physiological parameters like number of tillers per plant, number of leaves and leaf area per plant, Leaf area index, Leaf area duration, Photosynthetic rate and stomatal resistance as compared to other treatments. The mean increase in grain yield over absolute control was 28.65 % and 26.45 % in seed treatment and seedling spray with Thiourea @ 1000 mg/l and Thiourea seed treatment @ 1000 mg/l respectively. On the basis of experimental results, it can be concluded that the application of seed treatment and seedling spray of Thiourea @ 1000 mg/l significantly improved various growth parameters and yield of rice variety NAUR-1 during summer season.



03-23

**INFLUENCE OF SALICYLIC ACID AND UNICONAZOLE ON ANTIOXIDANT SYSTEM AND ANTIBIOTIC PROPERTIES OF *Cenchrus ciliaris* (CAZRI-358) GROWN *IN-VITRO***

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Plant cells have evolved a complex antioxidant system, which is composed of low molecular mass antioxidants (phenolics and carotenoids) as well as ROS-scavenging enzymes, such as catalase (CAT), peroxidase (POX) and polyphenol oxidase (PPO). *Cenchrus ciliaris* (CAZRI-358) is a drought hardy perennial grass. This highly nutritious grass is considered excellent for pasture in hot, dry areas and is valued for its production of palatable forage and intermittent grazing during droughty periods in the tropics. Plant growth regulators offer themselves as potential tool for upgrading plant performances under conditions of environmental stress. In the present study, the effect of salicylic acid and uniconazole on antioxidant system of *C. ciliaris* was investigated. The study was conducted in 5 days old seedlings (*in-vitro*). Antibiotic activity against three medically important bacteria viz. *Escherichia coli* (Gram-ve), *Raoultella planticola* (Gram-ve), *Staphylococcus aureus* (Gram +ve) and yeast *Candida albicans* were carried out. The dried and powdered parts (root, stem, leaf and seed) were subjected for extracted in petroleum ether, ethyl acetate and glacial acetic acid successively using soxhlet assembly. The antibiotic activity was carried out by both “Disc diffusion assay” and “Serial dilution methods”. Results indicates that lipid peroxidation (measured by MDA content) and phenolic content were enhanced whereas carotenoids content was decline in seedlings of *C. ciliaris*, treated with different concentrations of salicylic acid as well as uniconazole. Catalase (CAT, EC.1.11.1.6), Peroxidase (POX, EC.1.11.1.7) and Polyphenol oxidase (PPO, EC.1.10.3.1) were found to be increased as compared to control. The present study reveals that salicylic acid and uniconazole greatly modulate the endogenous level of antioxidant system in *C. ciliaris* depending upon different concentrations. Regarding antibiotic study results reveal that glacial acetic acid extract of leaves of *C. ciliaris* expressed highest activity against all the tested bacteria. The inhibitory effect is very identical in magnitude and comparable with that of standard antibiotics [gentamycin (for bacteria) and ketoconazole (for yeast)] used.

03-24

**STANDARDIZATION OF DNA EXTRACTION PROTOCOL IN GREENGRAM  
(*Vigna radiata* (L.) Wilczek)**

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Mung bean is a widely cultivated pulse crop rich in protein, high in vitamin-B content and essential aminoacids. It is easily digestible and low flatulence produced crop. The quality and quantity of DNA used for amplification by PCR is the key to reproducible results and success of genotyping. Especially, DNA purity is extremely crucial for obtaining clear and discriminate patterns. DNA extraction from mungbean is difficult due to presence of contaminants such as phenols. Therefore, the present study was under taken to obtain high quality and pure DNA in mungbean. With few modifications four different DNA extraction protocols were tried in the present study to obtain high quality and pure DNA viz., (i) Doyle and Doyle (1987), (ii) Method of Murray and Thompson (1980), (iii) Porebski *et al.* (1997), and (iv) Lin *et al.* (2001). Out of the four methods tried for DNA extraction, the method of Lin *et al.* (2001) was found most efficient, as the DNA obtained through this protocol was relatively pure which gave amplifying products in the PCR.



03-25

**IDENTIFICATION AND CLONING OF PROLINE RICH REGION IN LENTIL (*Lens culinaris* Medik.) WITH IN-SILICO ANALYSIS FOR APPLICATION IN GENETIC ENGINEERING**

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Lentil is a rainfed crop as a result relatively tolerant to drought. Under conditions of drought stress, proline is synthesised which act as an osmoregulator. It necessitates the development of high yielding varieties and also minimizing yield loss due to disease and abiotic stresses (such as drought and salinization). Engineering of plants for traits like yield or resistance to various stresses (biotic and abiotic) requires a thorough understanding of the cellular and functional aspects of the plant, which is dictated by its genetic make up. In present study a novel proline rich protein has been identified in lentil EST database using soyabean proline rich protein sequence as query sequence. Primer pairs were designed for this sequence and validated on selective *Lens culinaris* cultivars. Blastn results of the lentil sequence have shown 85 %similarity with Soyabean proline rich protein (NM001251664) and chickpea EST sequence (GR 398344). *Pisum sativum* (AJ233399), *Gossypium hirsutum* (AF044205) and *Phaseolus vulgaris* (AM158278) have also shown considerable similarity. Expression studies will help to study the role of Proline rich protein in response to various biotic and abiotic stresses. Annotation of the highly expressed ESTs in the tolerant cultivar predicted that most of them encoded proteins involved in cellular organization, protein metabolism, signal transduction, and transcription.

03-26

**EXOGENOUS APPLICATION OF 24-EPIBRASSINOLIDE AND GLYCINE BETAINE ALLEVIATES COPPER- INDUCED OXIDATIVE STRESS IN *Brassica juncea* L. BY ENHANCING ANTIOXIDANT SYSTEM**

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This study was designed to investigate the effects of exogenously applied 24-epibrassinolide (EBL) and glycine betaine (GB) to the foliage of *Brassica juncea* L. var. varuna, grown under copper (Cu) stress. The seedlings were raised in the soil amended with Cu (0, 50, 100 or 150 mg of Cu kg<sup>-1</sup> soil) at 10 d stage of growth and were sprayed with EBL (10<sup>-8</sup> M) or with GB (50 mM) at 28 d stage of growth. Cu stress noticeably decreased the growth, leaf chlorophyll content, maximum efficiency of photosystem II, net photosynthetic rate, activities of carbonic anhydrase and nitrate reductase, and yield attributes but increased lipid peroxidation and H<sub>2</sub>O<sub>2</sub> content in a concentration dependent manner of the metal. However, the follow-up treatment with EBL completely neutralized the damage caused by 50 or 100 mgkg<sup>-1</sup> of Cu and partially that of 150 mgkg<sup>-1</sup>. Moreover, the damages caused by the lowest concentration (50 mgkg<sup>-1</sup>) of Cu were largely overcome by GB application. EBL or GB enhanced the activities of antioxidant enzymes [viz. catalase (E.C. 1.11.1.6), peroxidase (E.C. 1.11.1.7) and superoxide dismutase (E.C. 1.15.1.1)], proline content and counteracted the Cu-induced oxidative stress in metal stressed mustard plants which was clearly manifested in terms of improved growth and biological yield. Out of EBL and GB, EBL was more effective in scavenging the free radicals, which are produced in greater amount from basic metabolic processes. Thus, Cu tolerance can be improved in mustard by the foliar EBL- or GB-treatment through enhancing the antioxidants capacity.



03-27

**EFFECT OF PLANT GROWTH REGULATORS AND NUTRIENTS ON MORPHOLOGICAL PARAMETERS AND YIELD IN SOYBEAN (*Glycine max* M.)**

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A field experiment was taken up to study the influence of plant growth regulators on morphological, physiological characters and yield in soybean cv. Co Soy 3 during February- May 2012. Kinetin @ 50 ppm, Gibberellic acid @ 100ppm, NAA @ 50ppm, Ethrel @ 250ppm, Brassinolide @ 100ppm and Nutrient mixture (0.5% DAP + 0.1% MnSO<sub>4</sub>, FeSO<sub>4</sub> + 0.01% Ammonium molybdate) were applied as foliar spray at two different stages viz., vegetative (30-35 DAS) and peak flowering stage (45-50 DAS). Foliar spray of Kinetin showed significant effect on the growth parameters by increasing the plant height, leaf area, leaf area index and leaf area duration, but, Nutrient mixture recorded maximum root length which is on par with NAA. This increase in growth is due to delayed senescence, protection of chlorophyll and photosynthetic proteins, enhanced uptake of nutrients and maintenance of source-sink relationship by the treatments. However, total dry matter accumulation and major yield attributes such as number of pods, fertility co-efficient, pod weight was higher in Brassinolide which is followed by nutrient mixture and NAA.

03-28

**EFFECT OF DIFFERENT GROWTH REGULATORS (NAA, GA, Cycocel and Ethrel) AND PINCHING ON GROWTH & FLOWERING OF AFRICAN MARIGOLD (*Tagetes erecta* L.) CV. PUSA NARANGI GAINDA IN DIFFERENT DATES OF PLANTING**

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African marigold (*Tagetes erecta* L.) is a popular flower crop grown throughout India as it is a hardy and quick growing plant. Growth regulating chemicals can be effectively used at various important stages of crop growth in cultivation of shrubs and annuals to bring changes like controlling the plant height, initiating flowering, improving size and number of flowers, breaking bud and seed dormancy etc. when applied at right time and at right concentration. In marigold, time of planting and use of growth regulating chemicals plays an important role for getting higher yields and regular supply of flowers to the market. In this back ground a field experiment was carried out at Horticultural Research Station, Dr. Y.S.R. Horticulture University, Venkataramannagudem, West Godavari dist. Andhra Pradesh to find suitable time of planting and use of growth regulators for extending the period of availability of flowers. Plant growth regulators NAA (100 ppm), GA (300 ppm), Ethrel (500 ppm) and Cycocel (500 ppm) were applied as foliar sprays and pinching was done 30 days after planting on August, September, October planted seedlings of African marigold cv. Pusa Narangi Gainda. Among different dates of planting September date of planting was found to be good for getting higher yields (65.09 q/ha) in marigold. Among the growth regulators spraying of CCC 500 ppm recorded maximum yield (64.99 q/ha) in September date of planting. In all the dates of planting maximum yields were recorded in spraying of CCC 500 ppm which was on par with ethrel 500 ppm and significantly higher than the control (44.7 q/ha) due to production of more number of side shoots (16.53, 12.67 & 11.67 shoots in August, September, October dates of planting respectively) and flowers per plant (39.86, 41.30 & 15.45 in August, September, October dates of planting respectively). However, the flowering duration was extended by the spraying of cycocel. But there is no significant interaction between growth regulators and dates of planting during this season.



03-29

### EFFECT OF SEA WEED SAP (SWS) ON GERMINATION AND EARLY GROWTH STAGES OF SORGHUM

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Seaweed forms an integral part of marine coastal ecosystems. Since, it grows in saline medium, its sap has wide range of application on plants such as early seed germination and establishment, and also elevated resistance to stresses. Here in our study, *Kappaphycus alvarezii* sea weed extract was used to study the efficiency on germination and early growth stages of Sorghum (M-35-1). Firstly, the seeds were soaked in 20%, 40%, 60% of SWS and water as control for 24 hours and then transferred to petriplates. After 24 hr, the germination was 100 % in case of 20% SWS as compared to other treatments. After 7 days the root length was two times higher (18.43 cm) in 20% treated seeds compared to control, where as it is little high (10.3 cm and 11.25 cm) in 40% and 60% treated seeds respectively. Shoot length and fresh weight followed the same pattern. In another experiment the seeds were soaked in water for 6 hr and immediately after the initiation of radicle they were transferred to 1%, 2.5%, 5%, 7.5%, 10%, 20%, 40% of SWS and water as control and were watered with SWS and maintained in laboratory. After 7 days, the root and shoot growth was found to be high in 1% to 5 % of SWS as compared to water. Overall study indicates that there is a positive effect of SWS on germination and early growth stages of Sorghum but in specific it is more effective on root growth, ultimately increase in root growth improves nutrient and water uptake.

03-30

### EFFECT OF PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF COWPEA (*Vigna unguiculata* L. Walp.)

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The field experiment entitled above was carried at Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahamednagar of state Maharashtra to evaluate the effect of plant growth regulators on growth, yield and yield attributes of cowpea (*Vigna unguiculata* L. Walp.) in Factorial Randomized Block Design. The two varieties viz., V1 (Shweta) and V2 (Phule Pandari) sprayed with different plant growth regulators such as Tri-iodo Benzoic Acid (TIBA), Cycocyl (CCC) and Ethrel (CEPA) in different concentrations at two stages of plant growth (25 DAS and 45 DAS). The study revealed that the spray treatment with CCC recorded most Significant results in case of different growth, yield and yield attributes at the concentrations of 1000 ppm such as number of leaves per plant, leaf area per plant, dry matter production, number of seeds per pod, number of seeds per plant, 100 seed weight, grain yield per plant and total biomass per plot in both the varieties over the control and rest all of the treatments at 60 DAS followed by spray treatment with CCC 500 ppm. The spray treatment with ethereal with 50 ppm showed the inferior results among all treatments. Spray treatment with TIBA showed at par results. All foliar spray treatments of PGRS found beneficial in increasing grain yield to the extent of 10 per cent to 24 per cent over the absolute control. The treatment CCC @ 1000 ppm recorded highest grain yield which was higher by 24.75 per cent over the absolute control.



03-31

### EFFICACY OF SEED TREATMENTS WITH BIOAGENTS, BOTANICALS, FUNGICIDES AND IRRADIATIONS ON YIELD OF GREEN GRAM

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A field experiment was conducted at Department of Seed Science and Technology, College of Agriculture, ANGRAU, Rajendranagar, Hyderabad, Andhra Pradesh, India during *kharif* season 2011-12 with three varieties of green gram viz., LGG-460, LGG-407 and TM 96-2 obtained from Regional Agricultural Research Station, Lam Farm, Guntur. The seed was treated with bioagents (*Trichoderma viride* and *Pseudomonas fluorescens*), botanical (neem oil), fungicide (captan), irradiations (gamma irradiation- 30 Gy and gamma irradiation - 40 Gy) and maintained untreated seeds (control). After treatments the seeds were sown in the field with three replications adopting split plot design in order to find out the effect of seed treatments on field emergence, disease incidence at different crop growth stages and yield of green gram. The results revealed that maximum field emergence index was recorded in captan and *T. viride* seed treatments in all the varieties particularly in variety LGG-460. Disease incidence was less in seeds treated either with captan or *T. viride* which exhibited superiority in reducing disease incidence in all the varieties. Yield per hectare was increased in seed treatments either with captan (1443 kg ha<sup>-1</sup>) or *T. viride* (1377 kg ha<sup>-1</sup>). Irrespective of varieties, seeds treated with captan or *T. viride* significantly recorded higher yield over untreated control (1181 kg ha<sup>-1</sup>) and other seed treatments viz., *Pseudomonas fluorescens* (1256 kg ha<sup>-1</sup>), neem oil (1213 kg ha<sup>-1</sup>), gamma radiation-30 Gy (1259 kg ha<sup>-1</sup>) and gamma radiation – 40 Gy (1348 kg ha<sup>-1</sup>). Thus it is recommended that seed treatments in green gram either with captan or *T. viride* were found effective and beneficial to the farmers in reducing the incidence of seed borne pathogens viz., cercospora leaf spot (*Cercospora canescens*), anthracnose (*Colletotrichum lindemuthianum*), root rot (*Macrophomina phaseolina*), corynespora leaf spot (*Corynespora cassicola*), bacterial leaf spot (*Xanthomonas phaseoli*), yellow mosaic (YMV) and leaf crinkle virus (LCV) and enhancing plant stand, getting better quality seed and repealing higher yields in green gram.

03-32

### OPTIMIZATION OF MEDIUM CONDITIONS FOR EFFICIENT REGENERATION FROM SHOOT TIP IN COTTON VARIETY NARASIMHA

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Cotton is most widely grown commercial crop in Andhra Pradesh and is a source of fibre, oil and feed. In India biotechnological intervention in improving crop traits was successful in cotton crop with introduction transgenic hybrids resistant to bollworms. Transgenic cotton has been mainly obtained either by *Agrobacterium tumefaciens* mediated or ballistic method and both were tissue culture dependent. Cotton is a recalcitrant crop and not easily amenable for tissue culture method of regeneration. Though protocols were developed for regeneration in cotton, usage is limited due to variety specificity. Narasimha is the popular cotton variety in Andhra Pradesh and also is the most widely used recipient parent in developing transgenic hybrids through backcross breeding. Hence in the present study simple method of regeneration was developed for Narsimha using shoot apex tissue. Auxin and cytokinin type and combination strongly influenced the organogenic potential of shoot tip explants of Narasimha. Highest shooting frequency (100%) and initiation was observed with hormonal combination of M.S (full strength) +Kinetin 0.1mg/l. Further shoot elongation was obtained with M.S+Kinetin 0.1 mg/l+GA3 0.1 mg/l. Highest rooting frequency (80%) was recorded in M.S medium fortified with IBA@ 0.5 mg/l.



03-33

**STUDIES ON BIO-EFFICACY OF GA<sub>3</sub> (40%) ON BERRY QUALITY AND YIELD IN THOMPSON SEEDLESS GRAPES**

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International markets largely depend on the quality of grapes. Berry size is the main quality factor for international markets. ProGibb is a plant growth regulator improves crops and fruit quality and increases the market value. ProGibb is a commercial form of gibberellic acid. Foliar application of GA<sub>3</sub> has been routinely used to increase berry and bunch weight in grapes. Hence, studies were conducted to evaluate the bio-efficacy of gibberellic acid (GA<sub>3</sub>) on grapevine (*Vitis vinifera* L.) variety Thompson Seedless grafted on Dog ridge root stock. The data on bunch and berry weight, berry size, berry quality and yield was recorded. The results revealed that foliar application of ProGibb 40% WSG at various concentrations (10 to 50 ppm) significantly increased mean bunch weight, 50 berry weight, berry length and yield as compared to control. Among various concentrations mean bunch weight (300 g), 50 berry weight (166.33 g), berry length (22.43 mm) and yield per vine (12.59 kg) were high with the application of 50 ppm ProGibb 40% WSG. No symptoms of any abnormality or toxicity were observed on leaves, canes / shoot and berries with the application of 50 ppm ProGibb 40% WSG. Overall results indicated that foliar application of GA<sub>3</sub> (40%) could be potential to enhance the berry size, bunch weight, berry quality and yield in Thompson Seedless grapes.

03-34

**EFFECT OF ASCORBIC ACID ON THERMOTOLERANCE LEVEL OF WHEAT POLLEN (*Triticum aestivum*) UNDER HEAT STRESS**

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Wheat is one of the staple food crops providing 70 % of the carbohydrate required in the diet. The reproductive stage of wheat is highly sensitive to heat stress. Here, we report the alteration in the expression of heat shock proteins and antioxidant enzymes in wheat pollen collected from tolerant and susceptible cultivars under ascorbic acid<sub>400mM</sub> + 42°C for 2h treatment (T<sub>2</sub>). The fold change in expression of catalase and ascorbate peroxidase was observed very high in pollens of HD2329 (thermosusceptible) compared to pollens of C-306 (thermotolerant) in response to T<sub>2</sub>. The transcript of high molecular weight HSPs (HSP70 and HSP90) was observed very high in C-306 and low molecular weight HSPs (HSP17 and HSP26) was observed high in HD2329 under T<sub>2</sub>. 1D and 2D PAGE analysis of wheat pollen showed more differentially expressed proteins in C-306 compared to HD2329 in response to T<sub>2</sub>. Osmolyte and hydrogen peroxide accumulation was observed more in pollen of C-306 compared to HD2329 in response to T<sub>2</sub>. Endogenous ascorbic acid accumulation was observed more in the leaves of thermotolerant cultivar compared to susceptible under T<sub>2</sub> treatment. Scanning electron microscopy of wheat pollens under heat stress showed disintegration of exine layer and loss of pollen structure in both the cultivars. The percent viability was less in case of HD2329 compared to C-306. Immunoblot analysis showed abundance of HSP70 and HSP90 in pollens of C-306 compared to HD2329 and increase in the total antioxidant capacity was observed in pollens of C-306 and HD2329 in response to T<sub>2</sub>. To conclude, pre anthesis treatment of ascorbic acid (400mM) prior to heat stress enhances the thermotolerance capacity of wheat pollen and can be used as a strategy to increase the percent seed setting in wheat grown under elevated temperature.



03-35

**EFFECT OF SEED PRIMING ON BIOCHEMICAL AND MOLECULAR CHANGES DURING SEED STORAGE OF MAIZE (*Zea mays* L.) HYBRIDS**

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The present study was carried out to investigate the effects of seed priming on biochemical and molecular changes during seed storage of maize hybrids viz., AH 122, SMH 9, DHM 111, DHM 117 and DHM 115 at Seed Research & Technology Centre and Department of Crop Physiology, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad. The results of the experiment revealed that the hydro-priming (with water) was shown better performance when compared to osmopriming (PEG 6000) and halopriming ( $KNO_3$ ) and the hybrid DHM 117 found superior for most of the physiological traits like germination, seedling vigour index, speed of emergence (%), field emergence and EC of seed leachates compared to the other hybrids. The significant interaction between hybrids and seed priming during entire storage period also revealed the fact that the hydro primed seeds were more superior in comparison to other treatments. It is interesting to note that the hydro primed seeds of hybrids were shown higher values of  $\alpha$  - amylase, peroxidase activity and high content of total soluble proteins and DNA.  $\alpha$  - amylase is the key enzyme which enhances the starch metabolism and in the present study, the advancement in the  $\alpha$ -amylase activity in hydro primed seeds was found in all hybrids resulted an increase in germination and other physiological parameters. While increased peroxidase activity was recorded at a very faster rate at '0' to 12 h after germination and further increases linearly from 12 to 24 h and 24 to 48 h after germination at a slower rate in all primed and unprimed seeds. The resolving image of the protein profile of the gels of all hybrids with priming at zero to 48 h after germination indicated that there is an increase in accumulation of protein from '0' to 12 h among all the priming treatments. It is most evident from the study that the seeds which are hydro primed showed better protein profile in all the hybrids as compared to the other primed and unprimed seeds also suggesting the fact that the priming with an appropriate duration may increase the seed vigour during storage.

03-36

**EFFECT OF DIFFERENT PLANT GROWTH REGULATORS ON ROOTING IN CUTTINGS OF KHAIR (*Acacia catechu* Willd.)**

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The investigation was carried out during March-2009 to June-2009 in Green House Complex, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The investigation included ten treatments in Complete Randomized Design (CRD) comprising of IBA, NAA and their combination each @ 250, 500 and 750mg<sup>-1</sup> along with control. The planting media was sand, soil and vermicompost in 2:1:1 ratio. The cuttings were planted in black polyethylene done during the spring season. The stem cuttings were of 20-25 cm length and 1-1.5cm thickness from the uniform hardwood cuttings. The results revealed that application of Auxins @ IBA 500mg<sup>-1</sup> proved the best treatment for better obtaining rooting percentage (53.52), number of main roots (3.78), length of longest root (4.27 cm), fresh and dry weight of roots (1.52 gm and 0.91 gm) and survival percentage (75.00) of rooted cuttings as compared to control. However, IBA 250mg<sup>-1</sup> treatment was found best for the thickness of longest root per rooted cuttings (0.21cm).



03-37

**AN INVESTIGATION INTO THE PHYSIOLOGICAL AND BIOCHEMICAL ASPECTS OF HERBICIDE RESISTANCE IN *Phalaris minor***

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Isoproturon resistance in *Phalaris minor* has become a serious problem for more than a decade in the rice-wheat cropping system. The experiment was conducted in a CRD with 3 replications to test the efficacy of isoproturon on *P. minor* populations. Seeds of *P. minor* were collected from the different localities. The cross-resistance of isoproturon resistant biotypes to sulfosulfuron and clodinafop was also checked. The efficacy of all the three herbicides was tested for two sowing dates viz. Nov.16 and Dec.07. The results showed that isoproturon failed to completely kill the weed from all the localities. Sulfosulfuron also could not successfully control the isoproturon resistant *P. minor* plants. Even the plants which were killed initially, were found to regenerate later on. The extent of regeneration was up to 50 per cent. Clodinafop was able to control the isoproturon resistant *P. minor*. Biochemical parameters such as chlorophyll content (a,b and total) and total soluble protein content of *P. minor* were reduced due to treatment with all the three herbicides. Reduction was more under late sown conditions. Physiological parameters such as photosynthetic rate and stomatal conductance, were decreased due to herbicide treatment in sensitive populations. Chlorophyll fluorescence Fv/Fm also varied with differentially with different herbicides.

03-38

**COMPARATIVE EFFICACY OF PUTRESCINE AND BENZYLADENINE ON PHOTOSYNTHESIS AND PRODUCTIVITY IN RELATION TO DROUGHT TOLERANCE IN BREAD WHEAT (*Triticum aestivum* L.)**

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A pot experiment was conducted to find out the comparative effect of putrescine and benzyladenine on photosynthesis and productivity in bread wheat. The widely adapted but drought sensitive genotype (HD 2329) was grown in ceramic pots under normal conditions and then plants were sprayed with putrescine (0.1 mM) and benzyladenine (0.05 mM) at the time of anthesis. After spray, half of the plants were subjected to water stress by withholding irrigation and the non stressed plants were irrigated to keep the soil humidity at field capacity. Results showed that the chlorophyll content, relative water content and accumulation of osmolytes increased but membrane injury reduced in putrescine and benzyladenine treated plants. The response of putrescine was better over benzyladenine. Rate of photosynthesis and transpiration increased and leaf diffusive resistance decreased with both the chemicals. Again, putrescine was comparatively more effective. The membrane injury and leaf diffusive resistance were found negatively related to grain yield whereas all other parameter were significantly and positively correlated with grain yield. Growth, yield and yield attributes increased significantly on account of putrescine and benzyladenine. The effect of putrescine in increasing growth, yield and yield attributes were found higher than benzyladenine. Present investigation suggests a significant role of putrescine and benzyladenine in enhancing productivity of wheat under non-stress and water stress conditions. The higher effect of putrescine in increasing yield is mediated by manipulating different physio-biochemical processes particularly under water stress conditions.



03-39

**STANDARDIZATION OF REGENERATION AND AGROBACTERIUM MEDIATED TRANSFORMATION PROTOCOL IN PIGEONPEA (*cajanus cajan* L. Millsp.) VARIETY LRG-41**

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Development of transgenic protocol in any crop requires development of regeneration protocol. Pigeonpea is not amenable to tissue culture due to recalcitrant nature. In the present study both regeneration and transgenic protocols were standardized in redgram variety LRG-41. Explants *i.e.*, cotyledon, axillary bud and shoot tip were used in the study. Among the three explants cotyledon showed better regeneration response compared to other two explants. Hence cotyledonary explant of LRG-41 was used for further studies on regeneration and transgenic protocols. Among the various plant growth regulator combinations tried, high shoot regeneration was obtained when MS medium was supplemented with BAP 2.0 mg l<sup>-1</sup> + NAA 0.1 mg l<sup>-1</sup> and high rooting frequency was obtained when MS medium was supplemented with IBA 1.0 mg l<sup>-1</sup>. Higher plantlet survival (91%) was obtained in soilrite mixture and 12.8 days was taken for acclimatization. The transformation was carried out using the *Agrobacterium* strain LBA4404 containing the binary vector pCAMBIA 2301 harboring *npt* II as selectable marker and GUS as reporter gene. Confirmation of the transgene integration in the putative transformants was done by using the histochemical staining and PCR. The transformation efficiency of 59.09 % was obtained in the cultivar LRG-41. The transformation frequency was 14.4 % and the GUS gene transient expression level in transformants was 59.09 %. Thus, the present study successfully demonstrated the indirect regeneration of transgenic plants from cotyledonary explants through *Agrobacterium* mediated genetic transformation approach in redgram variety LRG-41. The standardized protocols of present study may be utilized for further transgenics development in redgram cultivar LRG -41 genetic backgrounds.

03-40

**EFFECT OF LEVELS OF GIBBERELIC ACID AND PHOSPHORUS ON GROWTH, ENZYMATIC ACTIVITIES AND YIELD OF FENUGREEK (*Trigonella foenum-graecum* L)**

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Enhancement in yield and quality of fenugreek is immensely required as it is a valuable medicinal and spice plant. To achieve this goal, a pot experiment was conducted on fenugreek according to randomized block design under natural conditions in the net house of Botany Department, A.M.U., Aligarh, using four levels of gibberellic acid (0, 10<sup>-7</sup>, 10<sup>-6</sup> and 10<sup>-5</sup>M) as foliar spray and two levels of phosphorus (0 and 40 kg P ha<sup>-1</sup>) as basal application. Growth and yield analysis was carried out in terms of growth attributes, enzymatic activities and yield attributes. The results showed that foliar spray of GA<sub>3</sub> alone or in combination with 40 kg P ha<sup>-1</sup> augmented the vegetative growth, enzymatic activities and yield. Among the treatments, 10<sup>-5</sup> M of GA<sub>3</sub> applied with 40 kg P ha<sup>-1</sup> gave the best results for almost all the parameters studied compared to the control (no application of GA<sub>3</sub> or P) or 10<sup>-5</sup> M of GA<sub>3</sub> applied alone. Moreover, the total content of chlorophyll, carotenoids and leaf -N, -P and -K were significantly increased as a result of combined application of 10<sup>-5</sup> M of GA<sub>3</sub> and 40 kg P ha<sup>-1</sup>, compared to the control.



03-41

### EFFECT OF GROWTH REGULATORS ON THE GROWTH, DEVELOPMENT AND YIELD OF RABI SORGHUM VARIETY GRS-1

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A field experiment was conducted to study the effect of growth regulators on growth and development parameters viz., plant height, ear length, ear weight, ear diameter, and yield (grain weight and 100 grains test weight) in *Rabi* sorghum variety, GRS-1. The experiment was conducted in Randomized Complete Block Design with five replications and fourteen treatments including one untreated check. The treatment details include, spray with lihosin 500 ppm, lihosin 1000 ppm, KNO<sub>3</sub> 1%, KNO<sub>3</sub> 1%, KNO<sub>3</sub> 2%, Mepiquat Chloride (MPC) 500 ppm, MPC 1000 ppm, MPC 1500 ppm, GA<sub>3</sub> 100ppm, methanol 2%, KNO<sub>3</sub> 1% + lihosin 1000 ppm, KNO<sub>3</sub> 1% + MPC 1500 ppm, water spray and an absolute control. The crop was sprayed with the above mentioned growth regulators on 45th DAS. All the recorded data was statistically analyzed and possible interactions was determined. There was significant difference among all the treatments at p<0.01. The treatment with MPC 500 ppm was showed greater plant height (161cms), ear weight (52.61g), ear diameter (5.12cms) and grain weight (44.70g) and control being the lowest in all parameters. However, treatment with lihosin 500 ppm showed high results for ear length (15cms) and 100 grains test weight (3.75g). Results for the spray using KNO<sub>3</sub> 1% + MPC 1500 ppm showed highest in total biomass which is contributed by high shoot weight.

03-42

### INTERACTION OF BRASSINOSTEROIDS AND HYDROGEN PEROXIDE ENHANCES TOLERANCE TO COPPER STRESS IN *Vigna radiata*

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Brassinosteroids (BRs) regulate various responses to abiotic stress and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) in minute quantity serves as a signalling molecule. The role of H<sub>2</sub>O<sub>2</sub> in combination with BRs in the plants exposed to toxic levels of Cu is poorly understood. With an aim to further explore and elaborate their role in plants subjected to abiotic stress, the seedlings of mung bean (*Vigna radiata*) were grown in net house under natural condition. The plants were exposed to Cu (50 or 100 mg kg<sup>-1</sup>) stress through soil and sprayed with hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) (2.5 mM) or 28-homobrassinolide (HBL, 10<sup>-8</sup>) at 15d stage or 20d stage, respectively. The analysis of the plants at 45d stage of growth revealed that the presence of copper in the soil caused a sharp reduction in growth characteristics, activity of carbonic anhydrase and nitrate reductase, relative water content, chlorophyll content and the rate of photosynthesis. However, the activity of antioxidant enzymes (catalase, peroxidase and superoxide dismutase) and the content of proline in leaves increased in Cu stressed plants. The effects of exogenously applied HBL and H<sub>2</sub>O<sub>2</sub> in absence of Cu on mung bean strongly favour the growth, photosynthetic parameters and also improved the activity of antioxidant enzymes and proline content, which were enhanced by Cu stress. The interaction of HBL and H<sub>2</sub>O<sub>2</sub> on growth and metabolic biomarkers in mung bean plants resulted in enhanced tolerance to Cu stress. The study indicates that application of HBL and H<sub>2</sub>O<sub>2</sub> is an effective approach for Cu detoxification and the maintenance of Cu homeostasis in plants. Therefore, potential use of these compounds in improving agricultural production systems could be exploited in large field trials.



03-43

### EFFECT OF EARLY ETHREL APPLICATION ON GROWTH AND PRODUCTIVITY OF COTTON

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Cotton acreage in India has been continuously rising for last four years and it touched a record 12.2 million hectares in 2011/12 season (CCI, 2012). Cotton is recognized as a fibre crop with varied applications from marketing of tiny threads to fashionable clothing in the textile sector. The production of cotton in India for the year 2011-12 is 345 lakh bales. The indeterminate habit of cotton crop throws up many intricacies in respect of growth and developmental events in terms of varied expressions influenced considerably by the biotic as well as the abiotic factors. So modifying cotton growth has become an essential component of cotton production whether by mechanical or chemical means so as to improve the productivity and to bring about some more amenability for cultural manipulations. Applying plant growth regulators to modify early growth is an effective management practice. Keeping this in view the present study was conducted to manipulate the plant morphoframe for realizing higher quality cotton yield under existing agroclimatic situations. A field experiment was conducted during the *Kharif* seasons of 2008 and 2009 at RARS Lam, Guntur, in a split plot design with five cotton hybrids Viz; RCH2Bt, JKCH 99Bt, NECH 2RBt and NCS 145 Bt. and NCS 138Bt as main treatments and four manipulation treatments Viz; T<sub>1</sub>- Control, T<sub>2</sub>- Ethrel @ 30ppm at 35-45 DAS, T<sub>3</sub>- Ethrel @ 45 ppm at 35-45 DAS. T<sub>4</sub>- removal of squares manually in three replications. All the packages of practices were adopted as per the recommendations and plant protection measures were taken for the control of pest and diseases. The data on plant height, dry matter production, number of sympodia, per cent boll set and number of bolls were recorded from randomly selected five plants in each treatment. The final yield and yield components like lint index, seed index, GOT and harvest index were recorded after picking of kapas from the plant. The cotton fibre was analyzed for quality parameters with HVI in CIRCOT. Of all the treatment tried, T<sub>2</sub>- Ethrel @ 30ppm at 35-45 DAS recorded significantly higher seed cotton yield and it was on par with T<sub>3</sub>- Ethrel @ 45 ppm at 35-45 DAS. The higher seed cotton in Ethrel treated plants was associated with higher number of sympodial branches, higher dry matter production, bolls per plant and the ethrel application at lower concentration did not show any adverse effect on fibre quality.

03-44

### BIOSTIMULANTS ON QUALITY PARAMETERS OF RICE GENOTYPES

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A field experiment was conducted in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during 2009-2010. The objective of the study is to investigate the efficacy of biostimulants on the quality characters of two rice varieties namely ADT 43 and ADT 45. The treatments included soil and foliar applications of biostimulants have the combinations of humic acids, fulvic acids and amino acids. Soil application of biostimulants @ 1000 g ac<sup>-1</sup> at 5<sup>th</sup> days after planting and foliar spray of biostimulants @ 1.5 g l<sup>-1</sup> at 70<sup>th</sup> days after planting was effective in increasing the quality characters. The positive increase in peroxidase enzyme activity was accelerated by the soil and foliar application of biostimulants which maintained the higher activity during active tillering to panicle initiation irrespective of rice genotypes. The increase in reduction of IAA oxidase activity was an additional indicator for the improved growth of the rice for the higher biomass production at active tillering to flowering. The positive function of biochemical characters enhanced the quality characters of rice genotypes such as starch content and protease activity, were also increased significantly by the treatment.



03-45

### EFFICACY OF FOLIAR SPRAYS OF HUMIC ACID THROUGH VERMICOMPOST WASH ON CHEMICAL AND BIOCHEMICAL, YIELD AND YIELD CONTRIBUTING PARAMETERS OF MAIZE (PKVM-SHATAK)

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A field experiment was conducted during *kharif* season 2009-10 at college of Agriculture Nagpur, Dr P.D.K.V, Akola to find out the efficacy of Humic acid through Vermiwash on maize variety PKVM-Shatak. The experiment was laid out in randomized block design with three replications comprising of different doses of humic acid through vermicompost wash. Spraying of humic acid was done at 25, 45 and 60 days after sowing. The different treatments tested were control, 100, 150, 200, 250, 300, 400, 450 and 500 ppm humic acid. The result of the revealed that the foliar sprays of humic acid showed their significance over control. Foliar sprays of 400 ppm followed by 350 ppm humic acid increased the leaf chlorophyll content from 25 to 45 DAS. Thereafter, leaf chlorophyll was decreased at last stage of observation i.e 65 DAS. Variation in leaf chlorophyll content recorded at 45 and 65 DAS was found to be statistically significant but treatments effect were non significant at 25 DAS. The range of leaf nitrogen, phosphorus and potassium in percent increases at foliar application of 400 ppm (VCW) at 25, 45, 65 DAS respectively. The range of starch content was 66.20% in control to 68.01% in 400 ppm ( $T_8$ ) vermicompost wash. Significantly maximum protein content was recorded in  $T_8$  (400 ppm) it was on par with  $T_7$  (350 ppm) and  $T_6$  (300 ppm). However, remaining treatments  $T_5$  (250 ppm),  $T_{10}$  (500 ppm), and  $T_2$  (100 ppm) were also found to be on par with each other but were found significantly superior over control in seed protein content in a descending manner. All the treatments receiving VCW significantly increase grain yield  $\text{plant}^{-1}$ ,  $\text{plot}^{-1}$ ,  $\text{ha}^{-1}$  and harvest index when compared with treatment  $T_2$  (100 ppm) and control ( $T_1$ ). Significantly maximum grain yield was recorded in treatment receiving 400 ppm vermiwash. Next to this treatment, treatments were 350 ppm ( $T_7$ ), 450 ppm ( $T_9$ ), 500 ppm ( $T_{10}$ ), 300 ppm ( $T_6$ ), 250 ppm ( $T_5$ ), 200 ppm ( $T_4$ ), 150 ppm ( $T_3$ ) vermicompost wash in a descending manner in increasing grain yield in present investigation.

03-46

### REGULATION OF *CHRYSANTHEMUM* CUT FLOWER SENESCENCE BY USING VARIOUS CHEMICALS

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Experiment was conducted to study the effect of 5-sulphosalicylic acid and aluminium sulphate alone and in combination with sucrose in vase solution on vase life and senescence related parameters in *Chrysanthemum morifolium* cv. Thai Chen Queen. Different treatments composed of sucrose 1.5%, three levels of each 5-sulphosalicylic acid (75, 100 and 150 mg/l) and aluminium sulphate (200, 300 and 400 mg/l) alone and in combination, were applied in a factorial arrangement, carried out in a completely randomised design. The combined application of 5-sulphosalicylic acid and aluminium sulphate along with sucrose (1.5%) increased cut flower water absorption, fresh weight and vase life along with a high membrane stability index, chlorophyll and carotenoid retention. Among the different treatments, a vase solution comprised of 200 mg/l  $\text{Al}_2(\text{SO}_4)_3$  and 1.5% sucrose gave maximum vase life (22.3 days). The treatments, having 150 mg/l 5-sulphosalicylic acid + 1.5% sucrose and 300 mg/l  $\text{Al}_2(\text{SO}_4)_3$  + 1.5% sucrose, recorded a vase life of 20.85 and 19.85 days, respectively. A minimum vase life was recorded in control (17.84 days). However, both the chemicals (5-sulphosalicylic acid and  $\text{Al}_2(\text{SO}_4)_3$ ), used at higher concentrations without sucrose, exhibited the toxicity symptoms.



03-47

### PHYSIOLOGICAL EFFECTS OF BIOPROMOTOR ON GROWTH AND YIELD CHARACTERS OF HYBRID MAIZE (*Zea mays* L.)

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Field Experiment was conducted in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, during September 2011 to December 2012 to study the effect of biopromotor on growth and yield of hybrid maize. The treatment combination of seed treatment @ 2g kg<sup>-1</sup> + soil drenching @ 500g ha<sup>-1</sup> of biopromotor was found effective in increasing growth attributes such as LAI, LAD, SLW and CGR. The treatment had also increased the level of chlorophyll content and soluble protein. The biopromotor containing different *Bacillus spp.* is enhanced the uptake of Phosphorus by optimizing the root ATPase and Acid phosphatase activity. It was justified from the significant increase in Phosphorus solubilizing bacteria population and soil dehydrogenase activity by the seed treatment @ 2g kg<sup>-1</sup> + soil drenching @ 500g ha<sup>-1</sup> on 15 DAS. The major yield attributes such as cob length, cob girth, number of kernels per cob, 100 grain weight were significantly increased by the biopromotor resulted higher kernal yield and harvest index. The results of the present study revealed that the biopromotor seed treatment @ 2g kg<sup>-1</sup> + soil drenching @ 500g ha<sup>-1</sup> on 15 DAS favoured for better growth with an yield increase of 18 percent over the control.

03-48

### IMPACT OF BACTERIAL FORMULATED BIOSTIMULANT ON SEEDLING GROWTH AND BIOCHEMICAL CONSTITUENTS OF MAIZE

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The novel biological approach of using biostimulants is getting a great deal of attention today. The biostimulant is a biological product named as *NovoBac* containing bacterial *species* used to mineralize the organic forms of phosphorus. They have been shown to influence several metabolic processes such as respiration, photosynthesis, chlorophyll production, nucleic acid synthesis ion uptake and thereby enhance plant growth and development in various crops. The impact of bacterial formulated biostimulant (*NovoBac*) on seedling characters such as germination percentage, root length, shoot length, root dry weight, shoot dry weight, root volume, vigour index and biochemical constituents in maize seedlings were evaluated under lab study. The seedling parameters of maize were significantly influenced by bacterial formulated biostimulant (*NovoBac*). The seed treatment with *NovoBac* (2 g/kg of seed) recorded significantly higher percent of germination, root parameters and vigour of seedlings. The *NovoBac* (2 g/kg of seed) treated maize seeds registered higher root length (23.8 cm), root weight (110 mg). Simultaneously application of biostimulant (*NovoBac*) with different concentration significantly enhanced the chlorophyll content, total soluble protein content over other treatment and untreated control. The present study indicated effectiveness of bacterial formulated biostimulant in increasing seedling parameters and biochemical constituents of maize seedlings.



03-49

### MOLECULAR ANALYSIS OF COLD INDUCED SWEETENING IN POTATO (*Solanum tuberosum* L.)

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Low temperature storage of potato is an inevitable practice to prevent sprouting, retention of dry matter, decreased disease loss, extended marketability, and elimination of the need for dormancy-prolonging chemicals. Low temperature (4°C) stress leads to cold-induced sweetening (CIS) in potato, which is caused by accumulation of reducing sugars. Reducing sugars react with asparagine to yield acrylamide, when cold stored potato is used for making fries and chips. Hence, development of potato genotypes with very low CIS and asparagine accumulation under cold storage is required to avoid high levels of acrylamide in fries and chips. To understand the molecular basis of CIS in potato, Indian potato cultivars comprising of conventional table purpose and chipping varieties were subjected to three different storage temperatures namely 4°C, 12°C and room temperature. Initial sampling was done before storage. Second and third samplings were at 30 and 60 days after treatment. Reducing sugar content and asparagines levels were quantified in these samples. Genotypes with contrasting reducing sugar levels were selected for gene expression analysis. Semi quantitative expression analysis revealed that CIS tolerance of Kufri Chipsona 2 was associated with low expression levels of *ASI* (*Asparagine synthetase I*) 1 and *INV* (*Vacuolar Invertase*), and high expression of *UGP* genes as compared with CIS sensitive Kufri Khanchan during cold storage. Further, analysis of allelic variation in the *UGP* revealed that CIS tolerant varieties Kufri Chipsona 2 and Kufri Frysona possessed *UGPase* “A” allele.

03-50

### RESPONSE OF ISOPROTURON AT POST-EMERGENCE STAGE IN DIFFERENT CULTIVARS OF WHEAT

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A study was conducted to observe dose-dependent response of isoproturon on five cultivars of wheat. A pot experiment was conducted with five cultivars (2851, 550, 343, 502, DBW-16) of wheat (*Triticum aestivum*) to study the effect of different doses of isoproturon (0, 2, 3.5, 5, 10, 20 ppm) on growth, physiological and biochemical parameters of plants. Isoproturon treatment at 20 day stage of growth reduced root length, shoot length, fresh and dry mass of shoot and root, leaf area, chlorophyll content, net photosynthetic rate, internal CO<sub>2</sub> concentration, stomatal conductance and water use efficiency significantly at higher doses whereas no significant change was noticed at lower concentrations. The parameters such as lipid peroxidation, proline content and antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD) and peroxidase (POX) showed increase at higher concentration of isoproturon. Thus, moderate dose of isoproturon (5ppm) generated most appropriate response whereas higher doses (10 or 20 ppm) induced toxicity in different wheat varieties at 30 and 45 DAS. Among the different cultivars, cultivar 343 proved tolerant while cultivar 502 proved sensitive for the given isoproturon doses.



# **Session 04**

**Physiology of Flowering and Seeds  
and Plant Signalling**





#### 04-01

### EFFECT OF POLYETHYLENE GLYCOL 6000 UNDER DIFFERENT CONCENTRATIONS ON SEED GERMINATION AND EARLY SEEDLING GROWTH OF TOMATO (*Solanum lycopersicon* L.) ACCESSIONS

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Drought is the major inevitable and recurring feature of semi-arid tropics. Drought tolerance is the ability of plants to survive water deficit stress and to maintain plant growth under water deficit conditions. The aim of this study was to evaluate germination percentage, mean germination rate, root and shoot growth, and root: shoot ratio index in 45 exotic and indigenous accessions of tomato seeds. The drought screening was conducted during Rabi, 2011 at NBPGR regional station, Hyderabad in CRD with 3 replications. Drought stress was imposed through polyethylene glycol 6000(PEG) concentrations of 20 g/l, 40 g/l, 60 g/l and control. The average mean of Control treatment showed final germination percentage of 62.1 %, Seed germination is usually affected by water stress. The results indicated significant differences among accessions under different drought stress levels. In all accessions, a significant decrease was observed with increase in stress level. The result clearly indicated that drought tolerant lines were more tolerant than other lines. Sensitive lines showed very less germination 13.1%, root length 17.4 cm and shoot length 5.2 cm at 60g/l PEG concentration, while maximum germination 74.8%, root length 73.6 cm and shoot length 83.6 cm was observed in tolerant lines. The increase in concentration of PEG solution reduced the germination rate, seedling fresh and dry biomass, seedling vigour index and germination index in all accessions. Mean germination time increased with increase in drought stress. It was concluded that the inhibition in germination at equivalent water potentials of PEG was mainly due to an osmotic effect.

#### 04-02

### INFLUENCE OF PRIMING TREATMENTS ON STRESS TOLERANCE DURING SEED GERMINATION OF RICE

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Higher temperature and aggravating climate extremes have negative effects on agricultural production and the socioeconomic conditions of farmers. Germination and establishment are critical phases in plant life cycle and heat tolerance in germination phase may be important for successful establishment of plants growing in this environment. The main objectives of this study were to investigate the effect of temperature on germination of rice seeds and to evaluate the effects of pre sowing priming with salicylic acid, ascorbic acid, citric acid, proline, calcium chloride and Na<sub>2</sub>HPO<sub>4</sub> with the concentrations 50ppm, 200ppm, 200ppm, 0.2%, 2% and 100ppm respectively in addition to hydropriming on enhancement of seed germination of nine rice varieties under heat stress. The experimental design was Factorial Completely Randomized Design (FCRD). The temperatures used for the experiment were 30°C (control) and 38°C and the soaking duration is 12 hr. Results indicated that an increase in heat stress decreased germination components such as germination percentage, speed of germination, root length, shoot length and vigour index. Ascorbic acid presowing priming @ 200ppm resulted in improvement of germination properties of paddy under heat stress condition because of its antioxidant capacity. However, remaining treatments also showed improvement in germination properties but not at the level of significance.



04-03

### BEHAVIORAL STUDIES IN MAGNETOPRIMED CUCUMBER SEEDS UNDER ARTIFICIALLY AGEING

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Beneficial effects of seed priming are retained if primed seed is stored under conducive conditions (low temperature and low moisture). However, primed seed are known to deteriorate faster during prolonged periods of storage under high temperature and humidity. Magnetopriming is one of the physical dry seed treatments practised for vigor enhancement of seeds of many crops. As it differs from other priming treatments where hydration is a pre requisite, a study was undertaken to examine the changes associated with storage of magnetoprimed seeds of cucumber. Cucumber seeds exposed to static magnetic field (200 mT for 1 h) were subjected to accelerated ageing for 10 days at high temperature and humidity (45 °C and 100% RH) along with control. All germination parameters declined faster in treated seeds compared to control. Germination percentage reduced by 36%, seedling length by 51% in treated seeds compared to 9% and 21% in control seeds after 10 days of ageing. Similarly, vigor indices decreased in primed compared to control. A rapid uptake of water in treated seeds (0.51 fold) compared to control was observed. Water activity of the seed increased by 61% on 4<sup>th</sup> day of ageing in treated seed. Seed leachate conductivity also increased by 71% in treated seeds indicating loss of membrane integrity in these seeds. During seed storage, ROS are generated that result in loss of vigor and viability of the seed. In artificially aged treated seeds of cucumber, hydrogen peroxide content was significantly high. The antioxidant defense system was upregulated in treated seeds that was evident from the increase in activity of antioxidant enzymes viz. superoxide dismutase, catalase, peroxidase and ascorbate peroxidase. Our results evinced that magnetoprimed cucumber seeds deteriorated faster under accelerated ageing and could not be stored for long periods after seed treatment.

04-04

### EFFECT OF SEED SIZE ON GERMINATION AND SEEDLING VIGOUR IN GROUNDNUT (*Arachis hypogaea* L.) GENOTYPES

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Groundnut is one of the important oilseed crops in India. It occupies an area of 6.4 million hectares with an annual production of 9.1 million tones and with a productivity of 1432 kg/ha. In Andhra Pradesh, it occupies an area of 1.7 million ha with an annual production of 2.6 million tones and with a productivity of 1451 kg/ha. The seed replacement rate is very less (17%) in India and moderate (50%) in A.P. In order to bring awareness on usage of quality seed and its significance for enhancing the crop productivity to the extent of 2500 kgs/ ha. Laboratory experiment was conducted to study the effect of seed size on germination and seedling vigour in groundnut genotypes at Department of Seed Science and Technology, College of Agriculture, Rajendranagar, Hyderabad, A.P, India during 2009-2010 duly adopting factorial Randomized Block Design with two factors F<sub>1</sub> (Varieties - JL-24, K6, Narayani) F<sub>2</sub>: Seed sizes (Large -22/64, Medium - 20/64/, Small-18/64, shrivelled seeds - 16/64) and ungraded seed replicated thrice. Large size seed (22/64) recorded higher germination, root length, shoot length, seedling length, seedling vigour index on basis of length and dry weight, brick gravel test, Paper



exhaustion test, endosperm to embryo ratio as compared to medium (20/64), small (18/64) and shrivelled seeds (16/64) and ungraded seed (mixture of all sizes). Shrivelled and small seed sizes have shown reduction in seed viability and seedling vigour parameters. However, the ungraded seed performance in respect of root length, shoot length and seedling vigour was on par with the large seed. Seed quality character like oil content was also higher in large seed than other sizes. This might be due to higher reserve food materials in cotyledons of large sized seed. Seedling development during germination is mostly dependent on transfer of food reserves from the cotyledons. Seed reserves serve as the source for the early seedling growth. The quantity of reserves available to the seedling depends on the size of the seed. Cotyledons of a seed contain both organic and inorganic food reserves. The inorganic reserves constitute the mineral elements which are also mobilized and transfer to various parts of the seed. Electrical conductivity of seed was higher in shrivelled seed as compared to other seed sizes because of less integrity of membrane which resulted in more leakage of organic solutes (free sugars, fatty acids and minerals). It was concluded that seed processing and grading should be by using of 22/64 and 20/64 screens for obtaining better quality seed in groundnut for the benefit of farmers and seed industry personnel.

**04-05**

#### **INDUCTION AND SYNCHRONIZATION OF FLOWERING IN SUGARCANE CLONES FOR HYBRIDIZATION - A RETROSPECT**

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Sugarcane flowers during late autumn and early winter season. Flowering in sugarcane is governed by photoperiod, temperature and nutrition. While flowering is required for the purpose of developing improved varieties by the breeders, it is not desirable from the production viewpoint as it affects both yield and quality. With regard to the response to photoperiod, sugarcane is a qualitative intermediate day length plant (IDP) for induction and quantitative SDP for post-inductive flower development. The flowering process is very sensitive to small micro-environmental variations even within a field. Flowering was highly variable over the years and even within a year. This could seriously impact the crop improvement programs. Another impediment to achieving the planned/desired cross combinations was the difference in time of flowering among the clones within a season. Lack of simultaneous flowering among clones also impedes the planned crosses for crop improvement. The above problems could be overcome to a greater extent by subjecting the plants to optimum conditions for flower induction in controlled-environment facilities. Results using photoperiod facilities since 2001 clearly showed that clones too responded differently to combinations of photoperiod regimes consisting of different commencing day lengths (inclusive of twilight) and declination of day length at various rates. In our experiments, it was clearly demonstrated that a regime with an artificial sunrise and sunset was effective in initiating flowering in sugarcane clones. A photoperiodic regime with a commencing day length of 12 h 45 min decreasing by 60s/day was found to be optimum. In this treatment, 55-60% of the clones recorded initiation and emergence. While fifteen inductive cycles are considered optimum for flower induction, 30 inductive cycles along with 60s/day decrease in day length gave 87.5% initiation on stalk basis. The number of days from flag leaf to panicle emergence was lesser in photoperiod treatment as compared to natural day length. Flowering could be synchronized easily in field-grown early flowering clones by delaying induction and emergence in them by 3-4 weeks without affecting pollen stainability. A consistent delay of flowering in some of the clones resulted in synchronization of flowering time with the late flowering clones enabling the breeders to plan and hybridize clones with divergent flowering dates. Most of these clones had extended flowering time and more panicles were available for crossing at the peak flowering time. The flowering intensity was not reduced because of the delay in flowering time. A summary of the results obtained on the response of clones to photoperiod is briefly reviewed in the context of crop improvement programs.



04-06

### INTERACTION OF ROS AND ETHYLENE IN RELATION TO H<sup>+</sup>-ATPase GENERATED TURGOR PRESSURE DURING GERMINATION

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Cytological studies in the axes of *V. radiata* revealed that cell division is not a requirement for germination. However, cells in germinating axes of 12h imbibed seeds showed some signs of elongation. Water uptake is an important requirement for the germinating axes for generating turgor driven growth. Plasma membrane H<sup>+</sup>-ATPase is an important control point for osmotic build up of turgor. Seeds treated with H<sup>+</sup>-ATPase inhibitor, sodium-ortho-vanadate (Van; 25 mM and 50 mM), remarkably inhibited germination. Germination however, was promoted by ethylene and inhibited by its inhibitor Ag<sup>2+</sup>. Germination was also promoted by H<sub>2</sub>O<sub>2</sub> while it was inhibited by ROS scavengers like propyl gallate (PG) and ROS enzyme inhibitors like NaN<sub>3</sub>. Histochemical localization of O<sub>2</sub><sup>-</sup>, an important ROS precursor, showed its accumulation in the growing region of the axis which coincides with the iP accumulation, a by-product of H<sup>+</sup>-ATPase reaction. Accumulation of O<sub>2</sub><sup>-</sup> was further inhibited by treatment with AgNO<sub>3</sub>. Plasma membrane H<sup>+</sup>-ATPase also extrudes H<sup>+</sup> in the apoplast which may induce cell wall loosening and at the same time causes hyperpolarization required to accumulate osmotically active ions. It was observed that apoplastic H<sup>+</sup> extrusion during germination was greatly reduced by AgNO<sub>3</sub> and PG while it was accelerated by ethylene and H<sub>2</sub>O<sub>2</sub>. Native gel assay of NADPH oxidase (NOX) activity in the germinating axes showed NOX activity in ethylene treated seeds while it was inhibited by AgNO<sub>3</sub> treatments. A mechanism of involvement of NOX activity and H<sup>+</sup>-ATPase activity coordinated by ethylene in regulating seed germination is proposed.

04-07

### AGEING REGULATED ALTERATIONS IN *Cicer arietinum* SEEDS

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Specific knowledge regarding seed quality after harvest and during storage is of particular importance for seed producers and growers. Seeds loose germinability under storage, but the exact biochemical mechanisms underlying seed deterioration are not disclosed completely. Since ageing process is well characterized by many physiological and biochemical changes: leakiness of membranes, macromolecules damaged and deteriorative enzymes activate. As viability loss is well associated with the degradation of cellular macromolecules, the objective of the study was to explore whether the damage induced by accelerated ageing could be related with alterations in protein and nucleic acid along with their oxidative byproducts and deteriorating enzymes. Seeds of chickpea (*Cicer arietinum*) were artificially aged at 40°C and 100% relative humidity. In line to better understand seed conditions, the damage to membranes during ageing was assessed by estimating conductivity of the soaking solution, malondialdehyde (MDA) and total aldehyde. Protease, DNase and RNase were also estimated along with protein, nucleic acid and reactive oxygen species (ROS). Accelerated ageing of seeds involved a progressive loss of membrane integrity, with simultaneous upsurge in ROS and lipid peroxidation products. In addition, significant drop in protein and nucleic acid contents were also reported with seed ageing, but reverse were noticed with protease and nucleases. Remarkable rise in protein carbonyls and extent of DNA deterioration were well connected with ROS production during ageing. We are proposing a model in which different interlinked events contribute to seed ageing, which suggests that protection of cellular macromolecules during ageing is prerequisite for maintaining longevity.



04-08

**INTERACTION OF CALCIUM AND REACTIVE OXYGEN SPECIES IN REGULATION OF GERMINATION AND AXIS GROWTH IN *Vigna radiata***

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Germination in *Vigna radiata* is marked by protrusion of the axis breaking the barrier of seed coat within 12 hours of imbibition. We have demonstrated earlier that reactive oxygen species (ROS) and its associated enzymes such as peroxidases (POX) have an important role in germination and axis growth. In the present investigation we have attempted to find the interaction of calcium, an important signal molecule, with ROS in regulating germination and axis growth. It was observed that treatment of seeds of *Vigna radiata* with  $\text{CaCl}_2$  promoted both germination and axis growth, while  $\text{Ca}^{2+}$  chelator, EGTA, and  $\text{Ca}^{2+}$  channel blocker,  $\text{LaCl}_3$ , inhibited the processes. However, LiCl and TMB8 that inhibits endogenous calcium release by interfering  $\text{IP}_3$  signaling pathway could not inhibit germination. Histochemical localization of ROS using NBT and TMB in the axis revealed total inhibition of  $\text{O}_2^-$  and  $\text{H}_2\text{O}_2$  production in the axes of  $\text{LaCl}_3$  and EGTA treated seeds, while LiCl and TMB8 could not inhibit totally. Spectrophotometric assay of POX activity using  $\text{H}_2\text{O}_2$  and pyrogallol in the germinating axes of seeds treated with  $\text{CaCl}_2$  and EGTA showed that POX activity was dependent on  $\text{Ca}^{2+}$ , as the activity was remarkably inhibited by EGTA while promoted by  $\text{CaCl}_2$ . Native gel assay of POX activity in the axis using guaiacol as substrate further supported the finding that POX activity was inhibited by EGTA while it was promoted by  $\text{CaCl}_2$ .

04-09

**PHYSIOLOGICAL INTERVENTION TO REGULATE THE PRE-HARVEST SPROUTING IN MUNGBEAN (*Vigna radiata* (L.) Wilczek)**

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The field experiment entitled above was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar of state Maharashtra to evaluate the effect of plant growth regulators on yield and physiological intervention to regulate the preharvest sprouting in mungbean in Randomized Block Design. The variety Vaibhav was sprayed with plant growth regulators such as cycocyl (CCC) and Maleic Hydrazide (MH) at 45 DAS. Foliar application of CCC was observed to be most effective in increasing the yield (16%), number of branches per plant (9.13), number of Pods per plant (34.77), number of grains per pod,(12.21), number of grains per plant (423.63), highest 1000 grain weight (37.93 gm.) Followed by MH (8.80, 33.66, 13.10, 441.06 and 37.70 resp.) over the absolute control (5.89, 29.55,11.55, 341.42 and 33.66 resp.) and control (6.00, 28.22,10.77, 304.73 and 34.63 rest.). The MH recorded highest pod weight (10.93) and HI 22.84 followed by CCC (10.86 and 22.72 resp.) over the absolute control (9.79 and 19.54resp.) and control (9.71, 19.31 resp.). In quality parameters CCC application recorded highest vigour index (2901.66) and germination (88.00), and lowest moisture content (10.30 %) followed by MH (2863.33, 88.00 and 11.10 resp.). In the sprouted pod, number out of 10 pods, it was observed in treatments CCC (3.66) and MH (3.66) germinated pod number was less compared to control (6.66) and absolute control (6.33). The foliar sprays of cycocel and maleic hydrazide were found to be more effective and beneficial in increasing yield and reducing the losses of preharvest sprouting by reducing the moisture percentage in mungbean.



04-10

**EFFECT OF DIFFERENT CHEMICALS FOR INDUCING SEED DORMANCY IN RICE  
(*Oryza sativa* L.)**

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Rice is one of the most important food grain crops in the world. Rice is the staple food for most of the people in Asia. The absence of dormancy in the seed, if raining take place at seed maturity, the seed germinates on plants itself and loss in crop production. A loss of 20 per cent rice yield has been reported due to germination on plants itself due to lack of dormancy. During last two years due to late rains during October-November Germination of rice seed on panicles of early varieties take place. Keeping this view an attempt has been made to study the feasibility of inducing dormancy with various concentrations of Maleic hydrazide and NaCl in rice. The field experiment was carried out during *kharif* season of 2011 to study the effect of chemicals for inducing seed dormancy in rice. Three cultivars of rice Ratnagiri-1, Ratnagiri-24, Ratnagiri-711 were planted in the field. For inducing seed dormancy different germination inhibitors viz. NaCl-4 per cent, NaCl-6 per cent, MH-500 ppm and MH 1000 ppm were sprayed during 50 % flowering and 10 days after first spray. The seed dormancy was tested at 100 per cent maturity and at 0, 15, 30, 45, 60 and 90 days of harvest. The variety Ratnagiri-24 recorded significantly less germination over rest of varieties. The variety Ratnagiri-711 recorded significantly higher germination. Treatment T<sub>4</sub> - Maleic hydrazide 1000 ppm recorded significantly less germination 0%, 7.33%, 27.88%, 43.66%, 65.66% and 85.44% respectively at harvest, at 15 days, at 45 days, at 60 days and at 90 days of harvesting over the rest of the treatment. Thus MH 1000 ppm as promising treatment for inducing the seed dormancy in rice.

04-11

**COMPARATIVE ACCOUNT OF SEED PHYSIOLOGICAL TRAITS OF *Saraca asoca* AND  
*Caesalpinia pulcherrima***

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*Saraca asoca* (Roxb.)W.J.de Wilde and *Caesalpinia pulcherrima* (L.) Sw. are the two aesthetically and medicinally important species of the subfamily Caesalpinaceae. Seeds being their main propagule, aspects on viability with respect to moisture content were studied in detail. Roberts (1973) classified seeds in general and accordingly, *Caesalpinia* is orthodox while *Saraca* is found to be recalcitrant. Seeds of these two species could be used as a model to assess their adaptive mechanism acquiring from development to maturation phase. Observations from days after anthesis (DAA) pertaining to seed morphology and physiology were related for a cogent conservancy. Flowering and fruiting of *Caesalpinia* spreads throughout the year preferably more at dry season and usually attains germinability on 70-75 DAA. *Saraca* starts seed set at comparatively dry season though the post dispersal phase suits wet season. Physiological maturity (PM) ranges between 90-100 DAA while 120-140 DAA for harvesting maturity (HM). In both species, seed as well as fruit wall moisture content decreases with development aiding mechanical dispersal. Interestingly, the maturation drying is only with *Caesalpinia* where the gap between PM and HM is lesser than that of the *Saraca*. Observation on seed morpho-physiological traits like development, biomass accumulation, water physiology and viability are to be discussed in details.



04-12

## A SCREENING TECHNIQUE FOR PRE-HARVEST SPROUTING RESISTANCE IN GREEN GRAM

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The genotypic variation and screening of thirty elite green gram germplasm for different morpho-physiological responses and yield attributes with reference to pre-harvest sprouting under simulated rainfall was studied in augmented block design at SRTC, ANGRAU, Hyderabad. The test plants at physiological maturity stage of pod were subjected to weather damage by exposing to alternate wetting by simulated rainfall using overhead sprinklers in open field and drying. The extent of weather damage was best measured as reduction in seed viability and change in the appearance and permeability of the testa of seeds following the exposure. A screening technique of high - Low score evaluation was developed to screen the genotypes into resistant or susceptible to pre-harvest sprouting based on mean performance of all thirty-two morphological and physiological parameters together. The germplasm was classified as high or low depending upon the  $\pm$  standard deviation over mean. On totaling of the High-Low score, based on morphological characters, eleven genotypes were found high, six genotypes medium and thirteen low. Based on physiological parameters, ten genotypes were assessed as high, eight genotypes medium and twelve low. Similarly based on pod and seed characters affected by pre-harvest damage, eighteen genotypes were found high, eight medium and four low. Therefore, evaluation for sprouting parameters after wetting could not be made based on all the thirty-two characters together. Hence, emphasis was made only on four physiological parameters which are directly related to sprouting damage i.e. (i) Rate of moisture absorption (%), (ii) Pods with *in situ* sprouting per plant (%), (iii) Sprouted seeds per pod (%) and (iv) Healthy seed yield (%). Selection made based on the above characters indicated that two varieties i.e., LGG 450 and K 851 with low score as pre-harvest sprouting resistant and ML 267 and MGG 295 with high score as pre-harvest sprouting susceptible. Thus, screening of green gram genotypes will pave the way to develop resistance breeding programme against pre-harvest sprouting.

04-13

## INFLUENCE OF SEED PRIMING AGENTS IN REDUCING THE PURPLE SEED STAIN DISEASE AND ENHANCING SEED YIELD OF SOYBEAN (*Glycine max*)

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Purple seed stain disease caused by *Cercospora kikuchi* reduces seed yield and quality of soybean. Different seed priming agents have been tried both under laboratory and field experimentation at MARS, Dharwad to assess their role in enhancing physiological traits for managing purple seed stain disease on susceptible soybean Cv.JS 335. Under lab condition, carboxin 37.5% + thiram 37.5% @ 0.2% recorded highest germination and root length while, highest shoot length and seedling height were recorded in *Trichoderma harzianum* @ 0.6%, Seed primings tebuconazole 5% EC @ 0.2%, captan 70%WP + hexaconazole 5% EC @ 0.2%, and carbendazim 25% + mancozeb 50% WS @ 0.2% recorded high dry weight. All seed primers generally increased germination and seedling biomass compared to untreated control. In the field investigation seed priming with bio-agent *Bacillus subtilis* @ 0.6% recorded highest seed yield followed by captan 70%WP + hexaconazole 5% EC @ 0.2% and carbendazim 25% + mancozeb 50% WS @ 0.2%. There was positive influence of seed priming agents on both growth and yield attributes apart from minimum infection due to *Cercospora kikuchi* when compared to control. Seed priming with Captan 70%WP + hexaconazole 5% EC @ 0.2% and carboxin 37.5% + thiram 37.5% @ 0.2% recorded completely inhibited the disease infection.



04-14

**PHYSIOLOGICAL MANIPULATION OF PRE-HARVEST SPROUTING IN GREEN GRAM  
(*Vigna radiata* (L.) Wilczek)**

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The production of green grams (*Vigna radiata*, *V. mungo*) in India is limited by the susceptibility of current varieties to pre-harvest sprouting and to reductions in seed quality and viability following rainfall. This paper describes the morpho-physiological characters, ultra structural variations in pods and seeds, changes in enzyme activity, protein profile and regulatory water absorption pathway of thirty green gram genotypes in relation to pre-harvest sprouting behaviour. The genotypes were assessed for the traits responsible for pre-harvest sprouting resistance (or) susceptibility. The genotypes viz., ML 267, MGG 295, MGG 336 and LGG 407 with low epicuticular wax and hard seededness were prone to more weather damage (Simulated rainfall) and considered to be pre-harvest sprouting susceptible. On the other hand the genotypes LGG 450, K 851, PIMS 4 and LGG 460 with contrasting characters were found to be pre-harvest sprouting tolerant. Further the pre-harvest sprouting susceptible genotypes viz., ML 267 and MGG 295 examined under Scanning electron microscopy exhibited deep cracks, pores on pod wall, more number of large elongated trichomes, thin cuticular layer, one celled epidermis, embryo surrounded by large space etc. revealed histological feasibility for water accumulation leading to sprouting. On contrary the tolerant genotypes viz., LGG 450, K 851, PIMS 4 and LGG 460 showed the enhanced activity of  $\alpha$ -amylase, gradual increase of polyphenol oxidase followed by reduced nitrate reductase levels under simulated conditions. An attempt was made to regulate the pre-harvest sprouting damage by employing certain chemical treatments viz., NaCl, sodium molybdate, wax emulsion, neem oil and coumarin. Coumarin, sodium molybdate and NaCl treatments were found effective in reducing the pre-harvest sprouting in both susceptible and tolerant genotypes. Such effect was very high in susceptible genotypes (ML 267 and MGG 295). Chemical regulation of pre-harvest sprouting thus suggest that specific protein molecular markers of globulin fraction viz. 31 kDa in ML 267, 110.5 kDa in MGG 295 and heavy molecular weight protein bands of 140 and 139 kDa of LGG 450 and 154 kDa of K 851 respectively were induced by sodium molybdate, coumarin, and NaCl *de novo* and impart tolerance to pre-harvest sprouting.

04-15

**EFFECT OF HYDROXYUREA AND SODIUM ORTHOVANADATE IN AXIS GROWTH  
DURING SEED GERMINATION**

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Seed germination involves activation of embryonic growth that becomes visible as an elongation of the radicle. Seeds of *Vigna radiata* treated with Hydroxyurea (HU, 50mM), a DNA synthesis inhibitor showed a rate of germination comparable to that of control seeds after 24 hours. Cytological studies of axis tissue from seeds of *Vigna radiata* showed that the cells of axis tissue from 8 and 12 h incubated seeds showed no sign of cell division while a few dividing cells were noted in axis tissue at 16 h and the number of dividing cells increased further in case of 24 h incubated seeds. Thus, DNA synthesis and cell division are not a requirement for expansion of the germinating embryo. Germination is therefore based on the expansion of existing cells. That plasma membrane located plays a role in cell elongation was evident from treatment of seeds with sodium orthovanadate (Van, 25 and 50 mM), H<sup>+</sup>-ATPase inhibitor, which delayed germination. Length of axes was increasing gradually with incubation in both control and Van-treated axes but the increase for the latter was all through lower. In case of fresh weight measurement isolated axes incubated in water (control) showed the highest rate of increase in fresh weight with incubation while the rate of increase was slower in presence of sodium orthovanadate.



04-16

### STANDARDIZATION OF SEED TESTING PROCEDURES FOR GERMINATION AND VIGOUR IN Bt COTTON HYBRIDS

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Cotton is an important commercial crop cultivated in India over an area of 9.6 million/ha. with a total Production of 232 lakh bales. In Andhra Pradesh it is cultivated in an area of 11.34 lakh ha with production of 20.6 lakh bales of lint at an average of 420 Kg/ha. Andhra Pradesh alone is producing and supplying 150 to 160 lakhs packets (750g each) out of 240 lakhs pockets requirement in India. The release of world first commercial cotton hybrid H-4 has revolutionized the cotton production in terms of quality as well as quantity. Subsequently quantum jump in crop production in terms of quality as well as quantity subsequently quantum jump in crop production with introduction of transgenic technology in Bt cotton has played a significant dent in cotton seed production as well as crop productivity. Cotton play a key role in the national economy in terms of employment generation and foreign exchanges, and it impacts the lives of an estimated 60 million people in India including farmers. Availability of seed testing procedures for Bt cotton hybrids is scanty. In order to find out the suitable seed testing procedures, the present investigation on seed vigour and storability in Bt and Non-Bt cotton hybrids (TCH 9, PRCH 31, Rudra, NCS145, NCS 207 and Sandeep) was taken up during 2009 - 2010 at Seed Research and Technology Centre, ANGRAU, Rajendranagar, A.P. Hyderabad, India. Irrespective of Bt & NBt cotton hybrids, between paper method (86%) and sand method (84%) were recorded higher germination than Top-up paper method (83%) and soil method (81%). Among the vigour tests, first count (78%), final count (86%), brick gravel test (81%) and cold test (79%) were recorded higher germination in all the Bt cotton hybrids than Non-Bt cotton hybrids which were superior to speed of germination (74%), field emergence (76%), paper exhaustion test (68%), tetrazolium test for viability. Accelerating ageing test is one of the important tests particularly for predicting the shelf life of the seed and screening against seed deterioration at laboratory. It was concluded that between paper and sand method were found very effective for obtaining reproducible results of germination. Among the vigour evaluation methods first count, final count and brick gravel test were found effective for evaluation of vigour of the seed.

04-17

### EFFECT OF SEED OSMOPRIMING ON SEED GERMINATION AND SEEDLING VIGOUR IN WATER MELON

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In arid region, the crops are sown immediately after rains. In a situation such as this, there is need to develop technology by which the seed germination is enhanced and the uniformity of germination may be achieved. In order to achieve this, seed osmo-priming has been found to be an ideal tool. Thus, an experiment was conducted using water melon as the test material to assess the seed osmo-priming treatment which can give response as desired above. For this, the seeds were primed with different concentration of Sodium chloride, Potassium nitrate, Potassium dihydrogen phosphate and Polyethylene Glycol 6000 solutions for 1, 3, 5 & 7 days. The seeds were washed and stored for one week. Subsequently, the seeds were germinated in distilled water and data on percent seed germination, seedling length and seedling weight was recorded. These data were used to arrive at the germination, germination uniformity and seedling vigour parameters. The results thus obtained revealed that Water melon seeds primed with  $KNO_3$  (15%),  $KH_2PO_4$  (30%) and PEG (15%) improved germination percentage, reduced mean time of germination and improved seedling vigour.



04-18

**EFFECT OF VARIOUS TREATMENTS ON SEED GERMINATION AND DORMANCY BREAKING IN SESAMUM MULAYANUM**

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*Sesamum mulayanum* is a wild relative of cultivated sesame, *Sesamum indicum*, and widely used as a donor plant for resistance genes for pests and diseases in sesame breeding programmes. The drawback with this species is it shows deep seed dormancy. The aim of this study was to enhance the germination percentage and rate of *S. mulayanum*. The efficacy of different treatments including various levels of GA3 (500ppm, 1000ppm and 1500ppm), chilling (4°C) for 7&10 days, scarification and soaking with running water (6 h) for germination improvement was tested. Analysis of variance indicated that Cold stratification and GA3 concentration had significant effects on seed germination percentage. Combined treatments were also tested. Among the combined treatments, maximum germination was obtained at combination treatment cold stratification (10 days) with 1500 ppm of GA3 solution with scarified seed by alleviating seed dormancy in a relatively short period of time and minimum germination was at soaking in running water and control treatments. These results suggested that *Sesamum mulayanum* seeds exhibit combined dormancy.

04-19

**PHYSIOLOGICAL AND BIOCHEMICAL CHANGES ASSOCIATED WITH FLOWER DEVELOPMENT AND SENESCENCE IN *Iris versicolor* L.**

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Physiological and biochemical changes during flower development and senescence in *Iris versicolor* growing in Kashmir University Botanic Garden were studied. Flower development and senescence was divided into six stages (I-VI) from tight bud stage to senescent stage. Average life span of an individual flower after it opens fully is about 2 days. Membrane permeability of tepals was estimated as electrical conductivity of ion leachates decreased as the flower opens but shows a significant increase as the senescence progressed. Floral diameter, fresh & dry mass and water content increased during flower opening and decreased thereafter as senescence progresses. The soluble protein content showed a decrease during flower development and senescence. The protease activity decreased during flower development and increased sharply as senescence progressed. Sugar fractions in the tepal tissues increased during flower development and senescence. From this study, it becomes clear that membrane disruption, decrease in the sugar fractions and increase in protease activity leading to the degradation of proteins are the key changes associated with flower senescence in *Iris versicolor*. Electrophoretogram (SDS-PAGE) of protein extracts from the tepal tissues suggested a constant decrease of low molecular weight proteins as the flower opens and senesces. There is a sharp decline in both high and low molecular weight proteins as the flower senesces after opening.

# **Session 05**

**Physiology of Plantation, Forestry,  
Medicinal & Horticultural Crops and  
Post-harvest Physiology**





05-01

**EFFECT OF WATER STRESS ON GROWTH, PHOTOSYNTHESIS, METABOLIC INDICES AND HERB YIELD IN ACCESSIONS OF *Withania somnifera***

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Cultivation of medicinal and aromatic herbs possessing abundant medicinal values is becoming a convenient and attractive approach in our country to partially substitute for conventional agricultural crops. *Withania somnifera* is one of the most important commercial species which is in great demand by pharmaceutical companies and therefore grown by farmers. However, there is practically no information available on the impact of climate change on its performance and production ability. Water stress is an unavoidable constraint and may not allow the survival, growth and production of this commercial species. Therefore, the present study was aimed to critically examine the responses of different accession lines of *Withania somnifera* to water stress of various magnitude and durations and to identify the best performing accession in terms of growth, photosynthesis, metabolic indices and production efficiency. Intrinsic abilities of three accessions of *Withania somnifera* namely IC 210604, IC 210624, IC 210633 were investigated for relative drought tolerance by conducting pot culture experiment under controlled conditions in the poly house. Plants were subjected to water stress treatments of zero, 25, 50 and 75% water deficit for stress duration of 10, 20 and 30 days. The findings based on the quantum of data collected for growth, production and physiological behaviour revealed differential relative potential to sustain performance and cope with conditions of water stress. The data obtained for growth, herb yield and production efficiency for unstressed and stressed accessions indicated differential responses to imposed levels of water stress. Physiological parameters i.e. photosynthetic rate, chlorophyll fluorescence and transpiration rate and certain biochemical indices i.e. proline, total sugars and amino acids under control and water stress conditions correlated well with growth and herb yield. On the basis of findings of this investigation, IC 210604 was found relatively more tolerant to water stress compared to IC 210633 and IC 210624.

05-02

**EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON PHYSIOLOGICAL PARAMETERS IN SWEET BASIL (*Ocimum basilicum*)**

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An experiment was carried out during Rabi, 2005-06 to study the effect of organic manures (FYM and Vermicompost) and inorganic fertilizer on physiological parameters in sweet Basil (*Ocimum basilicum*). The treatments consisted of T<sub>1</sub> plot as control. Inorganic fertilizer was used in T<sub>2</sub> treatment (N – 120 kg ha<sup>-1</sup>, P<sub>2</sub>O<sub>5</sub> – 60 kg ha<sup>-1</sup> and K<sub>2</sub>O 105 kg ha<sup>-1</sup>). 10 Tons FYM per hectare was applied in T<sub>3</sub> treatment. 3 Tons vermicompost per hectare was applied in T<sub>4</sub> treatment, 5 Tons of FYM + NPK (N – 60 kg ha<sup>-1</sup>, P<sub>2</sub>O<sub>5</sub> – 30 kg ha<sup>-1</sup> and K<sub>2</sub>O 52.5 kg ha<sup>-1</sup>) was in T<sub>5</sub>, T<sub>6</sub> – 1.5 tons vermicompost ha<sup>-1</sup> + NPK (60 kg ha<sup>-1</sup>, P<sub>2</sub>O<sub>5</sub> – 30 kg ha<sup>-1</sup> and K<sub>2</sub>O 52.5 kg ha<sup>-1</sup>). LAI was increased gradually from 15 to 105 DAT and was maximum (2.88) at 105 DAT, with application of inorganic and organic fertilizers maximum CGR at 60-75 DAT, RGR at 45-60 DAT, NAR (2.68 mg / m<sup>2</sup> / d) at 45-60 DAT, SPAD values (chlorophyll content) at 75 DAT (53.45) were found. The Eugenol content (64.66 mg/kg) in T<sub>6</sub> oil content (7.8 ml/kg) in inorganic treatment), total herbage yield in T<sub>2</sub> (144.74 q/ha). While, extinction coefficient (K) was found non-significant.



05-03

### EVALUATION OF *Helicteres isora* L. FROM DIFFERENT LOCALITIES OF WESTERN GHATS FOR DIOSGENIN CONTENT AND ITS ENHANCEMENT USING HAIRY ROOT CULTURES

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Diosgenin is a natural sapogenin of prime importance and heavily used for commercial steroid production. Diosgenin is used as an intermediate in the synthesis of life saving drugs, corticosteroids, sex hormones and oral contraceptives, androgens, and estrogens. In spite of introduction of new precursors like solasodine, hecogenin and tigogenin for steroidal drug syntheses, diosgenin remain the major precursor. The major advantage of *H. isora* as a source of diosgenin is that unlike other sources, diosgenin is not admixed with other steroid sapogenins. Present investigation deals with diosgenin estimation from *H. isora* growing in various locations in Western Ghats region of Maharashtra to get elite genotype(s) in terms of maximal diosgenin content. Organic solvent based extraction was carried out to estimate the diosgenin from the seeds of *H. isora*. The diosgenin content was first estimated by spectrophotometric method by comparing with standard diosgenin content as confirmed by HPLC. Out of the five samples collected from different locations viz; Bhimashankar, Borivali national Park, Sawantwadi, Melghat, Dapoli, the Melghat sample showed highest (0.19%) diosgenin content indicating it as an elite genotype growing at Melghat, containing maximum diosgenin content amongst seeds of *H. isora* growing at all five selected locations. Therefore the plant samples from Melghat region were further used for *Agrobacterium rhizogenes*-mediated transformation to induce hairy roots for enhanced diosgenin content. Hairy roots were successfully induced from leaf explants and their further proliferation is being achieved.

05-04

### REGENERATION IN CALLUS CULTURES OF *Aloe vera*

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*Aloe vera*, is a semi-tropical medicinal plant of considerable importance. It is widely used in cosmetic and drug industry and its demand is increasing day by day. This demand can not be met entirely by vegetative multiplication because the rate of multiplication is very slow and highly dependent on climatic conditions. Thus, the present investigation was carried out with the objectives of optimization the conditions for callus induction, to initiate regeneration in callus culture and standardization of hardening protocol for regenerated plantlets. The microshoot explants were inoculated on MS medium supplemented with varying concentration of cytokinins (BAP/Kn) and auxins (NAA/ 2, 4-D) either added singly or in combination. The culture were incubated at  $25 \pm 2^{\circ}\text{C}$  under 14 : 10 photoperiod with light intensity of 3000 lux. Maximum shoot bud proliferation was achieved at 0.5 mg/l BAP. Profuse callus induction was observed at 0.5 mg/l Kn + 2.0 mg/NAA followed by 0.5 mg/l Kn on MS medium supplemented with 0.25 mg/l Kn + 1.0 mg/l 2, 4-D. was found to be the best for *de novo* shoot regeneration. Maximum root induction in *de novo* regenerated plantlets was observed at 0.25 mg/l BAP. Complete plantlets after hardening showed 80 per cent survival in culture room and 75 per cent in shade house.



05-05

### USE OF PHYSIOLOGICAL TOOLS FOR SAFE GUMMOSIS FOR GUM TAPPING IN KARAYA TREES (*Sterculia urens* Rox B.) IN CHHATTISGARH REGION

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Karaya tree (*Sterculia* species) present in Natural wild and semiwild conditions in dry, rocky hills and plateaus of central and northern region. Chhattisgarh has abundant potentiality of gum and this tree is also used in gum tapping Gum Karaya (Kullu gum, Kullo, kateer) being a commercial product used in food, pharmacy and other industries as petroleum and gas, textile, paper and pulp, leather and allide products, ammunition and explosive, electrical appliances, adhesive, confectionary, medicine, pharmaceuticals and cosmetics. Owing to the lack of scientific tapping technique and post harvest processing it has become difficult to utilize this product optimally. The ICAR Network project on Harvesting processing and value addition of natural resin and gum at IGAU, Raipur center is working since 2008 with the objectives to develop effective technology for safe gummosis in Gum Karaya tree using physiological tools to higher production of gum. Ethephon is a nontoxic, environment-friendly, inexpensive and easily available the plant growth regulator (PGR) manufactured in India and used extensively in agriculture and horticulture. In the present study different concentrations of ethephon was injected in the tree in different months at different temperatures and relative humidity to achieve maximum gum product of superior quality. As compared to the traditional methods the use of ethephon was found to be superior. Its application was found effective in hot months. Gum yield was positively correlated with temperature and negatively correlated with RH (relative humidity). As compared to the higher dose its concentration i.e., 290ug x 4 was found superior over other doses. However, the tree girth and age of tree also play significant role in deciding the dose of ethephon for maximum gum exudation. The gum exudation in karaya tree was highest in April-May, the exudation was 3-4 times as compared to the other traditional methods. Therefore, it is suggested that the gum tapping for commercial purpose be done only during April-May in Chhattisgarh and tree may be given rest in the remaining period of the year. This will ensure the regeneration of tapped trees, sustainable supply of this gum and good economic return.

05-06

### GROWTH AND YIELD OF CERTAIN HEVEA CLONES (*Hevea brasiliensis*) IN DRY SUB HUMID CLIMATE OF NORTH KONKAN REGION IN MAHARASHTRA

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An experiment composed of fifteen clones with objective of evaluating the growth and yield performance of Hevea clones was conducted in Regional Research Station, Dapchari (20.04° N altitude and 72.04° E longitude with 48 MSL), a dry sub humid climate of North Konkan region of Maharashtra in western India. The clones under evaluation were RRII 5, RRII 6, RRII 105, RRII 208, RRII 308, RRIC 52, RRIC 100, RRIC 102, RRIC 105, RRIM 605, PB 260, PB 310, PB 311, PR 255, PR 261. The variation of clones in growth and yield was assessed. The clone RRII 6 and RRII 208 exhibited relatively higher growth. Clone PR 261 was the least vigorous clone. Among the fifteen clones, RRII 208 continued to recorded highest yield. The growth and yield performance and yield pattern of fifteen clones under the agroclimatic condition of the region are discussed. Better initial survival, early tappareability, wide adoptability to initial growth, higher yield of clone RRII 208, RRII 105, RRII 6 indicates their potentiality for as a parents for improving breeding and selection work and for future planting in this drought prone region.



05-07

### TESTING OF MEDICINAL AND AROMATIC HERBS FOR RELATIVE DROUGHT TOLERANCE

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The aim of this study was to screen herb species; having immense medicinal values, for water stress tolerance. Intrinsic abilities of five herb species namely, *Chlorophytum borivilianum*, *Stevia rebaudiana*, *Withania somnifera*, *Andrographis paniculata* and *Salvia sclarea* for relative drought tolerance have been investigated by conducting pot culture experiments under controlled conditions in the poly house. The findings based on the quantum of data collected for growth, production and physiological behavior revealed differential relative potential to sustain performance and cope with the conditions of water stress. The data obtained for growth, herb yield and physiological parameters for unstressed and stressed medicinal and aromatic herb species indicated differential responses to imposed levels of water stress. Comparative performance of five herb species to stress magnitude including zero, 25, 50 and 75% water deficit for stress duration of 10, 20 and 30 days revealed that herb species like *Salvia*, *Chlorophytum* and *Withania* possess better abilities to sustain growth under conditions of water stress. For example, growth and herb yield reduction even at 75% water deficit up to 30 days of stress was substantially less in *Salvia*, *Chlorophytum* and *Withania* as compared to *Andrographis* and *Stevia*. Drought tolerance or susceptibility of herb species was judged based on growth, herb yield and physiological indices. Growth parameters like height, number of leaves, flower no, flower buds, leaf area, root characters, shoot and root fresh and dry weight, etc formed the basis for testing relative drought tolerance.

05-08

### COMPARATIVE ACCOUNT OF SEED PHYSIOLOGICAL TRAITS OF *Saraca asoca* AND *Caesalpinia pulcherrima*

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*Saraca asoca* (Roxb.)W.J.de Wilde and *Caesalpinia pulcherrima* (L.) Sw. are the two aesthetically and medicinally important species of the subfamily Caesalpinaceae. Seeds being their main propagule, aspects on viability with respect to moisture content were studied in detail. Roberts (1973) classified seeds in general and accordingly, *Caesalpinia* is orthodox while *Saraca* is found to be recalcitrant. Seeds of these two species could be used as a model to assess their adaptive mechanism acquiring from development to maturation phase. Observations from days after anthesis (DAA) pertaining to seed morphology and physiology were related for a cogent conservancy. Flowering and fruiting of *Caesalpinia* spreads throughout the year preferably more at dry season and usually attains germinability on 70-75 DAA. *Saraca* starts seed set at comparatively dry season though the post dispersal phase suits wet season. Physiological maturity (PM) ranges between 90-100 DAA while 120-140 DAA for harvesting maturity (HM). In both species, seed as well as fruit wall moisture content decreases with development aiding mechanical dispersal. Interestingly, the maturation drying is only with *Caesalpinia* where the gap between PM and HM is lesser than that of the *Saraca*. Observation on seed morpho-physiological traits like development, biomass accumulation, water physiology and viability are to be discussed in details.



05-09

### MICROPROPAGATION OF *Eulophia nuda* L. A MEDICINALLY IMPORTANT ENDANGERED ORCHID

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*Eulophia nuda* is a medicinally important herb used against tumors, rheumatoid arthritis, bronchitis and blood diseases, due to which it is being heavily exploited by local healers. In addition, the seed germination is very low (5%) in their natural environment because they need specific fungal associations, which even possess a problem for its large scale multiplication. As a result, this plant is now considered as endangered and there is an urgent need for its conservation and large-scale multiplication. Present report deals with its micropropagation using tuber explants. Bud breaking, multiple shooting, formation of protocorm like bodies & callus were achieved in *Eulophia nuda*. Four explants viz. rhizome pieces with sprouted bud, rhizome pieces with dormant bud (eye), Protocorm like body (PLB), and leaf were tested for In-vitro response on MS medium containing 2% sucrose and 0.8% agar fortified with different concentration of PGRs either singly or in combination. Certain additives (Adenine sulfate, arginine, ascorbic acid & citric acid) found to be beneficial for tissue culture response. Up to 7 shoots per axillary bud were obtained, whereas more than 20 shoots were produced per PLB on MS containing BAP and Kin within 4 months of inoculation. Protocorm like bodies were developed from PLBs on MS containing BAP and IAA within three weeks. Callus was obtained from PLBs on MS containing Additives plus BAP and Kin after four months.

05-10

### GAMMA-IRRADIATED CARRAGEENAN ENHANCES THE GROWTH, PHYSIOLOGICAL ACTIVITIES AND ALKALOIDS PRODUCTION OF *Catharanthus Roseus* L. (G.) Don

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Madagascar periwinkle (*Catharanthus roseus* (L.) G. Don). is a herb that contains over 70 kinds of alkaloids present in roots, stems, leaves, and seeds, including some anticancer alkaloids. Therefore, its production is highly desirable. Use of natural bioactive agents obtained from radiation processed polysaccharides as growth promoting substances is an emerging technology to exploit full genetic potential of crops in terms of growth, yield, and quality of plants. Keeping this in mind, a pot experiment was carried out in the net-house of Department of Botany, Aligarh Muslim University, Aligarh to investigate whether foliar application of depolymerised form of gamma irradiated (520 kGy) carrageenan (IC) would be able to improve growth and physiological attributes (shoot and root lengths, leaf area, fresh and dry weights of plant, chlorophyll and carotenoids contents, activities of nitrate reductase activity, carbonic anhydrase and content of leaf -N, -P and -K) as well as alkaloid production in Madagascar periwinkle. Aqueous solutions of different concentrations (0, 10, 50 and 100 ppm) of IC were sprayed seven times on foliage, using unirradiated carrageenan and water as control. Application of 50 ppm of IC significantly improved the growth characteristics, physiological parameters and biochemical attributes. This treatment also increased the total alkaloid content in leaves and roots by 36.8% and 38.8%, respectively. IC at 50 ppm enhanced the values of different morphological and biochemical attributes studied. Thus, this inexpensive technique may be employed to improve the performance of plant including alkaloid production.



05-11

### EFFECT OF PULSED ELECTRIC FIELD PRETREATMENT ON EXTRACTABILITY AND QUALITY OF JUICE FROM CARROT

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The effect of pulsed electric field (PEF) (9000V-50 Hz for 10 s) on the yield and quality of carrot juice was studied. The PEF treatment was given either to the carrot pieces or pomace or both and the effect was evaluated on the total soluble solids, total & reducing sugars, acidity, colour (hunter lab), antioxidant activity, total carotenoids, organoleptic quality & total plate count of the treated carrot juice. It was observed that the juice yield increased by 10.8 % over control when pulsed electric field was given to the carrot pieces. An increase in the total soluble solids, total and the reducing sugars & total carotenoids of the juice was observed for pieces treated with pulsed electric field. An increased antioxidant activity was detected for juice obtained from PEF treated pieces & pomace. Acidity of juice remained unaffected with PEF treatment. The total plate count revealed no significant effect of different treatments on microbial load of juices. No adverse effect of pulsed electric field was observed on the organoleptic quality of the juice.

05-12

### EXPLOITATION OF VARIATION IN NUTRITIONAL QUALITY OF BANANA CULTIVARS FOR HUMAN HEALTH

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Climate change could lead to bananas becoming a critical source of food for millions of people, as rising temperature could provide an opening for cultivation of certain varieties of banana at high altitude. In addition to provide 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 like India. The potential health benefits of carotenoids as anti cancer and antioxidant agents have recently been demonstrated. Banana, *Musa accuminata* in particular, is known to be the richest natural source of  $\beta$ -carotene. So, screening the genetic diversity of major Indian banana cultivars that contain various valuable bioactive compounds, such as carotenoids (specifically  $\beta$ -carotene), carbohydrates and mineral nutrients in the fruit may offer a potential food source for alleviating vitamin A deficiency and malnutrition. Peel of the banana which is thrown as waste may also offer a major source of nutrients as  $\beta$ -carotene and mineral nutrients are also found abundantly. Among the cultivars screened Nendran showed the highest  $\beta$ -carotene both in non edible peel and pulp. The estimated protein content also follows the same trend as banana peel contains more protein than in pulp. 'Red banana' contains the highest starch content in peel (82  $\mu$ g/g peel) and pulp (269  $\mu$ g/g pulp). Next to Red banana, 'Monthan' contain more starch in pulp (212  $\mu$ g/g pulp). Mineral nutrients like Ca<sup>+2</sup>, Mg<sup>+2</sup>, Fe<sup>+2</sup>, Zn<sup>+2</sup> and Mn<sup>+2</sup> also found to present more in peel than pulp. Thus, banana cultivars like 'Red banana', 'karpuravalli' and plantain cultivars like 'Nendran'; 'Monthan' can be regularly exploited for their bioactive compounds. The phytoene synthase (*psy*), a rate limiting enzyme in the carotenoid biosynthetic pathway in banana fruit was isolated and molecularly characterized. The allometric pattern of *MaPsy* expression in peel and pulp will be discussed.



05-13

**PETIOLE NUTRIENT STATUS OF THOMPSON SEEDLESS (VAR) AT BUD DIFFERENTIATION AND FULL BLOOM STAGES IN VINEYARDS AROUND HYDERABAD**

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A nutritional survey of vineyards was carried out for 3-years, aiming to evaluate actual leaf nutrient concentrations at bud differentiation (BD) and full bloom (FB) stages for comparison with published petiole nutrient guidelines (Bhargava and Chada 1993). During the years 2005-06, 2006-07 and 2007-08 sixty, ninety three and fifty three representative vineyards growing Thompson seedless (*Vitis vinifera* L.) were surveyed respectively. In grape (*Vitis vinifera* L.) production, petiole analysis at bud differentiation is often used as the primary assessment tool for in-season fertilizer adjustment. In this study petiole analysis was taken up both at BD and FB stages. Around 100 petioles at 5<sup>th</sup> node position were collected at fruit bud differentiation stage and the petioles were taken from opposite flower clusters near the base of the shoot at full bloom stage. Results from the nutritional survey indicated that N concentrations in many of the sampled vineyards at BD stage fall within or slightly outside the ranges currently considered normal in published standards whereas they fell under hidden hunger category at FB stage. The P content in petioles of most of the vineyards fell in high to toxic range at BD stage while they fell in optimum range at FB stage. The mean N and P content over three years decreased from 1.3 and 0.82 % at BD to 1.19 and 0.66% at FB stage respectively. This could be because of the low temperatures at FB stage. With respect to K an opposite trend was observed, where most vineyards fell within the range considered normal at BD stage where as in high to toxic range at FB stage. The mean K content increased from 2.51% at BD to 3.13 % at FB stage. In case of micronutrients with respect to Cu most vineyards fell in optimum range at BD stage and in high range at FB stage. The petiole content of Mn in many vineyards varied within the ranges given for hidden hunger to optimum at BD stage whereas, at FB stage they fell under hidden hunger range. Irrespective of the stages, the concentration of Fe in petioles most vineyards recorded optimum or high values, except during 06-07 where they fell hidden hunger range. The Zn content in petioles of most vineyards fell in optimum to high range at BD while 14 to 50% vineyards fell in the range of hidden hunger at FB stage. Except Cu where its mean concentration increased from 24.7ppm to 39.3 ppm the concentration of Mn, Fe, and Zn decreased from 76.3, 92 and 65.3 ppm at BD stage to 58, 73 and 58.3 ppm at FB stage respectively. These results therefore indicate that for in-season fertilizer adjustment petiole analysis results at both stages will give more appropriate picture.

05-14

**CURCUMINOID AND ESSENTIAL OIL COMPONENTS OF CURCUMA SPECIES FOUND IN MANIPUR**

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*Curcuma* species are well known indigenous herbal medicine. Rhizomes of different curcuma species exhibit different colours. In order to assess its odour, colour and other physical characteristics, the fresh rhizomes were examined of its morphological appearance. Its main active compounds are curcuminoids and essential oils. The aim of the present paper is to evaluate the curcuminoids and essential oil composition as well as curcumin content of different curcuma species found in Manipur. The curcuminoids and the essential oils were analyzed by TLC and GC-MS, respectively.  $\alpha$ -Phellanderen, terpinolen,  $\alpha$ -zingiberene,  $\beta$ -sequiphellanderen, and  $\alpha$ -turmerone were the main components of essential oils. The curcuminoids were detected as curcumin, desmethoxy curcumin, and bisdesmethoxy curcumin.



05-15

**EFFECT OF PLANT GROWTH REGULATORS ON GROWTH AND CUT FLOWER YIELD OF CARNATION (*Dianthus caryophyllus* L.) CV. DOMINGO IN SECOND SEASON CROP**

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The present study was under taken in a commercial floriculture farm under protected cultivation during July 2010 to February 2011. The experiment was laid out in randomized block design with factorial concept by using three different types of growth regulators at two different concentrations *i.e.*, gibberellic acid (150 and 250 ppm), benzyl adenine and naphthalene acetic acid (250 and 350 ppm) applied at three intervals *i.e.*, immediately, 15 and 30 days after harvesting of carnation flower stalk. These treatments were also compared with control. Among the growth regulators studied GA<sub>3</sub> recorded minimum number of days to bud sprout by increasing the concentrations from 150 to 250 ppm whereas NAA recorded maximum number of days to bud sprout than control. GA<sub>3</sub> also promoted early flowering and reduced the number of days to 50% flowering, colour break stage and harvest of flower stalks with higher concentrations. Floral characters such as flower stalk length, flower length, flower diameter and fresh weight of flower were maximum with GA<sub>3</sub>. BA significantly increased the number of flower stalks harvested per plant and recorded maximum vase life of cut flower with spray of growth regulators immediately after harvest of flower stalk than 15 and 30 days after harvest.

05-16

**EFFECT OF GROWTH REGULATORS ON SHELF-LIFE OF SWEET ORANGE cv. Sathgudi (*Citrus sinensis* Osbeck.)**

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Effect of different growth regulators along with fungicidal wax on shelf life of sweet orange Cv. Sathgudi at ambient (28 ± 1°C, 75 - 80 % RH) and low temperature (10±1°C, 95- 98 % RH) was studied. The fruits were treated with 2,4-D 500 ppm + wax 6%, GA<sub>3</sub> 500 ppm + wax 6%, Benzyl Adenine 50 ppm + wax 6%, wax 6% and control (distilled water) and physico-chemical changes was observed at regular intervals. Among the growth regulators BA 50 ppm + wax 6 % was effective in maintaining the physical and chemical properties followed by 2,4-D 500 ppm + wax 6 %. The efficacy of BA 50 ppm + wax 6 % in prolonging the shelf life of sweet orange fruits was due to reduction of weight loss, spoilage and retention of more juice and peel content with higher firmness. Quality parameters such as TSS, acidity, ascorbic acid, total and reducing sugars along with sensory characteristics was found to be more in BA 50 ppm + wax 6 % followed by 2,4-D 500 ppm + wax 6% at both ambient and low temperature. The storage performance of the fruits was good at low temperature due to low respiratory losses compared to the ambient condition. With increase in duration of storage period, the shelf-life and quality gradually decreased due to spoilage. The fruits treated with growth regulators were better in keeping quality over wax treated and control fruits. The marketable quality of the fruits was good upto 15 days at ambient and 75 days at low temperature.



05-17

### **INFLUENCE OF MICRO NUTRIENTS ON THE CORRECTION OF NUTRITIONAL DISORDERS AND YIELD IMPROVEMENT IN NIRMAL OKRA HYBRID (NOH-147)**

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Okra has been a popular vegetable crop in the tropics because of its easy cultivation, dependable yield and adaptability to varying moisture conditions. It is rich in vitamin-C and calcium and has medicinal value in curing ulcers. This crop is suitable for cultivation as a garden crop as well as on large scale commercial forms. In okra, the deficiency symptoms of phosphorus, potassium, nitrogen and iron have been present. Especially iron symptoms of interveinal chlorosis are one of the severe problems in okra for severe yield reduction. In this study, bhendi crop is highly deficient of iron. The interveinal chlorotic leaves have high iron concentration and it may be partly due to inactivation of iron in the leaves viz., Fe<sup>3+</sup> to Fe<sup>2+</sup> reduction inhibition. Based on these problems, it appears that understanding bhendi plant response to micro nutrients is the basic scientific interest and has potential application in bhendi. With the above background the present study was made on the influence of micronutrients on the correction of nutritional disorders and yield improvements in okra. The present investigation was carried out in farmers field located at near NRC for Banana, Tiruchirapalli, Tamil Nadu during 2009 with five treatments and four replications. The treatments viz., T<sub>1</sub> (control), T<sub>2</sub> (Urea 0.5% + FeSO<sub>4</sub> 1%), T<sub>3</sub> (Urea 0.5% + FeSO<sub>4</sub> 1% + ZnSO<sub>4</sub> 1%), T<sub>4</sub> (Urea 0.5% + FeSO<sub>4</sub> 1% + MnSO<sub>4</sub> 0.5%) and T<sub>5</sub> (Urea 0.5% + FeSO<sub>4</sub> 1% + MnSO<sub>4</sub> 0.5% + Boric acid 0.1%). The chemicals were applied through foliar spray. Two sprays were given, first spray at the time of observation of chlorosis and second spray fifteen days after first spray. All the characters were recorded at vegetative stage, iron deficient stage and harvest stage. The influence of chemical applied was studied in terms of morphological, physiological, biochemical and yield. The data were statistically analyzed (RBD: Randomized Block Design). Among the treatments T<sub>4</sub> (Urea 0.5% + FeSO<sub>4</sub> 1% + MnSO<sub>4</sub> 0.5%) registered highest plant height, number of leaves per plant at all the growth stages and also yield components of number of flowers per plant, number of fruits per plant and fruit weight. This treatment effect was followed by treatment T<sub>2</sub>. The highest chlorophyll a, chlorophyll b and total chlorophyll content was shown in treatments T<sub>4</sub>. The lowest value was registered by T<sub>1</sub>. Based on this experimental result T<sub>4</sub> shows a superiority performance in all the above parameters and this treatment was sprayed at iron deficient stage was very effective to the plant for correcting chlorosis and also increase yield.

05-18

### **INFLUENCE OF PHOTOPERIOD ON BIOMASS AND STEVIOSIDE PRODUCTION**

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*Stevia rebaudiana* is a short day plant, known for its low calorie sweetening agent stevioside. The distribution of stevioside varies within the plant parts and is highly influenced by environmental factors. Thus an experiment was designed to study the influence of *in vitro* environmental conditions particularly the effect of long and short day lengths upon biomass accumulation and stevioside synthesis. Fresh weight of callus subjected to a day length of 16 hr light and 8 hr dark period was better with lesser biomass accumulation. In contrast to this with longer duration of light, the fresh weight was less and dry matter content was more compared to that of short duration of light. The total soluble solids, chlorophyll and stevioside content were directly proportional to the length of day light and longer day length recorded maximum TSS, chlorophyll and stevioside content.



05-19

**PIGMENTS AND ANTIOXIDANTS IN RELATION TO RIPENING OF TOMATO  
(*Solanum lycopersicum* L.) FRUITS**

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Department of Forage Crops Tomato (*Solanum lycopersicum* L.) fruit due to its climacteric nature suffers huge postharvest losses (25 to 40 %). Ethylene is known to play major role in the ripening of tomato. However, free radicals also influence the ripening behaviour. Keeping in view the importance, the changes in the levels of different pigments, vitamin C, phenolics, flavonoids and glutathione and their regulatory role during fruit ripening was studied. Initially, tomato fruits of 10 commercial varieties [at green mature (GM) stage] were evaluated for their ripening behaviour during storage. Based on ripening index (RI %), varieties were categorised as fast ripening, slow ripening intermediate ripening. The above said bioactive compounds were analysed in varieties with contrasting ripening behaviour. With the transition of fruits from immature to GM stage, pigments showed no change but, changes in the levels of antioxidants indicated increase in the level of oxidative stress and tendency of tomato fruit to acclimatise against this change. Correlation between the levels of pigments/antioxidants pointed out the need for better protection of tomato fruits from oxidative stress at the GM stage. In this context, glutathione played an important role during the transition of tomato fruits from immature stage to GM stage. The study pointed out that the higher levels of total chlorophylls, oxidized glutathione and lower levels of vitamin C, total flavonoids and total soluble phenols in the pericarp of tomato fruit at GM stage facilitate the delay in the ripening of tomato fruits. Thus the trigger for senescence/ripening process was due to decrease in the level of chlorophylls, increase in the level of oxidative stress and tendency of tomato fruit to acclimatise itself against this change by enhancing the levels of antioxidants.

05-20

**NUTRIENT MANAGEMENT FOR ENHANCING THE PRODUCTIVITY OF PALMAROSA IN  
RAINFED AGRICULTURE**

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*Cymbopogon martinii* is a species of grass commonly known as palmarosa or rosha grass. This perennial grass is native to Southeast Asia, especially India. The essential oil of this plant contains the active compound geraniol which is valued for its scent and for a huge number of traditional, medicinal and household uses. Palmarosa oil has been shown to be an effective insect repellent when applied to stored grain and beans, an antihelmintic against nematodes and an antifungal and mosquito repellent. However, literature on nutrient management in palmarosa is lacking. Hence, a field experiment was conducted during 2007-08 to study the effect of nitrogen and phosphorus on oil yield and quality of Palmarosa. Four levels of nitrogen viz., 0, 40, 60 and 80 kg N ha<sup>-1</sup> and three levels of phosphorus viz. 0, 20 and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> were evaluated in a factorial RBD with three replications. The rainfall during the crop season was 771 mm and the mean maximum and minimum temperature was 33.5°C and 18°C. The first cutting was done after 110 days of planting at flowering stage; subsequently second and third cuttings were undertaken after 90 and 170 days after first cutting, respectively. The second cutting was delayed due to adverse affect of cold wave during December and January. The results revealed that growth parameters like plant height (222 cm) and number of tillers (28) were significantly higher with application of 80 kg N ha<sup>-1</sup> and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. Similarly, application of 80 kg N ha<sup>-1</sup> and 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> resulted in significantly higher oil yield (45.86 kg ha<sup>-1</sup>) and its quality (acid value and ester value) compared to other treatments.



05-21

**GROWTH, PHYSIOLOGY AND YIELD OF *Capsicum annum* L. cv. G4 AND PUSA JAWALA AS AFFECTED BY INTEGRATION OF INORGANIC FERTILIZER AND WASTEWATER**

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A study was made in the net house of plant physiology, department of botany, Aligarh muslim university, Aligarh to study the comparative effect of wastewater and groundwater along with three different rates of nitrogen (N) i.e. 0, 30, and 60 kg/ha on growth, physiology and yield of two varieties of chilli cv. G4 and Pusa Jawala. Data recorded at 60 days after sowing. Wastewater irrigation resulted significance increase in shoot and root length, fresh weight, dry weight, leaf number and area, net photosynthetic rate ( $P_N$ ), stomatal conductance ( $g_s$ ), water use efficiency (WUE), chlorophyll content, nitrogen, phosphorus and potassium content and yield. The physio-chemical parameters of wastewater met the irrigational characteristics, being well within the permissible limit as outlined by food and agriculture organization (FAO). Among the nitrogen doses 30kg/ha N along with wastewater proved optimum and being add par with 60 kg/ha N along with groundwater. Thus it may be concluded that wastewater reduced the demand of fertilizers and it may be profitably used for the cultivation of chilli.

05-22

**GROWTH, DRY MATTER PRODUCTION, YIELD AND QUALITY PARAMETERS AS INFLUENCED BY SEASON IN GUAR (*Cyamopsis tetragonaloba* L.) GENOTYPES**

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Investigations were carried out at College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad to screen 22 diverse *guar* genotypes to determine suitable season and to assess growth, dry matter accumulation and distribution of major nutrients (N, P and K). The study was also intended to identify the environmental conditions responsible for realization of higher seed and gum yields and to determine the protein and galactomannan content in seeds among genotypes, during the different seasons i.e. *Kharif*, *Rabi* and summer. The results revealed that plant growth in terms of plant height, number of branches, crop growth rate (CGR), relative growth rate (RGR), specific leaf area (SLA), leaf area index (LAI), leaf area duration (LAD) and nutrient accumulation were high in *kharif* season. The yield and its attributes were only marginal. In contrary, *guar* genotypes sown in summer showed moderate to high plant growth attributes with high photosynthetic rates and number of clusters per plant, number of pods per plant, number of seeds per pod, seed yield, harvest index, higher N,P,K accumulation (in leaf and stem) and distribution to seed. During *Rabi*, growth, development, yield and its components and N, P, K accumulation were drastically affected. There was little influence of the season on galactomannan content irrespective of genotypes. The present study clearly indicated that *guar* is warm loving crop and mean maximum temperatures, long days, low relative humidity and long sunshine hours are important for realizing yield potential in *guar* varieties. Hence, it is concluded that sowing *guar* in February as summer crop is highly suitable. Further, among the varieties tested RGM 115, RGM 114, RGC 1033 and RGC 1077 were suitable and recommended based on their stable and higher performance.



05-23

**EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON AVAILABILITY OF NUTRIENTS IN SOIL, UPTAKE AND YIELD OF TOMATO (*Lycopersicon esculentum* L.)**

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Tomato is one of the important vegetable crops grown in India. According to National Horticultural Board (2010), tomato is cultivated in 0.61 million hectares with a production of 11.97 million tonnes and productivity of 19.3 tonnes per hectare. A field experiment was conducted during *kharif* with 10 treatments in Randomised Block Design and replicated thrice, with a view to study the effect of integrated nutrient management on soil available nutrients, nutrient uptake and fruit yield. With regard to available nutrients, they decreased from vegetative to harvesting stage due to removal by crop. The highest available nitrogen of 284.3 and 269.5 kg ha<sup>-1</sup> were found at vegetative stage and flowering in 75% RDN through fertilizers + 25% RDN through Vermicompost, which was on par with 100% RDN through fertilizers and 75% RDN through fertilizers + 25% RDN through Poultrymanure. The highest available P<sub>2</sub>O<sub>5</sub> (48.3, 43.4 and 42.4 kg ha<sup>-1</sup>) and K<sub>2</sub>O (358.6, 350.7 and 332.9 kg ha<sup>-1</sup>) were recorded in 50% RDN through Vermicompost + 50% RDN through Poultrymanure at vegetative, flowering and harvest stage of the crop, respectively and it was on par with 100% RDN through Poultrymanure. The N (24.76, 46.97, 103.76 kg ha<sup>-1</sup>), P (2.86, 6.18, 17.40 kg ha<sup>-1</sup>) and K (13.80, 31.20, 61.82 kg ha<sup>-1</sup>) uptakes by tomato crop at vegetative, flowering and harvest stages respectively, were highest in 75% RDN through fertilizers + 25% RDN through Vermicompost and were on par with 100% RDN through fertilizers and 75% RDN through fertilizers + 25% RDN through Poultrymanure. The fruit yield (84.97 q ha<sup>-1</sup>) of tomato was highest in 75% RDN through fertilizers + 25% RDN through Vermicompost and was on par with 75% RDN through fertilizers + 25% RDN through Poultrymanure and 100% RDN through fertilizer.

05-24

**MORPHOLOGICAL CHARACTERIZATION AND GENETIC VARIABILITY STUDIES IN DOLICHOS BEAN (*DOLICHOS LABLAB* L.VAR. *TYPICUS*) GENOTYPES**

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Forty eight vegetable pole type dolichos bean (*Dolichos lablab* L.var. *typicus*) germplasm lines were evaluated in a replicated experiment at NBPGR Regional station, Hyderabad for pod yield, yield attributing characters and qualitative characters during 2010-11. The analysis of variance, range, mean, genotypic and phenotypic coefficients of variability, heritability and genetic advance were estimated for 19 quantitative characters in dolichos bean. Wide range of variability was observed among the 48 genotypes for 11 qualitative characters. Maximum number of genotypes had green pods with intermediate pod curvature. Maximum number of flowers shows white flowers. The seed colour and shape varied. Most of the seeds shows orange colour with oblong seed shape. Analysis of variance revealed highly significant differences for all traits studied. High genetic variability was noticed for marketable pod yield per plant, number of pods per plant, number of pods per inflorescence, number of inflorescences per plant, length of inflorescence, number of flowers per inflorescence, plant height, pod weight, pod length, 100 seed weight. High values of heritability as well as high genetic advance were recorded for all the characters except for days to first pod harvest, pod width and number of seeds per pod indicating additive action of genes controlling them.



05-25

**DIFFERENTIAL DROUGHT TOLERANCE POTENTIAL OF SEEDLING AND STEM CUTTING (CLONAL) PLANTS OF BIOFUEL PRODUCING TREE *Pongamia pinnata* (L.) PIERRE. IN A SEMI-ARID CLIMATE OF CENTRAL INDIA**

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*Pongamia pinnata* (L.) Pierre. is one of the important biofuel producing tree species which acclaimed much attention for its seed borne oil. Quality of its seed oil and the production potential from the trees created much interest in the research and development aspect with this throughout the globe. Although natural distribution of *Pongamia pinnata* trees is considerably wide from humid to sub-humid locations, its potential for dry agroclimate needs to be vividly explored. The response of these plants in term of its growth and production potential in a dry hot climate would reveal many mechanistic insights which would be useful for further improvement of this plant for increasing economic yield in the context of abiotic stresses mainly drought and atmospheric dryness in the climate change scenarios. At the same time for large scale production of elite planting materials of the plant, performance of the plants raised through mass propagation technique i.e. stem cutting in the harsh climate is also important to be studied at field level. In this direction, differential responses of the two types of plant as raised from stem cutting and seedlings were grown in field at the farm of National Research Centre for Agroforestry, Jhansi in the semi-arid location of the Central India in a bid to decipher the physiological basis of the drought tolerance potential of these two types of plants. The summer of this place is extremely hot during April to June being peak summer in May when the maximum temperature during the day reaches up to about 48°C and minimum temperature also hovers around 33°C. We have conducted comprehensive experiments on the field grown plants and observed clear temporal variation in phenology and water relation parameters depicting the differential responses in maintaining the cellular and physiological functions of the plants. We have observed that during the stress free situations, the difference in maintaining physiological functions mainly leaf water potential ( $\Psi_w$ ) and maximum potential quantum yield of photosystem II was less between the two types of plants. However, during the peak hot summer and stressful situations, the clonal plants (Stem cutting raised) maintained better leaf water potential and enzyme integrity than the seedling raised plants. Along with these important water relation parameters, several other physiological indices proved the better stress tolerance potential of the clonal plants than the seedling plants. Various tangible results in respect to the differential abiotic stress tolerance in seedling and clonal plants of *Pongamia pinnata* have been discussed.

05-26

**VARIETAL CHARACTERIZATION OF CHICKPEA VARIETIES USING CHEMICAL TESTS**

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Varietal characterization of chickpea varieties was undertaken at Seed Research and Technology Centre, ANGRAU, Hyderabad, Andhra Pradesh, India during *Rabi*, 2009-10 to characterize and identify the chickpea genotypes using rapid chemical tests. The material for the study comprised of twenty eight chickpea varieties. Grouping of chickpea varieties could be possible based on reaction of seeds to added chemicals such as modified phenol with  $\text{CuSO}_4$  and modified phenol with  $\text{Na}_2\text{CO}_3$ ,  $\text{NaOH}$ ,  $\text{KOH}$  and  $\text{FeSO}_4$  and seedling response to growth regulators ( $\text{GA}_3$  and 2,4-D). Based on chemical tests, flow chart was developed which is useful for field functionaries, certification officers, seed production officers and seed growers for maintaining quality of the seed and easy identification of chickpea varieties.



05-27

**STUDIES ON THE EFFECT OF GROWTH REGULATORS AND MICRONUTRIENTS ON GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* (L.) Moench) cv. Arka Anamika**

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Okra (*Abelmoschus esculentus* (L.) Moench) popularly known as 'Bhendi' is an important warm season vegetable, widely cultivated for its tender, green fruits. Effect of 13 different treatments involving three growth regulators ( $GA_3$ , NAA and triacontanol) and three micronutrients ( $ZnSO_4$ ,  $FeSO_4$  and Borax), at two different concentrations sprayed at 20 and 40 DAS during the *kharif*, 2011. on growth yield, yield attributes and nutrient uptake. Among the treatments  $GA_3$  at 50 ( $T_2$ ) ppm had resulted in maximum plant height (111.0 cm), minimum number of days to 50 per cent flowering (36.6) and highest number of nodes per plant at harvest (26.7), minimum number of days to first picking (42.6), increased number of days to final picking (84) and highest number of fruits per plant (22.6) compared to other treatments. In case of yield attributes, the highest fruit length (25.5 cm) was recorded with triacontanol 4000 ppm, followed by triacontanol 2000 ppm (24.8 cm) and  $GA_3$  50 ppm (24.3 cm). Among the micronutrients,  $FeSO_4$  0.2% recorded maximum fruit length (19.8 cm) followed by  $ZnSO_4$  0.4% (19.4 cm). The highest fruit diameter (7.5 cm) was recorded with NAA 20 ppm followed by borax 0.2% (7.3 cm). The highest fruit weight (23.8 g) was recorded with  $GA_3$  50 ppm followed by  $ZnSO_4$  0.4% (22.8 g). The  $GA_3$  50 ppm and triacontanol 4000 ppm recorded the highest number of seeds per fruit (54.3) followed by  $FeSO_4$  0.4% (48.3) and  $ZnSO_4$  0.4% (48.3). All the treatments showed increased the fruit yield per plant, fruit yield per plot and fruit yield per hectare compared to control. Among the treatments,  $GA_3$  50 ppm recorded the highest fruit yield per plant (452.4 g), fruit yield per plot (16.19 kg) and fruit yield per hectare (199.9 q) followed by  $GA_3$  25 ppm (373.2 g, 13.5 kg and 166.8 q). Among the micronutrients,  $FeSO_4$  0.4 % recorded the highest fruit yield per plant (290.8 g), fruit yield per plot (10.51 kg) and fruit yield per hectare (129.8 q) followed by  $FeSO_4$  0.2% (284.0 g, 10.07 kg and 124.4 q) respectively. Irrespective of growth regulators and micronutrients and their concentrations all the treatments recorded superior B: C ratios over the control. The highest benefit: cost ratio (5.06) was obtained with  $GA_3$  50 ppm followed by  $GA_3$  25 ppm (4.10) and triacontanol 4000 ppm (3.77).

05-28

**VARIETAL CHARACTERIZATION OF CHICKPEA (*Cicer arietinum*) VARIETIES USING MORPHOLOGICAL TRAITS**

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Varietal characterization of chickpea varieties was undertaken at Seed Research and Technology Centre, ANGRAU, Hyderabad, Andhra Pradesh, India during *Rabi* 2009-10 to characterize and identify the chickpea genotypes using morphological characters. Distinct Uniform Stable morphological characters of seed (seed shape, colour, size, testa texture, ribbing and seed type), seedling (stem anthocyanin colouration) and plant (height of insertion of first flower, number of flowers per peduncle, growth habit, leaflet size, green colour intensity of foliage, flower colour, stripes on standard petal, peduncle length, plant height and pod size) characters were used for twenty eight chickpea genotypes. Based on morphological characters flow chart was developed for each genotype at field level. Distinct Uniform Stable morphological characters have been developed for identification of chickpea varieties (28) which are useful for field functionaries, certification officers, seed production officers and seed growers for quality seed production and easy identification of individual chickpea varieties.



05-29

**STUDIES ON BIOCHEMICAL PARAMETERS OF WINE FROM DIFFERENT VARIETIES OF GRAPE (*Vitis vinifera* L.) FOR WINE PRODUCTION UNDER ANDHRA PRADESH CONDITIONS**

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India has achieved success in table grape production and much emphasis was not given for research on enology. Wine is the oldest fermented product known to the mankind since time immemorial. Wine industry in India is still in infant stage due to limited domestic consumption and lack of standard wine varieties to produce quality wine. Thus production of quality wines by introducing wine grape varieties from major grape growing countries of the world and evaluating their performance to ascertain their suitability for wine making under our climatic conditions is very much essential. Ripening and transformation of grape in to wine involves various biochemical changes under a given environmental condition. Such studies on biochemical properties of wine before and after aging found to be very limited in India. In this regard, an experiment was carried out with thirteen grape varieties (8 coloured and 5 white) for their suitability to wine making under semi- arid tropical conditions of Hyderabad, Andhra Pradesh. The bio-chemical parameters such as volatile acidity (%), alcohol content (%), tannin (%), flavonoids and sensory evaluation both before and after aging of wine was analyzed in different varieties. The decreasing trend was observed for all bio-chemical properties of wine after aging except alcohol content. After aging, the range of volatile acidity (0.010 to 0.065%) in different varieties was found to be below the acceptable limit ( $1 \text{ gL}^{-1}$ ) as per the Indian Standards for wine constituents. The alcohol content of wine in different varieties after aging ranged from 8.78% (Italia) to 12.25% (Shiraz). The wine prepared from coloured varieties showed higher content of tannins and flavonoids when compared to the white varieties due to presence of coloured pigments in skin of berries. The sensory evaluation of wine samples after aging indicated that among the coloured varieties, Shiraz, Cabernet Sauvignon and in the white varieties, Chenin Blanc and Sauvignon Blanc produced quality wine with acceptable limits and were ranked as 'Good' having scale range of 15-17 whereas wine prepared from Ruby Red, Gulabi and Italia varieties were found to produce ordinary quality.

05-30

**INFLUENCE OF VACUUM PACKAGING ON SEED PHYSIOLOGICAL PARAMETERS IN COTTON (*Gossypium hirsutum* L.)**

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A lab experiment were carried out to find out the influence of vacuum packaging on seed physiological parameters in cotton (*Gossypium hirsutum* L.) at Department of Crop Physiology, University of Agricultural Sciences, Dharwad. Freshly harvested Cotton seeds were stored in vacuum packed, Jute bags, Aluminum foil and Cloth bags at room temperature ( $25 \pm 2^\circ\text{C}$ ) as well as cold storage ( $4 \pm 1^\circ\text{C}$ ) for a period of 24 months. During the storage period bimonthly observation for various seed Physiological Parameters *Viz.*, germination percentage, root length, shoot length, total seedling length and Seedling Vigour Index (SVI) were recorded. The results of the investigation revealed that among the treatments cotton seeds were stored in jute bags and cloth bags were recorded significantly very less germination percentage, root length, shoot length, total seedling length and SVI compared to vacuum packed bags followed by aluminum bags. Because cotton seeds are hygroscopic nature, it absorbs moisture from air, if it is stored in an environment condition where relative humidity is higher than moisture content. The rate of absorbance was higher in jute bags, because those are not air tight container, but vacuum packed bags are maintains constant moisture content and theses containers are air tight. The samples stored in vacuum packed bags maintained the quality with least deterioration in all the quality parameters compared to samples stored in jute bags and cloth bags.



05-31

**MORPHOLOGICAL CHARACTERIZATION AND EVALUATION OF TEASLE GOURD  
(*Momordica dioica* Roxb.)**

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A set of 50 female genotypes of spine gourd (*Momordica dioica* Roxb.) collected by the Vegetable Research Station, Rajendranagar in collaboration with the National Bureau of Plant Genetic Resources Regional Station, Rajendranagar, were characterized and evaluated in a randomized block design with 2 replications on trellis system during *khariif* 2012. The analysis of variance revealed highly significant differences among the accessions for the 8 quantitative traits under study. The vine length and number of stems per plant ranged from 1.6 to 4.0 m and 1 to 7.5, respectively. The range of first flowering node and days to first flowering was 8 to 34 and 14 to 46, respectively. Fruit length, width and weight ranged from 3.35 to 5.45 cm, 2.33 to 3.23 cm and 5.8 to 25 g, respectively. Fruit yield per plant ranged between 0.04 and 5.13 kg. From these ranges, it is evident that there was considerable variability in the germplasm for all the characters under study. RNK-186 and RNK-192 produced highest number of stems per plant, while RNK -200 produced longest vine. RNK-185 produced its first flower at the lowest node. RNK-186 was the earliest in flowering. RNK-224 produced highest fruit yield per plant followed by RNK-197 and RNK-200. The characterization on the basis of qualitative traits revealed that RNK-224, RNK-197 and RNK-200 were not only superior with respect to fruit yield but also had desirable quality traits like oblong shape, dark green fruits with thick and hard spines, which are acceptable market quality traits of spine gourd.

05-32

**ORGANOLEPTIC ASSESSMENT OF ALPHONSO MANGO: INFLUENCED BY IRRADIATION AND STORAGE TEMPERATURE**

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The present investigation was conducted at Cold Storage, Navsari Agricultural University, Navsari (Gujarat) India during June-July, 2008 and 2010. The experiment was laid out in completely randomized block design with factorial concept with three repetitions. There were sixteen treatment combinations of irradiation dose (I<sub>1</sub> -0.00, I<sub>2</sub> -0.20, I<sub>3</sub> -0.40 and I<sub>4</sub> -0.60 kGy) and storage temperature (S<sub>1</sub>-Ambient, S<sub>2</sub>-9°C, S<sub>3</sub>-12°C and S<sub>4</sub>-CA storage at 12°C). Export grade mangoes of cv. Alphonso were harvested on 11<sup>th</sup> June 2008 and 12<sup>th</sup> June 2010. The fruits were exposed to gamma radiation for different doses from the source of <sup>60</sup>Co at ISOMED, Board of Radiation and Isotope Technology, Sir Bhabha Atomic Research Centre, Mumbai. The fruits were kept at various temperatures *i. e.* at ambient, 9°C (90% RH), 12°C (90% RH) and at control atmospheric storage (12°C, O<sub>2</sub> 2%, CO<sub>2</sub> 3% and RH 90%). The two years pooled data indicated that the, fruits irradiated with 0.40 kGy gamma rays (I<sub>3</sub>) stored at 12°C storage temperature recorded significantly maximum scores for skin and pulp colour, taste, texture and overall acceptability.



05-33

### PROXIMATE ANALYSIS OF TEASLE GOURD (*Momordica dioica* Roxb.)

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Spine gourd (*Momordica dioica* Roxb.), commonly known as ‘aagakara’ or ‘bodakakara’ in Andhra Pradesh, is an underexploited, underutilized, perennial, dioecious cucurbitaceous crop. Of the total 200 female lines of spine gourd collected in collaboration with NBPGR Regional Station, Rajendranagar and maintained at the Experimental Farm, Vegetable Research Station, Rajendranagar, 18 female genotypes were selected and their mature green fruits were sampled for proximate analysis at the Quality Control Laboratory, ANGRAU, Rajendranagar, during 2010 for determining nutrient, mineral and vitamin values of spine gourd fruits by microwave assisted acid digestion method (AOAC, 1990). The analysis of variance of CRD revealed highly significant differences among 18 female accessions of spine gourd for all the thirteen 1q parameters under study. The moisture content of the fruits ranged from 82.40% (RNK-179) to 88.37 (RNK-45), while the fibre content ranged from 1.62 (RNK-45) to 3.82% (RNK-179). The fat, carbohydrate and protein contents ranged from 0.53 to 1.57%, 6.12 to 9.89% and 7.49 to 12.57 g /100g of edible fruit, respectively. Thiamine, riboflavin and total carotene contents ranged from 0.05 to 0.06 g, 0.009 to 0.986 mg and 6637.57 to 8376.22 µg /100g of edible fruit, respectively. The calcium, copper, manganese, zinc and iron contents ranged from 24.14 to 68.80, 0.50 to 1.49, 1.01 to 2.60, 15.62 to 18.36 and 4.95 to 7.59 mg /100g of edible fruit, respectively. Over all, from these range values, it is evident that there was considerable variation in water, protein, fat, carbohydrate, vitamin and mineral composition of the fruits in the lines of spine gourd under study.

05-34

### GAMMA RADIATION AND STATIC MAGNETIC FIELD AFFECTS SHELF LIFE OF TOMATO

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Present investigation was carried out to delay the ripening of tomato (var. Pusa ruby) and to extend the shelf life using different doses of gamma radiation and magnetic field energy either alone and in combination. Changes in physical characteristics of tomato such as fruit colour, texture and physiological weight loss (PLW), biochemical characteristics such as total sugar, non reducing sugar, antioxidant enzymes (viz. catalase, SOD, peroxidase), total antioxidant enzyme, lycopene, total chlorophyll, ethylene, micro and macro nutrients were recorded at frequent intervals after the exposure of tomato fruit to different energy levels. Based on observations, gamma radiation dose of 0.5 and 1 kGy was found to be most efficient and effective in delaying the ripening and for enhancing the shelf life of tomato. Magnetic energy and the energy combinations were not as effective in delaying ripening process then radiation alone and control treatments. However, gamma radiation enhanced the shelf life of tomato by more than 7 days compared to the untreated tomato.



05-35

### HEALTHY, NUTRITIOUS AND CURATIVE-AMLA FRUIT DRINK

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Amla (*Emblica Officinalis*) has been a very important fruit of Indian origin. It is popularly known as Indian gooseberry and amlaki in Sanskrit language. Amla is small sized, minor subtropical fruit and grows along the hillsides areas of north India. It is highly nutritive and one of the richest source of ascorbic acid. Amla contains 500-1500 mg of ascorbic acid per 100g of pulp. The gallic acid present in amla fruit has antioxidant properties. Due to high nutritious values it has found an esteemed place in ayurvedic and unani preparations. Chawanpras is the dominance of amla. It is used to substitute vitamin C in disease like scurvy. Due to presence of five rasa, it finds its application in decreasing gastric troubles and flatulence. It also helps in restoring mouth taste and helpful in improving liver function. Good results have also been seen in gastric and piles. Amla has a good effect on circulatory system and is of great help in removing toxin in the body circulating in blood; Moreover, it also checks the plaque format in lowering cholesterol and blood sugar level. It is very helpful in countering Kapha, and gives very good results in chronic cough, and allergic asthma. Amla also helps in suppressing vata dosha, therefore it is helpful in paralytic conditions. It also works as brain tonic, makes our reflexes sharp and also improves general intelligence level of a person. It is helpful in conditions like Dysurea, skin diseases and promoting hair growth improves texture of the hair and improving eye sight. Amla comes under the category of rasayan, hence works as anti aging agent. Hence, this valuable fruit should be consumed throughout the year in the form of amla pulp, juice and drink. Considering the importance of this valuable fruits, scientist of the Post Harvest Technology Division, IARI, New Delhi has developed a novel technique for value addition of amla fruit and has been engaged in production and sale of amla drinks under the brand name of Pusa Fruit Drinks with FPO license of cottage scale production unit. The process of production of amla 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 color, flavor and class-II preservative. At the same time the goodness of drink is retained up to 12-15 months with all the nutraceutical properties. The amla drink is highly liked and acceptable to the consumers and possesses a great demand.

05-36

### RESPONSE OF PHOTOSYNTHESIS OF *Dendrobium* cv. EARSAKUL IN DIFFERENT GROWING SYSTEMS

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*Dendrobium* is an important orchid for cut flower and potted plant production. An experiment was conducted to study the photosynthetic response of *Dendrobium* cv. Earsakul to different combination of nutrients, plant growth regulators and plant growth promoting root endophyte (*Piriformospora indica*) under three growing systems viz., two level shade house, top ventilated polyhouse, fan and pad system. The experiment proved that, plants kept in top ventilated polyhouse had significantly higher photosynthesis ( $5.396 \mu\text{mol m}^{-2} \text{s}^{-1}$ ) than two level shade house ( $3.679 \mu\text{mol m}^{-2} \text{s}^{-1}$ ). The photosynthesis in fan and pad system was comparable to top ventilated polyhouse. Significant interaction was also noticed between stages of growth of plants and growing systems. The experiment thus proved that top ventilated polyhouse is better in terms of rate of photosynthesis in *Dendrobium* cv. Earsakul.



05-37

### CHANGES IN RESISTANT STARCH AND AMYLOSE CONTENTS OF COOKED POTATOES STORED AT LOW TEMPERATURES

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Consumption of boiled potatoes stored for one or two days in a refrigerator is a common practice. An experiment was conducted to determine changes in resistant starch and amylose content in potatoes of three cultivars viz. Kufri Jyoti, Kufri Sindhuri and Kufri Bahar cooked by three methods (boiled, microwave cooked, pressure cooked) followed by low temperature storage (-20, 4 and 12°C) for different durations (12, 24 and 48h). Resistant starch content ranged from 1.0 to 1.8 mg/100mg DW. In raw tubers stored at 4°C for 48 h, resistant starch formation was up to 42%, 14% and 21% in cv. Kufri Jyoti, Kufri Sindhuri and Kufri Bahar, respectively. Whereas increase in boiled tubers of Kufri Bahar, Kufri Jyoti and Kufri Sindhuri was 67%, 39% and 23% respectively. After microwave cooking, Kufri Jyoti showed higher increase as compared to other two cultivars and the increase was upto 38% in cooked samples stored at 12°C for 12h. Resistant starch formation was highest in pressure cooked tubers of cv. Kufri Sindhuri. All the storage temperatures and durations enhanced the formation of resistant starch. Under all cooking methods and storage conditions, Kufri Bahar showed the maximum increase in resistant starch formation i.e up to 67% in boiled and cooled tubers. Amylose content was highest in raw, boiled, microwave cooked and pressure cooked tubers of Kufri Sindhuri (23 to 31mg/100mg) followed by Kufri Bahar (18 to 29mg/100mg) and was minimum in Kufri Jyoti (18 to 25mg/100mg). Kufri Bahar potatoes boiled and cooled can provide more resistant starch.

05-38

### POST HARVEST PHYSIOLOGICAL AND ENZYMATIC CHANGES IN GUAVAS HARVESTED AT TWO STAGES OF MATURITY AT LOW TEMPERATURE STORAGE

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The present investigation was carried out at Post Harvest Laboratory, College of Horticulture, Rajendranagar, Hyderabad during Dec-Jan (2009-10 and 2010-11). Fruit firmness, pectin content, pectin methyl esterase (PME) activity, respiration and ethylene evolution rates were monitored during cold storage (10±1°C and 90±5% RH) of guavas (Lucknow-49) harvested at two stages of maturity, Mature Green (maximum growth of fruits is attained and skin colour changes from dark green to light green) and Colour Turning (skin colour turns slightly yellow from light green) treated with Naphthalene acetic acid (100 and 200 ppm), Gibberellic acid (150 and 300 ppm) and Benzyl adenine (25 and 50 ppm). Fruit firmness decreased consistently during storage. Pectin content also decreased with the advancement of storage period. Activity of cell wall degrading enzyme, PME declined gradually till the fruits became ripe, but increased in the over-ripe stage. Likewise, respiration and ethylene production rates also exhibited similar pattern of increase coinciding with ripe stage followed by a decline later. However, the peak in respiration rate was preceded by maximum ethylene production in guava during storage at 10±1°C. Among the calcium treatments, fruits treated with Ca(NO<sub>3</sub>)<sub>2</sub> (2.0%) exhibited longer shelf life and acceptable fruit quality during cold storage.



05-39

### RESPONSE OF POSTHARVEST TREATMENTS AND STORAGE TEMPERATURES ON THE QUALITY AND SHELF LIFE OF PHALSA (*Grewia asiatica* L.) FRUIT

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The aim of the present study was to investigate the effect of HPMC + Stearic acid with incorporation of cysteine on phalsa fruit stored at different temperatures. Effects of these treatments were evaluated on storage life and postharvest quality characteristics of phalsa fruit in terms of its impact on pH, TSS, total sugars, phenols, ascorbic acid, flavanols, anthocyanin, FRAP assay, proteins and their enzymatic analyses which include softening related enzymes (polygalacturonase, pectate lyase). The control fruits stored at room temperature decayed on first day itself while fruits treated with T1, which could be stored up to 2<sup>nd</sup> day and fruits treated by T2 up to 4<sup>th</sup> day. The control fruits stored at freeze temperature decayed on 8<sup>th</sup> day, followed by fruits treated with T1 which could be stored up to 12<sup>th</sup> day and fruits treated by T2 stored up to 14<sup>th</sup> day. The fruits treated with cysteine show higher antioxidant activity than that of control and other treated fruits. The fruits stored at freeze temperature showed extension up to 14 days, which was far better than the fruits stored at room temperature. The fruits stored at lower temperature showed good result as compared to fruits stored at higher temperature. From the present study it can be concluded that all treatments are having significant effect in extending the shelf life of phalsa fruits while improving its nutritional quality.

05-40

### EFFECT OF SOYBEAN EXTRACT ON PHYSICAL AND BIOCHEMICAL PARAMETERS OF SOYBEAN MILK

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The soybean seed comprises lipids, proteins, carbohydrates and minerals. Soybean is valued for variety of nutritional components that provide health promoting benefits. The health promoting activity associated with soy consumption is attributed to the presence of Isoflavones. It has a major proportion of antioxidants in the form of Isoflavones (phenolics). The phenolic constituents of the diet act as antioxidant by virtue of free radical scavenging properties of the constituent hydroxyl group allowing them to act as reducing agents, hydrogen-electron donating agents or singlet oxygen scavengers. In the present study, the antioxidant activity of soybean extracts and soymilk samples has been determined by DPPH scavenging test. Soybean extracts have been prepared by classical extraction process. Soy milk samples have been prepared by hot grinding method and modified Illinois method. The various steps in the processing of soybean milk involved the removal of various anti-nutritional compounds. The impact of addition of soybean extract to soy milk samples has been determined. Results revealed that the soybean extracts had antioxidant activity which influences the antioxidant activity of soybean milk. The percentage of antioxidant activity in soymilk samples increased on addition of soybean extracts. However, this percentage largely depends on the stage at which soybean extract has been added. Antioxidant activity of soybean milk samples showed that processing conditions played significant role in their biochemical properties. These results showed that soy samples have considerable percentage of antioxidants which provide several health benefits and which have the ability to inhibit harmful oxidation process that may lead to the development of beany flavor in soy samples as a result of lipid peroxidation.



05-41

## INTELLECTUAL PROPERTY PROTECTION OF ‘BANAGANAPALLE MANGO’ OF ANDHRA PRADESH, INDIA THROUGH REGISTRATION AS A GEOGRAPHICAL INDICATION

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The mango (*Mangifera indica* L.) crop is one of the most significant agribusiness in India. Mango business in India is based largely on single cultivar ‘Banaganapalle Mango’ which is called as the ‘King of mangoes’ due to its superior characteristics with excellent conditions for domestic and export markets. Andhra Pradesh is a major producer and supplier of ‘Banaganapalle Mango’. The agro-climatic and geographical conditions prevailing in ‘Banaganapalle’ and its adjoining regions have given unique characteristic to ‘Banaganapalle Mango’, which has given firm sustainability for more than 100 years. Hence, it can be an example of possible ‘Geographical Indication’ in India. A pilot project was implemented by the Dr. YSRHU in collaboration with NAARM and APTDC during 2010-11 with the objectives i) identify the origin, ii) to define and characterize ii) to develop production protocols and technical standards, and i) to survey and identify the traditional growing pockets of ‘Banganapalle Mango’. The literature has been extensively reviewed and found that ‘Banaganapalle Mango’ is of ‘Banaganapalle’ origin. ‘Banganapalle Mango’ as an agricultural commodity was defined. The geographical area covering 14 districts (Kurnool, Kadapa, Chittoor, Ananthapur, Prakasam, Krishna, East Godavari, West Godavari, Vizianagaram, Khmmam, Mahaboobnagar, Medak, Adilabad and Rangareddy) was identified as potential growing belt of ‘Banaganapalle Mango’, which was mapped with the help of Geological Survey of India. The method of production has been standardized. The logo has been developed by APTDC. The duly filled is application was filled with GI Registry, Chennai for the registration, which is in progress.

05-42

## EFFECT OF PRE-HARVEST APPLICATION OF PHYTOHORMONES ON LOW TEMPERATURE STORAGE LIFE BEHAVIOUR AND QUALITY OF BABY CORN (*Zea mays* L.)

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The term baby corn was commonly used by the food industry refers to the young flowering corn ear harvested 1-2 days after silk emergence depending on the development conditions of the plant and size of the ear shoot (cob). It is new economic product in the market. Baby corn may be used as fresh or canned. Baby corn is a highly perishable product because of the highest respiration rate among vegetables. Pre-harvest application of phytohormones have known to play a spectacular role in improving quality and shelf life of many fruits and vegetables. Extension of storage life of perishable fruits and vegetables can be achieved by refrigeration. A Field cum Lab experiment was undertaken at Acharya NG Ranga Agricultural University, Hyderabad with the baby corn variety G 5406 at to study the effect of effect of Pre-Harvest application of growth regulators on low temperature storage life and quality of baby corn. at low temperature. All the growth regulators extended extended the shelf life for 6 days over the control. Pre harvest spray of GA<sub>3</sub> 40 ppm followed by cycocel 1000ppm was proved to be promising in reducing the PLW, spoilage per cent, better retention of TSS, reducing sugars, titrable acidity, ascorbic acid and crude protein content.



05-43

### STORABILITY STUDIES IN Bt AND NON Bt COTTON HYBRIDS

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Cotton is an important commercial crop cultivated in India over an area of 9.6 million/ha with a total production of 232 lakh bales. In Andhra Pradesh it is cultivated in an area of 11.34 lakh ha with production of 20.6 lakh bales of lint at an average of 420 kg/ha. Andhra Pradesh alone is producing and supplying 150 to 160 lakhs packets (750g each) out of 240 lakhs pockets requirement in India. The release of world first commercial cotton hybrid H-4 has revolutionized the cotton production in terms of quality as well as quantity. Subsequently quantum jump in crop production in terms of quality as well as quantity subsequently quantum jump in crop production with introduction of transgenic technology in Bt cotton has played a significant dent in cotton seed production as well as crop productivity. Cotton play a key role in the national economy in terms of employment generation and foreign exchanges, and it impacts the lives of an estimated 60 million people in India including farmers. A laboratory experiment was conducted in order to determine the storage potential of Bt and Non-Bt cotton hybrids (TCH 9, PRCH 31, Rudra, NCS145, NCS 207 and Sandeep) at Seed Research and Technology Center, ANGRAU, Rajendranagar, Hyderabad, A.P. India during 2009 – 2010. Accelerated ageing test is one of the important tests particularly for predicting shelf life of the seed and screening against seed deterioration at laboratory conditions. Irrespective of genotypes of Bt and Non-Bt cotton hybrids, TCH-9 (25 months) and PRCH-31 (22 months) had shown better *storability* as compared with NCS-145, Rudra (20 months) NCS-207 (18 months) and Sandeep (16 months). Bt cotton hybrids had better *storability i.e.*, (24 months) than Non Bt cotton Hybrids (14) months with maintenance above seed certification standard of germination (75%) with better retention membrane integrity with lesser total fungal colonies. Such response was more pronounced in PRCH-31 and TCH-9 Bt cotton hybrids. Vapour proof containers of polythene bag (700 guage) was found very effective (24 months) as compared to cloth bag (14 months), poly pouch (16 months) for extending shelf life of seed. Among the seed treatments, imidacloprid was found very effective in extending shell life of seed (24 months) over thiram + carbendazim treatment (18 months) and untreated seeds (16 months). It was concluded that irrespective of Bt and Non-Bt cotton hybrids, seed treated with imidacloprid @ 5g/kg of seed and packed in polythene bag (700 gauge) was found very effective for extending the shelf life of the seed from 12 to 24 months. Irrespective of containers and seed treatments Bt and Non Bt cotton hybrids of TCH-9and PRCH-31 were shown less decline in germination and seedling vigour by accelerating ageing test. These varieties were shown resistance to seed deterioration against adverse factors and considered as resistant varieties under stress conditions and observed better storability.

05-44

### VARIETAL CHARACTERIZATION OF CHICKPEA VARIETIES USING SDS-PAGE

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Varietal characterization of chickpea varieties was undertaken at Seed Research and Technology Centre, ANGRAU, Hyderabad, Andhra Pradesh, India during *Rabi* 2009-10 to characterize and identify the chickpea varieties using Electrophoresis of total soluble seed proteins. The material for the study comprised of twenty-eight genotypes of chickpea. The total soluble seed protein banding pattern of twenty-eight chickpea varieties obtained through SDS-PAGE were conspicuously genotype specific which were enable us to identify a particular genotype based on presence or absence of specific position of a band, staining intensity, relative mobility values and also total number of bands. The electrophoregrams of seed proteins of 28 chickpea varieties revealed their uniqueness in identifying individual cultivars and it was considered reliable and give accurate reproducible results for varietal identification in chickpea.

# **Session 06**

**Natural Resources, Biodiversity,  
Climate Change and Simulation  
Modeling**





06-01

## POSTHARVEST PHYSIOLOGY AND BIOTECHNOLOGY OF HORTICULTURAL CROPS

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Postharvest practices for the preservation of fruits, vegetables, and flowers are perhaps one of the oldest in human history. With the understanding of the molecular processes that occur during plant senescence, this discipline has developed unique features of its own. Traditionally, postharvest science is considered as an applied science focusing on the physiological aspects of enhancement of shelf life and preservation of quality of horticultural produce. However, in the past two decades biochemical and molecular biological aspects have been extensively used for analyzing postharvest issues. Postharvest issues are common around the world. The extent of the loss of horticultural produce after harvest can vary in different countries. In those parts of the world where the methods of agricultural production and storage employ advanced technology, postharvest losses may be minimal, and most of it occurs during the transit of produce from the production site to the destination along the consumer chain. The losses can range from 10 to 20% by volume. In tropics (say India) where the production practices are basic and based on day-to-day demand, the postharvest losses can be as high as 50% or more. It is surprising and a bit disturbing to see that fruits are considered as luxury items in some part of the world. In an era where we consider the consumption of fruits and vegetables as a means of health promotion, postharvest science gets a new meaning. A recent understanding among the growers on the effect of growing conditions on the quality of produce has brought a welcome change in the attitude toward the goals of production. Simply producing a commodity in large amounts need not assure the optimum postharvest quality of the produce. In general, the quality of a produce cannot be enhanced through adopting postharvest storage technologies. The quality of a produce is determined by the growing conditions, nutritional regimes, and the genetic potential of the particular variety. Thus, increased attention is being given to these attributes. Several novel postharvest technologies developed in recent years have the potential to maintain the high quality of produce during subsequent storage at optimal conditions. These include active modified atmosphere and dynamic controlled atmosphere. In addition, there is growing concern about food safety, which is also being addressed in the postharvest area. This work is an attempt to provide some of the advances in basic aspects of postharvest science.

06-02

## GENETIC DIVERSITY OF PEACH (*Prunus persica*) IN UTTARAKHAND HIMALAYAS

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Survey, exploration and collection of Peach (*Prunus persica*) from Uttarakhand Himalayas was done during last 15 years. Scion wood of the identified accessions was collected and grafted for conservation in the field gene bank. A total of 18 accessions having distinct traits of horticultural importance were maintained, characterized and evaluated. Prior to collection of scion wood of a plant, data were recorded on growth habit, incidence of disease, intensity of flowering and fruit setting, time of ripening, fruit size, shape, colour and weight. Organoleptic evaluation of ripe fruits was done on 10 point scale. Total soluble solids (TSS), vitamin C content, carotenoids and total phenols in ripe fruits were estimated. Postharvest life of ready to eat fruits was calculated by storing them at ambient room temperature. The accessions collected from different sites were found to have fairly rich diversity in parameters under study. These accessions may be useful for cultivation as well as for breeding programme.



06-03

### APPLICATIONS OF REMOTE SENSING IN AGRICULTURE

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Agriculture is the world's major user of land, water and biological resources. It is the major source of livelihood of more than 70% of the people of the country. Present day agriculture has two major challenges: increasing productivity to feed the growing population and reducing the environmental degradation caused by the input-intensive agriculture. Earth observation data has enabled achieving sustainable agriculture. Acquiring information about an object / phenomenon on the surface of the earth, without coming into physical contact with it is called remote sensing (RS). RS is the science and art of obtaining information about an object through the analysis of data acquired by a device. Remotely sensed images can be used to identify drought, salinity, crop acreage and production estimation (CAPE), nutrient deficiencies, diseases, water deficiency or surplus, weed infestations, insect damage, hail damage, wind damage, herbicide damage and plant populations. Several satellite remote sensing based approaches are in use for assessment and monitoring of drought. Acreage estimation using RS data has been demonstrated in various parts of the world. RS can also be used to map areas of soils that have been contaminated by salt. Several studies have been carried out with the objective of using remote sensing and vegetation indices to determine crop nutrient requirements and also shown great potential for detecting and identifying crop diseases and weeds. Finally, RS in agriculture is moving toward nano-scale analysis. A new and non traditional remote sensing application involves the implanting of nano-chips in plant and seed tissue that can be used in near-real time to monitor the crop. Clearly, these and other new approaches will reinforce the importance of remote sensing in future analysis of agricultural sciences.

06-04

### INFLUENCE OF ENHANCED CO<sub>2</sub> LEVELS ON SEED QUALITY OF BLACK GRAM GENOTYPES

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The external conditions prevailed during the different growth stages of crop plant influence the seed quality. With the changing climate conditions due to increase in atmospheric CO<sub>2</sub> concentration is expected to influence the productivity of crops and quality of the produce. To determine the impact of enhanced CO<sub>2</sub> on the quality of black gram seed and the variability in the response among the genotypes. 18 black gram genotypes were raised in OTC's under two elevated levels of 550 ppm, 700 ppm CO<sub>2</sub> concentrations along with ambient (380 ppm) condition. The chemical constituents of seed material at harvest such as protein, total soluble sugars, free amino acids, starch, reducing sugars and phenols were quantified in all the genotypes grown under three levels of CO<sub>2</sub>. There is no significant change in average seed protein content at 550 ppm whereas an increase of around 1.0% in protein content was observed at 700 ppm. This could be due to enhanced symbiotic fixation under elevated CO<sub>2</sub> in this legume crop. The total soluble sugars, free amino acids showed increased content of seed at both elevated CO<sub>2</sub> levels whereas reducing sugars and starch content recorded decreasing trend. It was interesting to observe that the response trend was not similar with all the genotypes and the variability can be exploited for developing future varieties to fit into changed climatic conditions.



06-05

### RISING ATMOSPHERIC CO<sub>2</sub> AND ALPINE PLANT SPECIES OF NORTH-WEST HIMALAYA: MORPHOLOGICAL AND PHYSIOLOGICAL ANALYSIS

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Mountain regions, amongst the most fragile environments in the world consisting of alpine and subalpine regions are particularly vulnerable to climate change because of the diverse topography. Vulnerability assessment of alpine ecosystem to climate change requires analysis of physiological plasticity of alpine plants under simulated climate. To study the response of growth forms of alpine plant species to rising atmospheric CO<sub>2</sub>, a study was planned which is a first attempt in alpine region of Tungnath (3600m asl.) in Garhwal Himalaya, India, using Open Top Chambers (OTCs). Different growth forms viz., mat forming forbs, rhizomatous forbs, stoloniferous forbs and prostrate creeping dwarf shrubs were grown at ambient (330-380 μmolmol<sup>-1</sup>) and elevated CO<sub>2</sub> (600-700 μmolmol<sup>-1</sup>) environment to assess morphological changes, photosynthetic characteristics, dry matter allocation and associated biochemical traits in selected alpine species. Study revealed that response of alpine species under elevated CO<sub>2</sub> was species specific. Amongst four growth forms, three growth forms viz. rhizomatous forbs (*Rumex nepalensis*), stoloniferous forbs (*Picrorhiza kurrooa*) and prostrate creeping dwarf shrubs (*Skimmia laureola*) showed positive response to high CO<sub>2</sub> in terms of growth, morphological behaviour, photosynthesis, starch content and dry matter accumulation in shoot and root parts. On the other hand, mat forming forbs (*Plantago major*) showed a negative response to high CO<sub>2</sub>. The study concludes that CO<sub>2</sub> enrichment in alpine region of India will have positive as well as negative impacts on plant species of North-West Himalaya. High atmospheric CO<sub>2</sub> may change their morphological behavior, growth pattern and dry matter allocation, as well as physiological and biochemical alterations. Keeping in view the complexities of harsher climatic conditions in alpine region and the alterations observed in this study gives an insight for future research in this area.

06-06

### CULTIVAR DIFFERENCES IN NITROUS OXIDE EMISSION FROM WHEAT AND ASSOCIATED PLANT PHYSIOLOGICAL AND ANATOMICAL CHARACTERISTICS

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Increasing concentrations of Nitrous oxide (N<sub>2</sub>O) in the atmosphere have serious implications on global climate change. N<sub>2</sub>O is a potent agricultural greenhouse gas influencing stratospheric ozone depletion. N<sub>2</sub>O emissions vary within different crop cultivars. N<sub>2</sub>O emissions were recorded from three wheat varieties viz. Sonalika, DBW 39 and K 0307 to identify plant morphological and anatomical factors responsible for cultivar differences in N<sub>2</sub>O emission. Highest seasonal N<sub>2</sub>O flux (E<sub>soil</sub>) was recorded from DBW 39 (124.84 mg N<sub>2</sub>O-N m<sup>-2</sup>) and lowest from Sonalika (103.25 mg N<sub>2</sub>O-N m<sup>-2</sup>). Scanning Electron Microscopic investigation revealed that stomatal frequency and xylem size of the cultivars are strongly associated with N<sub>2</sub>O emission. Low N<sub>2</sub>O emitting cultivar Sonalika recorded higher grain yield which may be due to greater allocation of photosynthates towards the developing grains and lesser towards the roots. This indicates that efficiency of photosynthate partitioning between source and sink organs of plants may influence N<sub>2</sub>O emission. The diameter of xylem through which transport of N<sub>2</sub>O takes place also plays a decisive role in regulation of N<sub>2</sub>O emission from plants.



06-07

### PHYSIOLOGICAL AND MOLECULAR APPROACHES FOR ADAPTING HORTICULTURE CROPS TO CLIMATE CHANGE

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Climate change is one of the most important global environmental challenges in the history of mankind. The reason for worry is that climate change is taking place at a much faster rate than expected by the human interference. Horticultural production and horticultural science are both intimately involved with the debate and the policy shifts that are occurring around the factors that are closely associated with climate change. Mango, which had been synonymous with Uttar Pradesh, is losing its popularity against lychee with climatic changes affecting production. Commercial production of flowers particularly grown under open field conditions will be severely affected leading to poor flowering, improper floral development and colour besides reduction in flower size and short blooming period. Mild winters may reduce the yield of fruit trees, because colder temperatures are needed to break the buds. Higher temperatures and decreased summer rainfall will cause stress, especially in plants with extensive, shallow, fibrous root systems. To mitigate this problem by using most recent advances in plant physiology for precision phenotyping of heat and drought response, a vital step before implementing the genetic and molecular physiological strategies to unravel the complex multilayered heat and drought tolerance mechanism and further exploration using molecular breeding approaches for horticultural crop improvement. Molecular breeding approaches such as marker assisted back crossing, marker assisted recurrent selection and genome wide selection have been suggested to be integrated in horticultural crops improvement strategies to develop heat and drought tolerant cultivars that will enhance food security in the context of a changing and more variable climate.

06-08

### SELECTION OF RESPONSIVE GENOTYPES TO ELEVATED CO<sub>2</sub> BY ASSESSING THE VARIABILITY IN BLACK GRAM

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An assessment was made to identify superior black gram genotypes for efficient performance at three CO<sub>2</sub> levels (380ppm, 550ppm and 700ppm) under Open Top Chamber condition. Nineteen plant traits grouped under morphological, dry matter and yield components were analyzed while evaluating the performance of genotypes. The quantitative assessment was carried out based on *per se* values and the proposed weighted efficiency index (WEI). Five response trends of plant traits were observed with increasing CO<sub>2</sub> concentration from 380 ppm to 700 ppm *viz.*, i) linear increase; ii) linear decrease; iii) increase up to 550 ppm followed by decrease or no change at 700 ppm; iv) decrease or no change up to 550 ppm followed by increase at 700 ppm; v) no change. Fourteen out of 19 traits showed increasing trend with an increase in CO<sub>2</sub>, while three traits showed decreasing trend for maximum number of genotypes at 550ppm. The study clearly indicated superiority of blackgram genotype IC436610 at 550 ppm and 700 ppm whereas the genotype IC519805 at 700 ppm based on the performance of all the three groups of traits. IC436610 was also observed to be superior for dry weight traits while IC519805 was superior for yield traits over three CO<sub>2</sub> levels based on the WEI criteria.



06-09

### DIFFERENTIAL IMPROVEMENT IN TRANSPIRATION EFFICIENCY OF C<sub>3</sub> AND C<sub>4</sub> CROP PLANTS UNDER ELEVATED CO<sub>2</sub> CONDITIONS

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As the air's CO<sub>2</sub> content rises, most plants exhibit increased rates of net photosynthesis and biomass production and this increase varies for plants with C<sub>3</sub> and C<sub>4</sub> photosynthetic pathways. Plants respond to increase in the air's CO<sub>2</sub> content by reduced stomatal conductance which leads to reduced rates of transpirational water loss. Hence the amount, of carbon gained per unit of water transpired or transpiration efficiency should increase as the air's CO<sub>2</sub> content rises. Sunflower (C<sub>3</sub> crop) and pearl millet (C<sub>4</sub> crop) were grown in Open Top Chambers (OTCs) with ambient (370 ppm) and elevated CO<sub>2</sub> concentration (550 ppm) to determine the water use and transpiration efficiency (TE). Whole plant level TE was determined gravimetrically from seedling to maturity. Elevated CO<sub>2</sub> increased the biomass and grain yield by 22.8 and 26.8% respectively in sunflower and by 7.1% and 3.8% respectively in pearl millet. Under elevated CO<sub>2</sub>, TE<sub>biomass</sub> (biomass produced per unit of water transpired) improved by 10.5% and 21.9% for sunflower and pearl millet respectively. High TE in pearl millet under elevated CO<sub>2</sub> conditions was due to enhanced biomass production (7.1%) and decreased water use (-11.9%) while in sunflower it resulted from a 22.8% increase in biomass and 11% extra water use as compared to ambient condition. Transpiration ratio (TR) which is the ratio of amount of water transpired by a plant during its growing season to the weight of biomass produced, decreased from 370 g H<sub>2</sub>O/g biomass at ambient to 334.2 g/g at elevated CO<sub>2</sub> in sunflower and from 224.4 g/g at ambient to 183.7 g/g at elevated CO<sub>2</sub> in pearl millet. Results clearly show that in sunflower and pearl millet, 9.7% and 18.1% less water was transpired, respectively, to produce a gram of biomass when the CO<sub>2</sub> level was raised from ambient to 550 ppm, suggesting that less water will be required for pearl millet compared to sunflower in future higher CO<sub>2</sub> atmospheres, assuming weather and climate similar to present conditions.

06-10

### VARIABILITY IN PIGEON PEA GERMPLASM WITH RESPECT TO CANOPY TEMPERATURE AND CHLOROPHYLL CONTENT AT DIFFERENT GROWTH STAGES

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Pigeonpea (*Cajanus cajan*) is one of the major food legume crops of rain fed agriculture in tropics and subtropics. Pigeon pea is a drought tolerant crop with a large variations for maturity period. Pigeon pea is a second most important pulse crop in India accounting 3.53 mha area and 2.51 m tons of production with an average productivity of 780kg/ha. Pigeon pea seeds have 24 to 25 % proteins. Seventy two genotypes of pigeon pea along with the check PRG-158 were grown in kharif 2012. Canopy temperature was measured using infrared thermometer and chlorophyll content using SPAD. The canopy temperature ranged from 25.46°C to 32.13°C with a mean of 27.97°C. Chlorophyll content varied from 33.67 to 48.57 with an average value of 39.58. The genotype BAHAR maintained lower leaf temperature (25.46°C) and the genotype NDA-1 had the highest SPAD reading of 48.57. Among the 73 genotypes, 4 genotypes were found to have lower canopy temperature (< 27°C) and 12 genotypes were found to have high chlorophyll content (SPAD reading >42). These characters can be used to identify the germplasm which are adapted to climate change.



06-11

**IMPACT OF CO<sub>2</sub> ENRICHMENT ON PHOTOSYNTHESIS AND PROTEIN PROFILE OF A CO<sub>2</sub> RESPONSIVE BLACK GRAM GENOTYPE**

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Black gram (*Vigna mungo*) Var IC.436665- a highly CO<sub>2</sub> responsive genotype was grown in Open top chambers (OTCs) under three levels of CO<sub>2</sub> i.e. ambient (380 ppm) and two elevated levels 550 ppm and 700 ppm for entire growth period. Photosynthetic acclimation to elevated CO<sub>2</sub> was examined by comparing net photosynthesis rate (P<sub>n</sub>) and change in profile of leaf soluble protein based on SDS-PAGE at three different growth stages i.e. vegetative, flowering and pod setting stages. Growth at an elevated CO<sub>2</sub> concentration resulted in an enhanced photosynthetic capacity. The leaf carbohydrate constituents such as total soluble sugars, reducing sugars and starch content in leaves was monitored at the flowering stage in plants grown at all the three CO<sub>2</sub> levels. The study indicated that photosynthetic acclimation was observed at elevated CO<sub>2</sub> concentration due to down regulation of 52 kDa proteins at vegetative and flowering stages, however It is interesting to record that the photosynthetic rate showed increased trend with elevated CO<sub>2</sub> conditions at these growth stages. At pod setting stage the protein profile was similar to ambient grown plant. It was also observed that starch, total soluble sugars and reducing sugars were accumulated at higher concentration in leaves at elevated CO<sub>2</sub> conditions than the ambient control plants.

06-12

**GROWTH UNDER ELEVATED CARBON DIOXIDE INHIBITS NITRATE UPTAKE, ASSIMILATION AND ASSOCIATED GENE EXPRESSION IN WHEAT (*Triticum aestivum* L.) UNDER NON-LIMITING SUPPLY OF NITRATE**

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Wheat (*Triticum aestivum* L) cv PBW 343 was grown in Hoagland solution devoid of nitrogen (-N) under two carbon dioxide levels viz. ambient (370 µl/l, AC) and elevated (600±50 µl/l, EC) for twenty days in growth chambers. The rate of uptake, assimilation and accumulation of nitrate was compared. At low external nitrate concentration of (upto 0.5 mM), rate of nitrate uptake was more in EC grown seedlings as compared to AC grown seedlings. Under non limiting supply of external nitrate the rate of uptake declined in the EC grown seedlings. Nitrate reductase (NR) activity was high in EC grown seedlings at low external concentrations of nitrate. High NR activity was observed in AC grown plants as compared to EC grown plants at very high concentrations of external nitrate. EC grown plants had low level of accumulation of nitrate in shoots, when the nitrate availability was limiting, indicating lower influx towards storage pool and more availability of nitrate in metabolic pool. Decline in rate of nitrate uptake under EC in comparison to AC under high external concentrations is probably due to limitation in translocation of nitrate from root to shoot leading to higher accumulation of nitrate in roots of EC grown seedlings or decline in expression and activity of nitrate reductase enzyme. Increasing nitrogen fertilization therefore, may not compensate for slower NO<sub>3</sub><sup>-</sup> assimilation rates under EC, as uptake and assimilation both decline under nitrate sufficient conditions. Effective management practices and changes in the pattern of fertigation may be required in response to rising atmospheric CO<sub>2</sub> levels for wheat production.



06-13

### INTENSIFYING MANAGEMENT OF DECCANI SHEEP VIS-À-VIS PRODUCTION PERFORMANCE AND PHYSIOLOGICAL STATUS

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The present investigation was carried out at Instructional Livestock Farm, Hayatnagar Research farm (HRF), Central Research Institute for Dryland Agriculture (CRIDA), Hayatnagar, Rangareddy district, Hyderabad, India to document the process of intensification with respect to productivity of Deccani sheep. Eighteen growing lambs (Deccani breed) with an average body weight of 12 to 16 Kg were selected and were randomly distributed into three groups of six animals (three males and females each) taking into consideration the group averages of body weights in all 3 groups were as uniform as possible. First group of animals (Under Extensive system-Control) were kept with 100% grazing conditions and no concentrate supplementation; second group (Under Semi-intensive system-T<sub>1</sub>) was offered restricted grazing hours as well as restricted concentrate supplementation (100 gms/day) and third group (Under Intensive system-T<sub>2</sub>) was offered *ad lib* concentrate and 200 gm roughage on DM basis in the pen. Animals kept under intensive system (18.50±1.50) of rearing could achieve superior body weight as compared to extensive (17.20±1.21) and semi-intensive system (17.83±1.33) of rearing. The value in all systems of rearing was found to be within physiological limits (respiratory rate (45-75 per minute) and rectal temperature (103.38±0.19)) and there was no significant difference between the groups. However, the animals kept under intensive system of rearing showed least fluctuations in the rectal temperature as compared to those kept under extensive and semi-intensive system of rearing. The faecal egg count (egg per gram) was maximum under Control as compared to Group T<sub>1</sub> or T<sub>2</sub> which could be brought under control by anthelmintic treatment to a greater extent in T<sub>2</sub>. So, it can be concluded that Deccani sheep are well adapted to intensive system of rearing which was found to be superior to extensive system of rearing. Further study need to be investigated in the area of effect on immune status and genetic reasons for better adaptability to intensification in some breeds of sheep.

06-14

### INTERACTION OF ELEVATED CO<sub>2</sub> AND MOISTURE STRESS ON GROWTH AND YIELD OF BLACKGRAM

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Under the present global scenario of CO<sub>2</sub> increase, changes in temperature and water availability affect growth and many key metabolic processes in plants. An attempt was made to understand the interactive effect of the elevated CO<sub>2</sub> and moisture stress on growth and yield responses of blackgram (*Vigna mungo* L. Hepper) cv T-9. The plants were raised in Open top chambers (OTCs) at three levels of CO<sub>2</sub> i.e. 380 ppm, 550 ppm and 700 ppm and moisture stress was imposed by withholding irrigation at flowering stage. At harvest the total biomass recorded an improvement of 18.9% at 550ppm and 23.0% at 700ppm under irrigated conditions where as the improvement was 7.8% and 19.2% under moisture stress conditions at respective CO<sub>2</sub> levels. Similarly, the seed yield recorded 26.4% and 58.9% improvement under irrigated conditions and 8.6% and 34.2% under moisture stress conditions at 550ppm and 700 ppm respectively. The moisture stress reduced the total biomass, seed yield and HI at all three CO<sub>2</sub> levels, however the magnitude of reduction differed at different CO<sub>2</sub> levels. The ameliorative effect of enhanced CO<sub>2</sub> on seed yield of blackgram under moisture stress condition was found to be due to maintaining better pod number as compared with ambient control.



06-15

**PHYSIOLOGICAL PERSPECTIVES OF IMPROVING CLIMATE CHANGE (DROUGHT & HEAT STRESS) ADAPTATION OF DRYLAND SORGHUM IN SEMI-ARID TROPICAL CONDITION**

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Sorghum (*Sorghum bicolor* (L.) Moench) is the major nutritional coarse grain cereal crop grown for food, feed, fodder and bioenergy in India and around the world. In India, it is grown over 7.65 m ha both in rainy (3.00 mha) and post-rainy (4.65 mha) seasons. Abiotic (drought and heat stresses occurring during pre- and post-flowering stages) reduce sorghum productivity. Average yields are  $\approx 1.0$  t ha<sup>-1</sup> due to negative impacts of abiotic and biotic stresses, besides climate change and its variability. Phenotyping of sorghum germplasm carried out for last two decades with objective of identifying the key drought and heat adaptation traits that determine stress tolerance and productivity, besides isolating potential donors to be used in breeding under future climate change scenarios. Newly developed test kharif hybrids had superior sink potential, grain yield and HI than inbreds, while, test inbreds showed greater biological yields over hybrids. *Rabi* advanced test varieties have produced high biomass (25-28%) than hybrids, while, photosynthetic rate (Pn), post-anthesis assimilate production were higher in hybrids (8%). Several *rabi* landrace germplasm were characterized for drought adaptation and potential ones identified include NIC21282, IS40298, RSLG330, RSLG191, *Phulmalliga*, *Haligajola*, *Kumbanigoan local*, *Yermala local*, *Wakadijoot 2*, RSV407, RSV113, RSV398, RSV399, RS400, RSV412, RSV414, CRS1, CRS 4, BRJ 366 etc. Entry RSLG 262 had 4 % and 20.7 % higher photosynthetic rate than M35-1 and Sel.3 res. RSLG 262 gave 11% and 36% higher grain yields than M35-1 and Sel.3 in medium soil and 17 and 35% in shallow soil respectively, in twenty multi-location trials. RSLG262 was released as *Phule Maulee* for shallow to medium soil regions Maharashtra state and had desirable drought and heat tolerant phenes (traits). Foliar sprays of ‘K’ at 45DAS, and at boot stage had increased the grain yield by 21-32% over control in *rabi* sorghum. Ethanol foliar spray @ 2% on *rabi* sorghum resulted in increase of photosynthesis rate and TE by 25% and 31% resp. Grain yield increased by 19-24% at 1-2% ethanol spray application. In SPAD chlorophyll meter readings, QL10, B35 and CRS4 (41.1-53.0) were superior. CRS4 maintained lower membrane injury (35.9-38.5%) under post-flowering drought and heat stress. The carbon isotope discrimination i.e.,  $\delta^{13}C$  values ranged from 4.351 to 6.05‰. Cv. E36-1, CRS4 recorded relatively low  $\delta^{13}C$  values (4.86 and 4.92‰) under terminal heat stress, besides produced relatively higher grain yield. *Rabi* adapted sorghums showed 19-12% more root length over staygreen ones and *Phule Maulee*, Sel 3, E36-1\*R16 3/1 possessed relatively deep and thick root. To improve the sorghum for climate resilience, phenes (traits) to be considered are early phenology (drought escape), membrane thermostability, relative leaf water content, high Pn rate at panicle initiation and anthesis, high SPAD values, specific leaf nitrogen, chlorophyll stability, visual staygreen & plant rating, high rate and duration of grain filling, etc. The implication of these results is discussed for improving the climate change (heat & drought tolerance) adaptation and productivity of dryland sorghum in rainfed agro-ecosystem.



06-16

**MOLECULAR CHARACTERIZATION OF ALLELIC VARIATION IN SPONTANEOUS BROWN MIDRIB MUTANTS OF SORGHUM (*Sorghum bicolor* L. Moench)**

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Lignocellulosic ethanol is a valuable resource of renewable energy and an alternate for reducing green house gas pollution. The recalcitrant nature of lignin decreases the yield and increases the cost of lignocellulosic biofuel production. *Brown midrib (bmr)* mutants with altered lignin and enhanced glucose yields are valuable resource for modifying and enhancing the saccharification potential of lignocellulosic biomass. In the present study, four spontaneous *bmr* mutants of sorghum were analyzed for allelic variation at two candidate gene loci viz. *CAD2* and *COMT*. cDNAs of these two genes were cloned and sequenced from these mutants and wild type sorghum. Sequence analysis revealed that *bmr* mutants IS23789 and IS23253 share a new allele of *CAD2* and have a G191R substitution in the *CAD2* protein sequence. These two mutants can be distinguished by an Intron Length Polymorphic Marker developed based on the *COMT* gene sequence in this study. Mutant IS23549 which also has been assigned to *bmr6* group was found to have another new allele with A164V substitution in *CAD2* protein. In mutant IS11861, there was no mutation that leads to change in amino acid in *CAD2*, while a T302S substitution was found in *COMT*. This SNP at position 2645 in *COMT* gene was converted in to CAPS marker that can be used for its identification. Besides these, additional SNPs and/or indels based markers were developed, which can be used for exploiting these alleles in molecular breeding of sorghum for dedicated bioenergy feedstock.

06-17

**DOMESTICATION AND CONSERVATION OF ENDANGERED AND UNEXPLORED FLORA – A CASE STUDY**

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Plants play an integral role with human beings since time immemorial. Sustainable usage of these precious biological resources is very important for the development of country. Every plant has possessed its importance either ecologically or economically. Many plants are used as source of medicine and raw materials obtained from the natural habitat are used in most of the pharmaceutical industries. Precious plants are exploited legally or illegally from the natural habitat that leads to habitat destruction and put tremendous pressure on the population size. Whereas, Country cannot be developed until the biological resources are used in a sustainable manner. Therefore, this present study focused on identification of endemic, endangered and unexplored plants from Garhwal Himalaya and Western Ghats to bring into day-to-day usage towards betterment of humanity. The identification starts with survey and collection of ethno botanical usage from ethnic communities and conservation of germplasm by means of *in-situ* & *ex-situ* strategies. Domestication by using ammonium assimilatory enzymes as biochemical markers against adaptation, large-scale cultivation and investigation of biological activities are other parameters for validation. The results indicated evolving the adaptation strategy, commercial cultivation parameters are the major break through for popularization and sustainable usage of unexplored plants.



06-18

### SOLAR UV-B/UV-A EXCLUSION EFFECTS ON GROWTH, PHOTOSYNTHESIS, RUBISCO ACTIVITY AND YIELD OF C<sub>3</sub> AND C<sub>4</sub> PLANTS

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Current and projected increases in ultraviolet-B (UV-B) radiation may alter crop production. The field experiment was conducted for the comparative study of the effects of ambient UV-B/UV-A by the exclusion of solar UV components on growth, photosynthetic performance and yield among C<sub>3</sub> (cotton and wheat) and C<sub>4</sub> (*Amaranthus* and *Sorghum*) crop plants. The plants were grown in specially designed UV exclusion chambers, wrapped with Polyester filters that excluded both UV-A/B (< 400 nm), UV-B (< 315 nm) and grown under a filter transmissible to UV (FC) and in open field (OC) with no filters. The experimental results showed that all the four crop species response to exclusion of UV-B/UV-A irradiation was significantly increased plant height, leaf area, biomass of leaves and total biomass accumulation. The photosynthetic performance of the leaves was characterized by simultaneous measurements of photosynthetic pigments, gas exchange parameters, *Chl a* fluorescence and the activity of Rubisco by fixation of <sup>14</sup>CO<sub>2</sub>. The photosynthetic pigments were significantly increased while UV-B absorbing compounds were significantly decreased after exclusion of UV-B and UV-A/B in all crop species. UV exclusion increased the performance indices of all the four crops, this response was governed by a significant increase in RC/ABS, marginally non significant increased Fv/Fm and significant increased ETo/TRo. More over quantum yield of electron transport and estimated electron fluxes per cross section of leaf sample and the number of active RC of PS-II were increased in all the four crops, which lead to the increase in carbon uptake in these plants. Compared to filter control and open control the exclusion of solar UV, specifically UV-B exclusion significantly enhanced the net rate of photosynthetic and stomatal conductance along with a remarkable increase in Rubisco activity and amount of soluble proteins in all four crops. The results suggested that ambient UV-B induced limitations of growth and reduction in rate of photosynthesis appeared to be due to a decreased PS-II performance and significant decreased Rubisco activity. The presence of UV component in sunlight seems to arrest carbon sequestration in the crop plants. Thus UV exclusions increased light utilization efficiency and CO<sub>2</sub> fixation in these crop plants and channelized the additional fixation of carbon towards enhanced biomass accumulation/ improvement of yield. Cotton (C<sub>3</sub> dicot) and *Amaranthus* (C<sub>4</sub> dicot) showed more enhancements compared to Wheat (C<sub>3</sub> monocot) and *Sorghum* (C<sub>4</sub> monocot) after solar UV exclusion. It indicates that dicot are more sensitive to current level of UV than monocot.

06-19

### COMPARATIVE RESPONSE OF C<sub>3</sub> AND C<sub>4</sub> PLANTS TO INCREASE ELEVATED CO<sub>2</sub> LEVEL

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In order to study C<sub>3</sub> and C<sub>4</sub> plant growth in atmospheric CO<sub>2</sub> levels past through the future levels. Ground nut (C<sub>3</sub>) and pearl millet (C<sub>4</sub>) were growing from seed in growth at 30 days compared to chamber control. Various review on the response of different crops revealed that an increase in CO<sub>2</sub> has positive effect on the plant biomass. The results showed significant differences between crops for all the characters studied via; shoot dry weight, leaf dry weight and total dry weight showed a significant increase under enhances CO<sub>2</sub> condition. Among the C<sub>3</sub> and C<sub>4</sub> crops overall results showed the highest biomass response to elevated CO<sub>2</sub>.



06-20

## ENERGY RICH SUGARCANE: PROMISE FOR FUTURE AS AN ALTERNATIVE SOURCE OF BIOENERGY

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In recent years, with the increase in standard of living, the per capita energy consumption has increased substantially. The world energy consumption is expected to increase multifold by 2025 with much of the energy growth occurring in rapidly expanding economies including India. Fossil fuels such as coal, oil and natural gas currently supply 86% of the world's energy, and that will be used up in the foreseeable future. So the only way is to increase the energy availability through alternate sources. Among all crop plants, sugarcane which efficiently converts solar energy in to biomass has been ranked as a prominent crop supporting various agro industries (feed, bagasse, alcohol, paper and electricity) in addition to sucrose production. Quantification of energy produced by cane plant and variation among different varieties and germplasm is extremely important in commercial exploitation of sugarcane as a renewable and sustainable bioenergy crop. Accordingly, a field experiment was conducted during 2011-12 crop season utilizing six sugarcane varieties (Co 86032, Co 94008, Co 99004, Co 62175, Co 0218, and Co 0314) for assessing their energy production potential. The energy production in terms of calorific value of individual plant parts (leaf, leaf sheath and stem) was assessed at different growth phases (formative, grand growth and maturity) in these varieties. The energy production potential in the leaf tissue varied from a minimum of 2681 kcal/kg in Co 0314 to a maximum of 4025 kcal/kg in Co 99004 at formative phase. Varieties Co 94008 and Co 86032 recorded 3607 and 3228 kcal/kg, respectively. In the sheath tissue, the calorific value varied from a minimum of 2371 kcal/kg in Co 99004 to a maximum of 3805 kcal/kg in Co 86032. The stem of variety Co 99004 recorded a maximum of 3488 kcal/kg followed by Co 86032 which has recorded 3295 kcal/kg. At grand growth, the energy production potential was appreciably high in stem. Varieties Co 94008, Co 99004, Co 0314 recorded more than 4000 kcal/kg. It was obvious that stem contribution towards energy production was extremely high in all cane varieties. At harvest, leaf tissue of Co 0218 exhibited maximum energy production of 4131 kcal/kg while the stem of variety Co 99004 possessed maximum energy content of 4029 kcal/kg in stem. The stem of varieties Co 86032, Co 94008, Co 62175 and Co 0314 produced 3856, 3825, 3840 and 3825 kcal/kg, respectively, at harvest. Varieties which produced more biomass (>4.00 kg/m<sup>2</sup>) also endowed with more energy production potential. The average partitioning of dry mass in to leaf, sheath and stem was 16.87, 9.31 and 73.82%, respectively, suggesting greater dry mass production by stem which contributes as a greater energy storage compartment. In future, a drift towards energy generation is likely to occupy a prominent place in cane agriculture and identification and evolution of energy rich sugarcane varieties is the need of the hour. Since sugarcane cultivation is predominant in tropics and subtropics of India, it is important to explore and use the cane crop for energy generation in addition to sucrose.



06-21

**ANALYSIS OF PRODUCTIVITY POTENTIAL OF MAJOR RAINFED LEGUME CROPS UNDER PRESENT AND FUTURE CLIMATE SCENARIOS IN INDIA**

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The objectives of the study were to calibrate and validate crop growth models and use them for spatial and temporal assessment of production potential of major rainfed legume crops across major regions of their cultivation in India. InfoCrop model was calibrated and validated for soybean and groundnut and performance of these models was found to be satisfactory across wide range of environments and agronomic practices. These models were used for soybean and groundnut and DSSAT CROPGRO-Chickpea for simulation of crop growth and yield under current and future (A1B 2030 and A1B, B2 and A2 2080) climate scenarios under rainfed conditions. On an average, a positive impact of projected future climates (combined effect of changed temperature, rainfall and CO<sub>2</sub> levels) on soybean yield ranging from 8-13% as compared to baseline simulated yields was observed. Similarly, groundnut showed an average increase in yield ranging from 4 to 7% except for A1B 2080 scenario where the average yield declined by 5% as compared to baseline yields. Among these crops, the maximum positive impact of future climate was observed for chickpea which showed an average increase in yield ranging from 23 to 54% under future climate scenarios as compared to baseline yields. However, there were wide variability in the quantum of change in yield across the crop growing regions. Simulated soybean and groundnut yields showed a significant positive association with crop season rainfall while chickpea yields were significantly associated with crop season temperature.



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