



National Seminar
on
Sustainable Crop Productivity through
Physiological Interventions

(November 24-26, 2011)

Organized by
Department of Life Science
Ramnarain Ruia College, Matunga, Mumbai
&
Indian Society for Plant Physiology, New Delhi

National Seminar on Sustainable Crop Productivity through Physiological Interventions
November 24-26, 2011, Ramnarain Ruia College, Matunga, Mumbai

ORGANIZATION

Chief Patron

Dr. S. Ayyappan

Director General, ICAR & Secretary, DARE, Govt. of India

Patron

Dr. S.K. Datta

Deputy Director General (Crop Sci.), ICAR

Dr. Rajan M. Welukar

Vice-chancellor University of Mumbai

Dr. Tukaram A. More

Vice-chancellor, MPKV, Rahuri

Dr. K.P. Gore

Vice-chancellor, MAU, Parbhani

Co-patrons

Prof. Dr. Suhas Pednekar, *Principal, Ramnarain Ruia College, Matunga*

Prof. Dr. Uday Salunkhe, *Group Director, Welingkar Institute of Management Matunga, Mumbai*

Organizing Secretary

Dr. Ganesh Iyer

Advisors

Dr. R.K. Sairam

IARI, New Delhi

Dr. S.M. Karmakar

Plant Physiologist, Mumbai ISPP Member

Corporate Body Advisors

Shri Raju Barwale, *Mahyco* **Shri Dr. S.S. Randade**,
Ranade Micro Nutrients

Farmer Representative

Krishi Bhushan

Shri C.H. Bhadsavle

Joint Organizing Secretary

Dr. Seema Menon

INDIAN SOCIETY FOR PLANT PHYSIOLOGY

EXECUTIVE COUNCIL

<i>President</i>	:	Dr. S.K. Datta	<i>Ex-President</i>	:	Dr. P.S. Deshmukh
<i>Hon. Secretary & Executive Editor</i>	:	Dr. R.K. Sairam	<i>Vice-President</i>	:	Dr. V.P. Singh Dr. K.P. Singh
<i>Treasurer</i>	:	Dr. Madan Pal Singh	<i>Zonal Secretaries</i>		
<i>Editor-in-Chief</i>	:	Dr. Ajay Arora	<i>North Zone</i>	:	Dr. Rajiv Angrish
<i>Joint Secretary</i>	:	Dr. Ishwar Singh	<i>South Zone</i>	:	Dr. C. Raja Sekaran
			<i>East Zone</i>	:	Dr. Ranjan Das
			<i>West Zone</i>	:	Dr. Manish Das
			<i>Central Zone</i>	:	Dr. B.L. Kakralya

National Organizing Committee

Dr. S.K. Sopory, *VC, JNU, New Delhi*
Dr. R.P. Dua, *ADG, ICAR, New Delhi*
Dr. M.B. Chetti, *Dharwar*
Dr. P.K. Agarwal, *New Delhi*
Dr. M. Udayakumar, *Bangaluru*
Dr. A.K. Dhawan, *Hisar*
Dr. S.K. Sawhney, *New Delhi*
Dr. G.C. Srivastava, *New Delhi*
Dr. P.S. Deshmukh, *New Delhi*
Dr. B.B. Singh, *Former, VC, ANDUA&T, Faizabad*
Dr. Anil Grover, *New Delhi*
Dr. B.B. Jadhav, *Dapoli, MS*
Dr. R. Ezekiel, *Shimla*
Dr. J.P. Srivastava, *Varanasi*
Dr. V.P. Singh, *New Delhi*
Dr. Ajay Arora, *New Delhi*
Dr. Madan Pal Singh, *New Delhi*
Dr. Ishwar Singh, *New Delhi*

Local Organizing Committee

Prof. Dr. U.S. Bagde, *Head, Dept. of Life Sciences, University of Mumbai*
Dr. R.M. Pai, *Head, Department of Zoology, Ruia College, Mumbai*
Dr. Behnaz Patel, *Head, Department of Botany, Ruia College, Mumbai*
Dr. S.B. Pandey, *Associate Prof. Department of Life Science, Ruia College, Mumbai*
Dr. L. Neelima, *Assistant Prof., Ruia College, Mumbai*
Shri Bhupandar Madvi, *Asstt. Prof., Ruia College, Mumbai*
Dr. Kanchan Chitnis, *Asstt. Prof., Ruia College, Mumbai*
Dr. B.L. Thaware, *Rice Specialist, Regional Agril. Station, Karjat, MS*
Prof. Dr. M.M. Bourandar, *Plant Physiologist, Dapoli, MS*

CONTENT

S.No.	Title	Page No.
Session 01: Photosynthesis, Plant Productivity and Crop Modeling		
01-01(O)	Variation in radiation use efficiency of rice cultivars grown at different locations P. Raghuvver Rao, B. Sailaja, D. Subrahmanyam, D. Vijay, S.C. Shankdhar, I.M. Khan, R. Beena Ajit Kumar and S.R. Voleti	3
01-02(O)	Physiological studies on effect of stem girdling, root pruning and chemical treatments on induction of flowering in Alphonso mango M.V. Rakshe, M.M. Burondkar, S.G. Bhave and K.A. Shinde	3
01-03(O)	Evaluation of redgram varieties for physiological efficiency in <i>rabi</i> A.R. Nirmal Kumar, G. Rama Rao and K. Balakrishna Reddy	4
01-04(O)	Influence of sulphhydryl compounds on water relation, photosynthesis and yield of clusterbean (<i>Cyamopsis tetragonoloba</i>) under water deficit condition N.S. Nathawat, V.S. Rathore, N.K. Gupta, R. Bhargav, S. Bhardwaj, Birbal and Govind Singh	4
01-01(P)	Assessment of variability among flue-cured tobacco germplasm lines for gas exchange parameters and foliage index M. Anuradha, T.G.K. Murthy, D. Damodar Reddy and V. Krishnamurthy	5
01-02(P)	Physiological traits associated with tolerance to pre harvest sprouting and high yield in mungbean genotypes H. Vijayaraghavan, M. Pandiyan and S. Geetha	6
01-03(P)	Impact of pre harvest burning of sugarcane on cane yield and quality Ch. Mukunda Rao, K. Prasada Rao and K. Veerabhadra Rao	6
01-04(P)	Seasonal variation in physiological behavior of cashew nut in different season M.M. Burondkar, K.H. Pujari, K.A. Shinde and S.G. Bhave	7
01-05(P)	Variability in yield potential and nutritional quality of kiwifruit (<i>Actinidia chinensis</i> planch) A.K. Trivedi, S. K. Verma, K.S. Negi, R.R. Arya and P.S. Mehta	7
01-06(P)	Association analysis of physiological and biochemical parameters with yield components in cotton genotypes under drought stress K. Ananthi, H. Vijayaraghavan and R. Ravikesavan	8
01-07(P)	Genotypic variation of parameters in relation to physiological efficiency in greengram (<i>Vigna radiata</i> L. Wilczek) Ratna Kinkor Goswami, H. Choudhury, M.K. Sarma, R. Kandali and J. Goswami	8

01-08(P)	Physiological evaluation of wheat (<i>Triticum aestivum</i> L.) genotypes in relation to photosynthetic efficiency, growth and productivity Deepak Meena, R.K. Samaiya, R.S. Shukla, S.K. Dwivedi and Smt. S. Rao	9
01-09(P)	Morpho-physiological characterization of chickpea (<i>Cicer arietinum</i> L.) genotypes R.S. Wagh, K.K. Bodake and D.V. Deshmukh	10
01-10(P)	Stomatal characteristics, respiration and photosynthetic rates in wild rice (<i>Oryza</i> spp.) genotypes R. Kondamudi, K.N. Swamy, T. Vishnu, Y.V. Rao, N. Shobha Rani, N. Sarla, D. Subrahmanyam and S.R. Voleti	10
01-11(P)	Physiological studies on weed management practices in transplanted onion V.M. Dore, M.B. Kulkarni and V.C. Melavenki	11
01-12(P)	Screening of different <i>Ocimum</i> genotypes for growth parameters, oil and seed yield D.P. Nawalkar, A.S. Gontia, H.S. Thakare, V. Kumar, S.R. Patel and A. Narwade	11
01-13(P)	Genetic divergence of yield and yield attributing characters in aromatic rice (<i>Oryza sativa</i>) Manindra Nath Upadhyay and Navendu Shekhar	12
01-14(P)	Arbuscular mycorrhizal fungi: role in agriculture Tushar S. Kelkar and Satish A. Bhalerao	13
01-15(P)	Photosynthetic and yield response of chickpea (<i>Cicer arietinum</i> L.) to bioregulators and their dose optimization Prmod Kumar, T.V. Vineeth and Madan Pal Singh	13
01-16(P)	Genotypic and phenotypic correlation coefficients among yield components in rice (<i>Oryza sativa</i> L.) Navendu Shekhar and Manindra Nath Upadhyay	14
01-17(P)	Yield improvement in response to low dose of gamma irradiation is related to an improved carbohydrate metabolism in wheat Sumedha Ahuja and Bhupinder Singh	14
01-18(P)	Perturbation in source-sink relationship with GA ₃ treatment led enhanced cane yield and sucrose accumulation Rama Kant Rai, Pushpa Singh, A. Chandra and Rama Darash	15

Session 02: Plant Mineral Nutrition, Micro-irrigation and Phytoremediation

02-01(O)	Effect of NANO based calcium oxide spray on calcium up take, yield and quality in groundnut P. Sudhakar, T.N.V.K.V. Prasad, P. Latha and K. Raja Reddy	19
02-02(O)	Effect of zinc application on grain yield and phytic acid concentration in polished rice grains in some rice genotypes Rahul Tyagi, Kiran Bharti, Bhupendra Mathpal, Manish Shukla, S.P. Pachauri, S.C. Shankhdhar and P.C. Srivastava	19



02-03(O)	Impact of 'Allwin top drip special' for boosting groundnut yield through drip fertigation system H. Vijayaraghavan and S. Geetha	20
02-04(O)	Influence of micronutrients and source manipulation on growth and yield in different pigeon pea (<i>Cajanus cajan</i> (L.) Millsp) genotypes A.D. Patel, Tanmay Patel, Samarjit S. Jagtap and K.P. Patel	20
02-01(P)	Influence of organics on growth, yield and quality of tomato (<i>Lycopersicum esculentum</i> L. Mill.) C.S. Arahunashi, B.B. Channappagoudar, M.B. Chetti and B.T. Ningnur	21
02-02(P)	Optimization of plant C : N ratio for yield maximization in Bt cotton hybrids D.G. Dalvi, D.B. Deosarkar, S.S. Bhatade and Javed Jani	22
02-03(P)	Effect of integrated nutrient management practices on growth, yield and quality of chickpea plants Shikha Yadav, Digvijay Singh and Nirmala Nautiyal	22
02-04(P)	Effect of boron on spikelet fertility and zinc content in different genotypes of rice (<i>Oryza sativa</i> L.) Bhawna Pant, Narendra Kumar, S.C. Shankhdhar and Deepti Shankhdhar	23
02-05(P)	Studies on morphophysiological root traits for phosphorus efficiency in wheat genotypes Gunjan Gera, Anita Kumari and Sunita Sheokand	23
02-06(P)	Effect of water stress on mineral nutrient contents in different wheat genotypes Aradhna Kumari, R.K. Sairam, Lekshmy. S and Santosh Kumar Singh	24
02-07(P)	Effect of zinc in low and high vigour sorghum genotypes R.V. Koti, M. Harish, T.R. Raghavendra, H.B. Babalad, M.Y. Kamatar, U.V. Mummigatti and B. Basavaraj	24
02-08(P)	Photosynthetic nitrogen use efficiency and yield of rice hybrids grown under different nitrogen levels M.J. Baig, P. Swain and R.N. Rao	25
02-09(P)	Variations in micro and macronutrient contents in response to soil salinity in different wheat genotypes Lekshmy. S, R.K. Sairam, S.N. Rai and S.R. Kushwaha	25
02-10(P)	Effect of foliar application of 'Allwin top legume special' on growth and yield of pigeonpea H. Vijayaraghavan	26
02-11(P)	Studies the effect of zinc sulphate on growth, yield and quality of wheat (<i>Triticum aestivum</i> L.) under sodic soil R.K. Yadav, P.N. Singh, A.H. Khan and R.S. Kureel	26
02-12(P)	Physiological investigations on the influence of organics on productivity of cluster bean Lalit Meena, B.B. Channappagoudar, M.B. Chetti and R.V. Koti	27



02-13(P)	Effect of organics on biochemical parameters in cluster bean genotypes B.B. Channappagoudar, Lalit Meena and R.V. Koti	27
02-14(P)	Developing sustainable strategies with advance phytoremediation K. Boricha Hansa and S. Jadhav Pratima	28
02-15(P)	Growth responses and antioxidant activities in <i>Gmelina arborea</i> roxb. inoculated with <i>Gigaspora margarita</i> under aluminium toxicity Mayura Dudhane, Mahesh Borde and Paramjit Kaur Jite	28
02-16(P)	Identification and characterization of EMS induced rice var. Nagina mutants for phosphorus use efficiency and heat tolerance P. Yugandhar, D. Nageswara Rao, Madhusmita Panigrahy, D. Subrahmanyam, P. Krishnamurthy, S.R. Voleti and N. Sarla	29
02-17(P)	Genotypic variation in pigeonpea for yield, photosynthetic rate and p uptake at varying phosphorus levels Sunita Sheokand, Anita Kumari, Gunjan Gera, Ramdhari Vashisht	29
02-18(P)	Evaluation of antioxidative activity of <i>Marsilea</i> (<i>Marsilea minuta</i> Linn.) plant under cadmium (Cd) induction K. Das, C. Mandal, N. Ghosh, S.P. Das, Susmita Das, Saborni Maiti, Sudha Gupta, and M.K. Adak	30
02-19(P)	Cultivation of chilli (<i>Capsicum annum</i> L.) under city waste water in the presence of potassium Sugandha Varshney, Arif Inam and Shamsul Hayat	30
02-20(P)	Physiological studies of cotton hybrids as influenced by population densities under drip irrigation H.K. Kene	31
02-21(P)	Effect of fly ash and bio fertilizers on the physiological and biochemical parameters of onion in <i>kharif</i> season Nikita Parab and Seema Mishra	31
02-22(P)	NADPH oxidase as the source of ROS produced under waterlogging in roots of mung bean (<i>Vigna radiata</i> L.) Piyali Bhattacharya, Rohit Joshi, R.K. Sairam, S. Lekshmy and V. Chinnusamy	32
02-23(P)	Alleviation of b deficiency in tomato plants by application of inorganic fertilizers and organic manures to a soil deficient in boron Digvijay Singh, Shikha Yadav and Nirmala Nautiyal	32
02-24(P)	Combined effect of different nitrogen doses and weeds - wild mustard <i>Sinapis arvensis</i> L., wild oat <i>Avena ludoviciana</i> L. on spring wheat <i>Triticum aestivum</i> L. var. chamran P. Behdarvand, G.S. Chinchankar and K.N. Dhumal	33



02-25(P)	Using rice straw for weed management in wheat (<i>Triticum aestivum</i> L.): possibilities and limitations Kratika Bhandari and S.K. Guru	33
02-26(P)	Effect of root bark powder extract (RBPE) of <i>Berberis vulgaris</i> L. on <i>Leishmania major</i> (askh) <i>in vitro</i> A. Salehabadi and G.S. Chinchankar	34
02-27(P)	Phytoextraction of cr by some floriculture plants S. Ramana, A.K. Biswas, A.B. Singh, Ajay and N.K. Ahirwar	34
02-28(P)	Effect of different concentrations of boron on germination performance in different varieties of sweet sorghum Sujeet Jadhav and S.B. Bhamburdekar	35
02-29(P)	Arsenic uptake and translocation in rice seedlings as affected by nitrogen and phosphorus concentration in nutrient solution P.C. Gupta, S. Mondal and S. Sarkar	35
02-30(P)	Growth behavior of rice genotype (Shatabdi) under arsenic toxic condition in both boro and <i>kharif</i> condition P.C. Gupta, A.K. Rai, R. Islam, M.D. Bairagya and J. Kumari	36
02-31(P)	Silicon accumulation and its influence on the physiology and yield in rice hybrids and varieties (<i>Oryza sativa</i> L.) grown under aerobic situation K.B. Sujatha, S.M. Babu, S. Ranganathan, D.N. Rao, S. Ravichandran and S.R. Voleti	36
02-32(P)	Effect of micronutrients on dry matter, seed yield and oil content in Kasturi Brendi (<i>Abelmoschus moschatus</i> L.) G.S. Pawar, P.J. Kshirsagar and I.A. Madrap	37
02-33(P)	Effect of some chemical nutrients and bio-nutrients on <i>Hibiscus esculentus</i> (L. Wilzeck) Dhwani C. Goradia, Sudha A. Sawant and Sudhir D. Ghatnekar	37
02-34(P)	Assessment of growth, yield and kernel shelf life of sweet corn grown under different organic manure amendments Samarpita Roy and K.N. Dhumal	38
02-35(P)	Physiology, growth and yield of <i>Capsicum annuum</i> L. cv. Pusa Jawala as affected by integration of inorganic fertilizer and wastewater Saba Iqbal, Arif Inam, Seema Sahay and Shaista Chalkoo	38
02-36(P)	Effect of iron, calcium, and magnesium on growth of herbaceous plants found in amphibolites and hornblende biotite schist of the deoduar area of north Guwahati, Assam J. Medhi and M.K. Das	39

Session 03: Abiotic Stress Management, Signaling and Gene Expression

03-01(L)	Identification of source of tolerance to high temperature in tropical maize Ishwar Singh, S.K. Singh, and R. Sai Kumar	43
03-01(O)	Brassinosteroids: role in abiotic stresses in plants Qazi Fariduddin	43
03-02(O)	Cadmium-induced biochemical changes and cytotoxicity in mungbean [<i>Vigna radiata</i> (L.) Wilczek] S.P. Badole, Denish Rai, Pallab Kumar Das and A.K. Pal	44
03-03(O)	Salicylic acid (SA) induced physiological and biochemical changes in chickpea (<i>Cicer aritinum</i> L.) genotypes under drought stress Pradeep Kumar Patel, A. Hemantaranjan and B.K. Sarma	45
03-04(O)	Growth, physiological and biochemical responses of <i>Sesuvium portulacastrum</i> to pharmaceutical effluents Vinayak H. Lokhande, Mayuri S. Aivale, Sowjanya Illa, Nutan P. Malpathak and Neetin S. Desai	45
03-05(O)	Polyamines may alleviate the oxidative stress under condition of salinity in rice cultivars M.K. Adak, N. Ghosh, C. Mondal, S. Roy Choudhury and D.N. Sen Gupta	46
03-01(P)	Association of physiological traits with grain yield of rice genotypes grown under aerobic condition Shafina Haque, A.K. Mall, P. Swain and O.N. Singh	47
03-02(P)	Alleviation of the effects of NaCl salinity in spinach (<i>Spinacia oleracea</i> L. var. All Green) using plant growth regulators Anjali Ratnakar and Aruna Rai	47
03-03(P)	Electrolyte and phenolic leakage contents and their relation with photosynthetic pigments, activity of antioxidant enzymes at low temperature stress in sugarcane Radha Jain and A. Chandra	48
03-04(P)	The beneficial role of am fungi in bajra (<i>Pennisetum glaucum</i>) plants under drought stress condition Mahesh Borde, Mayura Dudhane and Paramjit Jite	48
03-05(P)	Effect of brassinolides on drought tolerance in pearl millet [<i>Pennisetum glaucum</i> (L.) R Br Emend Stuntz] Santosh Jakhad, B.S. Afria, B.L. Kakralya, Alka Choudhary and Jyoti Verma	49
03-06(P)	Photothermic indexing in rice (<i>Oryza sativa</i> L.) genotypes for yield and nutrient quality Jyoti, Deepika Sharma, Deepti Shankhdhar and S.C. Shankhdhar	49
03-07(P)	Growth and assimilatory functions of grasses under reduced light R.K. Bhatt	50



03-08(P)	Strategies adaptation of chick pea to high temperature Rinki Devi, P.S. Basu, S.K. Chaturvedi, Jagdish Singh and Pankaj Kumar Singh	50
03-09(P)	Salinity stress induced oxidative stress and expression of genes encoding antioxidant enzymes in tolerant and susceptible wheat genotypes Lekshmy. S, R.K. Sairam and V. Chinnusamy	51
03-10(P)	Physiological and biochemical attributes during complete submergence of two rice (<i>Oryza sativa</i> L.) varieties Alok Kumar Pradhan and B.R. Singh	51
03-11(P)	Morpho-physiological evaluation of wheat genotypes under early and late or terminal heat conditions D.C. Saxena, S.V. Sai Prasad and Renu Parashar	52
03-12(P)	Increase of ABA synthesis improves drought tolerance in cotton K. Anantbi and H. Vijayaragbavan	52
03-13(P)	Identification of chickpea (<i>Cicer arietinum</i> L.) genotypes with higher thermotolerance using temperature induction response technique Chandra Prabha, Madan Pal Singh and V. Chinnusamy	53
03-14(P)	Nutrient management in nursery for improving submergence tolerance in swarna <i>sub</i> rice (<i>Oryza sativa</i> L.) A.K. Singh and Preeti Singh	53
03-15(P)	Fiber quality related traits of cotton genotypes in relation to k content under water stress K. Ananthi and H. Vijayaragbavan	54
03-16(P)	Morpho-physiological parameters and antioxidant enzymes activity in field pea (<i>Pisum sativum</i> L.) genotypes as influenced by salicylic acid under salinity stress Radha Singh and A. Hemantaranjan	55
03-17(P)	Germination potential and productivity of four chickpea cultivars under salt stress Ranju Gulati and Neera Garg	55
03-18(P)	Differential effects of short term and long term salinity stress on growth, yield and oxidative metabolism in chickpea and its possible alleviation by nitric oxide Anita Kumari, Sunita Sheokand and Gunjan Gera	56
03-19(P)	Influence of different salinity levels of irrigation water on photosynthetic parameters of different rice varieties S.R. Patel, C.B. Pavaghadi, Kirti Vardhan and R.G. Patil	56
03-20(P)	Role of cell viability and membrane fluidity in heat tolerance of wheat: genetic options S.S. Dhanda, Renu Munjal and Vinita Arora	57
03-21(P)	Assessment of genotypic variability for growth, biophysical parameters, yield and yield attributing characters under drought stress in cotton B.C. Patil, A.G. Babu, K.N. Pawar and A.B. Shaheen	58



03-22(P)	Exogenous application of proline enhances antioxidative enzyme activity, growth, photosynthesis and yield of chickpea plants exposed to cadmium stress Shamsul Hayat, Qaiser Hayat, Arif Shafi Wani, Mohd. Irfan and Aqil Ahmad	58
03-23(P)	Chilling induced decrement in antioxidant enzyme activities causes irreversible injury in early maturing sugarcane Pushpa Singh, R.K. Rai, Namita Arya, R. Darash and S.P. Shukla	59
03-24(P)	Physiological and biochemical changes in senna (<i>Cassia angustifolia</i>) under saline conditions S.M. Shitole and K.N. Dhumal	60
03-25(P)	Evaluation of different wheat (<i>Triticum aestivum</i> L.) varieties for terminal heat stress on the basis of their morpho-physiological and yield traits Mukund Kumar, Satyendra Kumar Singh and S.P. Singh	60
03-26(P)	Efficacy of putrescine and benzyladenine on photosynthesis and productivity in relation to drought tolerance in wheat (<i>Triticum aestivum</i> L.) Sunita Gupta, V.P. Agarwal and N.K. Gupta	61
03-27(P)	Identification of upland rice genotype for tolerance to moisture stress and photosynthetic characters in kymore plateau sub-zone of MP O.P. Dhurve and I.M. Khan	61
03-28(P)	Increase in production of reactive oxygen species (ROS) as a secondary response to water deficit stress in groundnut K. Chakraborty, K.A. Kalariya, P.V. Zala and A.L. Singh	62
03-29(P)	Effect of alkali stress on seed germination and seedlings growth of <i>Vigna aconitifolia</i> (Jacq.) Marechal N.S. Patil and B.A. Karadge	62
03-30(P)	Screening for drought and high temperature tolerance by physiological traits K.D. Sharma, Ashok Kumar and S.K. Thakral	63
03-31(P)	Physiological response of pearl millet and clusterbean to high temperature Uday Burman	64
03-32(P)	Screening for thermotolerance in greengram (<i>Vigna radiata</i> L.) using fluorescence imaging Shweta Gupta, P.S. Basu and Jagdish Singh	64
03-33(P)	Remobilization studies in heat tolerant and heat susceptible wheat genotypes under heat stress Pravin Prakash and Chubasenla Aochen	65
03-34(P)	Non-symbiotic haemoglobin and nitric oxide homeostasis as an alternative to fermentation for waterlogging tolerance in <i>Vigna</i> spp. Rohit Joshi, Piyali Bhattacharya, R.K. Sairam, S. Lekshmy and V. Chinnusamy	66
03-35(P)	Physiological characterization of rice cultivars under alternate wetting and drying conditions D. Nageswara Rao, P. Raghuveer Rao, D. Subrahmanyam, M.S. Ramesha and S.R. Voleti	66



03-36(P)	Changes in <i>Mips</i> gene expression and phytate accumulation during seed maturation in soybean (<i>Glycine max</i> L.) Sweta Kumari, Awadhesh Kumar, Swati Kumari, Monica Jolly and Archana Sachdev	67
03-37(P)	Abiotic stress on <i>Vigna radiata</i> L. seedlings Monali Jathar, Seema Menon and Ganesh Iyer	67
03-38(P)	Screening of indian mustard genotypes for high temperature stress Sudhir Kumar and R.K. Sairam	68
03-39(P)	Role of antioxidant enzymes and physiological traits in high temperature tolerance of wheat genotypes Renu Munjal, Vinita Arora and S.S. Dhanda	68
03-40(P)	Comparison of response of <i>Populus deltoides</i> clones to different levels of water stress Aradhna Kumari and Santosh Kumar Singh	69
03-41(P)	Role of heat shock transcription factors and heat shock proteins in high temperature tolerance of wheat genotypes G. Krishna Kumar, R.K. Sairam and Lekshmy S.	69
03-42(P)	Improving the physiological efficiency and yield of wheat under terminal warm environment K.D. Sharma and Ashok Kumar	70
03-43(P)	Evaluation of blackgram (<i>Vigna mungo</i> L.) germplasm for thermotolerance using chlorophyll fluorescence Mukund Kumar, Sanjeev Gupta, Mudit Srivastava, Alagupalamuthirsoli, P.S. Basu and Jagdish Singh	70
03-44(P)	Influence of moisture stress on the status of water within the developing soybean grains as revealed by nuclear magnetic resonance (NMR) studies P. Krishnan, A.P.S. Verma, D.K. Joshi, S. Das and Ravender Singh	71
03-45(P)	Performance of cotton genotypes for water stress tolerance S.S. Bhatade, D.B. Deosarkar, D.G. Dalvi and Javed Jani	71
03-46(P)	Growth and plant water relations in mothbean (<i>Vigna aconitifolia</i> (Jacq) Marechal) under soil moisture stress Sunil Kumar, Shital and K.D. Sharma	72
03-47(P)	Morpho-physiological traits for screening heat tolerant lines of fieldpea under late sown conditions Vijay Laxmi	72
03-48(P)	Physiological effects of water stress in tomato genotypes (<i>Lycopersicum esculentum</i> Mill) S. Vincent, M. Shebin, C.N. Chandrasekhar and P. Jeyakumar	73
03-49(P)	Cytokinin induced photosynthetic efficiency during moisture deficit stress in two wheat cultivars differing in drought tolerance Shivani Nagar, Singh, V.P. and Ajay Arora	73

03-50(P)	Terminal stage heat tolerance studies on physiological and stress characters of different rapeseed-mustard genotypes Maharaj Singh, J.S. Chauhan, V.V. Singh and Kapila Shekhawat	74
03-51(P)	Salicylic acid-induced osmolyte accumulation leads to heat tolerance in <i>Triticum aestivum</i> Md. Iqbal Raja Khan and Nafees A. Khan	74
03-52(P)	Identification of groundnut genotypes for drought tolerant traits with high pod yields P. Pranusha, P. Sudhakar, V. RajaRajeswari, D. Mohan Reddy and P. Latha	75
03-53(P)	A physiological approach to screen rice genotypes with acquired thermo-tolerance at seedling stage Sapna Harihar, C. Vijayalakshmi, and P. Boominathan	75
03-54(P)	Identification of NaCl induced salinity-responsive transcripts in <i>Arachis glabrata</i> Rinni B. Raval, Nikita P. Ved and S.K. Bera	76
03-54(P)	Study of promising lines for anaerobic seed germination under flooded condition P.N. Singh, A.H. Khan, V.N. Singh, R.K. Yadav, Preeti Singh and A. Ismail	76
03-56(P)	Effect of polyethylene glycol induced water stress on physiological and biochemical responses in rice varieties P. Swain, M.J. Baig and M. Barik	77
03-57(P)	Morpho-physiological characterization of wheat (<i>Triticum aestivum</i> L.) cultivar under water stress conditions S.L. Khapke, R.K. Aher and B.A. Patil	77
03-58(P)	Evaluation of wheat cultivars for terminal heat tolerance under natural field conditions T.P. Singh, B.S. Phogat, M. Singh, M. Dutta, K. Srinivasan, R.K. Tyagi and D.K. Joshi	78
03-59(P)	Studies on waterlogging tolerance and microelement toxicities in key Indian and Australian varieties in sodic soil S.P. Singh, B.N. Singh, Mukund Kumar, Rama Kant, Preeti Singh and T.L. Setter	78
03-60(P)	Effect of drought on physiological parameters and yield components of upland rice genotypes Brajesh Kumar Mishra and G.S. Chaturvedi	79
03-61(P)	Agro-morphological classification and diversity analysis of soybean mutants D.D. Ahire, R.A. Tambe and S.G. Auti	80
03-62(P)	Effect of UV-B and monocrotophos on growth, pigments and antioxidants in heterocystous cyanobacterium <i>Nostoc muscorum</i> Abhishek Chris	81
03-63(P)	Physiological analysis of drought tolerance in groundnut C. Raja Babu and Vaidyanathan	81

Session-04: Plant Tissue Culture, Biotechnology and Germplasm Conservation

04-01(L)	Cloning and sequence characterization of a novel <i>shn</i> - like gene from mulberry (<i>Morus</i> species) R.S. Sajeevan and Karaba N. Nataraja	85
04-01(O)	Adventitious organogenesis in <i>Azadirachta indica</i> A. Juss. (Neem) using leaf explants Fatima Shirin and Anamika Rai	85
04-02(O)	Callus induction and gene transformation method for salt tolerance in finger millet A.G. Babu, V. Manjunatha, A.G. Shankar and M. Udayakumar	86
04-03(O)	Micropropagation in khirni (<i>Manilkara hexandra</i> Roxb.) S.S. Kale, R.M. Patel and B.K. Dhaduk	86
04-01(P)	Effect of cytokinins on multiplication of culture in custard apple (<i>Annona squamosa</i> L.) cv. Balanagar R.K. Panchal and R.M. Patel	87
04-02(P)	Micropropagation in papaya (<i>Carica papaya</i> L.) var. Rad Lady J.R. Patel, R.M. Patel and R.R. Shah	87
04-03(P)	Genetically modified organisms and their impact on environment Satnam Singh Sohal, Gauri Soman and Sunita S. Hajirnis	88
04-04(P)	Micropropagation and germination studies in <i>Datura metel</i> L.V.S. Kale	88
04-05(P)	<i>In vitro</i> screening of <i>Venchrus ciliaris</i> (Cazri-385) extracts against some micro-organisms Premlata Singariya, Krishan Kumar Mourya and Padma Kumar	89
04-06(P)	Screening of the <i>dianthus Caryophyllus</i> L. cultures for Dianthin; a ribosome inactivating protein Soniya Khawale, Nutan Malpathak	89
04-07(P)	Plant tissue culture, biotechnology and germplasm conservation Bharati Kannamma	90
04-08(P)	<i>In vitro</i> production of harmala alkaloids and propagation of <i>Fagonia schweinfurthii</i> (Hadidi) Ex Hadidi Gafoor T.D. Nikam and A.A. Naik	90
04-09(P)	Banana tissue culture for shortening conventional micropropagation protocol Jayeeta Chatterjee and Sabita Bhattacharya	91
04-10(P)	Plant tissue culture, biotechnology and germplasm conservation Erica B. Benson, B.D. Singh and Vijaya Geetha	91

04-11(P)	<i>In vitro</i> salt stress induced production of gymnemic acid in callus cultures of <i>Gymnema sylvestre</i> R. Br. Upendra Kumar and Y. Vimala	92
04-12(P)	Tissue culture of <i>Indigofera tinctoria</i> Linn and its biological activity M. Bhat, S. Kumthekar, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar	92
04-13(P)	<i>Agrobacterium tumefaciens</i> -mediated VPP-ASE gene transfer and stress tolerance in Neurotonic <i>bacopa monnieri</i> (L.) Pennell. M.L. Ahire, P.B. Kavi Kishor, T.D.Nikam	93
04-14(P)	<i>In vitro</i> shoot culture and cardiac glycosides production in <i>digitalis Purpurea</i> L.J.G. Patil, M.L. Ahire and T.D. Nikam	93
04-15(P)	Prediction of temperature induced micrnas and their targets in <i>Oryza sativa</i> B. Sailaja, SR. Voleti, D. Subrahmanyam, N. Sarla, V.P. Bhadana, and Satendra K. Mangrauthia	94
04-16(P)	<i>In vitro</i> induction of shoots from seedling explants of <i>Plumbago zeylanica</i> L. P.S. Kakade and G.S. Chinchankar	94
04-17(P)	<i>In vitro</i> response of leaf explants of <i>Adansonia digitata</i> Linn. M. Mohseni Delarestaghi and G.S. Chinchankar	95
04-18(P)	<i>In vitro</i> response of tuber explants of <i>Eulophia nuda</i> Lindl. S.P. Bhagat and G.S. Chinchankar	95

Session 05: Sustainable Agriculture in Relation to Global Climate Change

05-01(L)	Plant physiological processes associated with emission and transport of green house gas no from wheat agriculture K.K. Baruah	99
05-02(L)	Impacts of climate change on agriculture, agro-biodiversity and food security Shivadhar Singh	99
05-01(O)	Identification of thermotolerant inbreds by temperature induction response (TIR) technique in maize (<i>Zea mays</i> L.) Rajesh Paladugu, Ramesh Thatikunta and Keshavulu Kesoth	100
05-02(O)	Evaluation of bt cotton hybrids for drought tolerance under rainfed condition D.B. Deosarkar, S.S. Bhatade, D.G. Dalvi and Javed Jani	101
05-03(O)	<i>Oryza rufipogon</i> Griff.; A successful stress resistant plant in diversified ecological habitats Ekamber Kariali, Rajendra Kumar Behera and Pravat Kumar Mohapatra	101
05-01(P)	Investigations on physiological efficiency of Bt cotton hybrids with their non Bt counter parts K.N. Pawar, B.C. Patil, A.G. Babu and A.B. Shaheen	102

05-02(P)	Screening for high temperature tolerance in rice genotypes D. Subrahmanyam, P. Raghuvveer Rao, M. Umamaheshwar Reddy, S. Shivashanker, N. Sarla and S.R. Voleti	102
05-03(P)	Adaptation strategies to sustain agriculture production towards climate change K.K. Agrawal	103
05-04(P)	The potential effects of climate change on crop growth R.W. Bharud	104
05-05(P)	Genetic variability in rice genotypes for high temperature tolerance Jyoti Jha, R.N. Bahuguna, Sunil Kumar Pandey, Divya Shah, Sangeeta Khetarpal and Madan Pal Singh	105
05-06(P)	A comparative study on vermicomposting of agricultural waste P. Singh, D. Shah, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar	105
05-07(P)	Role of apolplastic calcium in mitigating high temperature effects in chickpea Rajeev N. Bahuguna, Sunil Kumar Pandey, Divya Shah, Jyoti Jha, Sadhna Singh, Sangeeta Khetarpal and Madan Pal Singh	106
05-08(P)	Preparation of activated carbon from agro-industrial waste P. Singh, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar	106
05-09(P)	Impact of elevated carbon dioxide (CO ₂) on growth and yield of rice crop at different nitrogen (N) levels S.D. Singh, B. Chakrabarti, B. Singh, R.C. Harit and Vinod Kumar	107
05-10(P)	Urban waste composting for agriculture Satnam Singh Sohal and Satish Bhalerao	107
05-11(P)	Influence of the environmental conditions on the modulation of cellular constituents and differential expression of proteins in <i>Azolla microphylla</i> G. Abraham, Altaf Ahmad and Vagish Mishra	108
05-12(P)	Effect of high temperature on spikelet sterility and electrophoretic profiles of polypeptides during anthesis in rice (<i>Oryza sativa</i> L.) S. Das, P. Krishnan and B. Ramakrishnan	108
05-13(P)	Effect of treated distillery spentwash fertigation on growth, physiological traits and yield in groundnut (<i>Arachis hypogaea</i> L.) D. Darmalingaiah, M.B. Doddamani, U.V. Mummigatti, M.B. Chetti, S.K. Gali and S.S. Angadi	109
05-14(P)	Effect of high temperature on reproductive behaviour in rice N. Sravan Raju, P. Senguttuvel, V.P. Bhadana, S.R. Voleti, A.S. Hariprasad, N. Shobha Rani, P. Revathi, K.B. Kemparaju, D. Subrahmanyam, and B.C. Viraktamath	110

Session 06: Plant Growth Regulators/Agrochemicals and their Applications, Allelopathy

06-01(O)	A comparative influence of 28-Homobrassinolide and 24-Epibrassinolide on activities of nitrate reductase, antioxidative enzymes and proline content of tomato Mohammad Irfan, Sangeeta Yadav, Shamsul Hayat, Arif Shafi Wani, and Aqil Ahmad	113
06-02(O)	Studies on application of chemicals to ameliorate leaf reddening in Bt cotton hybrid (RCH-2 Bt) B.C. Patil, A.G. Babu, K.N. Pawar and A.B. Shaheen	113
06-03(O)	Bacterial plant growth regulators and their applications Minu Ali, Ganesh Iyer, Seema Menon and Dipak Vora	114
06-04(O)	Effect of gibberellins and cytokinins on growth and flowering of <i>Iberis umbellata</i> L. Mushtaq Ahmad Bhat, Inayatullah Tahir, Waseem Shahri, Sheikh Tajamul Islam and Syed Sabhi Ahmad	114
06-01(P)	Effects of paclobutrazol and KNO ₃ on floral induction and associated hormonal changes in mango cv. Totapuri K.K. Upreti, Y.T.N. Reddy, H.L. Jayaram, S.R. Shivu Prasad and G.V. Bindu	115
06-02(P)	Role of ethylene in alleviation of cadmium-induced photosynthetic capacity inhibition by sulfur in mustard Asim Masood, Noushina Iqbal, Rahat Nazar and Nafees A. Khan	116
06-03(P)	The synthesis of indole-3-acetic-acid by an edible white-rot fungus <i>Pleurotus osteratus</i> using deoiled <i>Jatropha curcas</i> seed press cake under submerged condition Anjali Bose, Dharti Shah and Haresh Keharia	116
06-04(P)	Physiological and biochemical effects of different growth regulating chemicals on groundnut (<i>Arachis hypogaea</i> L.) productivity under salt stress condition S. Nithila and D. Durga Devi	117
06-05(P)	Effect of paclobutrazol on photosynthetic plant pigment in hydroponically grown mango seedling R. Islam, S. Mondal, A.K. Ghosh and P.C. Gupta	118
06-06(P)	Effect of brassinolides on physiological aspects of chick pea (<i>Cicer arietinum</i> L.) under drought conditions Jyoti Verma, B.L. Kakralya and Santosh Jakhad	118
06-07(P)	Effect of plant growth regulator, defoliation and flower drop on growth and yield of soybean D.G. Dalvi, S.S. Kasar, I.A. Madrap and D.B. Deosarkar	119
06-08(P)	24-Epibrassinolide and glycine betaine application mitigated copper stress in <i>Brassica juncea</i> Priyanka Varshney, Qazi Fariduddin, Mohd. Yusuf, Aqil Ahmad	119
06-09(P)	Comparative effects of salicylic acid derivatives on growth parameters in <i>arachis hypogaea</i> L. Sunita Jadhav and S.B. Bhamburdekar	120

06-10(P)	Comparative efficacy of 24-epibrassinolide and 28-homobrassinolide in amelioration of nickel stress in <i>Vigna radiata</i> by modulating antioxidant system Mohammad Yusuf	120
06-11(P)	Influence of thiourea on uniform vegetative growth, flowering and fruiting in alphonso mango A.K. Shinde, B.B. Jadhav, R.N. Shelke and K.A. Shinde	121
06-12(P)	Response of growth manipulation (pinching) and plant growth regulators on growth, seed yield and its quality in cluster bean cv. Pusa Navbahar B.N. Satodiya, H.C. Patel, A.D. Patel and K.B. Kathiriya	121
06-13(P)	Morpho-physiological and biochemical effects of biostimulant (<i>NovoBac</i>) on growth and yield of maize (<i>Zea mays</i> L.) S. Prabhakaran, V. Ravichandran, P. Jeyakumar, N. Sakthivel and C. Vijayalakshmi	122
06-14(P)	Response of 28-homobrassinolide and 24-epibrassinolide on the growth, carbonic anhydrase activity and photosynthetic efficiency of <i>Lycopersicon esculentum</i> Arif Shafi Wani, Sangeeta Yadav, Mohd. Irfan, Shamsul Hayat and Aqil Ahmad	122
06-15(P)	Role of brassinosteroids, salicylic acids and polyamines in salinity induced oxidative stress Bilal A Mir, Qazi Fariduddin, Mohammad Yusuf, Tanveer A. Khan and Aqil Ahmad	123
06-16(P)	Effect of growth regulators in seed quality of green gram (<i>Vigna radiata</i> L.) during storage under different environmental conditions Neelu Marmath, Neelam Yadav and V.K. Yadav	123
06-17(P)	Changes in physiological characters and yield of chilli (<i>Capsicum annuum</i> L.) due to biostimulant, <i>Novobac</i> P. Jeyakumar, S. Jidhu Vaishnavi, C.N. Chandrasekhar, N.O. Gopal and C. Vijayalakshmi	124
06-18(P)	Standardization of sufoof-e-mohazzil - a unani polyherbal formulation Avinash Patil, Aqsa Ansari, Swapneel Koli, Darshana Patil	124
06-19(P)	Effect of biostimulant (<i>Novobac</i>) on growth characters and yield of chilli (<i>Capsicum annuum</i> L.) S. Jidhu Vaishnavi, P. Jeyakumar, C.N. Chandrasekhar, N.O. Gopal and C. Vijayalakshmi	125
06-20(P)	Morpho - physiological effects of biostimulant (<i>Novobac</i>) on yield of vegetable cowpea (<i>Vigna unguiculata</i> L. Walp) M. Jayalakshmi, P. Jeyakumar, S. Vincent, N.O. Gopal and C. Vijayalakshmi	125
06-21(P)	Physiological and biochemical changes in vegetable cowpea (<i>Vigna unguiculata</i> L. walp) due to biostimulant (<i>Novobac</i>) P. Jeyakumar, M. Jayalakshmi, S. Vincent, N.O. Gopal and C. Vijayalakshmi	126
06-22(P)	Allelopathic effect of <i>celosia Argentina</i> L. on seed germination, growth and enzyme activities of <i>Pennisetum typhodes</i> Burm. A.B. Kamble and A.A. Inamdar	126

- 06-23(P) Brassinosteroids–indispensable for plant growth and survival 127
S. Seeta Ram Rao

Session 07: Physiology of Flowering and Seed

- 07-01(O) Effect of exogenous polyamine and pre-anthesis heat shock on expression of small heat shock protein and starch structure against post-anthesis heat stress in wheat (*Triticum aestivum*) 131
Ranjeet R. Kumar, Suneha Goswami, Sushil K. Sharma, Khushboo Singh, Manorama Singh, Kritika A. Gadpyle, S. D. Singh, Himanshu Pathak and Raj D. Rai
- 07-02(O) Effect of high temperature on spikelet fertility, heat susceptibility and grain yield of rice genotypes 131
I.M. Khan and O.P. Dhurve
- 07-03(O) Evaluation of rice germplasm and introgression lines for heat tolerance at germination and seedling stage 132
V. Vishnu Prasanth, D.V.N. Chakravarthi, T. Vishnu Kiran, Y. Venkateswara Rao, Madhusmita Panigrahy, S.R. Voleti and N. Sarla
- 07-01(P) Effect of teak perennial vegetable based agroforestry system on biophysical parameters of legumes 133
H.Y. Patil, M.B. Chetti, S.J. Patil, S.M. Mutanal and B.N Aravind Kumar
- 07-02(P) Location variation in vegetative and flowering behaviour of mango in konkan region 133
K.H. Pujari, S.L. Ghawale and K.A. Shinde
- 07-03(P) Physiological bases of dormancy and dormancy breaking by chemicals, temperature and growth regulators in gladiolus 134
K. Pal, A. Bhatt and S.K. Guru
- 07-04(P) Effect of desiccation and storage temperature on germination of *Lawsonia inermis* 134
Manisha Sharma, Manish Das and S. Pramod
- 07-05(P) An overview of physiology of flowering in citrus 135
A.D. Huchche
- 07-06(P) Changes in sugars during petal senescence in cut flowers of *Cosmos bipinnatus* 135
Goral Jani and Archana Mankad
- 07-07(P) Seed germination and enzyme activity in *Silybum marianum* (L.) Gaertn: an important medicinal plant 136
Manish Das and Manisha Sharma
- 07-08(P) Effect of storage period on the germination of foxtail millet (*Setaria italica* (L.) Beauv.) germplasm in laboratory conditions 136
Vandana Bhakuni and Rajendra Prasad

Session 08: Post Harvest Physiology of Perishables and Senescence

08-01 (L)	Physiological and biochemical basis of senescence in cut flowers V.P. Singh and Ajay Arora	139
08-01(O)	Influence of paclobutrazol on fruiting of jackfruits (<i>Artocarpus heterophyllus</i>) A.K. Shinde, B.B. Jadhav, R.N. Shelke and S.G. Mahadik	139
08-02(O)	Determination of glycoalkaloids in Indian potato cultivars Brajesh Singh, R. Ezekiel and Suruchi Sharma	140
08-03(O)	Effect of carbon dioxide concentration in the storage atmosphere on sugar accumulation and chip colour in potatoes of four cultivars stored at three temperatures R. Ezekiel, A. Kaul, P. Kumar, A. Sonkusare, A. Mehta and P. Kapur	140
08-04(O)	Regulation of fruit ripening through post harvest treatments of gibberellic acid (GA ₃) and other chemicals on quality and shelf-life of tomato (<i>Lycopersicon esculentum</i> Mill.) cv. Anand Tomato-3 Amarjeet Singh Thounaojam and A.D. Patel	141
08-05(O)	Physiological studies on effect of packaging material for storage of groundnut (<i>Arachis hypogaea</i> L.) pods A.K. Shinde, A.H. Bodare, B.B. Jadhav and R.N. Shelke	142
08-01(P)	Preparation of concrete from flowers of <i>Couroupita guianensis</i> and to study its aromatic and antibacterial properties Nilima Lankeshwar, Neha Sawakhande and Pritam Nanoskar	142
08-02(P)	Non-apoptotic programmed cell death in rice (<i>Oryza sativa</i> L.) root during aerenchyma formation Rohit Joshi, Alok Shukla and Pramod Kumar	143
08-03(P)	Post harvest care and papaya (<i>Carica papaya</i>) Kavita Rambal	143
08-04(P)	Variation in antioxidants, carbohydrates and their related enzymes of muskmelon (cv. Maduri) fruit at different stages of development and ripening Soumya V. Menon and T.V. Ramana Rao	144
08-05(P)	Biochemical and organoleptic analysis on hibiscus-rosa-sinensis Vidhi Shah and Rini Ravindran and Jyoti D. Vora	144

Session 09: Biotic Stress, Genomics, Proteomics and Metabolomics

09-01(O)	Enhancement of sheath blight tolerance in rice through transgenic approach R. Saikrishna, G. Chaitanya Kumar and G.J.N. Rao	147
09-02(O)	Identification of suitable rice varieties based on physiological parameters and yield components suitable for rainfed upland conditions V. Raja rajeswari, P. Pranusha and P. Sudhakar	147

09-03(O)	Varietal identification of cotton cultivars by sds page electrophoresis / electrophoretic technique Kavita P. Kumari and S. Madaan	148
09-01(P)	Aeromycological studies of groundnut field at Nashik (Maharashtra) M.D. Sonawane and S.G. Kotwal	148
09-02(P)	Soil solarization: an eco-friendly method of management of soil borne disease Satish A. Bhalerao	149
09-03(P)	Management of <i>Parthenium hysterophorus</i> through natural competitors Jai Knox and M.S. Paul	149
09-04(P)	Profiling of phenolic content of rice genotypes and its relationship to their competitiveness against weeds Babita Patni, and S. K. Guru	150
09-05(P)	Comparative efficacy study of antidiabetic activity of <i>Salacia reticulata</i> Manjusha V. Nikale, R.M. Mulani	150

Session 10: Physiology of Plantation, Horticultural Crops and Medicinal Plants, Natural Resources Management, Biodiversity and Pharmacognosy

10-01(O)	Effect of genotype and method of curing on aroma constituents of chewing tobacco (<i>Nicotiana tabacum</i>) grown in Tamil Nadu K. Siva Raju and V. Krishnamurthy	153
10-02(O)	Curcuminoids and anti-oxidative components in <i>Curcuma longa</i> and <i>Curcuma caesia</i> grown in Manipur Kananbala Sarangthem, Th. N.K. Singh and M.J. Haokip	153
10-03(O)	Influence of teak – perennial vegetable based agroforestry system on biochemical parameters of legumes H.Y. Patil, S.J. Patil, M.B. Chetti, S.M. Mutanal and B.N. Aravind Kumar	154
10-01(P)	Identification of suitable genotype of finger millet (<i>Eleusine coracana</i> Gaertn.) for mango based agroforestry system A.K. Shinde, B.B. Jadhav, J.K. Yadav and V.V. Dalvi	154
10-02(P)	Physiological studies of under utilized grasses of south India R. Hari Babu and N. Savithramma	155
10-03(P)	Biochemical variation in accessions of <i>Dolichos biflorus</i> Linn. Sachin B. Palekar, Vinaya A. Rane and Behnaz B. Patel	155
10-04(P)	Agro-morphological classification and diversity analysis of soybean mutants D.D. Ahire, R.A. Tambe and S.G. Auti	156

10-05(P)	Influence of pre harvest treatments of gibberellic acid (GA ₃) and other chemicals on growth and yield attributing characters of tomato (<i>Lycopersicon esculentum</i>) cv. Anand Tomato-3 A.D. Patel and Amarjeet Singh Thounaojam	156
10-06(P)	Die-back and related diseases of citrus: a case study based on surveillance, detection and development of management strategy Satya Prakash, C.S. Bhor and Sushama Chaphalkar	157
10-07(P)	Biodiversity of fungi from soil and water samples from Waldhuni river Deepak Pardeshi and Sharda Vaidya	157
10-08(P)	Physiological studies on weed control efficiency in turmeric V. Babu, B.B. Channappagoudar and M.B. Chetti	158
10-09(P)	Effect of mycorrhizal fungi (GM, GF) on growth of <i>Gymnema sylvestre</i> R. Br. Ex Schult Saurabha B. Zimare and Nutan P. Malpathak	158
10-10(P)	Phytochemical study in the dimorphic leaves of some aquatic pteridophytes M.V. Kale	159
10-11(P)	Biodiversity of algae from Chavadar tale, Mahad Latika Mehta and Sharda Vaidya	159
10-12(P)	Biodiversity of macrofungi from matheran Prashant Patil and Sharda Vaidya	159
10-13(P)	Nitrate reductase activity and gas exchange in pineapple plants (<i>Ananas comosus</i> L. Merrill.) in response to seasonal change S. Roy Chowdhury, Ashwani Kumar, O.P. Verma, P.S.B. Anand and Swagatika Panda	160
10-14(P)	The optimization of antioxidants in complex mixtures of <i>Mentha arvensis</i> L. <i>in vitro</i> produced Rashmi Bariya and H.A. Pandya	160
10-15(P)	Influence of irrigation methods on growth and yield of mature rubber clone RR11 105 under subhumid climate of north Konkan region Meena Singh, James Jacob, K Annamalainathan and S. Ravichandran	161
10-16(P)	Biodiversity and ethnomedicinal studies of some weeds of Ulhasnagar Neelam Parab and Sharda Vaidya	161
10-17(P)	Comparative karyomorphological studies in eleven accessions of <i>Allium cepa</i> Linn. Pankti Gosar, Behnaz B Patel, Vinaya Rane, Jacinta George, Anil Khar, V. Mahajan, Bhavna Narula, Sunil Shankhadarwar and Jessy Pius	162
10-18(P)	Diversity of ethnomedicinal plants of karnala forest, Maharashtra, India Gauri S. Soman and Satnamsingh Sohal	162
10-19(P)	Biomass production and biological activity of cyanobacterium <i>Nostoc calcicola</i> Y.R. Gahile, M.L. Ahire, K.M. Nitnaware, R.S. Shinde, B.N. Joshi, N.K. Jawali and T.D. Nikam	163

10-20(P)	Physiological approaches for in vitro production of pharmaceutically important metabolites of some important medicinal plants T.D. Nikam	163
10-21(P)	Pharmacognostic standards for an ethnomedicinally important food crop: <i>Parkia biglandulosa</i> Wight & Arn. Sunita Shailajan, Neelam Sayed, Suhas Pednekar, Naresh Chandra	164
10-22(P)	Diversity of orchids in the Sahyadri-a grave concern N. Surve Sameer, Sanghamitra R. Matil and M.S. Mulgaonkar	164
10-23(P)	Effect of customerised fertilizer on yield and quality of Alphonso mango A.K. Shinde, B.B. Jadhav and R.N. Shelke	165

Young Scientist Session

01	Differential accumulation of potassium, sodium, calcium and expression of SOS pathway genes in <i>Brassica</i> spp. under salinity stress K. Chakraborty, R.K. Sairam and R.C. Bhattacharya	169
02	Comparison of sugar metabolism in sweet sorghum and grain sorghum Hilal Ahmad Qazi and Sujata Bhargava	169
03	Effect of PGPR application on grain zinc content and its localization in rice (<i>Oryza sativa</i> L.) Ashish Sharma, Babita Patni and S. C. Shankhdhar	170
04	Leaf gas exchange parameters as criteria for selection under stressed environments – experiments with portable photosynthesis system V. Krishnapriya, C.N. Chandrasekhar, P. Jeyakumar, L. Pugalendhi, and C. Vijayalakshmi	170
05	Expression of antioxidant defence genes in mung bean (<i>Vigna radiata</i> L.) roots under water-logging is associated with hypoxia tolerance Rohit Joshi, R.K. Sairam, Piyali Bhattacharya, S. Lekshmy and V. Chinnusamy	171
06	Rice varieties are variable in expression of genes for salinity induced oxidative stress tolerance N. Ghosh, S.P. Das, C. Mandal, K. Das, S. Das, M.K. Adak	171
07	Pulsed magnetic field seed treatment for improving vigour in aged garden pea seeds Jyotsna Bharadwaj, Shantha Nagarajan, V.K. Pandita and Anjali Anand	172
08	Influence of osmotic stress and amino acids on somatic embryogenesis in callus of oilseed crop niger (<i>G. abyssinica</i> Cass.). S.G. Ghane and T.D. Nikam	172
09	Effect of zinc fertilization on grain yield and phytic acid concentration in different genotypes of wheat (<i>Triticum aestivum</i> L.) Kiran Bharti, Rahul Tyagi, Deepti Shankhdhar, P.C. Srivastava and S.C. Shankhdhar	173



- 10 Salvinia plants (*Salvinia natans* Linn.) are a successful hyper accumulator for aluminium and its evaluation on physiological basis 173
C. Mondal, N. Ghosh, S. Das, Saswati Das, K. Das Sudha Gupta and M.K. Adak
- 11 Effect of water stress on proline content and proteins of the wild *Ricinus communis* L. 174
Yogesh Pawar, Yash Gupte, Samruddha Phadnis, Seema Menon and Ganesh Iyer
- 12 Effect of zinc on root endodermis 174
Yash Gupte, Yogesh Pawar, Samruddha Phadnis. Bhupinder Madavi, Kanchan Chitnis, Seema Menon and Ganesh Iyer
- 13 Effect of kinetin and homobrassinolide on some morphological, physiological, biochemical characters, yield attributes and yield under water stress in chickpea (*Cicer arietinum* L.) 175
G. Vijayakumar, G. Lakshminarayana Reddy, S.S. Rao and J.V. Patil
- 14 Responses of wheat (*Triticum aestivum* L.) genotypes under different dates of sowing 175
Pratap Singh, Padmanabh Dwivedi and J.P. Srivastava
- 15 Impact of rising CO₂ on physiological characteristics of *desi* and *kabuli* chickpea 176
Puja Rai, Madan Pal Singh, V. Chinnusamy, S. Khetrapal, Divya Shah
- 16 Role of exogenous application of plant growth regulators on growth parameters and productivity of bamboo seedlings 177
Preetmaninder Kaur, Richa and M.L. Sharma
- 17 Effect of polysaccharide based edible coatings on the quality characteristics and the activities of softening enzymes of jamun (*Syzyium cumini* L.) fruit 178
Neeta B. Gol and T.V. Ramana Rao

Author Index

i-v

Session 01

**Photosynthesis, Plant Productivity
and Crop Modeling**



01-01(O)

VARIATION IN RADIATION USE EFFICIENCY OF RICE CULTIVARS GROWN AT DIFFERENT LOCATIONS

P. Raghuvver Rao*, B. Sailaja, D. Subrahmanyam, D. Vijay, S.C. Shankdhar, I.M. Khan, R. Beena
Ajit Kumar and S.R. Voleti

Directorate of Rice Research, Rajendranagar, Hyderabad-30
prrao@drircar.org / prrao2005@yahoo.co.in / srvoleti@drircar.org

The amount of solar radiation intercepted by a crop is a major determinant of biomass produced. Reasons for variation in biomass accumulation in rice cultivars in spite of being in the genetic background has been largely due to environmental factors in association with edaphic factors. Very few studies conducted with rice have analyzed crop performance for radiation interception and utilization. System of AICRIP experimentation will help in identifying genotypes that are stable in terms of biomass and yield. The major objective was to identify suitable donors/cultivar for high radiation use efficiency among the IET cultures. At five different agro climatic locations, Viz., Hyderabad, Maruteru, Pantnagar, Rewa and Pattambhi six rice cultures were studied for the variation in RUE. RUE was estimated using Oryza -2000 crop growth model and meteorological parameters based on actual biomass recorded at phenological stages and maturity. Significant differences were observed amongst the cultures for RUE at maturity. The interaction between location and cultures was also found to be significant. The mean RUE recorded was 0.33 for these cultures. IET 21429 and Lalat had minimum RUE at maturity and IET 20884 had maximum (0.37). The relationship between RUE and TDM was studied by simple regression analysis, at most of the centers there was a positive and significant relationship.

01-02(O)

PHYSIOLOGICAL STUDIES ON EFFECT OF STEM GIRDLING, ROOT PRUNING AND CHEMICAL TREATMENTS ON INDUCTION OF FLOWERING IN ALPHONSO MANGO

M.V. Rakshe¹, M.M. Burondkar², S.G. Bhav³ and K.A. Shinde⁴

Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli
Email: burondkarmm@yahoo.co.in

A field trial aimed at “Physiological studies on effect of stem girdling, root pruning, paclobutrazol (soil application and bark painting) and sea water spray treatments on induction of flowering in Alphonso mango” was undertaken during the year 2010-2011 at CES, Wakawali. The vegetative and flowering observations were taken periodically. The physiological observations were taken at three different stages i.e. before flowering, at flowering and thirty days after flowering. Result indicated that, PBZ soil applied and root pruning twice significantly delayed vegetative flush 71 and 69 days respectively till 5th week of June over all rest of the treatments. The flowering and yield data emphasized the fact that soil applied paclobutrazol followed by root pruning twice was significantly superior over all other treatments as both exhibited early and profuse flowering in 4th week of October. Recommended dose of PBZ, found highly promising in induction of early flowering (180 days), profuse flowering (85.52%) and fruiting (16.31 kg/plant) in Alphonso mango. This was closely followed by root pruning twice (Oct. 1st week and Oct. 3rd week) at par with PBZ and equally effective in induction of early flowering 187 days, profuse flowering 82.93% and fruiting 15.75 kg/plant. Thus, it could be concluded that to induce early and regular cropping in Alphonso mango in Konkan region, the method of root pruning twice as a cultural method, particularly under organic mango cultivation, holds a great potential and could be successfully adopted as effective as recommended method of PBZ soil application.

01-03(O)

EVALUATION OF REDGRAM VARIETIES FOR PHYSIOLOGICAL EFFICIENCY IN *RABI*

A.R. Nirmal Kumar, G. Rama Rao* and K. Balakrishna Reddy

Department of Plant Physiology, S.V. Agricultural College, Tirupati, A.P.

Field experiment was conducted during *rabi* 2009-2010 to study the “Evaluation of redgram varieties for physiological efficiency in *rabi*”. The experiment was laid out in randomized block design with tree replications in the wetland farm of S.V. Agricultural College Tirupathi. Treatments consists of six early maturing cultivars(ICPL85063, ICPL87119, LRG30, PILER LOCAL, TRG21, TRG7) matured by 135 days and four long duration varieties (ICPL8863, PRG148,LRG41 and TRG22) matured by 165 days. The results revealed that significant differences were observed among the cultivars for plant height, number of branches, dry matter production, growth characteristics and nutrient concentration. Among the early maturing cultivars tested, Piler local recorded highest plant height (120.4 cm), number of branches (10.8) root dry matter (4.27g plant⁻¹)pod dry matter (24.86 g plant⁻¹), total dry matter (46.58 g plant⁻¹), leaf area (406.86 cm² plant⁻¹), leaf area index (0.54), leaf area duration (11.16 cm² day⁻¹). SLA (86.49 cm² g⁻¹), SCMR (41.56) number of pods per plant (140.4), harvest index (44.98 %) and seed yield (1672 kg ha⁻¹). However, LRG 30 recorded highest leaf dry matter (5.48 g plant⁻¹), stem dry matter 14.24 g plant⁻¹), CGR (5.78 g m⁻² day⁻¹), RGR (0.010 g⁻¹ day⁻¹), number of seeds per pod (3.5). Test weight (11.0 g) was more in ICPL87119. Days to 50% flowering (69) was less in Piler local when compared to other varieties. Piler local also recorded higher concentration of nitrogen and phosphorus in leaves, stems and pods. Similarly the uptake of nitrogen and phosphorus was also high in different plant organs of Piler local. Among the late maturing cultivars tested, LRG 41 recorded highest plant height (131.13 cm), number of branches (11.9), leaf dry matter (6.4 g plant⁻¹), stem dry matter (22.12 g plant⁻¹), root dry matter (5.74 g plant⁻¹) pod dry matter (23.83 g plant⁻¹), total dry matter (57.86 g plant⁻¹), leaf area (414.7 cm² plant⁻¹), leaf area index (0.55), leaf area duration (11.32 cm² day⁻¹). SLA (65.01 cm² g⁻¹), SCMR (43.4) number of pods per plant (161.6), number of seeds per pod (3.7), harvest index (47.95%) and seed yield (1862 kg/ha) where as test weight was more in ICPL 8863 (11.4 g) when compared to other cultivars. LRG41 also recorded higher concentration as well as uptake of nitrogen and phosphorus in different organs. Hence LRG 41, Piler local and ICPL 8863 were considered suitable for *rabi* cultivation in chittoor district of A.P.

01-04(O)

INFLUENCE OF SULPHYDRYL COMPOUNDS ON WATER RELATION, PHOTOSYNTHESIS AND YIELD OF CLUSTERBEAN (*CYAMOPSIS TETRAGONOLOBA*) UNDER WATER DEFICIT CONDITION

N.S. Nathawat^{1*}, V.S. Rathore¹, N.K. Gupta², R. Bhargav³, S. Bhardwaj¹, Birbal¹ and Govind Singh²

¹Central Arid Zone Research Institute, RRS, Bikaner Rajasthan, ²Plant Biotechnology Center, SKRAU, Bikaner, Rajasthan, ³Central Institute of Arid Horticulture, Bikaner, Rajasthan

¹*Corresponding author: nathawatns@rediffmail.com

Water deficit is one of the most important environmental factors constraining plant photosynthesis and productivity in arid and semi-arid areas. Plants grown under drought condition have a lower stomatal conductance in order to conserve water. Consequently, CO₂ fixation is reduced and photosynthetic rate decreases, resulting in less assimilate production for growth and yield of plants. The sulphhydryl compounds are reported to have the capacity to counteract the water stress induced adverse effect on plant metabolism. The present field experiment was conducted during Kharif 2010 at CAZRI, RRS, Bikaner to study the efficacy of two sulphhydryl compounds i.e. thioglycollic acid (TGA) and thiourea (TU) on water relation, photosynthesis and yield of clusterbean

(*Cyamopsis tetragonoloba*) under water stress environment. The three concentrations of TGA (200, 300, and 400 ppm) and TU (500, 750, and 1000 ppm) were applied as foliar application. The application of –SH compounds showed significant ($P<0.05$) improvement in water relations under water stress condition. The highest improvement in water potential and membrane stability index was found with 1000 ppm TU over water sprayed control. The application of thioglycollic acid and thiourea showed significant ($P<0.05$) improvement in the photosynthetic pigments and gas exchange parameters. Maximum increase was recorded in chlorophyll content, carotenoid content, a/b ratio and chl/car ratio with application of 1000 ppm TU. The application of different concentration of –SH compounds significantly ($P<0.05$) influenced gas exchange parameters i.e. net photosynthetic rate (Pn) and stomatal conductance (gs) at flowering and post flowering stages. The highest increase in Pn was registered with application of 400 ppm TGA at both stages. Application of 1000 ppm TU brought maximum increase in stomatal conductance at flowering stage over control. The application of –SH compounds showed significant response ($P<0.05$) on yield attributes and yield. The highest increase in seed yield was recorded with application of 400 ppm TGA. Maximum increase in biological yield was observed with the spray of 1000 ppm TU. The results suggested that application of TGA and TU ameliorated the adverse effect of water stress and improved water relations, photosynthetic pigments, gas exchange parameters and productivity of clusterbean under water limiting conditions.

01-01(P)

ASSESSMENT OF VARIABILITY AMONG FLUE-CURED TOBACCO GERmplasm LINES FOR GAS EXCHANGE PARAMETERS AND FOLIAGE INDEX

M. Anuradha, T.G.K. Murthy, D. Damodar Reddy and V. Krishnamurthy

Central Tobacco research Institute, Rajahmundry-533 105
radhama2k2@yahoo.co.in

Gas exchange parameters, foliage index and specific leaf weight are the indicators of carbon assimilation efficiency of crops like tobacco where leaf is the economic product. Understanding the variability of these parameters among the germplasm lines helps the breeders in selecting the genotypes for developing high yielding varieties. In the present study thirty seven flue-cured tobacco germplasm lines were assessed for net photosynthetic rate (Pn), stomatal conductance (gs), transpiration rate (E), chlorophyll content index (CCI), specific leaf weight (SLW) and foliage index (FI) under field conditions at the CTRI research farm, Katheru, East Godavari district, Andhra Pradesh. All the observations were recorded in the first fully formed leaf at 70 days after planting. From these observations intrinsic and instantaneous water use efficiency were computed. Net photosynthetic rate varied from 6.62 to 22.3 $\text{mmol m}^{-2} \text{s}^{-1}$ with a mean of 14.21 $\text{mmol m}^{-2} \text{s}^{-1}$. Among the germplasm lines tested, TI 70, DR-1 and 95/15 showed greater Pn than other lines. Foliage Index of genotypes tested varied from 1.27 to 4.06, with the lines, DP-3, 95/4 and 95/15 having greater FI values. Chlorophyll content Index for different lines ranged from as low as 12.86 to as high as 95. Lines DR1, Jayalakshmi (PF) and Jayalakshmi (WS) showed greater CCI. The specific leaf weight varied between 6.3 to 12 mg cm^{-2} . Among the germplasm lines, COR-16, Jayalakshmi (PF) recorded greater values of instantaneous and intrinsic water use efficiency thereby implying that these lines were efficient in diverting absorbed water for photosynthesis rather than for transpiration and thus leading to their greater ability for carbon assimilation. This study suggests that wide variation existing among the germplasm lines in terms of physiological traits provide opportunity for evolving high yielding varieties of flue-cured tobacco.

01-02(P)

PHYSIOLOGICAL TRAITS ASSOCIATED WITH TOLERANCE TO PRE HARVEST SPROUTING AND HIGH YIELD IN MUNGBEAN GENOTYPES

H. Vijayaraghavan*, M. Pandiyan and S. Geetha

National Pulses Research Centre, TNAU, Vamban-622 303, Pudukkottai District, Tamil Nadu

* *vijayaraghavanprof@yahoo.co.in*

Mungbean is an important pulse crop in our country supplying proteins and the only source for vegetarians. The pulses have low productivity when compared to cereals due to inherent genetic and physiological make up of the crop. Pulses production is declining and limited by pre-harvest sprouting in high rainfall zones especially in mungbean and the problem need to be addressed by physiological evaluation to identify the superior genotypes showing tolerance to this character. Mungbean is grown in all seasons (*kharif, rabi*, spring and summer seasons) and the area of cultivation in India is 2.53 mha and the production is 0.86 mtonnes. Among the four seasons *kharif* is important and in this season preharvest sprouting is big problem causing considerable yield reduction. Preharvest sprouting is one of major problems to be addressed because untimely rains at the time of harvest, seeds in the pods germinate on the plant itself. No resistance source is reported so far. Hence it is imperative to study the factors associated with high yield and also to have tolerant genotypes towards preharvest sprouting. Experiments were conducted both under laboratory as well as under field conditions employing twenty genotypes. Among the 20 mungbean genotypes screened for evaluating the tolerance for pre harvest sprouting, seven genotypes KM-8-144, VGG05-008, VGG07-001, VGG-07-002, VGG05-009, VGG04-0023 and VGG04-0021 showed tolerance indicating that these genotypes could be used as donors for pre harvest sprouting in breeding programmes. Incidentally these genotypes were found to be the high yielders than the others and showed superiority. It is seen that the activities of amylase and dehydrogenase are lower in the genotypes indicating that these parameters deserve to be studied in depth. Among the growth parameters, higher NAR during 30 and 45 days is more related yield than other parameters.

01-03(P)

IMPACT OF PRE HARVEST BURNING OF SUGARCANE ON CANE YIELD AND QUALITY

Ch. Mukunda Rao*, K. Prasada Rao and K. Veerabhadra Rao

*Acharya N.G. Ranga Agricultural University, Regional Agricultural Research Station,
Anakapalle – 531001 (AP)*

Loss of cane in terms of cane weight and quality was more in burnt cane as harvesting delays after burning. The loss in cane weight and quality was less within 24 hours after burning. Cane quality in terms of reducing sugar percentage, dextrins contain in cane was high in burnt cane than unburnt cane. Loss in cane weight within 24 hours after burning was 4.5% and it raised up to 17.35% at 96 hours after burning. Burning of cane drastically reduces Juice extraction percentage up to 44. 23% at 96 hours after burning. Juice pH was more acidic in burnt cane than unburnt cane. Burning of cane reduces sucrose Percent 8.73% within 24 hours and it rises up 24.66 % at 96 hours after burning. Intentional burning of cane as a means of cost of harvest is not advisable because of loss in cane quality and quantity, environmental problems, additional cost in harvesting charges and differential cropping patterns of farming community etc.

01-04(P)

SEASONAL VARIATION IN PHYSIOLOGICAL BEHAVIOR OF CASHEW NUT IN DIFFERENT SEASON

M.M. Burondkar, K.H. Pujari, K.A. Shinde and S.G. Bhawe

Dr. B.S. Konkani Krishi Vidyapeeth, Dapoli, MS

burondkarmm@yahoo.co.in

A field trial aimed at studying seasonal variation in physiological behaviour of cashew nut in different season was conducted in Ratnagiri district of Maharashtra during 2009-2010. Influence of nine treatment combinations i.e. three seasons (winter, summer and monsoon) and three locations (10 km. away from sea in rocky lands, 10 km away from sea in deep soil and near sea coast) was investigated in FRBD on major physiological parameter using LICOR-6400. Results indicated that, all the three seasons significantly influenced the physiological behavior of cashew nut irrespective of locations. The net photosynthesis ($11.076 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$) and stomatal conductance ($0.244 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) was significantly higher during winter season as compared to summer ($7.367 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$, $0.201 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) and monsoon ($7.781 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$, $0.031 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) season. The rate of transpiration ($4.096 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) was significantly higher during winter season, and lowest observed during summer ($3.869 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) and rainy ($1.610 \mu \text{ mol H}_2\text{O}/\text{m}^2/\text{sec}$) season. The rate of respiration ($4.882 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$) was significantly higher during summer season and lower observed during winter ($2.642 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$) and rainy ($2.496 \mu \text{ mol CO}_2/\text{m}^2/\text{sec}$) season. The difference in air and leaf temperature was negative during rainy (0.362°C) season and positive during winter (0.411°C) and summer (0.615°C) season.

01-05(P)

VARIABILITY IN YIELD POTENTIAL AND NUTRITIONAL QUALITY OF KIWIFRUIT (ACTINIDIA CHINENSIS PLANCH)

A.K. Trivedi¹, S. K. Verma², K.S. Negi¹, R.R. Arya¹ and P.S. Mehta¹

¹National Bureau of Plant Genetic Resources, Regional Station Bhowali (Niglat)-263132

District – Nainital, Uttarakhand, ²National Bureau of Plant Genetic Resources, Regional Station Shillong, Umroi Road, Umiam, Shillong-793 103, Meghalaya

Availability of balanced nutrition for increasing population is a major constraint for sustaining life. Fruits play a major role in fulfilling this requirement. But due to reeling impact of climate change in Himalayan region the high chilling requirement fruits like apple and few varieties of apricot are shifting towards higher elevations. Owing to the demand of fruits exotic kiwifruit is taking the place of these temperate fruit crops. In the present investigation five varieties of Kiwi fruits (Abbott, Allison, Bruno, Hayward and Monty) were selected and fruits were analyzed for variability in certain growth parameters, yield attributes and nutritional quality traits. Days to 50% flowering ranged from 44–56, days to peak flowering 52–67, days to ripening 168–179, fruit length 4.22–7.54 cm, fruit width 3.58–5.28 cm, fruit weight 38.80–85.40 g, fruit volume 52.22–82.32 cc, fruit yield per plant 38.00–72.00 kg. Moreover, TSS ranged 10.5–18.8 °Brix, pH of juice 3.2–3.8, vitamin ‘C’ 76–124 mg 100 g⁻¹, calcium 15–54 mg.100g⁻¹, magnesium 9.2–33.0 mg 100 g⁻¹, nitrogen 90.0–166 mg 100 g⁻¹, phosphorus 18–68 mg 100 g⁻¹, potassium 182–580 mg 100 g⁻¹ and iron 0.2–1.3 mg 100 g⁻¹. Significant genotypic variability was found in these parameters among kiwifruit varieties. Available genotypic variability may be harnessed for cultivation of this fruit crop in Indian hills and on the basis of these traits suitable varieties may be selected for cultivation.

01-06(P)

ASSOCIATION ANALYSIS OF PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS WITH YIELD COMPONENTS IN COTTON GENOTYPES UNDER DROUGHT STRESS

K. Ananthi, H. Vijayaraghavan and R. Ravikesavan

Department of Crop Physiology, TNAU, Coimbatore

Drought stress adversely affects the growth, development and ultimately yield of cotton. The growth and productivity of cotton plants depend largely on their vulnerability to environmental stress. Water deficit is the major constraint that limits agricultural production. Cotton cultivars that can endure and recover from drought are needed to minimize yield loss in dry land areas and to reduce the water needs of irrigated production. Several efforts have been taken to improve cotton production under water limiting conditions through conventional breeding techniques. However, progress in traditional breeding approach has been slow due to limited knowledge on genetics of drought tolerance and involvement of several complex tolerance mechanisms. A study was conducted to determine the association analysis of physiological and biochemical and yield parameters related to water stress in cotton genotypes. Genotypic correlation coefficients between different characters were worked out. The present study indicated that seed cotton yield showed significant positive association with photosynthetic rate, NRase activity, SPAD and total chlorophyll content at genotypic level indicating that these characters can be improved simultaneously. Among the genotypes, KC 2 X MCU 13 showed superiority among the others and further evaluation is in progress.

01-07(P)

GENOTYPIC VARIATION OF PARAMETERS IN RELATION TO PHYSIOLOGICAL EFFICIENCY IN GREENGRAM (*Vigna radiata* L. Wilczek)

Ratna Kinkor Goswami*, H. Choudhury, M.K. Sarma, R. Kandali and J. Goswami

Department of Crop Physiology, B.N. College of Agriculture, AAU,

Biswanath Chariali- 784 176, Sonitpur, Assam

ratnakinkor_goswami@rediffmail.com

A field experiment was conducted during *summer* seasons of 2007, 2008 and 2009 with 19 greengram genotypes belonging to varying yield potentials under rainfed condition in the research field of B N College of Agriculture, Assam Agricultural University, Biswanath Chariali, Assam. The soil of the experimental plot is sandy loam with medium available N and K₂O and low P₂O₅ content. The experiment was laid out in a randomized block design with three replications and the crops were cultivated following the recommended package of practices including adoption of timely plant protection measures. Significant variations were observed among the genotypes with respect to the physiological traits analysed at different stages of plant growth. Among the parameters, stomatal frequency, stomatal conductance, photosynthetic rate, transpiration rate and total leaf chlorophyll content were found significantly higher in the genotypes having higher seed yield. Therefore, these traits may be used as indices for better physiological efficiency and higher productivity in greengram. However, the high yielding genotypes were found to possess lower seed protein. Among the genotypes, Pratap, KM 5-168 and AAU-34 were identified as superior genotypes with respect to the above physiological parameters coupled with higher seed yield and other yield components. These genotypes may be used as genetic source for improvement of physiological efficiency and yield potentials in greengram, particularly under upland rainfed condition.

01-08(P)

PHYSIOLOGICAL EVALUATION OF WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES IN RELATION TO PHOTOSYNTHETIC EFFICIENCY, GROWTH AND PRODUCTIVITY

Deepak Meena, R.K. Samaiya, R.S. Shukla, S.K. Dwivedi and S. Rao

Department of Plant Physiology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P.)– 482004

The present research investigation entitled “Physiological evaluation of wheat (*Triticum aestivum* L.) genotypes in relation to photosynthetic efficiency, growth and productivity”. Was conducted during Rabi season 2010-2011 at live stock Research Farm, Adhartal, Department of Plant Breeding and Genetics, JNKVV, Jabalpur, (M.P.). The research experiment was laid out in a Randomized Block Design with three replication and treatment comprised of twenty six wheat genotypes evaluated under rain-fed conditions. The various genotypes showed marked variability among themselves in relation to their phenological developments, biochemical estimations, physiological determinants and morphological structural attributing parameters and seed yield. Under rain-fed condition the genotypes flowered earlier viz., G₂₄ (PBW-343/CDWR-9563-6) and G₁₀ (PBW-343/K-9924) required lesser time for attainment of reproductive stages as compared to other genotypes. Maximum LAI accumulation was obtained in G₂₆ (HI-1531) upto 75-90 DAS. Similarly CGR and LAD and NAR had a progressive pattern of increase upto 60-75 DAS thereafter, it declined sharply. Maximum RGR was noted in G₂₀ (JW-3020) and G₁₄ (MP-3359/WH-1092) and RGR showed a differential pattern among different genotypes while SLA had a linear decrease while SLW showed a stable trend during crop growth periods. Maximum SLA was attained by G₂₀ (JW-3020) and G₁₈ (MP-3360/RAJ-4213). PAR, net photosynthesis, transpiration rate and stomatal conductance significantly reduced under rain-fed conditions. While some genotypes G₁₁, G₁₃, G₁₇, G₁₉ and G₂₀ maintained higher value. The relative leaf water content varied significantly among Wheat genotypes reduced under rain-fed condition. G₇, G₁₆, G₁₅ and G₂₀ maintained higher RLWC in rain-fed conditions at 75 DAS, 90 DAS and 105 DAS as high drought tolerance correlated with high value of relative leaf water content as reported in these wheat genotypes. While genotype G₁₂, G₂₄ and G₆ showed minimum RLWC on similar stages of crop growth. The photosynthetic pigment content in Wheat leaves reduced significantly. Significantly highest chlorophyll content was exhibited by G₁₉ showed maximum chlorophyll pigments content at 105 DAS which showed that high chlorophyll maintenance under high temperature. Seed quality parameters were also significantly influenced by rain-fed conditions. G₂₀, G₁₉, G₁₈, G₉ and G₁₇ estimated higher seed proline, nitrogen and protein was maintained followed by G₂₆, G₁₁, G₁, G₂₀, G₉. While maximum carbohydrates was estimated in G₂₆, G₂₀, G₁₁, G₁₀ and G₅. The improvement in morphological structural components caused a significant impact on maximum realization of yield potential G₂₃, G₈, G₁₁, G₁₂ and G₁₉, registered maximum seed yield per plant under rain-fed condition due to improved structural attributes of yield, biological yield with efficient partitioning efficiency and finally seed yield per plant. It may be concluded that rain-fed condition had an additive influence on all phenological developments, physiological, biochemical and morphological structural yield attributing parameters. G₂₃, G₈, G₁₁, G₁₂ and G₁₉, were promising for seed yield and its attributes under rain-fed conditions. The high RLWC and chlorophyll content are the good indicators for the temperature tolerance capacity of these genotypes and these genotypes may be further utilized for the development of temperature tolerant wheat varieties for rain-fed conditions.

01-09(P)

MORPHO-PHYSIOLOGICAL CHARACTERIZATION OF CHICKPEA (*CICER ARIETINUM* L.) GENOTYPES

R.S. Wagh, K.K. Bodake and D.V. Deshmukh

Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, Dist.: Ahmednagar (M.S.)

Thirty two chickpea genotypes were evaluated during *rabi* 2009 for morpho-physiological characterization at PGI Farm, M.P.K.V., Rahuri, Dist. Ahmednagar (M.S.) in RBD with two replications. The observations on morphological, physiological, dry matter accumulation and its partitioning, phenological and generative growth and sink capacity were recorded. Partitioning of total dry matter between the vegetative and reproductive plant parts played an important role in determining processes. Studies on leaf area revealed that it is good for increasing photosynthetic efficiency of plant. The photosynthetic rate, transpiration rate and stomatal conductance were highest at 50 % flowering and decreases after 15 days of 50 % flowering. The genotypes significantly differed in respect of yield per plant. The highest yield was recorded by the genotypes Digvijay, Vijay, ICC-13219, ICC-15868, ICC-1579 and ICC-4593. The most important yield attributes are pods/plant, grains/ pod and 100 seed weight which determines the sink capacity. Therefore, it can be concluded that the significant variation in yield could be seen in different genotypes due to their differential behaviour in respect of growth, development, phenology, dry matter production potential and translocation of photosynthates from source to sink. In high yielding genotypes the photosynthetic rate, number of pods, seeds per pod, yield per plant, harvest index etc. were observed to be the major yield contributing characters.

01-10(P)

STOMATAL CHARACTERISTICS, RESPIRATION AND PHOTOSYNTHETIC RATES IN WILD RICE (*ORYZA* SPP.) GENOTYPES

R. Kondamudi, K.N. Swamy, T. Vishnu, Y.V. Rao, N. Shobha Rani, N. Sarla, D. Subrahmanyam and S.R. Voleti

Directorate of Rice Research, Rajendranagar, Hyderabad-30
Email: drkondamudi@gmail.com

Wild genotypes are known for their hardiness but the reasons for this trait are poorly understood. In an attempt, six wild rice genotypes (*O. glaberrima*, *O. rufipogon*, *O. nivara*, *O. longistaminata*, *O. eichengeri* and *O. latifolia*) were phenotyped for some of the important physiological attributes which could be critical for developing "climate resilient rice genotypes" for various situations has been initiated under NICRA program at DRR, Hyderabad. The characters studied were stomatal number, respiration and photosynthesis. In vitro Photosynthesis values ranged at 30 °C was as low as 0.22 in *O. rufipogon* to as high as 4.34 in *O. glaberrima*. Similarly stomatal number was found to be relatively higher on adaxial side with maximum number in *O. nivara* while it was lower (8) in *O. latifolia*. In general, the stomatal number was lower on the abaxial surface in the wild genotypes ranging from 7 to 12 per unit area basis. Respiration rates on the hand exhibited wide variability ($\mu\text{MO}_2\text{RTA}$ was 3.83 to -3.08 *O. glaberrima* and *O. eichengeri* respectively). Regression analysis and curve fittings were done for rate of respiration, photosynthesis and their relationship with stomatal characteristics has been analyzed. The suitability of the some of these parameters and their utilization in developing the climate resilient rice is being explored.

01-11(P)

PHYSIOLOGICAL STUDIES ON WEED MANAGEMENT PRACTICES IN TRANSPLANTED ONION

V.M. Dore, M.B. Kulkarni and V.C. Melavenki

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

A field experiment was conducted at University of Agricultural Sciences, Dharwad to study the influence of weed management practices on growth and productivity of onion. The experiment was laid out in randomized block design (RBD) with 12 treatments and 3 replications. The prominent weed species observed in the experimental site were *Cyperus rotundus*, *Cynodon dactylon*, *Commelina benghalensis*, *Amaranthus viridis*, *Parthenium hysterophorus*, *Portulaca oleracea* and *Dinebra retroflexa*. The pre-emergent application of Butachlor @ 1 kg a.i./ha followed by post-emergent application of oxyfluorfyl @ 0.25 kg a.i./ha was found to be phytotoxic during the early stages of the crop and recovered thereafter while, pre-emergent application of oxadiarygyl @ 90 g a.i./ha and post-emergent application of pendimethalin @ 1kg a.i./ha was not found phytotoxic to the onion crop. The number of monocot, dicot and total number of weeds were found to be maximum in unweeded control. Among the integrated weed management practices pre-emergent application of oxadiarygyl @ 90 g a.i./ha followed by post-emergent application of oxyfluorfyl @ 0.25 kg a.i./ha at 40 days after transplanting (DAT) and pre-emergent application of oxadiarygyl @ 90g a.i./ha followed by two hand weeding at 40 and 60 DAT decreased the the number of monocot and dicot weeds. The weed biomass was also highest in unweeded control which was significantly reduced with pre-emergent application of oxadiarygyl @ 90 g a.i./ha followed by post-emergent application of oxyfluorfyl 0.25 kg a.i./ha and oxadiarygyl application supplemented with hand weeding treatments. Among the weed management practices highest weed control efficiency was recorded in pre-emergent application of oxadiarygyl @ 90 g a.i./ha followed by post-emergent application of oxyfluorfyl 0.25 kg a.i./ha. In general the growth parameters like plant height, number of leaves, total dry matter and it's partitioning were found to be higher in weed free check closely followed by the integrated weed management treatments viz. pre-emergent application of oxadiarygyl @ 90 g a.i./ha followed by the post-emergent application of oxyfluorfyl @ 0.25 kg a.i./ha and pre-emergent application of oxadiarygyl @ 90g a.i./ha + two hand weeding at 40 and 60 DAT. The physiological and biochemical parameters like chlorophyll content, photosynthetic rate and nitrate reductase activity (NRA) were found to be higher in weed free check and pre-emergent application of oxadiarygyl @ 90 g a.i./ha followed by the post-emergent application of oxyfluorfyl @ 0.25 kg a.i./ha and pre-emergent application of oxadiarygyl @ 90g a.i./ha + two hand weeding at 40 and 60 DAT. The bulb yield was also highest in weed free check closely followed by the above said integrated weed management practices. However net returns and benefit:cost ratio was highest with the pre-emergent application of oxadiarygyl @ 90g a.i./ha and post-emergent application of oxyfluorfyl @ 0.25 kg a.i./ha compared to all other weed management practices.

01-12(P)

SCREENING OF DIFFERENT *OCIMUM* GENOTYPES FOR GROWTH PARAMETERS, OIL AND SEED YIELD

D.P. Nawalkar¹, A.S. Gontia¹, H.S. Thakare², V. Kumar², S.R. Patel² and A. Narwade²

¹Department of crop and herbal physiology, J.N.K.V.V., Jabalpur (M.P.), ²NAU, Navsari (Gujarat)
dineshnawalkar@gmail.com

An experiment was conducted at the experimental area under department of crop and herbal physiology, J.N.K.V.V., Jabalpur (M.P.) during *kharif* season of 2007-2008 to screening the different *Ocimum* genotypes (10 genotypes) for different growth parameters and seed and oil yield. The growth parameters (*viz.* LAI, LAD,

SLA, CGR and NAR) were computed at 40, 80 and 120 DAT (Day after transplanting). LAI and LAD showed an increasing trend upto 80 DAT thereafter it declined. SLA, CGR and NAR recorded higher magnitudes in early growth period (upto 80 DAT) thereafter it declined. RGR exhibited inconsistent pattern. Genotype AIC 369247 showed higher LAI (1.24), LAD (44.71 m²/day) followed by genotype *Ocimum basilicum* JBP (0.83 and 30.07 m²/day respectively), whereas genotype AIC 369247 showed higher CGR (0.72 g/m²ground/day at 80 DAT) during most of the crop growth span. Also the genotype AIC 369247 possessed the significantly higher seed yield (2097.9 kg/ha) and oil yield (234.9 kg/ha) followed by the genotype *Ocimum basilicum* JBP (2088.9 kg/ha) and (231.8 kg/ha) respectively.

01-13(P)

GENETIC DIVERGENCE OF YIELD AND YIELD ATTRIBUTING CHARACTERS IN AROMATIC RICE (*ORYZA SATIVA* L.)

Manindra Nath Upadhyay^{1*} and Navendu Shekhar²

¹Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh ²Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh

*manindra_upadhyay@rediffmail.com

Present study was carried out to assess range of variation, character association and component analysis for genetic advance among 34 genotypes of basmati type rice during *khari* 2006 at the Research Farm of Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad. A wide range of variation was found for most of the characters namely, number of tillers per plant (12.60-27.06); days to 50 per cent flowering (101.8-113.6); biological yield (51.27-112.59 g); grain yield per plant (15.27-35.63 g); plant height (64.67-115.80 cm); flag leaf length (20.00-41.22 cm); flag leaf width (0.93-1.59 cm); panicle length (20.25-31.34 cm); test weight (15.81-22.53 g); harvest index (25.46-49.95 per cent); kernel length (6.10-8.15 mm); kernel width (1.61-2.05 mm); hulling percentage (43.66-70.33) and milling percentage (38.33-60.33). As of the genetic parameters; tillers per plant had maximum phenotypic coefficient of variation (21.75) followed by flag leaf length (21.64), biological yield, harvest index (18.11) and grain yield per plant (15.18). Also, maximum value of genotypic coefficient of variation was recorded for tillers per plant (21.05), followed by biological yield (20.57), plant height (16.07), harvest index (15.10), grain yield per plant (12.36) and flag leaf length (12.35). On an average, higher magnitude of GCV and PCV were recorded for tillers per plant and biological yield per plant suggesting sufficient variability and thus a scope for genetic improvement through selection of these traits. Here, heritability estimates were of high magnitude for tillers per plant, biological yield, flag leaf length, panicle length, plant height and kernel length; indicating that these characters are least influenced by environmental effects. Such characters are predominantly governed by additive gene action and could be improved through individual plant selection. The highest genetic advance was recorded for tillers per plant (41.97) followed by biological yield (40.93), plant height (30.03), test weight (25.95) and for flag leaf width (22.27). High heritability coupled with high genetic advance as per cent of mean was recorded for plant height, tillers per plant, panicles per plant and days to 50 per cent flowering; suggesting the predominance of additive gene action in the expression of these characters.



01-14(P)

ARBUSCULAR MYCORRHIZAL FUNGI: ROLE IN AGRICULTURE

Tushar S. Kelkar and Satish A. Bhalerao

*Environmental Sciences Research Laboratory, Department of Botany, Wilson College,
Chowpatty, Mumbai – 400 007*

Mycorrhiza is one of the most common types of symbiotic relationship between roots of higher plants and soil inhabiting fungi. Though also invagination of fungal mycelium in the cell of roots of plants is quite often, no visible tissue damage has been reported. And under certain conditions, this mutualism enhances the growth and vigor of plant. The term mycorrhiza was coined by Frank (1885). Since majority of crop plants form mycorrhiza, the subject is gaining importance in agriculture, olericulture, horticulture and forestry. These fungi can be divided into two major categories as ectotrophic mycorrhiza and endotrophic mycorrhiza. Ectotrophic mycorrhiza forms a mantle (Harting net) surrounding the host roots as well as an intercellular growth in the cell layers of the root cortex. The ectomycorrhizal associations present primarily in Gymnospermic plant roots including some genera of Angiosperms. Endomycorrhiza shows loose fungal network in the soil, and the fungal endophyte grows intracellular in the root cortex. Endotrophic mycorrhizae are prevalent in respective species of most families of Angiosperms. Of several kinds of mycorrhizae, the vesicular arbuscular is the most prevalent type now known as Arbuscular Mycorrhizae (AM fungi). The AM fungi derive carbon source from plant roots and in turn help the plant to draw more water and nutrients from the soil specially phosphate in abundance. It has been established that AM improves plant growth and health, qualitatively as well as quantitatively. Not only health but even the fitness of the plant can be improved because of AM colonization. It has been observed that AM improve the fitness of the plants to overcome adverse environmental conditions, such as drought and salinity. The fungi may have the ability to protect plants from salt stress but the mechanism is not speculative. The effect of AM colonization on heavy metals in plants are varied. They may protect their hosts plants to some extent from metal toxicity and enables such associations to colonize metalliferous soils. Mycorrhizal fungi are able to retard pathogen development in the root system and this influence is restricted to the site of mycorrhizal establishment. This may be partially responsible for limiting the activity of parasitic soil borne pathogens that attack the roots.

01-15(P)

PHOTOSYNTHETIC AND YIELD RESPONSE OF CHICKPEA (*CICER ARIETINUM* L.) TO BIOREGULATORS AND THEIR DOSE OPTIMIZATION

Pramod Kumar, T.V. Vineeth and Madan Pal Singh

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

Chickpea is the third most important food legume of the world ranking first in India and is rich in protein by virtue of N₂ fixation. Bioregulators are well known for enhancing growth and crop yield by improving photosynthetic efficiency. Presently, there is a greater research interest in identifying and employing bioregulator molecules. In order to identify the optimum dose of thiourea, benzyladenine (BA) and thidiazuron (TDZ), a pot experiment was conducted using two chickpea varieties namely *kabuli* type (PUSA 1108) and *desi* type (PUSA 362). Experiment consisted varying doses of thiourea (500, 1000 and 1500 ppm), BA (20, 40 and 60 ppm) and TDZ (5, 10 and 15 ppm). Foliar spray of all the bioregulators enhanced photosynthesis rate, photosynthetic pigments content, membrane stability index, nitrate reductase activity and yield of chickpea. Foliar spray of TDZ at higher dose displayed peculiar responses in the form of more pronounced branching, thicker shoot and delayed flowering. Maximum enhancement in terms of photosynthesis and yield among the varying doses of thiourea, BA and TDZ was recorded @ 1000 ppm, 40 ppm and 10 ppm respectively. In addition to this, *kabuli* type variety responded relatively better to bioregulators application as compared to *desi* type.

01-16(P)

GENOTYPIC AND PHENOTYPIC CORRELATION COEFFICIENTS AMONG YIELD COMPONENTS IN RICE (*ORYZA SATIVA* L.)

Navendu Shekhar^{1*} and Manindra Nath Upadhyay²

¹Department of Plant Physiology, ²Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, 221005, Uttar Pradesh

*navendu.india@gmail.com

Investigations were carried out during *kharif* 2010 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University to study the inter relationship of genotypic and phenotypic correlation coefficients between grain yield per plant and various yield components based on the evaluation of 16 rice genotypes for 12 yield attributing characters. As concerns phenotypic correlation coefficient (r_p), grain yield per plant showed highly significant positive association with harvest index (0.59), biological yield (0.48) and test weight (0.42); non significant but positive association with flag leaf width (0.21) and flag leaf length (0.13) and negative non-significant association for spikelets per panicle (0.32), plant height (0.19), panicles per plant (0.15) and tillers per plant (0.12). In genotypic correlation studies, grain yield per plant showed highly significant positive association with harvest index (0.59), biological yield (0.58) and test weight (0.51); positive non-significant association with flag leaf width (0.25), flag leaf length (0.20) and days to 50 per cent flowering (0.15); and negative non-significant association with spikelet per panicle (0.41), panicles per plant (0.23), plant height (0.22) and tillers per plant (0.16). In general, it was found that genotypic correlations were higher in magnitude than the phenotypic correlation coefficients, indicating their being governed by additive gene action; making them useful in crop improvement. However, direct selection for grain yield may not be effective, for high genotypic and environmental interactions very likely restrict the improvement.

01-17(P)

YIELD IMPROVEMENT IN RESPONSE TO LOW DOSE OF GAMMA IRRADIATION IS RELATED TO AN IMPROVED CARBOHYDRATE METABOLISM IN WHEAT

Sumedha Ahuja and Bhupinder Singh

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

We recently reported the use of low dose gamma irradiation to improve plant vigor, grain development and yield attributes of wheat. Further, we report here the results of a field experiment conducted on wheat cv. PBW-343 to assess the effect of gamma irradiation at 0, 0.005, 0.025, 0.1 and 0.5 kGy on flag leaf area, photosynthesis and transpiration rate and activities of key enzymes involved in carbon, nitrogen and starch metabolism. The plant mass and leaf area declined with an increase in the dose of gamma irradiation. LD₅₀ value for plant mass and leaf area was observed between 0.005 to 0.025 kGy. Membrane stability index (MSI) and leaf chlorophyll showed a decline in MSI only at 1kGy while chlorophyll content of the wheat seedlings was either unaffected or increased in response to gamma irradiation when compared with unirradiated control. Rate of flag leaf transpiration and photosynthesis were unaffected by gamma irradiation irrespective of dose. Starch synthase activity also remained unaltered by radiation while nitrate reductase activity was reduced by more than fifty percent at 0.025kGy than untreated control. An increase in the Rubisco activity of the flag leaf was evident in response to low dose of gamma irradiation. These results clearly indicate that the source of carbon and also the starch availability for grain filling is not limited by gamma irradiation, which further suggests that low dose of radiation fallout may not impact negatively the physiological processes determining grain productivity in wheat.



01-18(P)

**PERTURBATION IN SOURCE-SINK RELATIONSHIP WITH GA TREATMENT LED
ENHANCED CANE YIELD AND SUCROSE ACCUMULATION**

Rama Kant Rai, Pushpa Singh, A. Chandra and Rama Darash
Indian Institute of sugarcane Research, Lucknow 226 002, UP

Stagnating cane and sugar yield is a concern for growers as well as sugar mill industry. Improvement of yield is possible by perturbation of source and sinks relationship so that desired yield may be obtained. For this one experiment was started by application of GA on the foliage of sugarcane variety Co Se 92423 in early stage it was found that cane weight and sucrose% were increased by 5 and 2.5% as compared with control. The increased translocation of sucrose (235.80 mM/l) than (175 mM/l) of juice in control was main cause of sucrose accumulation in to the stalk. The *in vitro* uptake of sucrose in slices of internodal tissue increased by 24% in GA treated cane due to change in apparent free space by 25%. The cane length was increased by 21.1%, juice weight/cane was increased by 22% and number of millable cane (NMC) was increased by 69.3% compared with control. The activity of acid invertase and sucrose phosphate synthetase were the main enzymes responsible for growth and sucrose yield. The RGR and NAR along with increased LAI were major reasons for increased growth stimulated by GA treatment.

Session 02

**Plant Mineral Nutrition, Micro-
irrigation and Phytoremediation**

02-01(O)

EFFECT OF NANO BASED CALCIUM OXIDE SPRAY ON CALCIUM UP TAKE, YIELD AND QUALITY IN GROUNDNUT

P. Sudhakar*, T.N.V.K.V. Prasad, P. Latha and K. Raja Reddy

*Institute of Frontier technology, Regional Agricultural Research Station, Acharya N.G. Ranga
Agricultural University, Tirupati, A.P
sudakarp@yahoo.co.in*

Among the plant nutrients calcium plays pivotal role in regulating cell and plant functions as a secondary messenger apart from its role in cell structure. In groundnut calcium plays a crucial role in pod filling and which is met by soil application of gypsum (Calcium sulphate) at flowering stage. It was well documented that growing pods will directly take up calcium from soil, as calcium taken by roots do not reach pods, as Ca^{+2} cannot travel via phloem. Nano technology is the key technology of the 21st century and will reorient the applications in technologies including biology. Nanotechnology involves the production and application of physical, chemical and biological systems at scales ranging from individual atom or molecules at about 100 nanometers. At this institute nano based calcium was chemically synthesized to the size of 25 nm. A field experiment was conducted and three concentrations of nano based calcium were sprayed (50 ppm, 100 ppm, 200 ppm) along with soil application of gypsum @ 50 g/sq.mt (at flowering stage) and control. Spraying of nano calcium@ 100 ppm showed higher super oxide dismutase activity, higher pod yield and shelling percent compared to gypsum and control. The calcium uptake was also noticed throughout the plant parts.

02-02(O)

EFFECT OF ZINC APPLICATION ON GRAIN YIELD AND PHYTIC ACID CONCENTRATION IN POLISHED RICE GRAINS IN SOME RICE GENOTYPES

Rahul Tyagi, Kiran Bharti, Bhupendra Mathpal, Manish Shukla*, S.P. Pachauri*, S.C. Shankhdhar and P.C. Srivastava*

**Department of Soil Science, College of Agriculture
Department of Plant Physiology, College of Basic Science & Humanities
G.B. Pant University of Agriculture & Technology, Pantnagar, 263145 (Uttarakhand)
rahul.tyagi.121@gmail.com*

Nearly half of the world's population is malnourished in zinc, consuming diets based on cereal based plant foods. These plant foods contain anti-nutrient substances like phytic acid, which inhibit the absorption of trace elements. A field experiment was conducted to study the effect of different Zn levels (0 kg Zn ha⁻¹, 20 kg Zn ha⁻¹ as soil application and 20 kg Zn ha⁻¹+ foliar application of 0.5% solution of ZnSO₄) on grain yield, zinc and phytic acid content of grains and also phytate : zinc molar ratio in some rice varieties viz. Basmati 370, Pant Shankar Dhan 1, Pant Shankar Dhan 3, Pant Dhan 6, Pusa Sugandh 4 and Pusa Sugandh 5. With the application of the 20 kg Zn ha⁻¹ + foliar application of 0.5% solution of ZnSO₄, the yield was increased in the range of 5.1 to 43.8 % over the control. Application of 20 kg Zn through soil + foliar application increased grain yield from 17.4 (Pusa Sugandh 4) to 29.4 (Basmati 370) % over the control. In the absence of Zn fertilization, the content of Zn in polished rice ranged from 11.23 to 18.78. Application of Zn through soil or both through soil and foliar application increased the content of Zn in polished rice; the latter method of Zn application was more effective. The content of phytic acid in polished grains varied from 9.48 (Pant Shankar Dhan 1) to 11.52 (Pusa Sugandh 4) mg g⁻¹. Phytate : Zn ratio decreased with application of zinc through soil as well as both through soil and foliar application; the latter method of Zn application was more effective in lowering the phytate : Zn ratio.

02-03(O)

IMPACT OF 'ALLWIN TOP DRIP SPECIAL' FOR BOOSTING GROUNDNUT YIELD THROUGH DRIP FERTIGATION SYSTEM

H. Vijayaraghavan* and **S. Geetha**

National Pulses Research Centre, TNAU, Vamban-622 303, Pudukkottai District, Tamil Nadu

*vijayaraghavanprof@yahoo.co.in

'Allwin Top drip special' is a speciality commercial product by Sree Ramcides Chemicals (P) Ltd, Chennai containing Plant Growth Regulators and Succinic acid derivatives which induces the formation of defensive enzymes such as the Phenyl Ammonia lyase, Tyrosine Ammonia lyase, catalases and peroxidases. The bioefficacy of the product was tested in Groundnut variety VRI 2 raised under drip fertigation system. The objectives include to study the impact of Allwin Top drip special' growth, development and yield and also to analyse the root rhizosphere dynamics of nutrient uptake pattern. The chemical was applied through drip fertigation system during 5, 10, 30, 60 and 90 days after sowing. The dose of application ranged from 100 to 250 kg/ha along with a suitable control. The crop was raised under red lateritic soil which are normal in nutrient status. Two crops were raised and the data are pooled and analyzed. It was seen that the application of 150 kg/ha Allwin Top Drip Special at 5, 10, 30, 60, 90 DAS recorded highest mean pod number of 38.4 as against only 24.2 pods in the control. This has resulted in the highest mean yield of 2574.8 kg/ha as against only 1803.9 kg / ha in the control. There was an yield increase of 771 kg due to the treatment which is significantly higher than the control and other treatments. The soil nutrient analysis before the treatment imposition and after the crop harvest was done in order to visualize any nutrient addition or depletion due to the continuous application of Allwin Top Drip Special for groundnut. It was seen that in almost all post harvest soil analysis the treatments have increased the available nutrients considerably and interestingly it was observed that the increase is only marginal in the case of the best treatment i.e., 150 kg/ha Allwin Top Drip Special applied at 5, 10, 30, 60, 90 DAS. This may be due to the efficient utilization of nutrients for energy built up which in turn would have increased the groundnut yield and deserve to be studied further.

02-04(O)

INFLUENCE OF MICRONUTRIENTS AND SOURCE MANIPULATION ON GROWTH AND YIELD IN DIFFERENT PIGEON PEA (*CAJANUS CAJAN* (L.) MILLSP) GENOTYPES

A.D. Patel, Tanmay Patel, Samarjit S. Jagtap and K.P. Patel

Department of Plant Physiology, Anand Agricultural University, Anand-388110, Gujarat

A field experiment was conducted during the *rabi* 2010-11 at Anand Agricultural University, Anand, Gujarat to study the effect source sink manipulation studies in Pigeon pea (*Cajanus cajan* (L.) Millsp) using four diverse varieties (BDN-2, PKV-Trombay, C-11 and AAUT-2007-8). The nipping and 25% defoliation treatments were applied at 35 days after sowing and without treatment (control) along with three Fe treatments *viz.* No Fe (control), 20 kg Fe soil application as FeSO₄ and 0.5% FeSO₄ spray at flower initiation, pod development and grain filling stages with objective to study the influence of Fe on pigeon pea growth and yield. Among different treatments nipping produced significantly higher number of branches plant⁻¹, No. of pods plant⁻¹ and seed yield than control and defoliation. The numbers of leaves at flower initiation stage were significantly reduced due to defoliation treatment (133 leaves plant⁻¹) as compared to control (156 leaves plant⁻¹); whereas, nipping produce highest numbers of leaves (173 leaves plant⁻¹). In case of varieties, highest leaves numbers were

recorded for C-11 (189 leaves plant⁻¹) and minimum leaves with AAUT-2007-8 (126 leaves plant⁻¹). Among different Fe treatments spray treatment produced significantly higher numbers of leaves (163 leaves plant⁻¹) which was at par with Fe soil application (158 leaves plant⁻¹), however without Fe application it was (140 leaves plant⁻¹). The dry weight of plant was recorded maximum with nipping treatment (137 g plant⁻¹) followed by control (131 g plant⁻¹), which were significantly higher than defoliation (109 g plant⁻¹). Among the different varieties C-11 recorded maximum dry weight (147 g plant⁻¹); whereas varieties BDN-2 and PKV-Trombay both were recorded lowest plant dry weight (118 g plant⁻¹). Fe soil applications yielded maximum dry weight of plant (131 g plant⁻¹) which was at par with spray treatment (128 g plant⁻¹) and significantly differ from control (117 g plant⁻¹). Grain yield of pigeon pea was significantly influenced by physiological source sink manipulation treatments. Significantly higher grain yield was observed with the nipping treatment (1987 kg ha⁻¹); whereas defoliation reduced the grain yield (1719 kg ha⁻¹) which was at par with control (1784 kg ha⁻¹). Among different Fe treatments, Fe spray produce maximum grain yield (1949 kg ha⁻¹) followed by 1817 kg ha⁻¹ by Fe soil application, which were significantly higher than No Fe treatments (1723 kg ha⁻¹).

02-01(P)

INFLUENCE OF ORGANICS ON GROWTH, YIELD AND QUALITY OF TOMATO (*LYCOPERSICUM ESCULENTUM* L. MILL.)

C.S. Arahunashi, B.B. Channappagoudar, M.B. Chetti and B.T. Ningnur

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

A field experiment was conducted at the Main Agricultural Research Station, College of Agriculture, University of Agricultural Sciences, Dharwad during *rabi* 2009-10 to study the Influence of organics on growth, yield and quality of tomato (*Lycopersicon esculentum* L. Mill.). The investigation was carried in random block design with 14 treatments in 3 replications. Treatments include different organic sources of nutrients i.e. compost, FYM, green leaf manure, poultry manure, sheep manure and vermicompost alone and their combinations compared with RDF alone and RDF+FYM. The morphological characters mainly total dry matter accumulation, plant height, number of branches, canopy spread, leaf area and physiological parameters like leaf area index (LAI), leaf area duration (LAD) and biomass duration (BMD) were significantly higher with RDF+FYM, organics mainly FYM, compost, poultry manure and sheep manure applied equivalent to RDN as compared to only inorganic fertilizer, green leaf manure and control in all growth stages. The growth parameters like AGR and CGR were highest with the application of RDF+FYM followed by poultry manure at 30 to 60 DAT, while at 60 to 90 DAT AGR and CGR were higher with the application of poultry manure combined with vermicompost. The net assimilation rate, photosynthetic rate and chlorophyll contents were higher with the application of RDF+FYM followed by poultry manure, which were on par with other organic manures except green leaf manure and its combination with vermicompost. The quality parameters like ascorbic acid content, lycopene content, protein content, reducing sugar content, TSS, pH and shelf life were significantly higher with the application of poultry manure. The fresh fruit yield of tomato was found superior with the application of RDF+FYM followed by poultry manure, all other organic manures shows on par results except green leaf manure and its combination with vermicompost, RDF only and control. Net returns were significantly higher with RDF+FYM, on par with rest of the treatments except green leaf manure, RDF and control.

02-02(P)

OPTIMIZATION OF PLANT C : N RATIO FOR YIELD MAXIMIZATION IN Bt COTTON HYBRIDS

D.G. Dalvi*, D.B. Deosarkar, S.S. Bhatade and Javed Jani

Marathwada Agricultural University, Cotton Research Station, Nanded – 431604

**E-mail : dalvi46@rediffmail.com*

A field experiment was conducted during *kharif* 2010 at Cotton Research Station, Nanded to study the optimization of plant C : N ratio for yield maximization in Bt cotton with Object to study the effect of FYM application, level of nutrients and split application of nitrogen on yield and yield contributing characters and physiological parameters in Bunny Bt cotton hybrid. Application of FYM treatment was found significant for seed cotton yield, yield / plant and boll weight as compared to treatment without application of FYM. In case of recommended dose of nitrogen (RDN) the treatment 125% RDN followed by 100% RDN were found significantly superior over 75% RDN. Application of nitrogen in 4 splits were recorded higher yield and yield contributing characters as compared to 3 nitrogen splits. However, the differences were found non significant. Dry plant weight, green plant weight and harvest index were found significant with FYM application over non application of FYM. The application of 125% RDN followed by 100% RDN were found superior for dry plant weight, green plant weight and harvest index as compared to 75%. Application of nitrogen in two splits did not significantly influence the various treatments. However, values for green plant weight, dry plant weight and harvest index were higher in 4 splits of nitrogen as compared to 3 splits.

02-03(P)

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON GROWTH, YIELD AND QUALITY OF CHICKPEA PLANTS

Shikha Yadav*, Digvijay Singh and Nirmala Nautiyal

Botany Department, University of Lucknow, Lucknow-226007, UP

shikhagzp@gmail.com

A soil-pot culture experiment was conducted at the glass house of botany department, University of Lucknow, under ambient conditions to assess the effect of integrated nutrient management practices on the growth and yield of chickpea plants, with particular reference to the proper use of micronutrients. The soil used for the experiment was marginally deficient in Zn. The treatments given to the plants included: control with recommended dose of fertilizers (RDF i.e. N:P:K=120:60:60), RDF + Zn 10 mg kg⁻¹, RDF + B 1 mg kg⁻¹, RDF + Mn 2 mg kg⁻¹, RDF + S 20 mg kg⁻¹ and RDF + Zn 10 + B 1 + Mn 2 +S 20 mg kg⁻¹. As compared with control, the height and dry matter yield of plants increased with the application of all the nutrients but the maximum increase was obtained with the combined dose of all nutrients. Activity of enzyme carbonic anhydrase and starch phosphorylase although showed maximum increase with the sole application of Zn and B respectively but the combination of RDF with all other nutrients was also found helpful in increasing the activity of above enzymes. However, the activity of enzymes of peroxidase and ribonuclease showed a reverse trend and decreased with the application of nutrients, as compared to the control. Grain yield and grain protein content also increased with amendment of all nutrients along with RDF. Starch content of grains showed a slight decrease with the sole application of B, but increased in all other treatments as compared with the control.

02-04(P)

EFFECT OF BORON ON SPIKELET FERTILITY AND ZINC CONTENT IN DIFFERENT GENOTYPES OF RICE (*ORYZA SATIVA* L.)

Bhawna Pant, Narendra Kumar, S.C. Shankhdhar and Deepti Shankhdhar

Department of Plant Physiology, College of Basic Sciences & Humanities, G.B. Pant University of Agriculture & Technology, Pantnagar-263145, Uttarakhand
dshankhdhar@rediffmail.com

Rice is the most popular cereal worldwide, serving as a staple food for nearly half of the world's population. It is estimated that by 2030, 38% more rice production is needed. To meet these challenge rice varieties of higher yield potential and greater yield stability is needed. In the present study an attempt was made to evaluate the response of boron in rice genotypes in terms of their physiological and biochemical observations. The effect of different levels of boron 0 (T_0), 0.2 (T_1), 0.4 (T_2), 0.8 ppm (T_3) on the yield and the availability of Zn in six rice genotypes namely, IET20969, IET21003, IET21007, IET21014, IET21025 and Rasi were estimated. Boron was applied as a foliar spray at flowering stage. The yield which is influenced by factors like plant height, tiller number, leaf area index and total chlorophyll content increased with the increasing levels of boron. Biological yield of genotypes increased from 4.57 to 17.3% however, economical yield varied from 1 to 11.2% at different levels of boron. Most of the genotypes showed good response at T_2 level while some genotypes showed response at T_3 level. Number of grains per panicle varied from 77 in Rasi to 370 in IET 21003. Spikelet fertility in terms of fully filled grains also varied with B levels it varied from 25.0 % to 56.0% at T_2 level. Chaffy grains varied from 11.0 to 25.0% at T_2 level. The maximum grain yield was recorded in IET21003 at T_3 level. While other genotypes showed maximum yield at T_2 level. The zinc content was decreased with increasing levels of boron. It was decreased from 9.2% to 31.17% from T_1 to T_3 levels of boron. The maximum zinc content in grains was recorded in Rasi and minimum in IET20969. Amongst the genotypes Rasi showed least antagonistic effect of boron. Over all it indicate that boron was effective in the improving of yield. Amongst the genotypes IET21003 was most and Rasi least responsive to foliar application of boron.

02-05(P)

STUDIES ON MORPHOPHYSIOLOGICAL ROOT TRAITS FOR PHOSPHORUS EFFICIENCY IN WHEAT GENOTYPES

Gunjan Gera, Anita Kumari and Sunita Sheokand

Department of Botany and Plant Physiology CCS HAU Hisar

Twelve genotypes of wheat were raised in presence (+P) and absence (-P) of phosphorus to study the morpho- physiological root traits. Phosphorus deficiency evoked numerous adaptive mechanisms acclimation to P deficiency. Root length and number of secondary roots increased variably in all genotypes under -P conditions. Maximum root length was observed in the genotype WH1080 followed by WH1094, WH711 and WH147 in -P treatment. Similarly highest number of secondary roots was observed in WH1080 followed by WH711, WH1025 and WH147. Increase in root length under -P treatment was accompanied with a decrease in shoot length. C-306 genotype showed highest shoot length followed by WH1081, WH147 and WH1107. Acid and alkaline phosphatase enzyme activity in root extracts showed an inverse relationship and increased with decreasing P levels. Maximum increase in activity of alkaline phosphatase was observed in genotypes WH1025, C-306, WH1080 and WH1021 under -P treatment as compared to +P treatment. A similar increase in activity of acid phosphatase was found with a maximum increase in WH1025 followed by WH1021, WH1080, WH1107. Enhanced activity of phosphatases and increase in root length and number of secondary roots may be considered as adaptive mechanisms under P deficient conditions.

02-06(P)

EFFECT OF WATER STRESS ON MINERAL NUTRIENT CONTENTS IN DIFFERENT WHEAT GENOTYPES

Aradhna Kumari¹, R.K. Sairam^{1*}, Lekshmy. S¹ and Santosh Kumar Singh²

¹*Division of Plant Physiology, Indian Agriculture Research Institute, New Delhi 110012*

²*Department of Soil Science, RAU, Pusa, Samastipur, Bihar 848125*

Drought is one of the most important abiotic stress factors, and depending on the season it can seriously limit crop yield. An experiment was conducted with eight wheat genotypes to assess the effect of water stress on mineral nutrient content at harvest stage. Two sets of pots were maintained for all the wheat genotypes; one for control with normal watering at field capacity and another set at 60-70% of field capacity imposed by withholding irrigation. Water stress caused a decrease in membrane stability index (MSI) and relative water content (RWC), but the decrease was less in comparatively tolerant genotypes. Based on the results of MSI and RWC, C 306, HD 2987, HD 3016, NI 5439, were identified as tolerant, while HD 2733, PBW 343, PBW 373, HD 2967, as susceptible genotypes. Nutrient analysis was done both in grains and stems. Water stress caused changes in nutrient balance of the plants. Potassium concentration increased in stem and grains under water stress. However, concentration of iron decreased in stem, while increased in grain under water stress. The trend was opposite for zinc and manganese, i.e., an increase was observed in stem and reduction in grains under water stress. Nutrients like potassium were higher in straw in comparison to grain for all the varieties under control and water stress conditions. Concentration of phosphorus, manganese and zinc were greater in grains under both conditions. In general, drought tolerant genotypes showed lesser alteration in nutrient content than the susceptible genotypes, maintaining optimum nutrient levels in stem and seeds.

02-07(P)

EFFECT OF ZINC IN LOW AND HIGH VIGOUR SORGHUM GENOTYPES

**R.V. Koti, M. Harish, T.R. Raghavendra, H.B. Babalad, M.Y. Kamatar, U.V. Mummigatti
and B. Basavaraj**

Department of Crop Physiology, College of Agriculture, UAS, Dharwad, Karnataka

Email: rvkoti1@rediffmail.com

Zinc is deficit in most soils of sorghum growing areas leading to deficiency of zinc in crop as well as human beings who consume sorghum. To see the effect of externally applied zinc in low and high vigour sorghum genotypes, a pot experiment consisting of calcareous soil, 12 sorghum genotypes with two levels of zinc ($ZnSO_4$ @ 10 kg/ha and control without zinc) was laid out following CRD in three replications. Zinc content in both leaf and roots at 30 days after sowing (DAS) increased significantly due to zinc application and was 67% and 36% higher in leaf and root respectively as compared to control. The shoot length, shoot dry weight, number of roots, root length, root weight also increased significantly along with zinc content in leaf and root. The root density also enhanced and increase in root density in high vigour genotypes and checks was higher (12-13%) as compared to the low vigour genotypes (7.3%). It was concluded that application of zinc in calcareous soil at the time of sowing enhanced zinc content in leaf and roots of sorghum. The response of high vigour genotypes was higher than low vigour sorghum genotypes. It further needs to be confirmed whether the increase in zinc content in leaves and root is partitioned to grains at the time of harvest.

02-08(P)

PHOTOSYNTHETIC NITROGEN USE EFFICIENCY AND YIELD OF RICE HYBRIDS GROWN UNDER DIFFERENT NITROGEN LEVELS

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

Central Rice Research Institute, Cuttack, Odisha
mjbaigcrri@gmail.com

Photosynthetic characteristics are considered to be significant in nitrogen use efficiency (NUE) in view of their close association with dry matter production and grain yield in cereal crops. Photosynthetic nitrogen use efficiency (PNUE) and photosynthetic characteristics in relation to biomass production and yield were investigated using three rice (*Oryza sativa* L) hybrids viz. Ajay, Rajalaxmi and CRHR-32. The objectives of this study were to compare physiological efficiency of rice hybrids under four nitrogen levels. The result indicated that the photosynthetic rate linearly increased in all the hybrids when the nitrogen level increased from N_0 (No nitrogen) to N_{200} (200 kg nitrogen per hectare). Variations were observed in stomatal conductance (g_s), internal CO_2 concentration (C_i), Transpiration rate (E) and ratio of the C_i to g_s among all the rice hybrids irrespective of the N levels. Difference in the leaf nitrogen concentration (N%), specific leaf weight (SLW) and specific leaf area (SLA) were also found among all the hybrids. The P_N per chlorophyll (P_N/Chl) was higher in all the hybrids grown under N_{200} at vegetative stage and there was a significant increase in the P_N/Chl value under flowering stage irrespective of the rice hybrids and N levels. The grain yield of all the rice hybrids was influenced by the nitrogen level and was linearly increased when the nitrogen level increased from N_0 to N_{200} . The highest grain yield was recorded in Ajay (9.85 t/ha) followed by Rajalaxmi (8.70 t/ha) and CRHR-32 (7.79 t/ha) under N_{200} . The sterility percentage was ranged between 12-18% in all the hybrids under different N levels. There was a significant positive correlation between P_N and grain yield in all the hybrids. A significantly positive correlation between P_N and leaf N content per unit leaf are was observed in the hybrids tested. PNUE was positively and significantly correlated with agronomic efficiency in all the rice hybrids, suggesting that the PNUE at flowering stage of rice might be a good indicator for NUE and could be utilized in evaluating genotypes with high NUE in rice.

02-09(P)

VARIATIONS IN MICRO AND MACRONUTRIENT CONTENTS IN RESPONSE TO SOIL SALINITY IN DIFFERENT WHEAT GENOTYPES

Lekshmy. S, R.K. Sairam, S.N. Rai and S.R. Kushwaha

Division of Plant Physiology, Indian Agriculture Research Institute, New Delhi 110012

Salinity induced osmotic stress leads to water deficit. Nutrient imbalances may result from the effect of salinity on nutrient uptake, transport or partitioning within the plant or may be caused by physiological inactivation of a given nutrient resulting in an increase in the plant's internal requirement for that essential element. A pot culture experiment was conducted to study the effect of soil salinity on nitrogen, magnesium and some micronutrient accumulation in different wheat genotypes. Soil salinity was maintained by supplying 100 and 200mM NaCl and water for control. Final soil salinity levels were 1.21, 8.43 and 13.04 dSm⁻¹. Salinity caused changes in nutrient balance of the plants. Salt stress reduced the nitrogen content in leaves of wheat genotypes, however grain protein content were found to be increased under salinity stress. Contents of Fe, Mn and Mg were reduced due to soil salinity, whereas Cu and Zn contents increased under salinity. However, Kharchia 65 showed lesser alteration in nutrient content than the susceptible genotypes, maintaining optimum nutrient levels in leaves and seeds.



02-10(P)

EFFECT OF FOLIAR APPLICATION OF 'ALLWIN TOP LEGUME SPECIAL' ON GROWTH AND YIELD OF PIGEONPEA

H. Vijayaraghavan

National Pulses Research Centre, TNAU, Vamban-622 303, Pudukkottai District, Tamil Nadu
vijayaraghavanprof@yahoo.co.in

'Allwin Top legume drip special' is a commercial formulation containing Plant Growth Regulators and nutrients which induces vigour of the plants to withstand biotic and abiotic stresses. The product was evaluated in pigeon pea variety VBN 2 cultivated under red soil conditions. Foliar application was given during 30, 60 and 90 days after planting with the dose ranging from one to three gram per litre along with a suitable control and also a treatment with bacterial combination. It is seen that the foliar application of Allwin Top Legume Special at 2 g per liter at 30, 60 and 90 Days after sowing along with bacterial treatment (Rhizobium and phosphate solubilizing bacteria at sowing only) has recorded significantly higher grain yield of 965 kg/ha as against only 802.8 and 715.5 kg/ha in Bacteria treatment alone and in the control respectively. The yield increase is to the tune of 20.2 percent over bacterial treatment alone. The results suggest that foliar spray of Allwin top legume special for red gram is beneficial for increasing the yield.

02-11(P)

STUDIES THE EFFECT OF ZINC SULPHATE ON GROWTH, YIELD AND QUALITY OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER SODIC SOIL

R.K. Yadav, P.N. Singh, A.H. Khan and R.S. Kureel

Centre of advanced faculty training, Dept. of Crop Physiology, N.D.U.A.T Kumarganj, Faizabad, U.P.

Wheat is one of the important cereals due to its relatively higher Niacin and Thiamine content. It is also rich in Glutein which provides spongy cellular texture of bread and baked products. In India salt affected soils are spread 7.0 mha of which 1.29 mha exists in U.P. alone. The present experiment was conducted in field with three varieties of wheat namely NW-1012, PBW-343 and Malviya-468 and four treatments viz. control, Seed soaking 0.5% ZnSO₄, Seed soaking 1.0% ZnSO₄ and Basal application 20 Kg ZnSO₄/ha. Zinc application in the form of ZnSO₄ through seed soaking (0.5 and 1.0%) and basal application (20.0 Kg ZnSO₄/ha) significantly improve the all wheat varieties grown under sodic soil. Maximum plant height was recorded with application of 20 Kg ZnSO₄/ha followed by 0.5% seed soaking in ZnSO₄ at all the stage of crop growth. Total dry weight increased with the advancement in the age of crop up to maturity at various level of zinc. Grain yield per plant was recorded in NW-1012 significantly higher than Malviya -468 and PBW-343. However, seed soaking and basal application of ZnSO₄ showed progressive increased in grain yield in all the varieties. It was 30-38% more grain yield/plant than control. Maximum yield/plant was recorded with basal application of 20 Kg ZnSO₄ which was 21.8% higher than control while minimum was 0.5% ZnSO₄ as seed soaking. Maximum total soluble sugar was NW-1012 followed Malviya-468 and PBW-343 as compared to control. However, mean effect on total soluble sugar of wheat was significantly maximum 70.50 with basal application 20 Kg ZnSO₄/ha followed 1.0% and 0.5% ZnSO₄ as seed soaking than control. Total carbohydrate content of wheat was increase by spray of zinc. Zinc application also increases the synthesis and translocation of carbohydrate to site of grain formation.

02-12(P)

PHYSIOLOGICAL INVESTIGATIONS ON THE INFLUENCE OF ORGANICS ON PRODUCTIVITY OF CLUSTER BEAN

Lalit Meena, B.B. Channappagoudar, M.B. Chetti and R.V. Koti

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

A field experiment was conducted at main agricultural research station University of Agricultural Sciences, Dharwad to find out the effect of organics on various morph-physiological parameters and yield attributes in cluster bean genotypes. The experiment was laid out in a split plot design with three genotypes- local, Pusa Navbahar (improved variety) and Sarpan 101 (hybrid) and four organics (FYM, vermicompost, poultry manure and neem seed cake). All the morph-physiological traits varied significantly with genotypes and organics. Plant height was highest in Pusa Navbahar with FYM treatment. The leaf and stem dry weight was significantly higher in local at all the stages of growth. Among the organic treatments leaf dry weight was higher in poultry manure while stem dry weight was higher in FYM treatment. The dry weight of edible part was significantly higher with poultry manure treatment in hybrid Sarpan 101 compared to local and improved variety. The leaf area and leaf area index (LAI) were found significantly higher in local with poultry manure. The growth parameters like AGR, CGR and RGR were significantly higher in hybrid Sarpan 101 with poultry manure treatment, while NAR was significantly higher in sarpan with FYM treatment. The leaf area duration (LAD) was highest in local genotype with poultry manure treatment. The yield and yield attributes like number of pods per plant, pod yield and partitioning efficiency were found superior in hybrid sarpan 101 in combination with poultry manure treatment.

02-13(P)

EFFECT OF ORGANICS ON BIOCHEMICAL PARAMETERS IN CLUSTER BEAN GENOTYPES

B.B. Channappagoudar, Lalit Meena and R.V. Koti

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

A field investigation was conducted at University of Agricultural Sciences, Dharwad to know the influence of different organics on growth and biochemical parameters of cluster bean genotypes. The experiment was laid out in a split plot design with three replications. The main plot consisted of three genotypes comprising local, Pusa Navabhar (improved variety) and Sarapan 101 (Hybrid) and sub plot consisted of four organics (neem seed cake, poultry manure, vermicompost and FYM). The soil of the experiment plot was medium black with pH 7.6. The result of the present investigation reveals that leaf area, leaf area index (LAI) and leaf area duration (LAD) were higher in local genotype combined with poultry manure. The chlorophyll a, chlorophyll b and total chlorophyll contents were significantly higher in hybrid Sarpan-101 with poultry manure treatment while, the nitrate reductase activity (NRA) was significantly higher in local genotype with poultry manure treatment. The photosynthetic rate estimated at different stages of crop growth was significantly higher in hybrid Sarpan-101 in combination with poultry manure treatment. The quantity parameters like fibre content were highest in local genotype with FYM treatment. The compact non branching erect plant with cluster of fruits on every node observed in Sarpan-101 (hybrid) was an indicative parameter to establish a strong genetic relation among all yield and yield components and the biophysical parameters. The pod yield was also highest in sarpan 101 hybrid. The Harvest index which indicates the partitioning efficiency was also highest in hybrid compared to local genotype and improved variety in contrast to this shelling percentage was higher in local genotype with FYM treatment. However the highest B:C ratio was recorded in the treatment combination of Sarpan-101 and poultry manure.

02-14(P)

DEVELOPING SUSTAINABLE STRATEGIES WITH ADVANCE PHYTOREMEDIATION

K. Boricha Hansa¹ and S. Jadhav Pratima²

¹Department of Biotechnology, Elphinstone College, ²Elphinstone College, Fort, Mumbai-400032

¹Corresponding author: hansaboricha@gmail.com

Environmental contamination is the major issue of this century due to deterioration of the environment and its natural resources by human activities which has made irreversible damage to some extent and hence sustainability of life on the earth has become a global concern. Scientists are investigating different approaches to overcome these environmental challenges in which phytoremediation has its central focal point in sustainable development use of plants are natural decontaminators. The main thrust of this scientific investigation is to evaluate the potential of plants for its phytoremediation ability. Phytoremediation can be defined as environmental friendly, cheap and large scale method which uses the plant's natural ability and their associated microorganisms to contain, degrade, or eliminate toxic chemicals and pollutants (organic and inorganic) from the environment. It can be used to clean up metals/heavy metals, pesticides, solvents, explosives, crude oil, and contaminants that may leak from landfill sites (called leachates) or may enter the environment due to human activities. It can be achieved in several ways including phytoextraction, phytostabilization, phytodegradation, phytovolatilization, phytoremediation, phytomining, rhizosphere-enhanced degradation and rhizofiltration. Sustainable strategies can be worked out, planned, engineered and designed with ecological paradigm as our template so as to successfully defeat the environmental contamination by employing technology which not only safely utilize/consume all of the polluting components but also ultimately grow plants of economic value thereby embark upon the issue and getting further benefit out of it. Hence the article focuses on the recent advances in phytoremediation and biotechnological approaches for sustainable life and restoration of the environment.

02-15(P)

**GROWTH RESPONSES AND ANTIOXIDANT ACTIVITIES IN *Gmelina arborea* ROXB.
INOCULATED WITH *Gigaspora margarita* UNDER ALUMINIUM TOXICITY**

Mayura Dudhane, Mahesh Borde and Paramjit Kaur Jite*

University of Pune, Department of Botany, Pune, 411007

*paramjit.jite@gmail.com

Gmelina arborea Roxb. a medicinally and economically important tree species were selected for study. In present study, greenhouse experiment showed that *Gigaspora margarita* inoculated *Gmelina* plant showed increase in fresh and dry weight with increasing levels of Aluminium. As increasing Aluminium stress the mycorrhizal colonization goes on decreasing. Easily extractable glomalin was found to increase after 45, 75 and 100 days of mycorrhizal inoculation at first and second level of Aluminium. The root Proline accumulation was increased in mycorrhizal *Gmelina* plants for osmotic adjustment of stress tissues with increasing Aluminium level. The antioxidant enzymes like root POD and SOD was increased in mycorrhizal *Gmelina* under second level of Aluminium stress. Present study deals with the preliminary works of phytoremediation of heavy metal contaminated areas by using mycorrhiza inoculated *Gmelina* plants.

02-16(P)

IDENTIFICATION AND CHARACTERIZATION OF EMS INDUCED RICE VAR. NAGINA 22 MUTANTS FOR PHOSPHORUS USE EFFICIENCY AND HEAT TOLERANCE

P. Yugandhar, D. Nageswara Rao, Madhusmita Panigrahy, D. Subrahmanyam, P. Krishnamurthy, S.R. Voleti and N. Sarla

Directorate of Rice Research, Rajendranagar, Hyderabad 500030

Phosphorus availability is a major factor limiting growth, development and productivity of plants. It is a component of major organic molecules such as nucleic acids and ATP and is a part of membranes also. Breeding for P use efficiency is becoming important for sustainable agriculture. Mutants provide a means to discover genes for P use efficiency. In this study 400 EMS induced Nagina22 mutant lines were screened under low phosphorus field condition (Olsen P < 2 ppm) during 2008 and 2009. NH686, NH787, NH185 were identified as tolerant mutants and NH359 as a susceptible mutant based on grain yield in low P field compared to N22. The four mutants, N22 and the low P tolerant variety Rasi were screened in +P and -P Hoagland's medium in hydroponics also. Seedlings grown up to 18 days in water were transferred to +P and -P media for 12 more days. The total dry matter at 18 days was maximum in NH686 and least in NH185, NH686>NH787>N22>Rasi>NH359>NH185 in decreasing order. The shoot and root length, acid phosphatase activity and total dry matter accumulation in -P was same as in +P in NH686 indicating its tolerance to -P condition. NH185 showed increased shoot length, shoot acid phosphatase and total dry matter in -P medium compared to +P medium. NH787 roots respond to -P condition by two-fold increase in acid phosphatase activity. In +P and -P, the total dry matter was highest in NH787 and similar to Rasi. The susceptible mutant NH359 showed increased root length and increased acid phosphatase activity in roots in -P condition but the total dry matter was less in -P compared to +P. At 30 days the order of decreasing dry matter was NH185>NH787>Rasi>NH686>N22>NH359. Thus total dry matter of 30 day old seedlings in -P medium is a good criterion to select for gain of function or loss of function mutants for P as it corresponds to the field observations. In normal field, yield/plant of NH686 was 26g, NH787-18g and N22-16g. The P mutants were also examined for other traits related to high yield. Pollen number in closed anthers was more in NH686 and NH787 compared to N22. Likewise stigmatic papillae length was also more in the two mutants, 1.1cm in NH686, 1.3cm in NH787 but only 0.7 in N22. The total amylase activity in 10 days old seedlings of NH686 and NH787 was higher than in N22 indicating good initial seed vigour. N22 is one of the heat tolerant rice varieties in terms of seed set. One stay green mutant NH219 was identified with increased heat tolerance based on field experiments on CO₂ assimilation, Fv/Fm, electron transport rate, chlorophyll content after 3 days in dark, cut leaf assay for chlorophyll stability, stigma receptivity and pollen fertility. NH219 was crossed to IR64 to map these traits in F₂ generation and recombinant inbred lines are being developed.

02-17(P)

GENOTYPIC VARIATION IN PIGEONPEA FOR YIELD, PHOTOSYNTHETIC RATE AND P UPTAKE AT VARYING PHOSPHORUS LEVELS

Sunita Sheokand, Anita Kumari, Gunjan Gera, Ramdhari Vashisht¹

Department of Botany and Plant Physiology, CCS Haryana Agricultural University, Hisar

¹Pulses Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar

Genotypic variation in ten pigeonpea genotypes was studied at three P levels (100%, 60% and 20% P as per nutrient solution) in the pot culture house. The plant biomass decreased with decreasing P levels and the decline was highest at the reproductive stage. The genotypes which performed well in terms of plant biomass

were Paras and H03-41. Decline in number of leaves and branches could account for the decreased plant biomass at low P levels. The photosynthetic rate and chlorophyll content were adversely affected by low P levels. The genotypes H03-41, H04-24, ICPL 88039 and Paras maintained higher photosynthetic rates as compared to other genotypes at low P levels. Flowering was delayed by 1-5 days at 20% P levels in the different genotypes studied. The genotypes H03-41, H02-60, H01-22 and Paras performed better in terms of P content/plant as compared to other genotypes. A 35 to 60% decline in plant yield was observed at 20% P levels. Maximum decline was observed in the genotypes H01-14, H01-22 and H01-37 whereas minimum decline was observed in the genotypes H03-41, H-4-26 and Paras.

02-18(P)

EVALUATION OF ANTIOXIDATIVE ACTIVITY OF *MARSILEA* (*MARSILEA MINUTA* LINN.) PLANT UNDER CADMIUM (Cd) INDUCTION

K. Das, C. Mandal, N. Ghosh, S.P. Das, Susmita Das, Saborni Maiti, Sudha Gupta, and M.K. Adak*

**Plant Physiology and Molecular Biology Laboratory, Department of Botany, University of Kalyani, Kalyani, Nadia, 7412 35*

Marsilea minuta Linn., an aquatic herb belonging to the class Filicopsida of the Division Pteridophyta is well-known as rural medicinal plant. On growing as a sub terrestrial or aquatic herb, this plant often undergoes contaminated with some industrial pollutants and heavy metals like Cd, Pb, Al, Ni, Cr etc. In this present experiment, plants were evaluated for hyper accumulation of Cd in respect to its tolerance. The lipid peroxidation, protein oxidation were the common observations following the treatments with Cd exposure. The activity of some antioxidising enzymes like superoxide dismutase (SOD), guaiacol peroxidase (GPX), ascorbate peroxidase (APX) and catalase (CAT) were the sensitive modulated physiological parameters to be discussed. Cd induced reactive oxygen species (ROS) were the most symptomatic for oxidative stress. At the cellular level, plants have been recorded with altered activity of H⁺ATPase and DNA damage. Increased levels of polyamines were suggested to impart the metal induced oxidative stress.

02-19(P)

CULTIVATION OF CHILLI (*CAPSICUM ANNUUM* L.) UNDER CITY WASTE WATER IN THE PRESENCE OF POTASSIUM

Sugandha Varshney, Arif Inam and Shamsul Hayat

Plant Physiology Section, Department of Botany, Aligarh Muslim University, Aligarh, 202002, India

Corresponding author: varshneysaca@gmail.com

A pot experiment was conducted on chilli (*Capsicum annum* L. var. Pusa Jwala) to observe the effect of ground and city waste water supplemented with varying doses of potassium (K0, K25, K50, K75) along with basal application of nitrogen and phosphorus during the winter season of 2009- 2010 in the net house of Department of Botany, Aligarh Muslim University, Aligarh. City waste water irrigation proved efficacious in increasing root length, shoot length, number of leaves, fresh and dry weight of plant and increased NR activity by 3.57% and 5.89% ,chlorophyll 'a' content by 5.17% and 4.59%, chlorophyll ' b' by 6.76% and 3.82% and total chlorophyll content by 5.97% and 4.07% over ground water at 30 and 60 DAS respectively. Thus, it was concluded that waste water proved an effective source of both nutrients and irrigation water. Potassium at 50 kg/ha (K50) proved optimum. The combination of wastewater and potassium at 50 kg/ha (K50) proved best and significantly enhanced growth and physiological characteristics at both the sampling stages.

02-20(P)

PHYSIOLOGICAL STUDIES OF COTTON HYBRIDS AS INFLUENCED BY POPULATION DENSITIES UNDER DRIP IRRIGATION

H.K. Kene

Regional Research Center, Dr. P.D.K.V., Morshi Road, Amravati-444603, Maharashtra

A field experiment was conducted at Akola Maharashtra during *kharif* 2000-01 and 2001-02. The experiment comprising three cotton hybrids grown at four population densities under drip irrigation was laid out in split plot design with four replications. Correlation studies showed positive association of number of leaves, total leaf area, number of monopodial and sympodial branches per plant at harvest, total dry matter, number of bolls harvested per plant, test weight and harvest index (%) with seed cotton yield. Significant negative correlation coefficient (r) were noted between seed cotton yield per plant ('g') and plant height, leaf area index (LAI), RGR, NAR (60-80 DAE), total chlorophyll content (TCC) at different stages i.e. flowering, boll setting (BS) and boll development (BD), LAD, extinction coefficient and light interception percentage. Path analysis indicated positive direct effects of number of bolls harvested, total dry matter per plant and harvest index (%) on seed cotton yield. Total leaf area, no. of monopodial branches, and plant height showed negative direct effects. Seed cotton yield could be successfully predicted by total dry matter, harvest index, chlorophyll content at bolls setting and light interception % (100 DAE).

02-21(P)

EFFECT OF FLY ASH AND BIO FERTILIZERS ON THE PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF ONION IN *KHARIF* SEASON

Nikita Parab and Seema Mishra*

SIES Indian Institute of Environment Management, Plot No.-1E, Sector-V, Nerul,
Navi Mumbai 400 706

E- mail: seema.mishra03@gmail.com

Fly ash is the major solid waste produced in thermal power stations due to burning of coal and lignite. Approximately 260 million tonnes of coal is consumed per annum by 120 utility thermal power plants (TPPs) in India which results in the production of 108 million tonnes of fly ash per annum. Out of this about 80% of ash is utilized by local brick kiln, cement and agriculture industries and 20% still remain unutilized. Fly ash was being treated as waste and source of water and air pollution till recent past years. However, being a reservoir of a number of macro and micro nutrients, it has proved to be an economical soil amendment to improve the physical (texture, water holding capacity, pH, EC, etc.) and chemical (enhance the absorption of B, Cu, Co, Fe, Mg, Mn, Mo, Se, Zn, etc.) properties of soil and yields of variety of agricultural crops, although, it is deficient in nitrogen and phosphorus. By amending fly ash with organic and bio fertilizers (*Azotobacter* and AM fungi, etc.) productivity of crops could be enhanced especially under adverse environmental conditions. The *kharif* production of onion is highly vulnerable due to erratic monsoon, cloudy weather, constant drizzling which aggravate the problems like foliar as well as soil borne diseases, intensive weed. Due to this, *kharif* season contributes only 15% to the total onion production in India. On going study demonstrate the optimization and utilization of fly ash with bio fertilizers to enhance the *kharif* production and the solution to overcome the shortage of onion in the month of December and January due to exhaustion of stored stock of *rabi*. The present study aims to examine the effect of fly ash with bio fertilizers on the production of onion in *kharif* season with respect to its physiological and biochemical parameters like, chlorophyll content, nitrate reductase activity, proline content, relative water content etc.

02-22(P)

NADPH OXIDASE AS THE SOURCE OF ROS PRODUCED UNDER WATERLOGGING IN ROOTS OF MUNG BEAN (*VIGNA RADIATA* L.)

Piyali Bhattacharya¹, Rohit Joshi¹, R.K. Sairam¹, S. Lekshmy¹ and V. Chinnusamy²

¹Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

²Department of Botany and Plant Sciences, University of California, Riverside, CA 92521, USA

*rks_ppl@yahoo.co.uk

The objective of this study was to examine the role of NADPH oxidase on superoxide radical production under waterlogging in mung bean (*Vigna radiata* L.) cvs. T 44 (tolerant) and Pusa Baisakhi (PB) (susceptible), and wild species *Vigna luteola*. Two days of waterlogging caused decline in superoxide radical ($O_2^{\cdot-}$) contents in all the genotypes, however, further waterlogging to 8 days caused significant increase in $O_2^{\cdot-}$ contents. In control and revived plants $O_2^{\cdot-}$ contents were higher in PB, while under waterlogging stress T 44 and *V. luteola* showed greater increases in the $O_2^{\cdot-}$ contents. During waterlogging the increase in $O_2^{\cdot-}$ content was found to be due to the diphenylene iodonium chloride-sensitive NADPH oxidase (NOX). This was further confirmed by the waterlogging induced increase in NOX activity, which was higher in tolerant genotypes T 44 and *V. luteola* compared with PB. Gene expression studies showed enhanced expression of *NOX* in the roots of waterlogged *V. luteola* and T 44, while little expression was observed in control or treated plants of PB. PCR band products were cloned and sequenced, and partial cDNAs of *NOX* was obtained. Results suggest that increase in $O_2^{\cdot-}$ content during waterlogging could be due to the induction of membrane linked-*NOX*.

02-23(P)

ALLEVIATION OF B DEFICIENCY IN TOMATO PLANTS BY APPLICATION OF INORGANIC FERTILIZERS AND ORGANIC MANURES TO A SOIL DEFICIENT IN BORON

Digvijay Singh*, Shikha Yadav and Nirmala Nautiyal

Botany Department, University of Lucknow, Lucknow-226007

dr.digvijaysingh09@gmail.com

Tomato plants were grown in B deficient soil in pot culture under the glass house conditions at University of Lucknow. Aim of the experiment was to assess the effectiveness of various inorganic and organic sources of B to alleviate the B deficiency in a soil deficient in hot water extractable B. Seven treatments given to the plants included: control (untreated), two doses of B as borax (1 and 2 mg B kg⁻¹ soil) and two doses each of farmyard manure (FYM) and poultry manure (PM) (4 and 8 g kg⁻¹ soil). Application of borax at 1 mg kg⁻¹ soil as well as FYM and PM at 8 g kg⁻¹ soil gave encouraging results in terms of increased height of plants and higher dry matter yield. Activities of enzymes peroxidase, polyphenol oxidase and starch phosphorylase decreased by the application of borax and higher doses of both the organic manures. Accumulation of proline was more in control plants and it reduced significantly by the application of all the sources of B except for the treatment containing borax at 2 mg B kg⁻¹ soil where it increased slightly. However, among all the sources of B, application of PM at 8 g kg⁻¹ soil was found most beneficial in alleviating the B deficiency and improving the soil health.



02-24(P)

**COMBINED EFFECT OF DIFFERENT NITROGEN DOSES AND WEEDS - WILD MUSTARD
SINAPIS ARVENSIS L., WILD OAT *AVENA LUDOVICIANA* L. ON SPRING WHEAT *TRITICUM
AESTIVUM* L. VAR. CHAMRAN**

P. Behdarvand, G.S. Chinchani* and K.N. Dhumal

Department of Botany, University of Pune, Pune-411007, MS

**gsc@unipune.ac.in*

Wild mustard and wild oat are the worst and troublesome weeds in cereal crop production worldwide. In present work the field experiments were performed to determine the effects of wild oat and wild mustard in different densities along with different nitrogen levels on yield and yield components of wheat at research field of Azad University of Ahvaz-Iran in 2007-09. The experiments were laid out in randomized complete block design under split-factorial arrangement. Three nitrogen levels (90, 150 and 210 kg ha⁻¹) were maintained by fertigating the soil with Urea to main plots. Wild oat in four densities (0, 25, 50 and 75 plants m⁻²) and wild mustard in four densities (0, 5, 10 and 15 plants m⁻²) were maintained in sub-plots. Wheat density was considered 400 seeds per square meter. Yield and yield components of wheat were recorded after harvesting (155 days after sowing). The statistical analyses of data showed that yield and yield components of wheat were significantly affected by wild oat and wild mustard densities individually or together along with nitrogen levels. The wheat biomass, spikes number per square meter, grain number per spike and 1000-grain weight decreased by interspecific competition (oat-wheat, mustard-wheat, oat-mustard-wheat). The wheat grain yield decreased by 26.3 % and 30.3 % under 90 and 210 kg N ha⁻¹, respectively when wild oat density was 75 plants per m⁻² whereas the grain yield decreased by 22.1 % and 43.1 % with 90 and 210 kg N ha⁻¹, respectively at wild mustard density (15 pl m⁻²). Results indicated that wild mustard density (15 pl m⁻²) had lower competitive ability than wild oats density (75 pl m⁻²) at low level of nitrogen but, increasing nitrogen led to increase competitive ability of wild mustard more than wild oat and increased yield losses of wheat in the presence of weeds.

02-25(P)

**USING RICE STRAW FOR WEED MANAGEMENT IN WHEAT (*TRITICUM AESTIVUM* L.):
POSSIBILITIES AND LIMITATIONS**

Kratika Bhandari and S.K. Guru

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

kratika2106@live.com

A field experiment was conducted at the Norman E. Borlaug crop research center, G.B. Pant University of Agricultural and Technology, Pantnagar during the *rabi* season of 2009 and 2010 in wheat under rice-wheat cropping system to study the effect of incorporation of rice straw on weed management and yield of wheat. Application of three varieties of rice straw such as Pant Dhan 16, UPR 2962-6-2-1 and UPR 2992-17-3-1 was effective in reduced biomass of weeds @ 250 g/m² and 500 g/m². Rice straw applied one month prior to the wheat sowing lowered the weed biomass at 60 and 90 DAS. The grain yield of wheat was higher in both weed free and rice straw treatment.

02-26(P)

**EFFECT OF ROOT BARK POWDER EXTRACT (RBPE) OF *BERBERIS VULGARIS* L. ON
LEISHMANIA MAJOR (5ASKH) *IN VITRO***

A. Salehabadi and G.S. Chinchani

Botany Department, University of Pune, Pune 411007

In present work the effect of different concentration of root bark extracts of *Berberis vulgaris* on *Leishmania major* was studied *in vitro* culture. RBPE stock (10%) was prepared using 70% aqueous ethanol. Eighteen Falcon flasks were selected. To every flask 10 ml of RPMI 1640 medium with (4×10^5) promastigotes was added. These falcon flasks were divided to 6 groups (each group with 3 flasks). Group A, (Control 1) only promastigotes; Group B, (Control 2) promastigotes plus 2.5 μ l alcohol; Group C, (Positive control) promastigotes plus 32 μ g/ml Amphotericin B; Group D, promastigotes plus (0.2 μ l/ml extract=20 μ g ethanol soluble compounds/ml); Group E, promastigotes plus (0.3 μ l/ml=30 μ g ethanol soluble compounds/ml) and Group F, promastigotes plus (0.4 μ l/ml=40 μ g ethanol soluble compounds/ml). The cultures were incubated at $24 \pm 1^\circ\text{C}$ in dark. Average of number of promastigotes for every group was calculated. In control groups (A and B) the number of promastigotes increased every after 24 h till 144th h by 168th h decreased. In Group C (positive control) after 24 h, all promastigotes were dead. The mean number of promastigotes in Group D increased till 48 hours of incubation. By 72 and 96 hours of incubation the number of promastigotes decreased. Eventually all promastigotes were dead. The mean number of promastigotes in Group E and F decreased till 24 hours of incubation, increased by 48th h incubation and by 72 h and 96 h of incubation the number of promastigotes decreased. Eventually all promastigotes were dead.

02-27(P)

PHYTOEXTRACTION OF Cr BY SOME FLORICULTURE PLANTS

S. Ramana, A.K. Biswas, A.B. Singh, Ajay and N.K. Ahirwar

Indian Institute of Soil Science, Nabi Bagh, Berasia Road, Bhopal

In recent years, contamination of the environment by Cr, especially hexavalent Cr, has become a major area of concern. Chromium is used on a large scale in many different industries, including metallurgical, electroplating, production of paints and pigments, tanning, wood preservation, Cr chemicals production, and pulp and paper production. The tanning industry is an especially large contributor of Cr pollution to water resources. It has been estimated that in India alone about 2000 to 3200 tonnes of elemental Cr escape into the environment annually from the tanning industries, with a Cr concentration ranging between 2000 and 5000 mg L^{-1} in the effluent compared to the recommended permissible limit of 2 mg L^{-1} . The accumulation of Cr in soil is of great concern because of its movement into the food chain. Therefore, an experiment was conducted to screen different floriculture plant species (calendula, chrysanthemum, aster and dahlia) for their tolerance to different levels of Cr (0,5,10,15,20, and 25 ppm). In all the four plant species, beyond 10 ppm, chromium was toxic to the plants and there was a drastic reduction in growth and of plants. In 20 and 25 ppm, there was negligible growth and mortality of the plants. In calendula, chrysanthemum and dahlia the application of chromium beyond 10 ppm inhibited flowering. The chromium content in different plant parts of calendula, chrysanthemum, dahlia, aster was determined. It was found that in all the plant species, the highest concentration of Cr was found in the roots and was followed by shoots and flowers. Dahlia recorded the highest concentration of chromium among the plant species and calendula the least.

02-28(P)

EFFECT OF DIFFERENT CONCENTRATIONS OF BORON ON GERMINATION PERFORMANCE IN DIFFERENT VARIETIES OF SWEET SORGHUM

Sujeet Jadhav* and S.B.Bhamburdekar**

*S. Bhaiyasaheb Rajemane College, Mhaswad Tal. Man Dist. Satara (MS)

**Krishna Mahavidyalaya, Rethare Bk. Tal. Karad. Dist. Satara (MS)

The surface sterilized seeds of sweet sorghum cv. MADHURA, SSV-84 and RSSV-9 were germinated in laboratory with different concentrations of boron i.e. 5ppm, 10ppm, 50ppm, 100ppm and 200ppm up to 120 hrs. The different parameters were analysed. Germination percentage in all varieties adversely responded to all concentrations of boron at the initial stage of germination, which was recovered in later stages except 200 ppm boron. Variety- MADHURA and RSSV-9 showed better performance than variety SSV-84. The root growth increased with lower concentration of boron i.e. 5 and 10 ppm in Variety- MADHURA and RSSV-9 throughout the course of germination as compared to higher concentrations of boron. Similar response was also noticed with shoot growth in all varieties under the investigation. A noticeable increase in fresh weight with lower concentration of boron in all varieties was observed. However, no change in dry weight except variety SSV-84 at 120 hrs was recorded.

02-29(P)

ARSENIC UPTAKE AND TRANSLOCATION IN RICE SEEDLINGS AS AFFECTED BY NITROGEN AND PHOSPHORUS CONCENTRATION IN NUTRIENT SOLUTION

P.C. Gupta*, S. Mondal and S. Sarkar

Department of Plant Physiology, Bidhan Chandra Krishi Viswavidyalaya,
Kalyani-741235, Nadia, West Bengal

*Email: neelkamalrb@yahoo.com

Arsenic contamination of agriculture produces grown in arsenic contaminated areas is serious concern now a day. Arsenic enters in to the plant system mainly in the form of its oxy-anions namely arsenate (As-V) and arsenite (As-III). Nitrogen and phosphorus also enters in to the plant system in the form of their oxy-anions nitrate and phosphate respectively. An experiment was conducted to investigate the effect of these two nutrient oxy-anions on the uptake of arsenic oxy-anions in rice seedlings. Rice (*Oryza sativa* L.), IET-4786 (Shatabdi) seedling of 18 days were exposed to Hoagland solutions with varied concentration (Deficient, Low, Normal and High) of nitrogen (N) and phosphorus (P) which were contaminated with 5 ppm of arsenate or arsenite and allowed to grow for 7 days. Uptake of nitrogen and phosphorus reduced to 55.3 % and 51.3 % under As-V contaminated condition and to 71.3 % and 66.4 % under As-III contaminated nutrient solution respectively compared to those of normal nutrient solution. Even fifty percent enhancement of phosphorus concentration in nutrient solution could not compensate the decline in nitrogen and phosphorus uptake. Arsenic concentration of root and shoot was higher in arsenite treated seedling than arsenate treated seedling at all level of nitrogen and phosphorus indicating that arsenite was more readily taken up by rice seedling. Arsenic concentration of both arsenate and arsenite treated seedling declined with increased level of both nitrogen and phosphorus though total uptake of arsenic differed only slightly due to variation in nitrogen and phosphorus in nutrient solution. It appeared that dilution in concentration of arsenic in seedling grown in higher concentration of nitrogen and phosphorus was due to higher growth under higher regime of nutrient element like nitrogen and phosphorus.

02-30(P)

GROWTH BEHAVIOR OF RICE GENOTYPE (SHATABDI) UNDER ARSENIC TOXIC CONDITION IN BOTH BORO AND KHARIF CONDITION

P.C. Gupta^{1*}, A.K. Rai², R. Islam¹, M.D. Bairagya⁴ and J. Kumari³

¹Department of Plant Physiology, ²Department of Seed Science and Technology,

³Department of Agriculture Biotechnology, ⁴Department of Agronomy

Bidhan Chandra Krishi Viswavidyalaya, Kalyani-741235, Nadia, West Bengal

*Email: haiimindia@gmail.com

A field experiment was conducted at Gontra village, Nadia, west Bengal, India during boro and *kharif* season of 2009-2010 of rice crop cv. Shatabdi (IET-4786). In each replication, three seedling transplanting was done in the main plots. The observations were recorded at two days before harvesting from five hills, which were uprooted from inner five rows of two farmer field. Population from those five hills was subjected to take records of different parameters viz., plant height, number of tiller per hill, seed index, panicle length, seed yield per panicle and seed yield/ha. Average plant height was higher in *kharif* season in compared to that in boro season. Number of effective tiller was more during boro season in compared to that during *kharif*. Panicle length was high in *kharif* season compared to that during boro season. 100 seed weight, seed yield per panicle and yield/ ha did not create any significant difference in both seasons. Arsenic concentration of root, shoot, leaf and grain was higher in boro season compared to *kharif* season because in boro season water is supplied from tube well which was arsenic toxified.

02-31(P)

SILICON ACCUMULATION AND ITS INFLUENCE ON THE PHYSIOLOGY AND YIELD IN RICE HYBRIDS AND VARIETIES (*ORYZA SATIVA* L.) GROWN UNDER AEROBIC SITUATION

K.B. Sujatha¹, S.M. Babu³, S. Ranganathan³, D.N. Rao², S. Ravichandran² and S.R. Voleti^{2*}

¹Tamilnadu Agricultural University, Mettupalayam, Coimbatore (TN)

²Plant Physiology, ²Directorate of Rice Research, Rajendranagar, Hyderabad-500030

³Indian Institute of Chemical Technology, Hyderabad

Efforts to minimize water use in rice cultivation and stress tolerance are important in the present climate change scenario. Silica solubilizers might help in understanding the tolerance of plants to water deficit situation or aerobic situation. Rice cultivation in combination with silica was applied in the form of fertilizers (sodium silicate) and solubilisers (Imidazole and glycine) was studied in experimental farm and also as a field trial in farmer's field. The varieties used were 'KrishnaHamsa' (KH), 'Rasi, Jaya', 'PA-6201' (hybrid) and 'PHB-21' (hybrid) under aerobic situation both in wet (Kharif) and dry (rabi) seasons. Transmission electron microscopy in this study provided evidence that silicon was deposited in the epidermal cell wall and the intercellular space of the silicon-treated rice leaves. The epidermal cell wall accumulation was absent in the control plants. Genotypic variation and treatment influences were observed for relative water content, the stability of the cell membrane. Among the different rice cultivars Rasi followed by PHB-71 and PA-6202, were able to maintain cell membrane stability and chlorophyll content. Leaf rolling, chlorophyll, relative water contents and dark adapted chlorophyll fluorescence were superior under aerobic situation with application of solubilizers. However, significant differences in stomatal conductance were observed. The Si treated plants were able to maintain similar yields under aerobic situation also as that of irrigated controls.

02-32(P)

**EFFECT OF MICRONUTRIENTS ON DRY MATIER, SEED YIELD AND OIL CONTENT IN
KASTURI BRENDI (*ABELMOSCHUS MOSCHATUS* L.)**

G.S. Pawar, P.J. Kshirsagar and I.A. Madrap

*Department of Agricultural Botany, College of Agriculture, Marathwada Krishi Vidyapeeth,
Parbhani-431 402 (MS)*

A field experiment was conducted on the field of Department of Agricultural Botany, College of Agriculture, Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season of 2010-11 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 full dose of N, P and K @ 60:30:30 kg/ha was given at the time of sowing. The micronutrients sprayed at 60 and 90 days after sowing. The treatment T₈ (0.5% ZnSO₄ + 0.2% borax) recorded overall better performance than all other treatment in respect of yield and yield contributing characters. Oil content in seed was improved with the foliar spray of zinc or boron or their combination. The effect of the treatment with foliar spray of 0.5% ZnSO₄ + 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.

02-33(P)

**EFFECT OF SOME CHEMICAL NUTRIENTS AND BIO-NUTRIENTS ON *HIBISCUS
ESCULENTUS* (L. WILZECK)**

Dhwani C. Goradia¹, Sudha A. Sawant² and Sudhir D. Ghatnekar³

^{1, 2}*Department of Botany, D. G. Ruparel College, Mahim, Mumbai 400 016*

³*Biotechnology Resource Centre, A/103, Jupiter, Dosti Estate, Wadala (E), Mumbai 400037*

Farmers use inorganic fertilizers in order to increase the soil fertility. Though they promote the growth of crop, susceptibility to diseases is the negative impact by either over or improper utilization. At times it may give rise to pathogenic mutants. All these negative factors could be overcome by application of biofertilizers. In the present study, Growmore a wholesome Biofertilizer of Suvash Biogenics Pvt. Ltd Cellrich an organic fertilizer from Excel industries was selected to study its effect on the morphological parameters of *Hibiscus esculentus*. Suphala (N:P:K :: 15:15:15) an inorganic fertilizer of Rashriya Chemicals & Fertilizers Ltd. was chosen for the comparative study. The morpho-physiological parameters selected for the studies were shoot length, biomass and phosphate uptake on *Hibiscus esculentus*. Present findings revealed that plants treated with higher percentage Growmore biofertilizer showed fresh, green and healthy foliage in relation to plants treated with organic fertilizer and Suphala. Different combinations of Growmore and Suphala [at a very low concentration] showed relatively better growth rate and refreshing healthy foliage. Phosphate uptake was increased when Growmore was supplemented with Suphala. Plants treated with only inorganic fertilizer showed significantly less growth. Out of the total six characteristics studied, it was observed that in case of plant height plot 2(combination) with average plant height of 137.00±0.9487 was taller in comparison to the other 4 plots. In comparison to the other 4 plots, the plants in plot 5(absolute control) were of the least average height of 76.920±2.6129. However plants of plot 1 (Growmore) gave startling results with the average height of 126.1640±1.4237 in comparison with plot 3, 4, and absolute control. Growmore enriched the soil with triple combination of cellulose degraders, nitrogen fixers, and phosphate solubilizers along with humus made from castings of Red Wrigglers. Hence its application helped in optimum growth of the plant system.

02-34(P)

ASSESSMENT OF GROWTH, YIELD AND KERNEL SHELF LIFE OF SWEET CORN GROWN UNDER DIFFERENT ORGANIC MANURE AMENDMENTS

Samarpita Roy and K.N. Dhumal

*Department of Environmental Sciences, University of Pune, Pune-411007, Maharashtra
email: dhumal@unipune.ac.in, samarpita.p.roy@gmail.com*

Organic or natural farming has become an ardent need of today's world and a tremendous demand of organic agro products is due to increasing health consciousness amongst the consumers. An increase in Sweet corn (*Zea mays* var. *saccharata*) consumption rate and its industrial utility is felt not only in the Western countries but also in India. Therefore organic cultivation of sweet corn will indeed be a value addition. Considering these facts the following investigation was attempted to draw a comparative analysis of yield, growth and kernel shelf life in Sweet corn grown under six different combinations of organic manures using Cow dung manure, neem cake, Vermicompost, Fishmeal, Sterameal, Poultry manure with bioinoculant *Azospirillum*. Treatment T3 (Cow dung manure+ Neem cake + *Azospirillum* + Sterameal) emerged out as the most superior treatment in comparison to control (Absolute control- No fertilizers) in parameters like corn yield per acre, green weight, yellow weight and grain yield per corn followed by treatment T1(Cow dung manure + Neem cake + *Azospirillum* + Vermicompost) and T4 (Cow dung manure + Neem cake + *Azospirillum* + poultry manure). T3 explicitly exhibited a steady decline of total soluble sugars (TSS) during the post harvest conditions in comparison to control and other treatments, thus demonstrating a steady shelf life pattern. However in growth parameters like plant height, fresh and dry plant weight; treatment T3 once again demonstrated a significant amount of superiority over control.

02-35(P)

PHYSIOLOGY, GROWTH AND YIELD OF *CAPSICUM ANNUUM* L. CV. PUSA JAWALA AS AFFECTED BY INTEGRATION OF INORGANIC FERTILIZER AND WASTEWATER.

Saba Iqbal, Arif Inam, Seema Sahay and Shaista Chalkoo

*Environmental and Plant Physiology Section, Department of Botany, A.M.U. Aligarh
Email: saba.iqbal5067@gmail.com*

A pot experiment was conducted during Kharif season of 2008 in the net house of the Plant Physiology, Department of Botany, A.M.U. Aligarh. The aim of this study was to monitor the comparative effect of the application of wastewater and groundwater on the physico-morphological characteristics of chilli cv. Pusa Jawala along with three basal doses of nitrogen with the rates of 0, 30, 60 kg N ha⁻¹ with a uniform basal doses of phosphorus and potassium with the rates of 60 kg P ha⁻¹ and 50 kg K ha⁻¹ respectively. Data recorded at 30, 60, 90 days after sowing. The result revealed that wastewater caused significant increase in shoot length, fresh and dry weight, photosynthesis, chlorophyll content and yield. Among nitrogen doses N₃₀ along with wastewater proved best for growth and yield and N₆₀ along with wastewater at luxury consumption. Thus it may be concluded that wastewater reduce the demand of fertilizers and it may be used profitably for the cultivation of chilli.

02-36(P)

EFFECT OF IRON, CALCIUM, AND MAGNESIUM ON GROWTH OF HERBACEOUS PLANTS FOUND IN AMPHIBOLITES AND HORNBLENDE BIOTITE SCHIST OF THE DEODUAR AREA OF NORTH GUWAHATI, ASSAM

J. Medhi* and M.K. Das**

**Department of Geology, Arya Vidyapeeth College, Guwahati,*

***Department of Plant Physiology and Bio-chemistry, Guwahati College, Guwahati,
jonalimdh@gmail.com, mrinal_kumar06@rediffmail.com*

An experiment was carried out to study the effect of Iron, Calcium and Magnesium on herbaceous plants – *Polygonum hydropiper* and *Amaranthus spinosus*. For this study Deoduar – Ganesh Mandir area of North Guwahati area is selected. This Deoduar area is composed of highly irregular, discontinuous layers of dark coloured rocks like amphibolites and biotite schist. The geochemical analysis of this area was done which reveals that the presence of high content of macronutrients. Mainly iron, calcium and magnesium. Under high content of these macronutrients an experiment was done to study the growth behavior and carbohydrate content on *Polygonum hydropiper* and *Amaranthus spinosus*. From the experiments it was observed that the growth pattern of *P.hydropiper* and *A. spinosus* are less vigorous due to the amphibolites and hornblende schist, though iron, calcium and magnesium content is high in comparison to the growth of these plants under normal soil condition. Similarly, the carbohydrate contents of *P.hydropiper* and *A. spinosus* plants under amphibolites and hornblende schist condition also less than normal soil condition.

Session 03

**Abiotic Stress Management,
Signaling and Gene Expression**

03-01(L)

IDENTIFICATION OF SOURCE OF TOLERANCE TO HIGH TEMPERATURE IN TROPICAL MAIZE

Ishwar Singh, S.K. Singh, and R. Sai Kumar

*Directorate of Maize Research, Indian Agricultural Research Institute,
Pusa Campus, New Delhi 110012 [E-mail: isingh.dmr@gmail.com]*

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 of both inbred lines and hybrids in target environment. Sixteen promising single cross hybrids and eighty-seven inbred lines were evaluated under field conditions for their performance at high temperature during summer 2010. The crop season (March-June) was hot and dry with maximum and minimum temperatures ranged between 29-44°C and 13-29°C, respectively, and total rain fall of 8.8 mm during the period. Most of the hybrids tested could survive at high temperature but there was a significant decrease in plant growth and grain yield as compared to their performance in preceding *Kharif* season. The anthesis-silking interval (ASI) ranged between 0 and 4 days. Based on their general performance and grain yield, hybrids Prakash, Buland, PMH-1, PMH-3, HM-9 and HQPM-1 performed better at high temperature stress with less tassel blasting and low leaf firing. Out of 87 inbred lines evaluated for heat stress tolerance, grain formation was recorded only in 13 inbred lines and rests of the inbred lines were susceptible to high temperature stress. Most of the high temperature susceptible inbred lines died at either seedling or knee high stage. Only few susceptible lines could flower, but showed high degree of tassel blasting with no grain formation. Six inbred lines viz. HKI 170(1+2), HKI 325-17AN, LM 17, CA14514-B-1-B-2-B, G18Seq C5 F68-2-1-1-2-2-B-B, G18Seq C5 F100-1-1-3-1-2-B-B showed good degree of tolerance to high temperature with proper grain formation (grain yield ranged between 3.01 to 15.30 g per plant) with low ASI (d² days) and less tassel blasting.

03-01(O)

BRASSINOSTEROIDS: ROLE IN ABIOTIC STRESSES IN PLANTS

Qazi Fariduddin*

*Plant Physiology and Biochemistry Section, Department of Botany, Aligarh Muslim University,
Aligarh-202002, UP; *Email: qazi_farid@yahoo.com*

Brassinosteroids (BRs), a unique plant steroidal hormone which have essential role in plant growth and development are also implicated in wide range of morphological, physiological, and biochemical responses. In addition to this, in the recent years, BRs have shown the ability to confer tolerance against wide array of abiotic stresses such as salinity, drought, temperatures, and heavy metal stresses. Plants can tolerate stresses up to certain limits, beyond which they show symptoms of toxicity in plants. This toxicity is apparent in the form of reduction in plant growth, chlorophyll (chl) content, net photosynthetic rate, efficiency of PSII and activities of nitrate reductase and carbonic anhydrase. These abiotic stresses led to an increase in the generation of reactive oxygen species like hydroxyl radical (OH[•]), superoxide radical (O^{•-}) and hydrogen peroxide (H₂O₂). BRs have been widely used to counter these stresses in plants. In addition to this, BRs improve all the growth parameters, photosynthetic attributes, enhances the activities of carbonic anhydrase, nitrate reductase, and antioxidant enzymes; catalase (E.C. 1.11.1.6), peroxidase (E.C.1.11.1.7) and superoxide dismutase (E.C. 1.15.1.1) and also increases the proline content in the presence as well as absence of stresses. The enhanced activities of antioxidant system and osmolyte could be responsible for conferring the tolerance against various abiotic stresses and this tolerance is reflected in improved growth and photosynthesis.

03-02(O)

**CADMIUM-INDUCED BIOCHEMICAL CHANGES AND CYTOTOXICITY IN MUNGBEAN
[VIGNA RADIATA (L.) WILCZEK]**

S.P. Badole, Denish Rai, Pallab Kumar Das and A.K. Pal*

*Department of Plant Physiology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Nadia, West Bengal 741252*

**anjan_kumar66@yahoo.co.in*

Cadmium (Cd) is a non-essential heavy metal and is a toxic trace pollutant for humans, animals and plants. It is considered as one of the most dangerous heavy metals owing to its high mobility, large solubility in water, long biological half-life and the low concentration at which it produces toxic effects on plant. An experiment was conducted to study the effect of cadmium stress on growth and different physiological and biochemical parameters at seedling stage of mungbean [*Vigna radiata* (L.) Wilczek]. The seeds of mungbean cultivar B 1 were germinated and seedlings were grown in presence of 50, 100, 250, 500, 750 μM and 1 mM of cadmium supplemented in the form of CdCl_2 , H_2O . Results indicated that cadmium did not produce any adverse effect on germination percentage at lowest concentration (50 μM), but then the germination was inhibited linearly with increase in concentration of cadmium in the solution. The length of root and shoot and the fresh and dry weight of root, shoot, leaf as well as the whole seedling also decreased proportionately along with increase in cadmium concentration in the solution. The application of cadmium in the root medium adversely affected the root elongation rate scored at various intervals and reduced the ultimate root length. Relative leaf water content (RLWC), chlorophyll a, chlorophyll b as well as the total chlorophyll content showed significant decrease in most of the cadmium treatments. Data on different biochemical parameters revealed that the proline content in the leaves increased significantly and proportionately as the cadmium concentration in solution increased from 100 μM to 1 mM. The phenol content in the leaves was low in presence of low concentrations of cadmium in the solution, but then increased with increase in stress intensity in a concentration-dependent manner. In the present experiment cadmium stress induced substantial oxidative damage as indicated by increased content of thiobarbituric acid-reactive substances (TBARS). The enzymatic antioxidants (viz., SOD, GPX and CAT) enhanced their activities at low to moderate concentrations of cadmium in the solution, but then the activities reduced at elevated concentration of cadmium, especially, at 750 μM and 1mM. The amylase activity in the cotyledons indicated significant and linear enhancement with cadmium concentration upto 750 μM at 24 hours of germination. It then dropped remarkably in all the cadmium treatments at 48 hours of germination. Studies of root tip mitosis indicated that more number of cells entered the divisional stages in case of control root tips than the cadmium-treated ones. In case of cadmium-treated root tips the dividing cells indicated some abnormalities. The presence of micronucleus and anaphase bridge were clearly noted in some cells. In some cases, the orientation of the metaphase plate completely changed.



03-03(O)

SALICYLIC ACID (SA) INDUCED PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN CHICKPEA (*CICER ARITINUM* L.) GENOTYPES UNDER DROUGHT STRESS

Pradeep Kumar Patel¹, A. Hemantaranjan^{1*} and B.K. Sarma²

¹Department of Plant Physiology, ²Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University Varanasi – 221005

*hemantaranjan@gmail.com

Drought is one of the major factors limiting chickpea production in arid and semi arid regions. There is little information available regarding SA induced physiological and biochemical changes in chickpea (*Cicer aritinum* L.) genotypes under drought. Four chickpea genotypes (Tyson, ICC4958, JG 315 and DCP 92-3) treated with salicylic acid (SA) @1.0 mM and 1.5 mM were subjected to pre- and post- anthesis drought stress to recognize its influence on physiological and biochemical parameters. Water stress reduced leaf relative water content (RWC), leaf water potential (Θ_{leaf}) and starch content, whereas increased the levels of soluble sugar, proline content, ascorbic acid (AA) and lipid peroxidation level (MDA content). The activity of antioxidant enzymes superoxide dismutase (SOD) and peroxidase (POX) was upregulated by drought stress and was further enhanced by SA treatment. Results indicate wide variation in tolerance to drought stress amongst chickpea genotypes at both the critical stages, i.e., pre- and post-anthesis. On the basis of physiological and biochemical performance (antioxidant and antioxidant enzymes activity) better genotypes Tyson and ICC-4958 appear to be adapted to drought stress tolerance. Early drought stress (pre-anthesis drought) was found to be more damaging than the late drought stress (post- anthesis drought). Results also signify the role of SA in regulating drought response of plants suggesting that SA could be used as a potential growth regulator for improving plant growth through strengthening antioxidant system under drought stress.

03-04(O)

GROWTH, PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF *SESUVIUM PORTULACASTRUM* TO PHARMACEUTICAL EFFLUENTS

Vinayak H. Lokhande¹, Mayuri S. Aivale², Sowjanya Illa², Nutan P. Malpathak¹ and Neetin S. Desai²

¹Department of Botany, University of Pune, Pune – 411 007 and ²Padmashree Dr. D.Y. Patil University, C. B. D. Belapur, Navi Mumbai – 400 614, Maharashtra

vhl1983@gmail.com

Sesuvium portulacastrum (Aizoaceae family) is a facultative halophyte, with enormous importance in abiotic stresses management. Industrial effluent is the ever-growing serious problem of environmental pollution. In the present investigation, effluents collected from Vamsi, Vasava, and Smriti pharmaceutical industries located at Solapur, Maharashtra were evaluated for various physico-chemical properties. Efforts have been made on effect of these effluents on growth, physiological and biochemical responses of *Sesuvium*. Physico-chemical analyses revealed highly toxic and hazardous nature of the effluents due to presence of significantly higher values for pH, EC, BOD, COD, TDS, sulphates, chlorides, and dissolved phosphates in comparison to limits

provided by the MPCB. Phyto-toxicity experiments on glycophytes (*Brassica* and *Triticum*) demonstrated complete inhibition or poor rate of seed germination and seedling growth (root and shoot length). In contrast, *Sesuvium* showed better survival under the influence of the effluents at the cost of reduced growth rate and tissue water content. The physiological and biochemical analysis of the plants exposed to the effluents under hydroponic conditions affected significantly. Total chlorophyll and carotenoids content and chlorophyll stability index of effluent stressed plants increased significantly in comparison to control. Osmolytes accumulation such as proline and total soluble sugars in response to effluent treatments showed significantly higher accumulation in shoot parts than root as compared to their respective control. Oxidative damage to membrane in terms of MDA content was also found higher in stressed plants than control. Antioxidant defense mechanism demonstrated increased activities for superoxide dismutase (SOD) in both shoot and root; however, catalase (CAT), ascorbate peroxidase (APX), and guaiacol peroxidase (GPX) and glutathione reductase (GR) activities were significantly higher in roots than shoots of stressed plants in comparison to control. The present study suggested urgent need for detoxification or remediation of these effluents using halophytes such as *S. Portulacastrum*. In addition, strategies of microbial consortium in combination with other abiotic stress tolerant plants have also been suggested.

03-05(O)

POLYAMINES MAY ALLEVIATE THE OXIDATIVE STRESS UNDER CONDITION OF SALINITY IN RICE CULTIVARS

M.K. Adak, N. Ghosh, C. Mondal, S. Roy Choudhury* and D.N. Sen Gupta*

Department of Botany, University of Kalyani, Kalyani 74 1235, West Bengal

**Department of Botany, Bose Institute, 96/1, APC Road, Calcutta 700 019, West Bengal*

Changes of cellular redox are one of the basic events of Salinity induced cellular and physiological alteration in plants. The oxidative stress so induced in plants is typically investigated particularly for its inbuilt or induced tolerance mechanism in two rice cultivars namely Nonabokra and Swarna. Preliminary the plants were markedly variable in terms of stress induced lipid peroxidation as measured by MDA and protein oxidation. Gradual deposition of sodium ion is also demarcated in the cortical layer of the tissue as studied by Energy Disperse X-ray Spectroscopy (EDXS) study. Significant amount of Reactive Oxygen Species in the form of Superoxide (O_2^-) and Hydrogen peroxide (H_2O_2) was detected in the tissue of both the varieties. Membrane disintegration is associated with maximum loss of potassium K^+ and an over folded activity of H^+ ATPase as detected both at transcript and protein level. The elevation of polyamines: Spermine, Spermidine, Putrescine were also correlated to the tolerance of the plants under salinity, being significantly higher in Nonabokra. Admittedly, specific key enzymes for polyamine biosynthesis as taken SAM-DC was also evident to be un-regulated at transcript level and *in-vitro* assay of enzyme. Oxidative stress as measured also in the induction of Abscisic acid generation was taken in consideration and specific RAB gene was variable in the cultivars. Non-enzymatic and enzymatic antioxidation pathways were predominant and Putrescine recorded as an alleviator by up-regulating the phenolics and flavonoid moieties. Significant variations of expression of different gene with their iso-enzymic profiles were distinct trait as evident from both the varieties. In-gel staining studies were most important to demark the two varieties under for response under salinity and effects of Putrescine thereon. Finally, the transcription factors as OSBZ8 were notably variable in expression under salinity and induced with polyamine.

03-01(P)

**ASSOCIATION OF PHYSIOLOGICAL TRAITS WITH GRAIN YIELD OF RICE
GENOTYPES GROWN UNDER AEROBIC CONDITION**

Shafina Haque, A.K. Mall, P. Swain and O.N. Singh

Central Rice Research Institute, Cuttack, Orissa

Extreme weather is becoming more frequent in present climatic scenario. The available water for irrigation is getting scarce in rice growing areas. The increasing scarcity of water threatens the sustainability of the irrigated rice production system as well as the food security and livelihood of rice producers and consumers. To save irrigation water and to develop some alternate management methods, aerobic rice, bred to require significantly less water than ordinary lowland rice, promises to be a step in the right direction. Keeping this in view, seventy rice genotypes including five checks were evaluated under aerobic condition in the fields to study the physiological traits associated with higher yield potential of promising genotypes under water limited condition. Relative water content of leaves and SPAD chlorophyll content was recorded thrice during dry cycles. Genotypes IR 84899-B-183-1-1-1, IR 84899-B-184-19-1-1-1 and IR 83929-B-B-291-3-1-1-3 had high water retention capacity (RWC>75%) during dry cycles, while the genotypes IR 84899-B-183-1-1-1, IR 84899-B-184-19-1-1-1, IR 83929-B-B-291-3-1-1-3, IR 84887-B-158-16-1-1-1, IR 84899-B-185-8-1-1-3, IR 84899-B-185-15-1-1-1 and IR 83387-B-B-109-4-89-3 recorded higher SPAD value (>35) indirectly indicating higher chlorophyll content compared to other genotypes. However, highest grain yield was recorded in IR 84899-B-184-19-1-1-1 (5.18 t ha⁻¹) followed by IR 83387-B-B-109-4-89-3 (5.14 t ha⁻¹), IR 83929-B-B-291-3-1-1-3 (5.08 t ha⁻¹) and IR 84899-B-179-13-1-1-1 (5.04 t ha⁻¹) with higher HI of more than 0.45. Though genotype IR 84899-B-183-1-1-1 yielded moderately (4.61 t ha⁻¹) with HI of 0.41 had high RWC (89.96 %) and SPAD (36.42) values during the dry cycles. As RWC and SPAD chlorophyll values had positive correlation with grain yield, to combine the overall performances of the above said varieties, genotypes IR 84899-B-183-1-1-1, IR 84899-B-184-19-1-1-1 and IR 83929-B-B-291-3-1-1-3 are identified as best suited varieties for water limited condition having higher grain yield (>5.0 t ha⁻¹) with high RWC (70-80%), high SPAD value (32-35) and high HI (>0.40).

03-02(P)

**ALLEVIATION OF THE EFFECTS OF NaCl SALINITY IN SPINACH (*SPINACIA OLERACEA* L.
VAR. ALL GREEN) USING PLANT GROWTH REGULATORS**

Anjali Ratnakar and Aruna Rai

*Dept of Botany, Smt. C.H.M. College, Ulhasnagar – 421003
anjali.ratnakar@gmail.com, aru_r17@hotmail.com*

Exposure to environmental stress due to salinity has been reported to result in adverse effects on the growth of plants. Studies have shown that the use of plant growth regulators (PGRs) has an ameliorative effect on plants grown under saline conditions. In the present investigation, the effect of gibberellic acid (GA₃), 6-furfuryladenine (Kinetin) and 6-benzylaminopurine (BA) on *Spinacia oleracea* L. var. All Green, cultivated under saline conditions has been studied. After a pre-soaking treatment of six hours in 20 mg L⁻¹ solutions of GA, Kinetin and BA, the seeds were allowed to germinate and grow for forty-five days under saline conditions. On the analysis of mature leaves, it was observed that both chlorophyll a and b, and total chlorophyll showed an increase in PGR-treated plants compared to the untreated set. With the pretreatment, the reducing and non-reducing sugar content, as well as protein content of the leaves showed an increase in accumulation compared to the untreated plants. The accumulation of the stress metabolite proline, which increases under saline conditions, showed a significant decrease of 50% in the plants pretreated with GA.

03-03(P)

ELECTROLYTE AND PHENOLIC LEAKAGE CONTENTS AND THEIR RELATION WITH PHOTOSYNTHETIC PIGMENTS, ACTIVITY OF ANTIOXIDANT ENZYMES AT LOW TEMPERATURE STRESS IN SUGARCANE

Radha Jain and A. Chandra

*Indian Institute of Sugarcane Research, Lucknow-226002, UP
radha_dinesh@yahoo.co.in*

Ten sugarcane (*Saccharum* spp, hybrids) varieties were evaluated for low temperature stress tolerance based on electrolyte and phenolic leakage contents. Electrolyte leakage (EL) was more (30.8 to 51.8%) at -10°C while, 21.7 to 28.4% at 25°C. 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^2 , while MDA ranged from 7.18 to 15.44 μg per g fwt. Catalase activity ranged from 72 (CoJ 64) to 309 (CoS 97264) $\mu\text{mol H}_2\text{O}_2$ 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. Yield and juice quality data indicated highest stem mass (1.155kg) and plant height (211 cm) in variety CoS 95255. Pol % juice was lowest (16.66%) in Co J 64 and highest (18.44%) in CoLk 8001 variety. Similarly, juice purity varied from 85.29% (CoLk 8001) to 92.8% (CoS 97264). Electrolyte and phenolic leakage showed negative correlation with chlorophyll, carotenoids, activity of antioxidant enzymes, yield and quality traits. 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.

03-04(P)

THE BENEFICIAL ROLE OF AM FUNGI IN BAJRA (*Pennisetum glaucum*) PLANTS UNDER DROUGHT STRESS CONDITION

Mahesh Borde*, Mayura Dudhane and Paramjit Jite

Department of Botany, University of Pune, Pune-411007

**maheshmyco@gmail.com*

The study deals with beneficial effect of Arbuscular Mycorrhiza on growth performance, antioxidant and non antioxidant defensive mechanism system of bajra plants under drought stress condition. The study also deals with the water absorption by mycorrhizal plants and change in soil fertility under drought stress condition. Under drought stress condition Arbuscular Mycorrhiza increased the growth of bajra plants in terms of increase biomass. More Proline accumulation was observed in roots of mycorrhizal plants under drought stress. AM fungi increase the antioxidant defense system as well as More Proline accumulation in roots of mycorrhizal plants leads to more osmotic adjustment under drought stress. Increase in phosphatase activity enhances the phosphate uptake of mycorrhizal bajra plants under drought stress. Arbuscular Mycorrhiza secretes the glycoprotein i.e. Glomalin it increase the water holding capacity and fertility of soil under drought stress condition.

03-05(P)

**EFFECT OF BRASSINOLIDES ON DROUGHT TOLERANCE IN PEARLMILLET
[*Pennisetum glaucum* (L.) R. BR EMEND STUNTZ]**

Santosh Jakhad, B.S. Afria, B.L. Kakralya, Alka Choudhary and Jyoti Verma
Department of Plant Physiology, S.K.N. College of Agriculture, Jobner-303329
ja.sonu27@yahoo.com, kakralya@gmail.com

A pot experiment was conducted at S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif* season of 2010 to the effect of brassinolides on physiological aspects on pearl millet [*Pennisetum glaucum* (L.) R.Br emend stuntz]” under drought conditions. Two pearl millet cultivars namely RHB-121 and RHB-173 were grown in ceramic pot under normal conditions till vegetative stage and then plants were sprayed with brassinolides (0.0, 0.5, 1.0 and 1.5 ppm concentration) and then half the plants were subjected to water stress by withholding irrigation as frequently and observations were recorded at vegetative (35 days) and anthesis stages (45 days) after sowing. Brassinolides significantly increased relative water content, chlorophyll stability index, photosynthetic rate, transportation rate, stomatal conductance in both cultivars under non-stress and water stress conditions. The 1.5 ppm concentration of brassinolides was most effective under both non-stress and water stress conditions. Yield and yield attributes were significantly increased on account of brassinolide treatment under non-stress and water stress conditions. Most of the physiological parameters are positively and highly correlated with seed yield. It is concluded that between the cultivars studied, RHB-121 was drought tolerant and the tolerance was mediated by physiological characteristics. Brassinolide increased productivity by reducing the adverse effect of drought stress on growth and yield attributes.

03-06(P)

**PHOTOTHERMIC INDEXING IN RICE (*ORYZA SATIVA* L.) GENOTYPES FOR YIELD AND
NUTRIENT QUALITY**

Jyoti, Deepika Sharma, Deepti Shankhdhar and S.C. Shankhdhar
*Department of Plant Physiology, College of Basic Sciences & Humanities, G.B. Pant University of
Agriculture & Technology, Pantnagar-263145, Uttarakhand*

In India majority of rice is grown during the wet seasons (July-November). During this season the major limiting factors for higher productivity are sunlight (duration and intensity) and temperature. In the present study the effect of photothermic period were studied in two planting field grown conditions i.e. normal (early) and after 15 days (late) sown in six rice genotypes namely IET 21075, IET 21105, IET 21119, Tulasi, Govind, and Annada. Different physiological parameters such as chlorophyll content, SOD, Zn content in leaves, shoots and grains along with yield were recorded in early and late sown conditions. All the six genotypes showed wide genotypic variation amongst physiological characteristics. The total chlorophyll content was the maximum in IET 21075 and IET 21105 and minimum in Govind during early and late sown conditions, respectively. The maximum super oxide dismutase activity was recorded in IET 21119 in early and late sown condition. Zn content was found the maximum in IET 21075 and IET 21105 in shoots and leaves, respectively in an early sown condition while Annada showed the maximum zinc translocation in late sown condition. The accumulation of zinc in grains at early sown condition was in the order IET 21119> Tulasi> IET 21075> Govind> IET 21105> Annada while in late sown condition in the order IET 21119> Govind> IET 21105> IET 21075> Tulasi> Annada. Overall all the varieties performed better in early sown condition however, Govind showed less sensitivity of photoperiod. There was 50.85% and 27.96% increase in yield during early sown as compared to late sown conditions in IET21105 and Govind, respectively. The sensitivity of rice genotypes for photoperiod in terms of yield was as IET21105> Annada> IET21119> IET21075> Tulasi> Govind.

03-07(P)

GROWTH AND ASSIMILATORY FUNCTIONS OF GRASSES UNDER REDUCED LIGHT

R.K. Bhatt

Central Arid Zone Research Institute, Jodhpur-342003, Rajasthan

Light is one of the most important factor affecting growth, development and competition of plants as it is directly concerned with adaptation, growth, assimilatory functions and biomass accumulation. Some plants have inherent adaptability to light or shade conditions by modifying the leaf area, leaf thickness and accumulation of chlorophyll content. The photosynthetic variations exist among the species and even at the level of genotypes. Under different growth environment the plant genotypes having the adaptability to alter photosynthetic rates in response to a change in quantity and quality of light. In grass species rate of photosynthesis and stomatal conductance decreased with decreasing light intensity and reached the minimum level under high shading (25% light intensity). Trispecific hybrid, *Panicum antidotale* and *Setaria sphacelata* maintained relatively higher rate of photosynthesis followed by *Bracharia mutica*, *Panicum maximum*, *Penisetum polystachyon* and *Cenchrus ciliaris* under lower light intensity (25 – 50%) as compared to other grass species tested, indicating their potentiality towards shade adaptation and therefore, suitable under shading environment of tree canopies in semi-arid tropics. The adaptation may be due to higher accumulation of chlorophyll and particularly chl b. These grass species also produced higher fresh biomass, dry matter yield, specific leaf weight, leaf area index and crop growth rate under low light intensity exhibiting their shade adaptation. In the shading conditions of tree canopies the micro environment influenced by the available radiation which influences the assimilatory functions, growth and biomass accumulation of the under canopy growing crops. *C. ciliaris* and *P. maximum* produced 5.9 t/ha and 6.22 t/ha dry matter yield respectively under tree canopies at 40% and 70% shading indicating that these grasses have the potentiality to adapt under shading environment under semi-arid environment. A significant positive relationship have been established between dry matter yield (DMY), leaf area index (LAI), intercepted photosynthetically active radiation (IPAR) and light utilization efficiency (LUE) indicating the interdependence of these parameters.

03-08(P)

STRATEGIES ADAPTATION OF CHICK PEA TO HIGH TEMPERATURE

Rinki Devi, P.S. Basu, S.K. Chaturvedi, Jagdish Singh and Pankaj Kumar Singh

*Division of Crop Physiology, Biochemistry and Microbiology, Indian Institute of Pulses Research
(ICAR) Kanpur-208024, sachanrinki9@gmail.com*

Terminal heat stress for check pea during anthesis and grain filling period has become a serious and recurrent problem in northern plains of India. For all optimum physiological processes threshold temperature limit for check pea was found to be 35°C. At full blooming stages during February end or March beginning, this crop often experiences high temperature even reaching upto 41°C leading to almost complete flower abortion or failure of anthesis processes. Two contrasting check pea genotypes e.g. ICCV 92944 and ICC 10685 having differential response to high temperature were evaluated under field condition. The excised flowers of both the genotypes were incubated at 25°C, 35°C, 39°C, 41°C, and 43°C. The *in vitro* and *in vivo* pollen germination and growth in terms of pollen tube length showed a complete reduction in the tube length at 43°C. Relative tube length and percent pollen germination was higher in ICCV 92944 at 41°C and above than in genotype ICC 10685. The sucrose synthase activity in developing grains of ICCV 92944 was much higher than ICC 10685 which is well correlated with seed size and grain filling rate. The combination of characters such as early flowering, higher pollen germination rate, high sucrose synthase activity, larger leaf, size and vigorous root system were found to be improved strategies of ICCV 92944 to adopt under warmer environments. Lacking all these above attributes made the genotype ICC 10685 strategically poorly adapted to high temperature condition.

03-09(P)

**SALINITY STRESS INDUCED OXIDATIVE STRESS AND EXPRESSION OF GENES
ENCODING ANTIOXIDANT ENZYMES IN TOLERANT AND SUSCEPTIBLE WHEAT
GENOTYPES**

Lekshmy. S, R.K. Sairam and V. Chinnusamy

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

Approximately 20% of the world's irrigated land is affected by salinity. Therefore, there is an urgent need to address the problem of salinity, especially with an increasing global population. Salinity imposes both ionic toxicity and osmotic stress to plants, leading to growth inhibition. A pot culture experiment was conducted with six wheat genotypes and two levels of salinity treatment i.e. 100 and 200 mM NaCl and control. The study showed significant reduction in Relative Water Content, Membrane Stability Index, total chlorophyll and carotenoid content in all the six genotypes studied. Oxidative stress, which is a secondary response to salt stress increased with increase in salinity levels in all the cultivars in terms of H₂O₂, superoxide radical production and lipid peroxidation at vegetative and anthesis stages of the plant. Activity of superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR) and catalase (CAT) increased significantly under salinity, especially in Kharchia 65, which could be one of the reasons of its tolerance to salinity stress compared to other varieties. Expression of genes encoding various antioxidant enzymes suggests the differential induction of mRNA could be the basis of salinity tolerance in wheat.

03-10(P)

**PHYSIOLOGICAL AND BIOCHEMICAL ATTRIBUTES DURING COMPLETE
SUBMERGENCE OF TWO RICE (ORYZA SATIVA L.) VARIETIES**

Alok Kumar Pradhan and B.R. Singh

*Department of Molecular Biology and Genetic Engineering, College of Basic Sciences and Humanities, G.B.P.A.U. &T, Pantnagar, Distt.-Udham Singh Nagar -263145, Uttarakhand
singhbr@rediffmail.com*

Complete submergence of rice is a serious problem in the rain fed lowlands of humid and semi-humid tropics of Asia, which include approximately 25% of the world's rice-growing area. Unexpected and uncontrollable flash floods up to 50 cm deep are common and can be sustained for several days in these area. In most of these rain fed rice environments, rice production is restricted by one or more abiotic stresses, the most important of which are drought (23 million ha), submergence (20 million ha), and salinity (15 million ha). As a cereal grain, it is the most important staple food for a large part of the world's human population, especially in East and South Asia, the Middle East, Latin America, and the West Indies. The present study was carried out to characterize the effects of complete submergence on physiological and biochemical parameters viz. plant height, leaf area, root length, photosynthetic rate, total chlorophyll content, ethanol accumulation, activities of alcohol dehydrogenase, isocitrate lyase and pyruvate decarboxylase at three developing stages of rice (Seedling, tillering and booting stages). Two varieties of paddy were used, namely Pant Dhan-11 (Submergence susceptible) and Jal Lahri (Submergence tolerant) for investigation. Percentage increase in plant height, leaf area and root length were less in Jal Lahri than to Pant Dhan-11. Photosynthetic rate and total chlorophyll content was less in Jal Lahri than Pant Dhan-11. Ethanol accumulation was more in case of Jal Lahri than Pant Dhan-11. The activities of alcohol dehydrogenase, isocitrate lyase and pyruvate decarboxylase were more pronounced in Jal Lahri In comparison to Pant Dhan 11. These studies, suggest that, Jal Lahri is a submergence tolerant variety, which can survive under prolonged conditions of complete submergence.

03-11(P)

MORPHO-PHYSIOLOGICAL EVALUATION OF WHEAT GENOTYPES UNDER EARLY AND LATE OR TERMINAL HEAT CONDITIONS

D.C. Saxena, S.V. Sai Prasad and Renu Parashar

Indian Agricultural Research Institute, Regional Station, Indore

Various phenophases of wheat crop are subjected to different and wide range of temperature spell. Early heat and late or terminal heat conditions have been limiting the wheat productivity and production. An experiment was conducted to evaluate some high yielding and low yielding wheat genotypes for their morpho-physiological characteristics under early heat (early sown) and late or terminal heat (late sown) conditions. For early sown conditions, the high yielding genotypes included HI 1531, HD 4672, C 306, HW 2004 and HD 2888, whereas the low yielding genotypes were HS 277, UP 2338, DBW 17, NIAW 34 and DBW 16. For late sown conditions, the high yielding genotypes included HI 8627, HD 4672, C 306, NI 5439 and HUW 234, while the low yielding genotypes were HS 277, DBW 16, VL 829, UP 2338 and A9-30-1. High yielding genotypes showed early germination and early flowering under early sown conditions possibly due to more amylase, the germination enzyme and gibberellin and auxin hormones which promote flowering. The flag leaf area played a key role for trapping photosynthetic active radiation (PAR), and hence, was desirable under both the growing conditions. It contributed to enhance source-sink ratio, and thereby the grain yield. The high yielding genotypes projected high CTD values under early heat conditions which provide high degree of cooling effect, which helps in reducing evapo-transpiration and thus improve translocation of assimilates. The relative water content (RWC), which plays a vital role in metabolic and physiological processes that are occurring in the plant tissues, was found to be high in high yielding cultivars under both the growing conditions, maintaining the higher water potential. Under early, sown condition, the high yielding genotypes showed higher number of tillers/plant, number of ears/ plant, biomass grain yield and harvest index, whereas under late sown or late/terminal heat conditions, high yielding genotypes demonstrated lesser number of tillers/ plant and number of ears/plant. This indicates that under late sown conditions, it is better to select genotypes with less number of tillers and ears for promoting number of productive tillers and filled ears to increase the grain yield. This may be due to effective partitioning of assimilates to produce number of effective tillers and good grains bearing ears, and thus contributing to high yield.

03-12(P)

INCREASE OF ABA SYNTHESIS IMPROVES DROUGHT TOLERANCE IN COTTON

K. Anantbi and H. Vijayaragavan

Department of Crop Physiology, TNAU, Coimbatore

Water stress is commonly attributed to situations where the water loss exceeds sufficient absorption intensity causing a decrease in plant water content, turgor reduction and, consequently, a decrease in cellular expansion and alterations of various essential physiological and biochemical processes that can affect growth or productivity. An experiment was conducted to determine the ABA content of cotton plants under Water stress in cotton. The experiment was conducted by adopting Factorial Randomized Block Design with three replications. The treatments comprised of water stress imposed at vegetative, squaring and boll development stages of crop growth. Withholding water at any growth stage significantly increased the leaf ABA content. Among the different treatments, stress at squaring had a major impact over the ABA quantity enhancement. Upon rehydration, the ABA level ceased to increase and returned to pre-stressed levels. Substantial evidence suggests that increased ABA levels limit water loss by reducing' stomatal aperture. The genotype KC 2 x MCU 13 showed tolerance to water stress as it accumulated relatively higher ABA.

03-13(P)

IDENTIFICATION OF CHICKPEA (*CICER ARIETINUM* L.) GENOTYPES WITH HIGHER THERMOTOLERANCE USING TEMPERATURE INDUCTION RESPONSE TECHNIQUE

Chandra Prabha, Madan Pal Singh* and V. Chinnusamy

Division of Plant Physiology, IARI, New Delhi

* *madanpal@yahoo.com*

Higher temperature is considered as the major limitation for growth and productivity of crops in tropical environment under climate change scenario. Increase in temperatures above optimum decreases both plant growth rate as well as crop duration and reduce the yield drastically. Therefore, development of genotypes that are capable to survive better under high temperature stress is essential to sustain economic yield in the changing environment. Chickpeas (*cicer arietinum*) is an important pulse crop of India that are high in protein and occupies 31% of pulse growing area (7.29ha) and contribute up to 40% to total pulse yield (5.77mt) of our country. The information about the response of chickpea to climate change is scanty; therefore it is necessary to analyze the response of chickpea genotypes to rising atmospheric temperature. In the present study, a core set of germplasm of Chick pea (*cicer arietinum* L.) genotypes was evaluated for high temperature tolerance using Temperature Induction Response (TIR) technique. This technique is based on acquired thermotolerance which plants adopt on exposure to sub-lethal stress (induction stress). According to this technique, the seedlings are exposed to an optimum induction temperature before being exposed to a severe challenging temperature and subsequently allowed to recover at room temperature. The surviving seedlings at the end of the recovery period are selected as thermotolerant genotypes. Two days old seedlings were exposed to gradually increased temperature from 24°C to 47° for *desi* type genotypes and 24° to 46° for *kabuli* type genotypes for a specific time and finally subjected to the lethal temperature. The genotypes showed maximum survivability at 47° for *desi* and 46° for *kabuli* and growth were considered as high temperature tolerant and which showed less or no survivability and recovery growth were categorised as sensitive to high temperature. The results of the study revealed a significant genetic variability among the genotypes for high temperature tolerance. Using above, two genotypes Pusa-1103 (Desi), Pusa-1105 (*kabuli*) were identified as temperature tolerant. This tolerance was associate with higher accumulation of heat shock proteins (HSPs). The molecular basis of thermotolerance was studied in Pusa-1103 (Desi) & Pusa-1105 (Kabuli) control and induced at seedling level. The induced seedlings showed enhanced expression of HSP 17.7 and 23.9 compared to control & non-induced.

03-14(P)

NUTRIENT MANAGEMENT IN NURSERY FOR IMPROVING SUBMERGENCE TOLERANCE IN SWARNA SUB1 RICE (*ORYZA SATIVA* L.)

A.K. Singh* and Preeti Singh

Dept. of Crop Physiology, N.D. University of Agric. and Tech., Kumarganj, Faizabad-224229, (UP)

**Corresponding Author: Email; assinghkumar3@gmail.com*

The present investigation was conducted at the Instructional Farm, N.D.U.A & T. Kumarganj, Faizabad (U.P.) during *Kharif* (wet) season of 2010. In nursery various nutrients in combination or alone applied at 10d seeding. In main field, FYM (cow dung) was applied @ 6.5 t ha⁻¹ one week before transplanting. Single super phosphate and muriate of potash were applied as basal before puddling @ 0:40:40 (N:P₂O₅:K₂O) kg ha⁻¹; and

Nitrogen was applied as urea @ 80:0:0 (N:P₂O₅:K₂O) in three splits: 1/2 N at 5th days of de submergence, 1/4N at 80DAT and 1/4N at 100DAT. Present study showed that application of potassium in nursery @ 40 kg ha⁻¹ was found beneficial to enhance the survival of Swarna Sub1. Lower doses of Phosphorus in nursery did not enhance survival, whereas dose of P₂O₅ at 60 kg ha⁻¹ with K₂O at 40 kg ha⁻¹ or alone significantly increased the survival of Swarna Sub1. Inorganic N (as Urea) @ 40 kg ha⁻¹ in nursery significantly reduced the survival of Swarna Sub1 rice variety under 13d complete submergence while application of nitrogen during post-submergence (5 days after de submergence) was found to be beneficial to improve recovery, growth and regeneration of Swarna Sub1. Swarna Sub1 showed higher survival when fully or partially submerged because of the *sub1*-mediated suppression of elongation. But the seedbed treatments also increased the seedling vigour which also contributed to a better crop performance during and after submergence. A regression analysis indicated that plant survival was significantly positively correlated with shoot potassium content (R²=0.81), followed by chlorophyll b (R²=0.79), total soluble sugar of shoot (R² = 0.35) and dry weight of seedlings (R² = 0.27). Whereas Significant negative correlation coefficient was obtained with shoot N content (r = -0.43). Similarly Chlorophyll a content (r = -0.32) and NR reductase activity in the leaf (r = -0.21) were also showed negative relationship with survival but r values were found non significant. Enriching seedlings in nursery through nutrient management can improve submergence tolerance and yield of lowland rice through better survival during submergence. However, the technology needs further evaluation and validation.

03-15(P)

FIBER QUALITY RELATED TRAITS OF COTTON GENOTYPES IN RELATION TO K CONTENT UNDER WATER STRESS

K. Ananthi and H. Vijayaragavan

Department of Crop Physiology, TNAU, Coimbatore

Field experiment was conducted with treatments comprising of water stress imposed at vegetative, squaring and boll development stages of crop growth: Eight parents, four F₁ hybrids, five F₂'s, four back crosses and one F₄ population along with parents were subjected for genetic diversity analysis using physiological features. The moisture stress treatments were imposed at vegetative, squaring and boll development stages along with control in all the selected cotton genotypes. Among the genotypes, the highest potassium content was recorded in the AS 1 x Suvin (F₁ and F₂) genotype followed by KC 2 X MCU 13 (F₁ and F₂) at boll development stage (17.8 and 14.4 in AS 1 x Suvin and 14.4 and 13.7 in KC 2 X MCU 13). The K content was found to be higher (AS 2) (14.6) in the case of parent materials when compared to the crosses. The overall mean genotypic values were between 12.9 and 13.1 irrespective of the treatments. The genotype Suvin showed the lowest mean value of 8.4 throughout the crop growth stage. The short fibre length and uniformity ratio were found to be decrease with respective stress given either at square formation or boll formation stage. Among the genotypes KC 2 (24), KC 2 x MCU 13 (30.5) followed by (AS 2 x MCU 13) X MCU 13 (30.4) were found to show least reduction due to moisture stress indicating that these two parents were relatively stable for moisture stress. Among the F₁ and F₂ generations, KC 2 x MCU 13 has shown the least reduction for short fibre length and uniformity ratio irrespective of the treatments indicating that KC 2 X MCU 13 is fairly tolerant to drought situation than others. With respect to the bundle strength, there significant decreases under the stress treatments were observed. The plants receiving full irrigation have shown higher values than the stressed plants. Among the treatments, the stress given at squaring reduces the bundle strength value (18.9 to 17.2) in JKC 770, significantly over others. The MIC was found to be the highest with 5.6 in JKC 770 which was significantly higher than rest of the genotypes. Among the genotypes stress given at squaring stage, KC 2 x MCU 13 (F₁, F₂ and F₄) maintained higher values of MIC.

03-16(P)

MORPHO-PHYSIOLOGICAL PARAMETERS AND ANTIOXIDANT ENZYMES ACTIVITY IN FIELD PEA (*PISUM SATIVUM* L.) GENOTYPES AS INFLUENCED BY SALICYLIC ACID UNDER SALINITY STRESS

Radha Singh* and A. Hemantaranjan

Department of Plant Physiology, Institute of Agricultural Sciences, BHU, Varanasi-221005, U.P.

**radhasingh18@gmail.com, hemantaranjan@gmail.com*

Field pea (*Pisum sativum* L.) is one of the most important salt-sensitive legumes. In this investigation, seeds of five field pea genotypes, viz., DDR 61, DDR 45, KRMR, HUDP 15 and C 5026 were presoaked for 6 hours with different concentrations of salicylic acid (SA), i.e., @ 0.5 mM, 1.0 mM and 1.5 mM to grow in soil stressed with salinity through NaCl @ 0 mM, 50 mM, 100 mM and 150 mM with development of different electrical conductivity. Salinity influenced growth and physiological parameters of field pea at early growth stage. Comparisons of performance were made with the control plants (without NaCl and SA) of each genotype. As observed, in general, SA alleviated the deleterious effect of salinity in different field pea genotypes. Out of five pea genotypes seeds treated with three SA concentrations under salinity, DDR 61 showed more tolerance, whereas genotype HUDP 15 showed least tolerance than other three genotypes at the threshold combined level of SA and NaCl @ 1.0 mM and 100 mM, evaluated on the basis of observations made on various morpho-physiological and biochemical parameters, i.e., germination percentage, root length, shoot height, leaf area, total dry weight, total chlorophyll and proline accumulation. The identified two tolerant and susceptible genotypes DDR 61 and HUDP 15 respectively were further grown under three levels of salinity (NaCl @ 50, 100, 150 mM) in combination with the threshold level of 1.0 mM SA with a view to examine influence of SA on the antioxidant enzymes ascorbate peroxidase, superoxide dismutase and catalase, which were significantly increased when compared with untreated plants under salinity. Therefore, obviously salicylic acid enhanced tolerance in DDR 61 even being relatively tolerant genotype and in HUDP 15, the susceptible genotype, under salinity stress.

03-17(P)

GERMINATION POTENTIAL AND PRODUCTIVITY OF FOUR CHICKPEA CULTIVARS UNDER SALT STRESS

Ranju Gulati¹ and Neera Garg²

¹DAV College Sector 10 Chandigarh, ²Department of Botany, Panjab University, Chandigarh-160014

Four cultivars of chickpea (*Cicer arietinum*) CSG 9651, BG 267, CSG 8962 and DCP 92-3 were tested to assess their relative germination potential and productivity under different levels of salinity (EC= 0, 4, 6 and 8dSm⁻¹). The aim was to select tolerant chickpea cultivars. The seeds of these cultivars were inoculated with *Mesorhizobium ciceri* and grown in petridish for germination studies. Germination count was taken after 48 hrs of sowing and was terminated on the 7th day after sowing, since no further change in germination was noticed. For studying response of salinity on productivity experimented was conducted in a green house. Salt treatments were applied 15 days after sowing and continued until harvest. Salinity delayed germination and caused a significant reduction in the ultimate per cent germination in all the cultivars. Speed of germination also showed negative effect of saline stress in all the cultivars under study. Salt stress decreased the biomass and grain yield in all the cultivars. The more severely affected chickpea cultivars were BG 267 and DCP92-3 at all levels of salinity compared to control. Cultivars CSG 8962 and CSG 9651 showed better results in terms of germination and ultimate yield. Results indicate that the salinity tolerance of cultivar CSG 9651 as manifested by fewer declines in grain productivity and harvest index was associated with better germination potential. It is suggested that germination is an important parameter to study relative salt tolerance in chickpea cultivars.

03-18(P)

DIFFERENTIAL EFFECTS OF SHORT TERM AND LONG TERM SALINITY STRESS ON GROWTH, YIELD AND OXIDATIVE METABOLISM IN CHICKPEA AND ITS POSSIBLE ALLEVIATION BY NITRIC OXIDE

Anita Kumari, Sunita Sheokand and Gunjan Gera

Department of Botany and Plant Physiology CCS HAU Hisar

The present study investigates the effect of both long and short term salinity stress in chickpea plants and evaluates the protective effect of exogenous nitric oxide (NO) supplementation as sodium nitroprusside (SNP). Salinity treatments were given before sowing (long term stress) and thirty days after germination (short term stress). Sodium nitroprusside was given as foliar spray 30 days after germination to both long and short term salinity treated plants. Salinity stress adversely affected the membranes as was evident from increased electrolyte leakage and lipid peroxidation levels. Sodium nitroprusside treatments decreased ion leakage and lipid peroxidation levels significantly. Short term salinity stress resulted in a higher induction of the catalase, peroxidase, ascorbate peroxidase, glutathione reductase, superoxide dismutase, dehydroascorbate reductase and monodehydroascorbate reductase as compared to long term salinity stress. Nitric oxide showed its positive effect by further increasing the activities of antioxidant enzymes. Salinity stress also altered the level of antioxidant metabolites by reducing the ascorbate redox ratio (ASC/DHA) and glutathione redox ratio (GSH/GSSG). Sodium nitroprusside treatments increased the redox ratios. Salinity stress also adversely affected the seed yield and a greater decline was observed with long term salinity stress as compared to short term salinity stress. Nitric oxide had a positive effect on seed yield and biomass accumulation. On the basis of above studies a hypothetical model was proposed according to which short term salinity stress resulted in a greater increase in membrane injury (%), malondialdehyde (MDA), reactive oxygen species and hydrogen peroxide content as compared to long term salinity stress. It activated the antioxidant defense system more pronouncedly and resulting in a lesser oxidative stress and a smaller decline in plant yield. However, long term salinity stress had a lesser effect on antioxidant defense system, thus leading to a higher oxidative stress and ultimately a higher decline in plant yield. The study concludes that short term salinity stress was found to be more deleterious than long term salinity stress and exogenous supply of NO protects chickpea plants from salinity stress.

03-19(P)

INFLUENCE OF DIFFERENT SALINITY LEVELS OF IRRIGATION WATER ON PHOTOSYNTHETIC PARAMETERS OF DIFFERENT RICE VARIETIES

S.R. Patel, C.B. Pavaghadi, Kirti Vardhan and R.G. Patil

N.A.R.P. (Paddy), S.W.M.R.U., Navsari Agricultural University, Navsari-396450, Gujarat

E-mail: lpsr_p_1951@yahoo.in

In South Gujarat, rice is predominantly grown on salt affected soils during *Kharif* season. Thus an experiment conducted to study the influence of different salinity levels on photosynthesis and associated parameters of four widely cultivated varieties of rice of the region. The pot experiment was conducted with 20 treatment combinations consisting of four varieties (Dandi, NAUR-1, GNR-2, IR-28) and five water salinity level (0.1 dS/m Rain water, 0.8 dS/m tube well water, 3 dS/m, 6dS/m and 9 dS/m) in FCRD with three replications during *Kharif* 2010. Grain and biological yields were significantly declined with increase in salinity level irrespective of variety. Different EC level was also affected significantly the leaf temperature, photosynthetic rate, transpiration rate and internal CO₂ concentration. All the parameters showed decreasing trend with increasing salinity except transpiration rate. The experimental results indicated that salinity levels above 3 dS/m were more detrimental on physiological and yield parameters which ultimately reduced the grain yield of rice varieties. Among the rice variety, Dandi and NAUR-1 showed superiority over rest of the varieties.

03-20(P)

ROLE OF CELL VIABILITY AND MEMBRANE FLUIDITY IN HEAT TOLERANCE OF WHEAT: GENETIC OPTIONS

S.S. Dhanda, Renu Munjal and Vinita Arora

Department of Plant Breeding, CCS HAU, Hisar- 125004, Haryana

Heat stress is an important production constraint of wheat during grain-fill period in India and in other parts of the world where the temperature become high during anthesis to maturity stage of plant growth. This study was determined by genetic control of heat tolerance through diallel analysis of selected wheat genotypes. Heat induced damage of plasma membrane was assayed by membrane thermo-stability (MTS), which measure electrolyte leakage from leaf tissues after exposure to high temperature. Leaf membrane stability (LMS) and tetrazolium triphenyl chloride (TTC) test, heat susceptibility index (HSI), heat response index (HRI) and grain yield were used to evaluate these genotypes under normal and heat stress conditions for two years. Mean value for grain yield per plant under heat stress (6.94 ± 0.43 gm) was significantly lower than that under normal conditions (11.56 ± 0.67 gm) indicating significant influence of heat stress. The varieties 'Seri' and 'Raj 3765' had significantly higher mean values for TTC (67.57^* and 62.53^* , respectively) LMS (73.18^* and 70.01^* , respectively) under heat stress and significantly higher grain yield under both environments indicating a desirable combination of high yield potential and heat tolerance, while, 'WH 730' and 'WH 533' were better only for TTC and LMS. The genotypes 'Kauz' (9.29^*) and 'PBW 373' (9.24^*) were significantly higher for grain yield under heat stress conditions as well as better in heat resistance/ tolerance parameters. This revealed that high grain yield under heat stress in these genotypes might have been contributed by the other traits other than the TTC and LMS. Correlation coefficients revealed that the genotypes having high cell viability (TTC) also had high LMS ($r=0.83^*$) high grain yield ($r=0.46^*$) under heat stress and high value of HRI ($r=0.54^*$) (Table 2). LMS was also significantly positively related with HRI ($r=0.59^{**}$). Significant positive association of TTC and LMS with HRI revealed that these characters appeared to contribute towards heat tolerance. High grain yield under normal environment was associated with early heading ($r=-0.46^*$) and susceptibility to heat stress (HSI, $r=0.48^*$), while high grain yield under heat stress was contributed by heat escape ($r=-0.60^{**}$) and combination of both, i.e., high grain yield potential and heat escape (HSI, $r=-0.56^*$), and heat tolerance (HRI, $r=0.49^*$). The varieties 'Seri' and 'Raj 3765' had a desirable combination of cellular thermotolerance (TTC and LMS), heat tolerance (HRI) and high grain yield potential under heat stress, while 'WH 730' and 'WH 533' were better in cellular thermotolerance and heat tolerance. The varieties 'PBW 373' and 'Kauz' also performed better under heat stress in terms of grain yield and HSI/ HRI. The varieties 'Kanchan', 'PBW 373', 'NIAW 34' and 'GW 173' were avoiders/ escapers, 'Seri' and 'HUW 234' were tolerant to heat stress, while 'WH 730', 'WH 533', 'Nesser', 'Raj 3765' and 'Kauz' showed the combination of both. Correlation coefficients revealed that HRI was the most important trait followed by TTC because the genotypes having high HRI also had high grain yield and better in mitochondrial viability and membrane stability under heat stress. The mean square for additive variance were higher in magnitude than that of non additive, but the components of genetic variance indicated considerable influence of dominance variance in determining inheritance of this trait. Results suggested that the selection for heat tolerant genotypes based on MTS in this material may be more effective by reducing the dominance variance after a few generation of selfing. The varieties, Hindi 62 was the best general as well as specific combiner followed by NIAW 34 in heat tolerant group, while WH 542, HD2329 and HD 2687 were good specific combiners in heat sensitive group. For improvement of MTS in this material selection after a few generations of selfing is suggested to contain dominance type gene action/ interaction.

03-21(P)

ASSESSMENT OF GENOTYPIC VARIABILITY FOR GROWTH, BIOPHYSICAL PARAMETERS, YIELD AND YIELD ATTRIBUTING CHARACTERS UNDER DROUGHT STRESS IN COTTON

B.C. Patil*, A.G. Babu, K.N. Pawar, A.B. Shaheen

Agricultural Research Station, University of Agricultural Sciences, Dharwad-580005, Karnataka

**bc_patil@yahoo.com*

Cotton (*Gossypium, hirsutum*) responds to drought stress which is an important abiotic stress affecting growth and yield. An experiment was conducted using twenty *Gossypium, hirsutum* genotypes grown in RBD design at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka and evaluated them for the effect of water deficit on yield, numbers of bolls, boll weight, water potential, photosynthesis rate, SPAD reading under rainfed and irrigated conditions. There was significant difference between the genotypes for seed cotton yield in both rainfed and irrigated situations. In irrigated condition highest numbers of bolls per plant were recorded in genotypes ARBH-813 (15.6) and H-1353/10 (14.53) while least in HBB-101 (7.43) and GSHV-96/612(7.73). In rainfed condition highest number of bolls per plant were observed in ARBH-813 (14.2) and H-1353/10 (13.33) while GSHV- 96/612 (5.60) and HBB-101 (6.47) recorded least. Maximum boll weight was recorded by AKH-0205 (5.57 g/boll) followed by H-1452/10 (5.04 g/boll) and the least by NH-635 (3.19 g/boll) in irrigated condition. In rainfed condition H-1452/10 recorded the highest boll weight (4.51 g/boll) while HBB-101 recorded the least (2.63 g/boll). In irrigated condition BS-30 and ARBH-813 recorded the highest water potential -15.2 bars and -15.8 bars respectively, while GJHV-358 (-18.2 bars) and GISV-218(-17.4 Bars) recorded least. In rainfed condition BS-279 (-20.9 bars) followed by BS-30 (-21.3%) recorded highest, while H1452/10 (-26.8 bars) followed by HBB-101 (-27.2%) recorded by least water potential. In irrigated condition highest photosynthesis rate was recorded in BS-279 (16.1) and GSHV97/612(15.1), while MR-786 (11.8) and RCR-102(12.8) recorded least. In rainfed condition the highest photosynthetic rate was recorded by BS-279 (14.6) and AKH-0205 (14.5) while H-1452/10(9.1), ARBH-2004(10.3) recorded least. Genotype H-1452(45.7) followed by F-2228(45.2) recorded the highest SPAD reading while LRA-5166 (34.3) and CPD -168(37.3) recorded least. In irrigated condition BS-279 recorded highest yield (1750.1kg/ha) followed by BS-30 (1737.2 kg/ha) while GIHV- 218 (691.1 kg/ha) and LRA -5166 (591.7 kg/ha) recorded the least. In rainfed situation BS-279 (1526.7 Kg/ha) followed by ARBH -813 (1096.9 kg/ha) recorded the highest yield while GIHV- 218(481.1 kg/ha) followed by LRA 5166 (581.0 kg/ha) recorded least yield. The genotypes BS-279, ARBH -813 and Sahana proved better as they recorded highest seed cotton yield both in irrigated as well as rainfed condition and least to moderate drought susceptibility indices. These are found to be desirable genotypes for drought situations.

03-22(P)

EXOGENOUS APPLICATION OF PROLINE ENHANCES ANTIOXIDATIVE ENZYME ACTIVITY, GROWTH, PHOTOSYNTHESIS AND YIELD OF CHICKPEA PLANTS EXPOSED TO CADMIUM STRESS

Shamsul Hayat, Qaiser Hayat, Arif Shafi Wani, Mohd. Irfan and Aqil Ahmad

Plant Physiology Section, Department of Botany, Aligarh Muslim University, Aligarh 202002, UP

Corresponding author: hayat_68@yahoo.co.in

Seeds of chickpea (*Cicer arietinum* L.) were inoculated with specific *Rhizobium* and were sown in earthen pots supplemented with different doses (0, 25, 50 or 100 mg per kg of soil) of cadmium (Cd). The plants were allowed to grow under the Cd stress and at the stage of 30 days after sowing (DAS), the resulting plants

were sprayed with 20 mM of proline and were sampled at 90 DAS to assess the various parameters. The foliar treatment of Cd stressed plants with 20 mM proline resulted in the alleviation of the adverse effects generated by metal exposure which was expressed in terms of the increase in the length of root and shoot, fresh and dry mass per plant over that of the control. The activity of carbonic anhydrase in the Cd fed plants and also sprayed with proline also increased over that of the control. The proline treatment also increased the photosynthetic attributes and yield characteristics in the Cd stressed plants and also sprayed with 20 mM of proline. The activity of antioxidative enzymes (catalase, peroxidase and superoxide dismutase) in the Cd fed plants and also sprayed with 20 mM proline increased with increasing concentration of the metal where maximum values were recorded in the plants exposed to a Cd stress of 100 mg per kg of soil showing 31.5% (catalase), 82.9% (peroxidase) and 61.4% (superoxide dismutase) increase over control.

03-23(P)

CHILLING INDUCED DECREMENT IN ANTIOXIDANT ENZYME ACTIVITIES CAUSES IRREVERSIBLE INJURY IN EARLY MATURING SUGARCANE

Pushpa Singh, R.K. Rai, Namita Arya, R. Darash and S.P. Shukla
Indian Institute of Sugarcane Research, Lucknow

Sugarcane crop experiences sub optimal temperatures ($<7^{\circ}\text{C}$) in months of December and January in subtropical region. The plant crop is grown from stem cuttings called setts and its ratoon crop is raised from the underground stubbles left after the harvest of plant crop and covers about 50% of total cultivated area. Sugar recovery is thus governed not only by yield and sucrose contents but also by duration of harvest season of plant and ratoon crops as sugar mills run from November to April. As the raw material supplied to sugar mill during a crop season includes both plant and ratoon canes, generally plant and ratoon crops are raised from early (10 months) and late maturing varieties (12 months) so as to aide harvest of early varieties in month of November and stretch the harvesting schedule till April with late maturing varieties. Ratoon crops thus have significant role in governing the yields and the sucrose recovery. However early maturing varieties in subtropics are harvested in month of December when temperatures are sub optimal (ranging from $2-7^{\circ}\text{C}$). As a result of chilling temperatures, sprouting of underground stubble buds gets adversely affected and even after low temperatures are over in succeeding months, the stress continues to implicate stubble bud sprouting, delays physiological growth, reduces the stalks biomass and sucrose accumulation. This low temperature induced reduced growth is responsible for decline in ratoon yields and proves to be a major bottleneck for poor sugar recovery in subtropical India. Thus the main concern of this zone is to attend to low temperature induced suppression of stubble bud sprouting in early maturing varieties harvested in months of December. The late maturing varieties though are susceptible to low temperature stress, but have rejuvenation potential and on mitigation of low temperatures, revert back to their normal vigour and growth. Thus the effects of low temperature on late maturing cane are not as apparent as they are in early maturing varieties. The chilling induced implications on metabolites and enzymes governing bud sprouting have been determined in the present work. Exposure of sugarcane single bud setts of early and late maturing varieties to low temperatures caused growth inhibition and membrane alterations and it was observed that chilling imposed irreversible oxidative stress on early maturing sugarcane setts. Accumulation of reactive oxygen species (H_2O_2) during and after low temperature exposure of sugarcane setts indicated dual effects. After removal from low temperature, early transient accumulation causing induction of antioxidant enzymes such as catalase 3 and peroxidase to scavenge H_2O_2 while at 5°C , its damaging levels in the tissues because of low levels of catalase, peroxidase and perhaps other antioxidant enzymes have been discussed.



03-24(P)

**PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN SENNA (*CASSIA ANGUSTIFOLIA*)
UNDER SALINE CONDITIONS**

S.M. Shitole and K.N. Dhumal

Department of Botany University of Pune, Pune-411 007, Maharashtra

Email-dhumal@unipune.ac.in

The soil salinity, which is prevalent in many parts of the world, poses serious threat to plant production. For maintaining a balance between conventional crops and medicinal plants, saline lands can be brought under their cultivation. Hence screening of salt tolerance of medicinal plants is the urgent need of the time. With this view present study was conducted on commercial medicinal plant, senna (*Cassia angustifolia*). A field experiment was conducted in Randomized Block Design with three replications at Department of Botany, University of Pune, during 2008 to 2010. The first NaCl treatment was given at 45 DAS and the subsequent treatments were given through soil upto flowering at the interval of 15 days. Physiological and biochemical analyses of control and treated plants were carried out at 75 (pre-flowering), 90 (flowering) and 120 DAS (post-flowering). The results revealed that there was significant reduction in total chlorophylls and proteins with all the treatments of NaCl. On the contrary proline, glycine betaine and activities of POX, PPO and SOD were highly stimulated. Present investigation have clearly indicated that senna is able to tolerate low NaCl salinity (25mM) and hence may be a probable candidate for cultivation in saline soils. The low-level salinity stress helped to enhance the sennoside content by 6.2% in leaves and 2.8% in pods.

03-25(P)

**EVALUATION OF DIFFERENT WHEAT (*TRITICUM AESTIVUM* L.) VARIETIES FOR
TERMINAL HEAT STRESS ON THE BASIS OF THEIR MORPHO-PHYSIOLOGICAL AND
YIELD TRAITS**

Mukund Kumar*, Satyendra Kumar Singh and S.P. Singh

N.D. University of Agriculture and Technology, Kumarganj, Faizabad-224229 U.P. India

**Email: mukundkumar27@gmail.com*

A field experiment was conducted during *rabi* 2006-07 and 2007-08, to identify high yielding bread wheat genotypes against terminal heat stress at Student Instructional Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad, U.P. India. The treatment consisted of three dates of sowing *viz.*, 10th December, 25th December and 10th January in order to expose the reproductive period of crop to high temperature in field conditions. The genotypes included in the trial were selected on the basis of yield performance and other agronomic characters under normal and late planting conditions. A total fifteen wheat varieties *viz.*, Halna, Raj 3765, NW 1014, PBW 242, HD 2643, HP 1744, NW 2036, PBW 14, NW 1076, Sonalika, HD 2285, HD 2307, K 8962, UP 2425, and HP 1633 were taken for study purpose. The experiment was planned under split plot design with three replications. Statistical analysis of the data revealed that significant differences in plant height, number of tillers/plant, biological yield, total chlorophyll, total soluble protein, total soluble carbohydrate, starch content, membrane injury index in leaves, days to 50% flowering, days to physiological maturity and grain yield were observed for all the genotypes with respect to all dates of sowing. The results indicated that the overall performance of the genotypes was the best with respect to normal sowing. Though all the characters were negatively affected as a result of late sowing yet the genotypes Raj 3765, HD 2285, K 8962, Sonalika and NW 2036 comparatively recorded less reduction in above traits under late sowing. However, higher reduction was found in UP 2425, PBW 343 and HP 1633. Moreover, under 30 days late sowing maximum grain yield was found in NW 2036 followed by Raj 3765, Sonalika and HD 2285 and yield reduction in these varieties ranged from 34 to 39 %. However, higher grain yield reduction (51-59%) was observed in HP 1744, PBW 343, UP 2425, HP 1633 and HD 2643.

03-26(P)

EFFICACY OF PUTRESCINE AND BENZYLADENINE ON PHOTOSYNTHESIS AND PRODUCTIVITY IN RELATION TO DROUGHT TOLERANCE IN WHEAT (*TRITICUM AESTIVUM* L.)

Sunita Gupta, V.P. Agarwal and N.K. Gupta

*Swami Keshwanand Rajasthan Agricultural University Bikaner 334006
sunitagupta69@rediffmail.com*

An experiment was conducted to find out the efficacy of putrescine and benzyladenine on photosynthesis and productivity in wheat. Seeds of wheat genotype HD 2329 were grown in ceramic pots under standard package and practices. Putrescine (0.1 mM) and benzyladenine (0.05 mM) were sprayed on the aerial portion of these plants at the time of anthesis. After spray, half of the plants were subjected to water stress by withholding irrigation. The non stressed plants were irrigated to keep the soil humidity at field capacity. Results showed that drought stress severely reduced the photosynthetic attributes, water status and chlorophyll content which were significantly improved by putrescine/benzyladenine spray. The level of free proline, amino acids and soluble sugars were higher under water stress conditions which further enhanced with putrescine/benzyladenine. Membrane injury was also reduced by both the chemicals. Yield and yield attributes reduced under water stress conditions but putrescine and benzyladenine treated plants exhibited significantly higher values over control. Most of these parameters were found significantly correlated with grain yield. It is suggested that both benzyladenine and putrescine were able to impart drought tolerance in wheat but the response of putrescine was more promising owing to better management of various physio-biochemical processes, particularly under water stress conditions.

03-27(P)

IDENTIFICATION OF UPLAND RICE GENOTYPE FOR TOLERANCE TO MOISTURE STRESS AND PHOTOSYNTHETIC CHARACTERS IN KYMORE PLATEAU SUB-ZONE OF MP

O.P. Dhurve and I.M. Khan

*Department of Plant Physiology, JNKVV, College of Agriculture, Rewa 486001 M.P.
op_dhurve@rediffmail.com*

Moisture stress is the most important limiting factor for crop production and becoming serious problem in central India region. Global climate change resulting frequent moisture stress in crop growth period and these making the situation more serious. The Kymore plateau sub-zone of Madhya Pradesh have an average attitude of 365 and 700 to 900mm rainfall during *kharif* season with early mid or terminal drought during crop growth. Therefore, twenty three rice breeding lines were grown in upland field condition during *kharif* 2009 and 2010. Morpho-physiological parameters related to moisture stress tolerance including photosynthesis (Licor-6400), stomatal conductance, transpiration rate, LAI, chlorophyll content, dry matter production, and yield parameters were used as indices for moisture stress tolerance. The perusal of rain revealed that crop received of 759.6 mm rainfall with 39 rainy days during vegetative phase with one dry spell and 18mm scant amount of rains in 3 rainy days during grain filling. Significantly superior rate of photosynthesis at flowering was found in IET-20708 ($16.29 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$) with the highest grain yield 585 g m^{-2} following by IET 20710 and IET 21106. Genotypic differences were also observed with respect to stomatal conductance, transpiration rate, chlorophyll content index and LAI. The genotypes belonging high yield ($>400 \text{ g m}^{-2}$) possess higher values for all physiological parameters as compared to other genotypes and check Annada. Higher photosynthetic rate in leaves of IET-20708 resulted in higher stem dry weight at flowering and harvest (25.2 and $12.3 \text{ g plant}^{-1}$) respectively and TDM (1508.3 g m^{-2}). Higher number of panicles m^{-2} , test weight and filled grain% also contributable for attaining superior sink size and grain yield. Thus, IET 20708 was found most tolerant rice genotype among 23 test entries with superior physiological parameters and found suitable in Kymore plateau sub-zone of M.P.

03-28(P)

INCREASE IN PRODUCTION OF REACTIVE OXYGEN SPECIES (ROS) AS A SECONDARY RESPONSE TO WATER DEFICIT STRESS IN GROUNDNUT

K. Chakraborty*, K.A. Kalariya, P.V. Zala and A.L. Singh

¹Directorate of Groundnut Research, Ivnagar Road, P.B. No. 5, Junagadh-362001

*koushik_iari@rediffmail.com, koushik@nrcg.res.in

Drought is the major abiotic stress limiting productivity in groundnut (*Arachis hypogaea* L.) and thus affecting livelihoods of millions of resource-poor farmers in arid and semi-arid regions. Yield losses due to drought vary widely in nature depending on the stage of the crop, and intensity and duration. Drought (water deficit) stress has osmotic (cell dehydration) and toxic (ROS accumulation) effects on leaf and whole plant physiology. Water deficit stress induced osmotic stress triggers the formation of reactive oxygen species (ROS) such as superoxide ($O_2^{\cdot-}$), hydrogen peroxide (H_2O_2), hydroxyl radical ($\cdot OH$), and singlet oxygen (1O_2), which damage mitochondria and chloroplasts by disrupting cellular structures (Mittler, 2002). Plants have developed a series of enzymatic and non-enzymatic detoxification systems to counteract ROS, and protect cells from oxidative damage. Thus a field experiment was conducted by taking six Spanish cultivars of groundnut viz. 'SG 99', 'ICGS 44', 'ICGV 86031', 'AK 159' and 'DRG 1' during rabi-summer season of 2011. Water deficit stress was imposed on plants by withholding irrigation at 30 DAS for 30 days and 60 DAS for 20 days while the control plants were irrigated at weekly interval. Significant reduction was observed in relative water content (RWC), membrane stability index, total chlorophyll and carotenoid contents in all the six genotypes due to water deficit stress. Among these however, 'ICGS 44' and 'TAG 24' performed better compared to other genotypes. Oxidative stress, which is a secondary response to water stress, was studied in all the six cultivars in terms of hydrogen peroxide and superoxide radical production as well as lipid peroxidation at both flowering and pod development stages. Production of ROS was more in 'SG 99' and 'DRG 1' compared to 'ICGS 44' and 'TAG 24' which could be attributed to the ability of these genotypes maintaining better RWC and sustaining much less membrane injury due to imposition of water deficit stress.

03-29(P)

**EFFECT OF ALKALI STRESS ON SEED GERMINATION AND SEEDLINGS GROWTH OF
VIGNA ACONITIFOLIA (JACQ.) MARECHAL**

N.S. Patil and B.A. Karadge

Department of Botany, Shivaji University, Kolhapur-416004

Vigna aconitifolia (Jacq.) Marechal is one of the most important food and forage crops in India. It is small, drought resistant annual herb. We quantified the effect of alkaline salts ($NaHCO_3$, $KHCO_3$ and $(NH_4)_2CO_3$) stresses on germination and seedling growth in *V. aconitifolia* (Jacq.) Marechal. The results showed that alkali stress significantly reduced seed germination with increasing concentration of carbonate salts. Germination was highly affected by ammonium carbonate as compared to that by sodium bicarbonate and potassium bicarbonate. Root and shoot length were affected more by ammonium carbonate and sodium bicarbonate than by potassium bicarbonate. Fresh and dry weights of seedlings were reduced with increasing concentration of $NaHCO_3$, $KHCO_3$ and $(NH_4)_2CO_3$. From the results it appears that *V. aconitifolia* appears to be rather sensitive to carbonate salts during germination and seedling growth.



03-30(P)

**SCREENING FOR DROUGHT AND HIGH TEMPERATURE TOLERANCE BY
PHYSIOLOGICAL TRAITS**

K.D. Sharma¹, Ashok Kumar² and S.K. Thakral¹

¹*Department of Agronomy, ²Room No. 113, New Wing, College of Agriculture, CCS Haryana
Agricultural University, Hisar -125004*

Email: dtr10@hau.ernet.in

Drought in the summer season and terminal high temperature stress in the winter season have routinely been encountered by field crops in north-western parts of India. To realize high productivity of crops, identification of better adapted cultivars to these stresses is required. Physiological research can impact on effectiveness and outcomes of plant breeding in stressful environments, but it needs to be integrated with traditional approach to be adopted and to be of value. But most physiological processes used as screening tests in breeding programmes are too slow and complex to be suitable for testing large numbers of plant genotypes. The utility of a particular physiological trait as selection criteria in a breeding programme depend on the rapid assessment of the plant at a critical stage, using small quantities of plant material. Therefore, identification of simple indicator is required, which can be easily employed in the plant breeding programmes. Experiments were conducted in drought plots and under field conditions at Crop Physiology Field Laboratory, CCS Haryana Agricultural University, Hisar on wheat, barley, chickpea and Brassica species in winter season and on mung bean and cowpea in summer season to screen their cultivars for drought and terminal high temperature tolerance by using physiological traits. Under drought, the results revealed that processes such as CO₂ and H₂O exchange, stomatal conductance, electrolyte leakage (relative injury to cell membrane), osmotic adjustment and soil water extraction from sub-soil showed significant correlation with seed yield in these crops. But the growth stage and time of measurement of these traits varied among the crops and environments. The critical growth stages were anthesis in wheat (for drought and high temperature stress), 50% flowering in chickpea, heading in barley, silique formation in Brassica species, 50% pod formation in mung bean and pod initiation in cowpea. For comparisons under irrigated conditions midday hours (between 1200-1400 hours) and under unirrigated or rainfed conditions both pre-dawn and midday measurements were important. Because the measurement of above-mentioned processes were time consuming and tedious, measurement of simple traits such as tissue water content and canopy temperature depression were also made concurrently. It was found that maintenance of smaller drop in midday tissue water content and greater canopy temperature depression were positively related to degree of osmotic adjustment, CO₂ and H₂O exchange, stomatal conductance, sub-soil water extraction and negatively to electrolyte leakage. Canopy temperature depression is measured by infrared thermometers, which are quite expensive and need many precautions such as full ground cover, sun direction, distance from plants etc. Therefore, midday drop in tissue water content expressed as ratio of midday to pre-dawn tissue water content is an effective indicator of plant performance under drought and high temperature conditions, and it has utility to be used as selection criteria in plant breeding programmes for screening crop germplasm for drought and terminal high temperature tolerance.

03-31(P)

PHYSIOLOGICAL RESPONSE OF PEARL MILLET AND CLUSTERBEAN TO HIGH TEMPERATURE

Uday Burman

Department of Plant Physiology, Central Arid Zone Research Institute, Jodhpur-342003, Rajasthan

Climate change will lead to significant increase of heat exposure during the hot season in most part of India. Variations in regional spatial and temporal pattern are expected to have important consequences for crop production. These changes cause an array of physiological and biochemical changes in plants. Principal arid zone crops of *khariif* season viz. pearl millet and cluster bean are likely to be exposed to increasing temperature in years to come. Experiments were conducted on pearl millet var. CZP-923 and clusterbean var. RGM-112 in 10 kg earthen pots which were exposed to high temperature at vegetative and reproductive stage. Exposure of both the crops at vegetative stage to comparable elevation of high temperature (3-5 °C higher than ambient) led to comparable drop in plant water potential in both the crops. However, clusterbean recorded 12.2% while pearl millet registered 7.2 % drop in relative water content of leaves. In case of both pearl millet and clusterbean, high temperature exposure at reproductive stage was more deleterious than at vegetative stage. High temperature exposure also resulted in depression in nitrate reductase activity and lower starch accumulation compared to control. Exposure of clusterbean to high temperature at vegetative stage reduced nitrate reductase activity by 74.7% whereas exposure at flowering resulted in 33.2% reduction. Reverse trend was observed with respect to starch accumulation wherein reduction was more at latter stage. Similar trend was observed in pearl millet with respect to NRA. Such adverse effects on plant metabolism consequently reduced dry matter production and yield in both the crops. Harvest Index of clusterbean dropped from 24.0 to 19.1 when high temperature was imposed at vegetative stage. It was further reduced to 16.4 on exposure at flowering stage. Similar trend, though of varying magnitude, was observed in pearl millet with respect to HI. The research effort is important considering the fact that thorough understanding of physiological responses to high temperature and mechanism of heat tolerance are required to develop potential strategies to improve yield safety in arid zone crops. This is more relevant considering the fact that climate change and climatic variability requires improved understanding of impacts of not only increased mean temperature but also that of short term temperature extremes, a situation quite common in Indian Arid Zone.

03-32(P)

SCREENING FOR THERMOTOLERANCE IN GREENGRAM (*VIGNA RADIATA* L.) USING FLUORESCENCE IMAGING

Shweta Gupta, P.S. Basu and Jagdish Singh

Division of Crop Physiology, Biochemistry & Microbiology, Indian Institute of Pulses Research, Kanpur -208 024 (UP)

Drought and extremes of temperature are the major environmental stresses to mungbean productivity. To improve crop tolerance to these abiotic stresses, researches have been focussed on the physiological and molecular mechanisms of plant response to these stresses. Exposure of greengram to high day temperature exceeding 43°C during summer causes reduced seed size and hardening of developing seeds, flower drop and retarded growth of pollen tubes on stigmal surface. Photosynthesis is known to be one of the most heat-sensitive processes and it can be completely inhibited by high temperature before other symptoms of the stress are detected. The photosynthesis decrease could result from the inhibition of photosystem II (PSII) activity, which has been shown to be the most thermally labile component of the electron transport chain. In the present study

it was observed that photosynthesis was almost completely inhibited at 45°C as evident by drastic reduction in the quantum yield of photosystem II. Chlorophyll fluorescence has been shown to be a sensitive and reliable method for detection and quantification of temperature-induced changes in the photosynthetic apparatus. A large number of greengram lines of diverse genetic background were screened for thermotolerance using chlorophyll fluorescence imaging. Leaf discs of 12mm² were put into multiwell plates which can accommodate about 96 discs at a time. These leaf discs were treated at 35 °C for 1 hour and fluorescence images for minimal fluorescence (F_0), maximal fluorescence (F_m), quantum yield (F_v/F_m), photochemical (Q_p) and nonphotochemical quenching (Q_n) were captured and corresponding fluorescence data was recorded. Same leaf discs were further treated at 46°C for 1 hour and fluorescence images were taken thereafter. High temperature treated leaf discs were subsequently allowed for recovery for 1 hour at normal temperature and images were again taken to ensure the genotype's ability to recover from heat shock. Large differences in fluorescence images were observed between normal and treated leaf discs and the corresponding fluorescence values were compared for relative thermotolerance in genetic stock under test. Genetic variations in heat tolerance were significant and the chlorophyll fluorescence method proved to be a viable screening technique for thermotolerance allowing precise testing of large number of samples at a time.

03-33(P)

REMOBILIZATION STUDIES IN HEAT TOLERANT AND HEAT SUSCEPTIBLE WHEAT GENOTYPES UNDER HEAT STRESS

Pravin Prakash and Chubasenla Aochen

Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, U.P.

A field experiment was conducted at the Agricultural Farm, Institute of Agricultural Sciences, B.H.U., at three different dates of sowing (DOS) [DOS I: 1st Dec 2009 (normal sowing); DOS II: 20th Dec 2009 (moderate heat stress); DOS III: 10th Jan 2010 (intense heat stress)] to evaluate two relatively heat tolerant (NW-1014 and DBW-14) and two relatively heat susceptible (Yangmai-6 and K-65) wheat genotypes for stem nitrogen (N) content, stem N Remobilization, N Remobilization efficiency, stem total non-structural carbohydrate (TNC) content, stem TNC remobilization, TNC remobilization efficiency and chlorophyll loss rate per day during post anthesis stage. Mean growth cycle temperature recorded an increment of 2.5 to 3°C and mean grain filling temperature showed an increment of 3.5 to 4°C at DOS III with respect to DOS I. Stem N content increased from DOS I to DOS II and DOS III at both 5 days after anthesis (DAA) and at maturity. The percent increase in stem N content, was higher in relatively susceptible genotypes than relatively tolerant genotypes. On the other hand, stem TNC decreased from DOS I to DOS II and DOS III at both stages, and highest percent decrease was observed in relatively susceptible genotypes. Percent N remobilization efficiency also decreased under late sowing, with the least decrease observed for NW-1014. Mean TNC remobilization efficiency was determined to be greater in relatively tolerant genotypes across all dates of sowing, though the relatively susceptible genotypes experienced greater % increase in remobilization efficiency under late sown condition. Chlorophyll content (SPAD units) decreased greatly under DOS III with respect to DOS I with a loss rate of 2.04 and 2.06 SPAD units per day for DBW-14 and NW-1014, and 2.19 and 2.12 SPAD units per day for Yangmai-6 and K-65. Among genotypes, NW-1014 had significantly higher chlorophyll content compared to other genotypes at all dates of sowing. Stem N remobilization efficiency showed a strong positive significant correlation with 1000-grain weight, grain yield and HI. Positive correlation of stem N at 5DAA with chlorophyll content at 5DAA was also noticed. Negative correlation was registered for stem N at maturity with chlorophyll at 20 DAA, 1000-grain weight, grain yield and harvest index.

03-34(P)

NON-SYMBIOTIC HAEMOGLOBIN AND NITRIC OXIDE HOMEOSTASIS AS AN ALTERNATIVE TO FERMENTATION FOR WATERLOGGING TOLERANCE IN VIGNA SPS.

Rohit Joshi¹, Piyali Bhattacharya¹, R.K. Sairam¹, S. Lekshmy¹ and V. Chinnusamy²

¹Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012, India.

²Department of Botany and Plant Sciences, University of California, Riverside, CA 92521, USA².

*Corresponding author e-mail: rks_ppl@yahoo.co.uk

The objective of this study was to examine the role of nitrate reductase, nitric oxide and non-symbiotic hemoglobin in imparting waterlogging tolerance in mung bean genotypes. Experiment was conducted with two cultivated mung bean [*Vigna radiata* (L.) Wilczek] genotypes viz., T 44 (tolerant) and Pusa Baisakhi (susceptible) and a highly tolerant wild species *Vigna luteola* under pot-culture condition. The concentration of nitric oxide (NO) increased up to 6 days of waterlogging treatment in *Vigna luteola* and T 44, and up to 4 days of treatment in Pusa Baisakhi. The waterlogging induced increase in NO concentration was greater in *Vigna luteola* and T 44 than in Pusa Baisakhi. Increase in nitrate reductase (NR) activity under waterlogging was observed only up to 4-days of treatment in *Vigna luteola* and T 44, and up to 2 days of treatment in Pusa Baisakhi, and thereafter the activity decreased in all the genotypes. However greater increase was observed in *Vigna luteola* and T 44 than in Pusa Baisakhi. *Non-symbiotic hemoglobin (NSHb)* and *cNR* mRNA expressions were observed only in waterlogging treated roots of *Vigna luteola* and T 44, while very little expression was observed in control plants of *Vigna luteola* and T 44, and in control and waterlogged plants of Pusa Baisakhi. PCR bands of *Hb* and *cNR* were cloned, and nucleotide and deduced amino acid sequences were obtained and conserved regions and domains were identified using data base. In this study for the first time we have reported the involvement of non-symbiotic hemoglobin-nitric oxide homeostasis in the waterlogging tolerance of mung bean (*Vigna radiata*) and its wild relative *Vigna luteola*.

03-35(P)

PHYSIOLOGICAL CHARACTERIZATION OF RICE CULTIVARS UNDER ALTERNATE WETTING AND DRYING CONDITIONS

D. Nageswara Rao, P. Raghuveer Rao, D. Subrahmanyam, M.S. Ramesha and S.R. Voleti

Directorate of Rice Research, Rajendranagar, Hyderabad-500030

Corresponding author-email: dokula07@gmail.com

Rice (*Oryza sativa* L.) is an important grain crop worldwide. Cultivation of rice under alternate wetting (AWD) conditions saves water resources without significant changes in the yield potential. The present study involved characterization of physiological and biochemical traits in the rice cultivars comprising 15 rice hybrids and 8 inbred varieties under alternate wetting and drying (AWD) and normal irrigated conditions. Hybrids showed slight decrease in plant height during wet season while varieties did not show any significant change, where as in the dry season the variations were not significant. Total number of tillers per plant, number of productive tillers per plant and panicle length did not alter between AWD and normal irrigated condition. Among the traits of physiological importance chlorophyll content did not alter significantly with the main treatment. Little increase in aerenchyma volume was detected in both hybrid and varieties under AWD conditions. Percent ion leakage was moderately increased under AWD conditions, in which hybrids were seemed to be less affected than varieties. Both hybrids and varieties showed reduction in stomatal conductance, while the varieties were less affected than hybrids under AWD. Large scale variation in time taken for leaf rolling was evident in hybrids than varieties. Total soluble sugars and proline levels did not vary significantly due to AWD treatment, where as free amino acid content increased moderately under AWD situation. The yield reduction under AWD was 9 and 19 percent

during wet and dry seasons respectively. It was also found that the hybrids performed better than varieties with reference to grain yield levels under AWD. The hybrids PA 6444 and PSD 3 and the variety NDR 97 recorded, an increase in grain yield under AWD condition during wet season, while in the dry season the hybrids PA 6201, DRRH-44 and PA 6444 recorded higher yields under AWD condition. Thus hybrids performed better than inbred varieties in terms of grain yield under AWD treatment due to their better adaptations as revealed by the physiological characteristics.

03-36(P)

CHANGES IN MIPS GENE EXPRESSION AND PHYTATE ACCUMULATION DURING SEED MATURATION IN SOYBEAN (*GLYCINE MAX L.*)

Sweta Kumari, Awadhesh Kumar, Swati Kumari, Monica Jolly and Archana Sachdev
Division of Biochemistry, Indian Agricultural Research Institute, New Delhi-110012

Phytic acid, (PA; myo-inositol 1,2,3,4,5,6 hexakisphosphate) is a phosphorylated derivative of myo-inositol, which functions as the major storage form of phosphorus in plant seeds. However, this negatively charged molecule binds to minerals, starch and proteins resulting in serious nutrient effect for both human and poultry diets. D-myoinositol-3-phosphate synthase (MIPS) (EC 5.5.1.4) catalyses the first step in the biosynthesis of phytic acid and is the most important control point of phytate accumulation in seeds. In the present study seed phosphorous and phytate accumulation patterns and MIPS expression analysis were conducted in the developing soybean seeds and vegetative tissues. Phytic acid was detected early in embryogenesis in field grown soybean and it followed a linear accumulation pattern during seed development. A final concentration of 1.9% was reached at maturity, which constituted ~70% of total phosphorus in seeds. Inorganic phosphorus was almost constant 0.3% in stems, roots, flowers and developing seeds with a slight decline at seed maturity to a final concentration of 0.25%. MIPS expression analysis by RT-PCR and by northern hybridization in developing seeds and vegetative tissues of soybean detected MIPS transcripts in the early stages of seed development and their level reached a peak at 6-8mm of seed size followed by a gradual decline in expression. Complete absence of expression was observed in the mature (12-14mm) seeds and other vegetative tissues except leaves. Presence of MIPS expression in leaves and a phytate content of 0.73% suggested the presence of a leaf specific MIPS isoform which may be involved in synthesis of phytate in the leaves.

03-37(P)

ABIOTIC STRESS ON *VIGNA RADIATA L.* SEEDLINGS

Monali Jathar, Seema Menon and Ganesh Iyer
Department of Life Sciences, Ramnarain Ruia College, Matunga, Mumbai-400019
monalijathar@yahoo.co.in, ipomoeabiloba@yahoo.com

Vigna radiata L. is one of the most important pulse crops used as food throughout the world. Changes in the climatic conditions globally has put this pulse crop under stress, however it does have the ability to overcome the stressed conditions. The present study was conducted to study the response of *Vigna radiata L.* to different types of stresses i.e. Drought stress, Flooding stress and Saline stress. The stress conditions were induced at the seedling stage. Saline stress was given using different concentrations of Sodium chloride (NaCl); drought stress was induced using Polyethylene glycol (PEG-6000), while stress due to flooding was done using excess of mud water. Each of the parameters causing stress had a control group which was given with distilled water for optimum germination. Physiological parameters indicating stress were quantified in terms of an amino acid Proline with Bates method, while Total protein content was estimated by Folin Lowry method. *Vigna radiata L.* seedlings were allowed to recover from induced stressed conditions. A comparative study of Proline and Total protein content was analyzed for stress as well as recovery. SDS-PAGE electrophoresis was carried out for stress conditions and for its recovery indicating the number of proteins detected.

03-38(P)

SCREENING OF INDIAN MUSTARD GENOTYPES FOR HIGH TEMPERATURE STRESS

Sudhir Kumar and R.K. Sairam

Division of plant Physiology, IARI, New Delhi-110012

Temperature stress is one of the major limitations to crop productivity worldwide. Identifying suitable screening indices and quantifiable traits would facilitate the crop improvement process for temperature tolerance. Keeping these things a study was done to screen and to identify temperature tolerant *Brassica* genotypes on the basis of physiological parameters viz. relative water content (RWC), total chlorophyll content, membrane stability index (MSI), yield and yield attributes. Fifteen *Brassica juncea* genotypes subjected to temperature stress by growing the crops at three dates of sowing showed decrease in RWC, MSI and chlorophyll content at D2 and D3 sowings compared to the D1. Yield attributes, such as number of primary branches, secondary branches and no of pods per plant and seed yield also showed a similar trend as the level of temperature stress increased at D2 and D3 sowings. Genotypes like Proagro, NDR 8801 and CS 52 showed lower decline in RWC, MSI, chlorophyll content, seed yield and yield attributes, while Pusa Agrani, EJ 15 and Pusa Tarak showed comparatively greater decline in the above parameters. The results suggest that simple parameters like RWC, MSI and chlorophyll contents can be used as simple indices for screening and identifying temperature tolerant genotypes.

03-39(P)

ROLE OF ANTIOXIDANT ENZYMES AND PHYSIOLOGICAL TRAITS IN HIGH TEMPERATURE TOLERANCE OF WHEAT GENOTYPES

Renu Munjal, Vinita Arora and S.S. Dhanda

Wheat & Barley Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar-125004, Haryana

Twelve wheat genotypes including checks (PBW 373 and WH 1021) were evaluated at seedling and post-anthesis stage for high temperature tolerance based on morpho-physiological criteria and antioxidant enzymes activities. It is now well known that all biotic and abiotic stresses induce or involve oxidative stress to some degree, and the ability of plants to control oxidant levels is highly correlated with stress tolerance. High temperature stress is one of the major stresses affecting wheat productivity. Approximately 9 million ha of wheat in tropical or subtropical areas is subjected to heat stress. Different physiological mechanisms may contribute to heat tolerance under field conditions. These traits may be considered for selection of heat tolerant lines in segregating generations, or advanced lines. Canopy temperature depression is suitable for selecting physiologically superior lines in warm environments with low relative humidity where high evaporative demand leads to leaf cooling of up to 10°C below ambient temperature. However, such differences cannot be detected in high relative humidity environments, because the effect of evaporative cooling of leaves is negligible. In view of this genetic diversity in wheat genotypes conferring heat tolerance was measured through stomatal conductance and chlorophyll fluorescence and antioxidant enzymes activities. An experiment comprising 12 wheat genotypes was conducted under field conditions during the year 2009-10. The genotypes were subjected to high temperature stress after anthesis by late sowing. The high grain yield under heat stress condition was found associated with higher Catalase and SOD enzyme activity and high value of stomatal conductance. Results also revealed that heat response index was the most important trait followed by antioxidant enzyme activity and stomatal conductance as genotypes having high heat response index also have high grain yield under heat stress condition and better in other physiological traits related to heat tolerance.

03-40(P)

COMPARISON OF RESPONSE OF *POPULUS DELTOIDES* CLONES TO DIFFERENT LEVELS OF WATER STRESS

Aradhna Kumari¹ and Santosh Kumar Singh²

¹Division of Plant Physiology, Indian Agriculture Research Institute, New Delhi 110012

²Department of Soil Science, RAU, Pusa, Samastipur, Bihar 848125

Poplar (*Populus deltoides*) plantations have acquired a considerable economic importance in many regions of the world. Wide natural distribution, considerable genetic variation, rapid early growth and vegetative propagation have made poplar attractive for genetic improvement and plantation programs. Poplar is very sensitive against water stress during seedling establishment period. A pot culture experiment was conducted to study the effect of different levels of water stress on physiological parameters in two poplar clones during seedling establishment period. Four sets of pots were arranged, with eight replications for each set for both the clones. One set maintained at field capacity, while others were maintained at 25, 50 and 75% of field capacity. Different levels of water stress were maintained on IW/CPE (irrigation water/cumulative pan evaporimeter) ratio, which is the standard method of maintaining water stress both in field and pot experiments. The variety G-48 showed better growth characteristics and lesser cytotoxic damage under stress, as assessed through better plant height, more number of leaves, higher biomass accumulation, more proline accumulation, and lesser membrane permeability and lipid peroxidation, and damage to photosynthetic pigment as compared to Kranti. The results obtained clearly indicated that the clone G-48 has higher drought tolerance potential than the clone Kranti. It was also observed in this investigation that Poplar seedlings can withstand drought up to 25% of the field capacity. But beyond this level of drought, plant growth and biomass were severely decreased to an extent that plant could not maintain further growth.

03-41(P)

ROLE OF HEAT SHOCK TRANSCRIPTION FACTORS AND HEAT SHOCK PROTEINS IN HIGH TEMPERATURE TOLERANCE OF WHEAT GENOTYPES

G. Krishna Kumar, R.K. Sairam and Lekshmy S.

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

India is the second largest producer of wheat in the world. High temperature spells towards the end of the crop season are a major determinant of wheat yield, especially under Indian conditions. The present study was conducted with three wheat genotypes in terms of temperature tolerance viz. Halna, DBW 14 (Tolerant) and HD 2687 (Susceptible), sown on 25th November, 15th December and 10th January of 2010-11. Late sowing induced high temperature stress led to the reduction in relative water content, membrane stability index, chlorophyll content, carotenoid content and photosynthetic rate and an increase in lipid peroxidation in all the varieties. Comparatively greater changes were observed in susceptible genotype, HD 2687 as compared to Halna and DBW 14. Halna and DBW 14 maintained comparatively higher grain weight per ear, 1000 grain wt, grain yield per plant and yield stability index under high temperature stress. Expression analysis of heat shock transcription factor, *HsFA4a* and small heat shock proteins, *HSP16.9* (NCBI Accession no: JN634765) and *HSP17.3* revealed that tolerant genotypes were having higher levels of gene expression than susceptible genotype. From the study, it can be concluded that the efficient up-regulation of *HSFs* and *HSPs* played a major role in imparting high temperature stress tolerance in wheat.

03-42(P)

**IMPROVING THE PHYSIOLOGICAL EFFICIENCY AND YIELD OF WHEAT UNDER
TERMINAL WARM ENVIRONMENT**

K.D. Sharma* and Ashok Kumar

*Crop Physiology Lab, Department of Agronomy, CCS Haryana Agricultural University,
Hisar-125004, Haryana, E-mail: kdutt1966@gmail.com*

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 VAM (DS + VAM) and primed seed with VAM (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/m² 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.

03-43(P)

**EVALUATION OF BLACKGRAM (*VIGNA MUNGO* L.) GERMPLASM FOR
THERMOTOLERANCE USING CHLOROPHYLL FLUORESCENCE**

**Mukund Kumar, Sanjeev Gupta, Mudit Srivastava, Alagupalamuthirsolli, P.S. Basu
and Jagdish Singh**

*Division of Crop Physiology, Biochemistry and Microbiology, Indian Institute of Pulses Research
(ICAR) Kanpur-208024, mukundkumar27@gmail.com*

Blackgram (*Vigna mungo* L.) is grown during summer or kharif season and this crop is often subjected to high temperature even beyond 43°C. Poor yield and seed hardening are some of the symptoms associated with high temperature. Photosynthetic membrane was found to be most sensitive component which is distorted when subjected to temperature above 43°C. Energy transduction through thylakoid membrane was found to be easily and most precisely assessed through extremely weak modulated light of intensity 0.15 μmole photons m⁻²s⁻¹. The distorted membrane hinders flow of electrons from PS II to PS I causing rise in the minimal chlorophyll fluorescence irreversibly. Hence increase in the minimum fluorescence value in heat treated leaf proved to be a potential tool to assess the relative heat tolerance and membrane stability. In order to evaluate large number of black gram germplasm for heat tolerance, the leaves were treated at 46°C for 1 hour and fluorescence emission was recorded. The significant genetic variation in F₀ was observed in the test population. The quantum yield (Fv/Fm) was significantly correlated with the membrane stability measured by electrolyte leakage simultaneously. The results indicated that heat sensitive lines can not even tolerate very weak light at high temperature. If both high temperature and high light intensity superimposed, the sensitive lines are subjected to oxidative stress which is caused by alternate mode of energy dissipation through formation of superoxides.

03-44(P)

INFLUENCE OF MOISTURE STRESS ON THE STATUS OF WATER WITHIN THE DEVELOPING SOYBEAN GRAINS AS REVEALED BY NUCLEAR MAGNETIC RESONANCE (NMR) STUDIES

P. Krishnan, A.P.S. Verma, D.K. Joshi, S. Das and Ravender Singh

Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi-110012

Water is an important determinant of productivity and grain quality of soybean. Moisture directly contributes to grain development by its effect on grain filling and rate of dry matter production. Restrictions due to moisture stress on grain growth are mainly due to disappearance of enzyme activities relating to the synthesis of starch. In addition, stress leads to greater loss of final grain weight and poor grain growth rates. Numerous biochemical and biophysical changes in tissues along with dehydration of water affect grain maturation adversely. Water compartments within grains are correlated with organic properties of macromolecular structures associated with the grain development. Nuclear Magnetic Resonance (NMR) relaxation studies allow the nondestructive determination of changes in the status of water in plant tissues. Therefore, the present study was undertaken to evaluate the changes in water status during grain development in soybean exposed to moisture stress and to analyze the profiles of NMR relaxation times in relation to grain quality during development and maturation. The water status of soybean grains, which were sampled from soybean plants grown at flooded (control), every furrow irrigated, and alternate furrow irrigation, was evaluated by NMR spin-spin relaxation time (T_2). The grain quality was determined by NIR grain analyzer. The NMR relaxation time (T_2) decreased to less than 40 ms in grains from plants grown at the alternate furrow irrigation than those from the control. In general, the moisture stress reduced the rate of dry matter accumulation. NMR relaxation times qualifying the water mobility showed significant correlation with water content and dry matter accumulation. NMR study revealed that free water in grains remained for a longer period at control than those from the water deficit conditions. The decreases in NMR signal intensity in the endosperm of soybean grains during the developmental stages corresponded with the changes in the physical properties of the storage tissue, which were evident from the seed osmotic potential, and the changes in the oil-, moisture- and protein contents, estimated by the NIR grain analyzer. These results clearly indicate that water proton relaxation times of NMR provide rapid and quantitative information on water status, which indicates the quality of soybean grains. The changes in T_2 due to moisture stress conditions are also a sensitive diagnostic indicator of dry matter accumulation at grain filling stage of soybean.

03-45(P)

PERFORMANCE OF COTTON GENOTYPES FOR WATER STRESS TOLERANCE

S.S. Bhatade, D.B. Deosarkar, D.G. Dalvi* and Javed Jani

Marathwada Agricultural University, Cotton Research Station, Nanded – 431604

**E-mail : dalvi46@rediffmail.com*

A field experiment was undertaken for two years during *kharif* 2009-10 and 2010-11 at Cotton Research Station, Nanded to study the performance of 18 cotton genotypes for water stress tolerance, yield components and Physiological parameters under rainfed situation. The genotypes BS-30 followed by ARBH-813 and NH-635 were recorded highest leaf area index, specific leaf weight (%), harvest index (%) and yield components i.e., No. of bolls / plant, boll wt (g), seed cotton yield / plant and seed cotton yield kg/ha. On the basis of Physiological parameters the genotypes BS-30, ARBH-813 and NH-635 were found superior for water stress tolerance under rainfed situation which were also found early in maturity.

03-46(P)

GROWTH AND PLANT WATER RELATIONS IN MOTHBEAN (*VIGNA ACONITIFOLIA* (JACQ) MARECHAL) UNDER SOIL MOISTURE STRESS

Sunil Kumar, Shital* and K.D. Sharma

Department of Botany & Plant Physiology, CCS Haryana Agricultural University, Hisar- 125 004
E-mail: sheetal033@gmail.com

The low productivity of Mothbean is due to lack of suitable genotypes, poor crop stands, cultural practice and low adoptions of improved technologies. So there is need of more judicious matching of suitable genotypes and cultural practices with the most probable soil moisture pattern, which remains highly unpredictable under arid conditions. The present investigation was conducted on four genotypes of mothbean, namely RMO 40, RMO 257, CZM 10 and MB 99-1 in concrete micro plots with rainout shelters and filled with dunal sand located at crop physiology research area of Agronomy Department, CCS Haryana Agricultural University, Hisar. The experiment was laid out in factorial RBD with four replications. Two levels of moisture stress was created namely, irrigated control (normal irrigations were applied) and water stressed (by withholding irrigation at 50% flowering and 50% pod filling stages). Moisture stress reduced the LAI, LAD, CGR, and SLA significantly. However, SLW increased under moisture stress. LAD and CGR increased up to pod filling and then decline at maturity under water stress. However, under irrigated control it increased up to maturity. Genotype MB 99-1 had higher LAI, LAD, RGR, SLW. However genotype RMO 257 possessed higher SLA, RGR and CGR at pod filling. The plant water relation parameters viz., Θ_w , Θ_s and RWC decreased from morning to afternoon. The leaf water potential decreased under water stress because of decreased absorption and translocation of water due to loss of gradient in Θ_w between the soil and roots and declined transpiration pull due to decreased stomatal conductance. Osmotic potential (Θ_s) of leaf decreased under stress was also accompanied by change in RWC and thus pointing to a higher or lower osmoregulation depending upon the magnitude of decrease whereas, water retention increased under moisture stress. Genotypes MB 99-1 maintained higher plant water status, whereas, lowest was observed in CZM 10 under moisture stress.

03-47(P)

MORPHO-PHYSIOLOGICAL TRAITS FOR SCREENING HEAT TOLERANT LINES OF FIELDPEA UNDER LATE SOWN CONDITIONS

Vijay Laxmi

*Division of Physiology, biochemistry and Microbiology, Indian Institute of Pulses Research
Kanpur-208 024, e-mail: vijaylaxmi01@yahoo.com*

A field experiment was conducted during rabi (winter) season. Fifteen fieldpea genotypes (Fifteen fieldpea genotypes were sown under normal medium and late sown irrigated condition. Under late planting crop was exposed to high temperature during flowering and grain filling stages. High temperature stress caused significant reductions in physiological parameters and yield. High temperature and late sowing induced decline in membrane stability index (48.33%), plant height (79.30%) biomass (85.55%) and seed yield (89.05%) were observed in (DPR 13, IPFD 1-10, IPFD 1-10, and IPFD 3-17 respectively) Genotypes Pant 5, KPF 103 DMR 15, IPFD 4-6 showed lower values of heat susceptibility index (0.5) and higher values of yield stability index (>90%), and therefore grouped as temperature tolerant. Membrane stability index at seed development stage showed positive association with biomass and seed yield in fieldpea genotypes under normal and late sown conditions. The linear relationship of MSI with seed yield and biological yield showed dependence of seed yield and biomass on membrane stability index.

03-48(P)

**PHYSIOLOGICAL EFFECTS OF WATER STRESS IN TOMATO GENOTYPES
(LYCOPERSICUM ESCULENTUM MILL)**

S. Vincent, M. Shebin, C.N. Chandrasekhar and P. Jeyakumar

Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore

Investigations were 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. Tomato genotypes were evaluated for their germinability and their seedling characters under room temperature and *in vitro* condition. Germination and vigour characters were significantly reduced under lower water potential. Germination percentage, vigour index and stress tolerance index were showed that they can be used as selection indices for screening drought tolerance under room temperature and *in vitro* condition. Response of water stress in tomato genotypes was brought out in terms of adverse impact 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, 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 an useful indices for screening of drought tolerance under field condition. The genotypes, CLN 2123, LCR 2, 09 TOPURA, LE13 and LE315 showed higher expression in respect of the above characters than the other genotypes. 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. 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 study thus, conclusively proved that flowering stage was more critical as for as occurrence of water stress was concerned. The water stress at this stage would be more detrimental on plants growth and development as well as in yield.

03-49(P)

**CYTOKININ INDUCED PHOTOSYNTHETIC EFFICIENCY DURING MOISTURE DEFICIT
STRESS IN TWO WHEAT CULTIVARS DIFFERING IN DROUGHT TOLERANCE**

Shivani Nagar, Singh, V.P. and Ajay Arora

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

Water stress is one of the major limiting factors in wheat production which is more pronounced at reproductive stage. Experiments were carried out to study the effect of cytokinin (6-Benzyl amino purine; 40 μM) on photosynthesis and related traits under two different water regimes in two contrasting wheat cultivars differing in their tolerance to drought at pre-anthesis, anthesis and post-anthesis stages of wheat development. Decrease in RWC and MSI were observed under water stress condition but application of cytokinin enhanced the RWC and MSI in both the conditions. There was reduction in chlorophyll and carotenoid content under water stress condition whereas application of cytokinin helped in maintaining the stability of chlorophyll and carotenoid in both the conditions. Maximum photosynthesis and related components were found at anthesis stage. Application of cytokinin significantly improved the rate of photosynthesis and its components in both the cultivars and water regimes. Wheat cultivar C-306 performed better under water stress condition compared to PBW-343. 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.

03-50(P)

TERMINAL STAGE HEAT TOLERANCE STUDIES ON PHYSIOLOGICAL AND STRESS CHARACTERS OF DIFFERENT RAPESEED-MUSTARD GENOTYPES

Maharaj Singh, J.S. Chauhan, V.V. Singh and Kapila Shekhawat

*Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur-321303, Rajasthan
ms_drmr@rediffmail.com*

Rapeseed-mustard constitutes an important source of edible oil next to soybean and groundnut grows under diverse agro ecological situations such as timely / late sown, rainfed / irrigated, sole-& / or mixed crop with cereals (wheat, barley etc.) and *rabi* (October-April) pulses (chickpea, lentil etc.). Flowering and grain filling are the most sensitive stages for temperature stress damage probably due to vulnerability during pollen and grain development, anthesis and fertilization leading to reduce crop yield. High temperature in *Brassica* enhanced plant development and caused flower abortion and poor grain filling with appreciable loss in seed yield. A rise of 3°C in maximum daily temperature (21-24°C) during flowering and grain filling caused a decline of 430 kg / ha in canola seed yield. Therefore, improving seed yield of Indian mustard under late sown conditions is main challenge for rapeseed mustard research. Effects of heat (high temperature) stress during terminal stage were investigated on plant height, primary and secondary branches/plant, siliquae on different branches, seeds/siliqua, 1000-seed weight, seed yield, harvest index, photosynthesis, transpiration, stomatal conductance, stress intensity, mean productivity and geometric mean productivity of 44 germplasm of rapeseed-mustard during 2010-11. Forty three rapeseed-mustard genotypes were sown in the field at two dates of sowing i.e., 1st optimum, D1 (Oct. 26, 2010) and 2nd in the last week of November, D2 (November, 2010) to allow the crop exposure to high temperature at terminal stage viz., grain filling stage. The crop sown in late November faced average maximum temperature of > 30°C at grain filling stage. Genotypes were sown in augmented design. The genotypes EJ-22, EJ-20, NPJ-124, NDT-05-02 showed less reduction because of escape high temperature at terminal stage due to earliness. While the genotypes, BPR-549-9, BPR-540-6 and BPR-349-9 showed < 20% reduction in seed yield with high 1000-seed weight were identified as high temperature tolerant genotypes. Late sown condition adversely effected photosynthesis and caused appreciable reduction from 9.8 (JS-29) to 48.3% (PBR-378). The genotypes JS-29, KM-26, RMM-09-02 and PBR-357 showed < 15% reduction in photosynthesis under high temperature stress. All these genotypes showed superiority over both the checks (BPR 541-4 and JD-6). The study revealed that genotypes, BPR-549-9, BPR-540-6 and BPR-349-9 showed tolerant to high temperature at terminal stage based on less reduction in seed yield, moderate to high transpiration and low to medium transpiration rate. Thus these genotypes can be used to breed for high temperature tolerance at terminal stage.

03-51(P)

SALICYLIC ACID-INDUCED OSMOLYTE ACCUMULATION LEADS TO HEAT TOLERANCE IN *TRITICUM AESTIVUM*

Md. Iqbal Raja Khan* and Nafees A. Khan

**Corresponding author: amu.iqbal@gmail.com*

The protective role of proline and glycine betaine (GB) in heat tolerance in *Triticum aestivum* L. cultivar '711' was studied under the influence of salicylic acid (SA). Salicylic acid-induced osmolyte accumulation under heat stress in '711' lead to reduced oxidative stress. Heat stress decreased photosynthesis and plant growth and SA application increased photosynthetic pigments, photosynthesis and growth through increased content of proline and GB. The results suggest that the effect of SA on proline and GB might be responsible for inducing heat tolerance because '711' with increased content of these osmolytes showed greater adaptation to heat stress with increased photosynthesis and growth.

03-52(P)

IDENTIFICATION OF GROUNDNUT GENOTYPES FOR DROUGHT TOLERANT TRAITS WITH HIGH POD YIELDS

P. Pranusha, P. Sudhakar*, V. RajaRajeswari, D. Mohan Reddy and P. Latha*

*S.V. Agricultural College, Tirupati, A.P , *Regional Agricultural Research Station, Tirupati, A.P
Email: pranushaag@gmail.com*

Groundnut is predominantly grown in southern zone of Andhra Pradesh under rainfed conditions and farmers often loss yields due to frequent droughts. 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 other genotypes which recorded higher drought tolerance traits with low yields can be exploited as donor source in developing drought tolerant groundnut genotypes.

03-53(P)

A PHYSIOLOGICAL APPROACH TO SCREEN RICE GENOTYPES WITH ACQUIRED THERMO-TOLERANCE AT SEEDLING STAGE

Sapna Harihar, C. Vijayalakshmi, and P. Boominathan

Tamil Nadu Agricultural University, Coimbatore – 641003

Thermo-tolerance is one of the various acquired stress tolerance phenomenon observed in all living organisms, when the stress is imposed gradually. Acquired stress tolerances to temperature extremes are complex traits dependent on many attributes. One of the approaches to improve thermo-tolerance is to transfer superior alleles from intrinsically thermo-tolerant wild relatives, but due to a high throughput screening method to screen for variability and identify donors this method has poor progress. Response (TIR) technique has been developed to identify and select thermo-tolerant genotypes. This technique involves exposing seedlings of rice genotypes (cv. White Ponni) to induction stress and subsequently exposing to a lethal temperature and selecting the surviving seedlings at the end of the recovery period (72 h). The germination progressively decreased with increase in temperature from 36°C- 1 h, 38°C- 1 h, 40°C- 1 h, 42°C- 1 h, and 44°C- 1 h, after which they were exposed to a lethal temperature of 52°C. Shoot length and root length gave a differential response to high temperature. Three days old seedlings were also exposed to different temperature regimes 48, 50, and 52°C for 3 h and their mortality percentages were calculated. The induction temperature was standardized as 36-44°C and the lethal temperature was standardized as 52°C. Thus we propose that this technique can be used as a potential tool to identify and select temperature-tolerant lines from a large population at seedling level.

03-54(P)

IDENTIFICATION OF NaCl INDUCED SALINITY-RESPONSIVE TRANSCRIPTS IN *ARACHIS GLABRATA*

Rinni B. Raval, Nikita P. Ved and S.K. Bera

Directorate of Groundnut Research, PB#05, Ivnagar Road, Junagadh-362001, Gujarat

Groundnut, a major oil seed crop of India grown in about 5.5 million hectare, mostly under rain dependent environments and the average productivity fluctuates from 600 kg/ha to 1500 kg/ha due to various biotic and abiotic factors. Salinity is one of the major abiotic factors limiting the groundnut production in India. *Arachis glabrata* (accession number NRCG-11832), a wild species of cultivated groundnut; grouped into tertiary gene pool of genus *Arachis* has been tested *in vitro* as tolerant to NaCl stress. Tapping of tolerance to NaCl stress from *A. glabrata* to cultivated groundnut through conventional breeding is not feasible due to cross incompatibility between cultivated groundnut and *A. glabrata*. Transcriptional analysis was done through DDRT-PCR using *Arachis glabrata*. A total of 20 differentially expressed transcripts were eluted from leaf induced callus cultured in 250mM NaCl stress *in vitro*. Transcripts were coded as groundnut transcript responsive to salt stress (GTRS). In total nine out of 20 differentially expressed transcripts could be sequenced. After performing BLAST, GTRS-12 showed 91% similarity with NC_003070.9 *Arabidopsis thaliana* chromosome 1, complete sequence 426 bp at 5' side: WRKY10 (WRKY DNA-BINDING PROTEIN 10); transcription factor. WRKY transcription factors have been shown to play a major role in regulating the plant defense transcriptome in response to wounding, pathogen infection or abiotic stresses in numerous plant species. WRKY genes are widespread in land plants, as over 40 species have expressed WRKY genes.

03-54(P)

STUDY OF PROMISING LINES FOR ANAEROBIC SEED GERMINATION UNDER FLOODED CONDITION

P.N. Singh, A.H. Khan, V.N. Singh, R.K. Yadav, Preeti Singh and A. Ismail

Centre of Advanced Faculty Training in Plant Physiology, Department of Crop Physiology, NDU&T, Kumarganj, Faizabad – 224229; International Rice Research Institute, Philippines
Email: pnsingh.singh604@gmail.com

Rainfed lowland rice crop experiences not only water deficits condition but also excess water leading from partial to complete submergence. Early flooding that persists for several days usually reduces plant survival and productivity of rice in rainfed lowlands. More than 20 million hectare is annually affected in South and South East Asia. Damage is mainly caused due to flood water interference in normal gas exchange and illumination. The present work was therefore under taken to screen out genotypes/lines were direct seeded in tray culture experiment under flooded condition (10 cm water level above from the soil surface in the tray). About 6 lines were promising and could germinate and grow in 5-10 cm standing water. The best being is NDR8024 and Swarna Sub1 with 80 and 73% germination respectively. Other promising lines which showed about 20-65% germination under hypoxic condition are NDR 9930095, NDR 8842, NDR 9930070, NDR 9930017, NDR 9730018, Rajendra Mahsuri, NDR 8850 although had only 20% germination. Shoot biomass maximum in Swarna Sub1 (9.64g/plant) followed by NDR 8024 (9.39 g/plant), NDR 9730018 (9.26 g/plant), NDR 9930070 (8.36g/plant) and lowest in NDR 8850 (4.24 g/plant). Grain yield was maximum in NDR 8024 followed by NDR 9730018, Swarna Sub1 and minimum in NDR 8850. It is clear from the finding that same of these lines can be used as donars for future breeding programme on tolerance to hypoxic seed germination especially required for direct seeded flood prone areas.

03-56(P)

EFFECT OF POLYETHYLENE GLYCOL INDUCED WATER STRESS ON PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES IN RICE VARIETIES

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

Central Rice Research Institute, Cuttack-753006

E. mail: pswaincrri@gmail.com

Among the abiotic stresses, drought is a serious limiting factor that reduces rice production and yield stability in rainfed ecosystems. As rice is grown in rainfed upland and rainfed low land situations, early vegetative stage drought is a regular occurrence in these areas. When plants are subjected to drought stress, a number of physiological responses have been observed. To understand the physiology of crop adaptation to early vegetative stage moisture stress, eight rice varieties viz. Kalakeri, Mahulata, Sahabgaidhan, Saruchina, Bhoja, Nachin-II, CR-1006-8, Dubraj, with susceptible (IR-20) and tolerant (CR-143-2-2) checks were tested under induced moisture stress of -5 and -10 bar by the soil application of PEG-6000 in pots. Observations on physiological parameters were recorded at 2, 4 and 7 days of imposing stress, biomass production and accumulation of sugar was recorded on the 7th day of the stress. Under moisture stress, leaves were rolled in and water potential declined to an extent of -2.88 MPa under -10 bar. Sahabgaidhan and CR 143-2-2 maintained relatively higher water potential (-2.01 MPa and -2.12 MPa respectively) compared to other varieties even at 7th day of stress under -10 bar. Photosynthetic rate was decreased in both the treatments and the pace of decline was more under -10 bar. Kalakeri recorded minimum decrease at the 7th day stage of the stress followed by CR 1006-8 under both the treatments. Stomatal conductance (g_s) followed similar pattern of photosynthetic rate. Expressions of free amino acid, proline and soluble protein were quite opposite such that proline content raised by 164% under -5 bar and 227% under -10 bar, whereas protein content declined by 40% and 51% respectively over control. Kalakeri showed maximum tolerance with respect to highest proline accumulation (327%) at -10 bar and lowest protein degradation (8.35%) at -5 bar. Total biomass was significantly affected by the stress. Mahulata recorded minimum reduction in biomass production and maximum accumulation of soluble sugar followed by Kalakeri showing their tolerance towards drought.

03-57(P)

MORPHO-PHYSIOLOGICAL CHARACTERIZATION OF WHEAT (*TRITICUM AESTIVUM* L.) CULTIVAR UNDER WATER STRESS CONDITIONS

S.L. Khapke*, R.K. Aher and B.A. Patil***

**Department of Botany, New Arts, Commerce and Science College, Ahmednagar-414 001*

***Department of Botany, New Arts, Commerce and Science College, Parner - 414 302*

E-mail: sajankhapke@gmail.com

A study was conducted to characterize the morpho-physiological parameters in wheat during FC (Field capacity) percent treatment at the seedling and anthesis stage. Wheat cultivar (var.496) was subjected to water stress (FC) percent treatment in pot culture. The study revealed that root length, shoot length, plant height, stem girth, number of leaves and leaf area decreased with increasing water stress at seedling and anthesis stage in the wheat. The concentration of proline increased significantly with an increase in the degree of water stress. Similarly phenolic contents also increased along with increased water stress level. However, photosynthetic pigments were highly reduced with increasing water stress at seedling and anthesis stage.

03-58(P)

EVALUATION OF WHEAT CULTIVARS FOR TERMINAL HEAT TOLERANCE UNDER NATURAL FIELD CONDITIONS

T.P. Singh¹, B.S. Phogat¹, M. Singh¹, M. Dutta¹, K. Srinivasan¹, R.K. Tyagi¹ and D.K. Joshi²

¹National Bureau of Plant Genetic Resources, New Delhi-110012

²Division of Agricultural Physics, IARI, New Delhi-110012

Wheat is the second most important staple food crop after rice in the world. In India, the lower productivity of wheat is due to shorter crop duration and period of grain filling. High temperature stress at anthesis and post anthesis reduces the grain number per ear due to reduction in spikelets per spike, florets per spikelet and floret fertility, grain weight and subsequent reduction in harvest index, resulting in lower grain yield. Assimilate availability is further reduced by heat and water deficit stresses as they induce and enhance the rate of senescence. Late sown wheat is more affected by high temperature stress leading to reduced yield and quality. Keeping in view the above points, an experiment was conducted at NBPGR, Farm IARI, New Delhi, to evaluate the wheat cultivars for terminal heat tolerance. 106 wheat cultivars were sown under natural field conditions on 20.11.2010 (normal sown) and 20.12.2010 (late sown). Observations were recorded for different morpho-physiological characters i.e. duration of different phenophases, chlorophyll value, membrane stability index, relative water content, seed protein content, grain yield and its components traits under both planting dates. The data recorded on the above traits indicated wide range of variability in the cultivars. Days to physiological maturity under normal sowing varied from 130 days (IC-282300 and IC-75219) to 144 days (IC-75240) and under late planting 108 days (IC-296383) to 123 days (IC-128228); chlorophyll values at milk stage under normal planting ranged from 24.33 (IC-145286) to 55.26 (IC-282300) and under late planting 11.56 (IC-128272) to 41.30 (IC-574388); under normal planting membrane stability index maximum 72.05% in (IC-75215) and under late planting maximum 69.52% (IC-565811). Under normal planting relative water content maximum 72.0% in (IC-128155 and IC-128167) and under late planting maximum 68.51% in (IC-128155); biomass per plant varied from 10.3 (IC-252732) to 36.9 (IC-128235) and under late planting 7.0 (IC-536235) to 25.35 (IC-75240); seed yield per plant(g) under normal planting ranged from 2.75 (IC-252818) to 13.20 (IC-128167) and under late planting 2.10 (IC-75212, IC-252818) to 10.30 (IC-75240). Protein (%) in seed under normal planting varied from 10.22 (IC-252929) to 15.15 (IC-122726) and under late planting 10.32 (IC-128175) to 15.11 (IC-290230). Harvest index (%) in normal sown ranged from 23.71 (IC-252818) to 50.28 (IC-128180) and in late planting 22.92 (IC-128195) to 50.99 (IC-75219). In general, reduction were observed in the values of all traits under late planting condition as compared to normal planting due to temperature stress. In late planting genotype IC-75240 performed better for high biomass and seed yield. This genotype can be used in breeding programme for enhancing the yield potential of wheat under terminal heat stress condition.

03-59(P)

STUDIES ON WATERLOGGING TOLERANCE AND MICROELEMENT TOXICITIES IN KEY INDIAN AND AUSTRALIAN VARIETIES IN SODIC SOIL

S.P. Singh, B.N. Singh, Mukund Kumar, Rama Kant, Preeti Singh and T.L. Setter

Department of Crop Physiology & CAFT in Plant Physiology, N.D. University of Agriculture and Technology, Kumarganj-224229, Faizabad (U.P.)

Eleven wheat varieties viz., KRL 3-4 (T), KRL99 (T), Kharchia 65(T), KRL 19 (MT), KRL 210 (MT), NW 1014 (MT), Brookton, Ducula-4, DBW 17, HD 2851(S) and HD 2009 (S) were evaluated for waterlogging

tolerance 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). 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). Leaf sampling for ICP analysis was done just after termination of waterlogging. Plant height and shoot biomass were recorded after the termination of WL and at maturity. Yield and yield traits were recorded at harvest. 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 then it increased to the level of +437.3 mV at 10d after WL. In general, waterlogging decreased plant height, shoot biomass, yield and yield traits of all varieties. The decrease in plant height ranged from 8 to 21% after WL and 6 to 29 % at maturity. Highest biomass tolerance index (WL/NWL) at maturity followed the sequence KRL3-4(.801) > Kharchia 65 > KRL 99 > NW1014 > DBW 17 > KRL 19 (.567), while, lowest was recorded in HD 2009 (.384). Waterlogging delayed the days to 50% flowering (5 to 14 d) and maturity duration (4 to 13 d).Yield traits like, EBT/ 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 (.768) followed by KRL 3-4, KRL 99 and NW-1014, while, HD 2009 had lowest (0.397) followed by HD2851 (.416). ICP analysis of leaves collected after WL showed tremendous increase in Fe (10 fold), Al (9 fold), Mn, and Na with respect 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, besides anaerobiosis, Fe, Mn, Al and Na toxicities play important role in decreasing the growth and yield of wheat.

03-60(P)

EFFECT OF DROUGHT ON PHYSIOLOGICAL PARAMETERS AND YIELD COMPONENTS OF UPLAND RICE GENOTYPES

Brajesh Kumar Mishra* and G.S. Chaturvedi

*Center of Advance Studies in Plant Physiology, N.D. University of Agriculture and Technology,
Narendra Nagar (Kumar Ganj) Faizabad-224229 (U.P)
Email: brajeshmishrad@gmail.com*

Rice eco-system mostly suffers from flowering stage drought, both in upland and lowland condition. Upland rice is relatively more vulnerable to flowering stage drought than other stages drought. Rice eco-systems are mostly depending on rainfall distribution and residual precipitation. In Uttar Pradesh, most of rainfall occurs between first week of July to last week of August and there is no rain during mid September to mid November and this is the period which coincides the flowering stage. Mechanism of drought tolerance at vegetative stage is different from those at flowering stage. There is little information regarding the factor responsible for drought tolerance at reproductive stage in the genotypes of upland rice, popularly grown in eastern Uttar Pradesh. The present investigation was carried out in pot culture (Earthen pot, 12" diameter) experiment at experimental site of Department of Crop Physiology during *kharif* season. The experiment was executed factorial CRD with five replication. Thus, artificial drought treatment (80 k pa±) at flowering stage was given to six upland rice genotype (three traditional, Bagri, Nankawa, Bakaiya and three improved, N-22, Ashoka-228, NDR-97) with specific objective, effect of flowering stage drought on some morpho physiological parameters, yield and yield components

of upland rice genotypes. In our study, we have found that plant height, leaf area, root: shoot ratio, total biomass varied significantly among different traditional and improved upland rice genotypes. N-22 and Bagri found better than improved and traditional respectively. Flowering stage drought adversely affect all above growth and morphological parameters but, leaf area, root: shoot ratio were the main character which had greater impact on tolerance behavior of genotypes. Improved genotype N-22 maintained greater leaf area, root: shoot ratio under drought condition and after recovery in comparison to other improved and traditional ones. Percent fertile spikletes could also be major yield determining factor in rice. Drought at flowering stage reduced grain yield both of the improved and traditional genotypes. The percent fertile spikletes found more in N-22 improved and traditional genotype Bagri. Besides this percent fertile spikletes, number of panicle, grain weight per plant were also reduced during drought, which ultimately reduced grain yield. Reduced grain weight per plant in traditional type was linked with reduction in panicles number, percent fertile spikletes and grain weight per plant. Thus, it may be final concluded that greater yield of improved genotype of upland rice under flowering stage drought condition was due to better water uptake as reflected in extracting water through root system and more water storage capacity within the cell, better translocation ability of assimilates. Fertile spikletes was also an important factor to determine the grain yield. Plant height, leaf area, root: shoot ratio, percent fertile spikletes could be taken as index for drought tolerance in upland rice. Among all improved and traditional genotype studied in our experiment N-22 emerged as most drought tolerance to flowering stage drought with a better yield and could be used in breeding programme as drought parent doner in breeding rice crop for drought prone environment.

03-61(P)

AGRO-MORPHOLOGICAL CLASSIFICATION AND DIVERSITY ANALYSIS OF SOYBEAN MUTANTS

D.D. Ahire, R.A. Tambe and S.G. Auti

*Post Graduate Department of Botany, H.P.T. Arts and R.Y.K. Science College Nashik-422005, MS
digambar12@rediffmail.com*

Soybean (*Glycine max* (L.) Merrill,) is an annual leguminous species cultivated mainly for its seed. The present day soybean cultivars are derived from narrow genetic base. The genetic variability present in any crop is of vital importance in the formulation of effective breeding programme. Fifty six stable mutant lines were selected from M_3 generation to evaluate significant variability among the mutant using twenty morphological and agronomic traits and 72 morphological markers. A dendrogram of 56 lines was constructed on the basis of qualitative traits by Hierarchical cluster analysis using between groups linkage cluster method with Squared Euclidean Distance interval. The 56 mutant lines with parent cultivar 'MACS 450' were clustered into 9 main groups with similarity matrix ranging from 0.09-1.00%. A mutant line DI-3-4 was grouped separately from rest of mutant lines followed by P-5-1, CII-93-5 and DI-130-34. The highest similarity (1.0%) was observed between mutant lines BII-61(45) and BII-90-9; CII-26-6 and DII-9-1; DI-1-4 and DI-8-4, DII-21-4. Very less similarity was observed between mutant lines DI-3-4 and CII-13-5, P-44-1, J-5-27 (0.10, 0.09 and 0.10 respectively). The lines Q-9-3, R-10-1 and P-54-4 were very close to parent thus had less alterations for morphological and agronomic characters considered here. Based on the present study the mutants DI-3-4, DI-130-34 and P-5-1 were found to be distinct and diverse and can be utilized in the breeding programme for developing better varieties of soybean.

03-62(P)

EFFECT OF UV-B AND MONOCROTOPHOS ON GROWTH, PIGMENTS AND ANTIOXIDANTS IN HETEROCYSTOUS CYANOBACTERIUM *NOSTOC MUSCORUM*

Abhishek Chris

*Department of Biological Sciences, Allahabad Agricultural Institute-Deemed University Allahabad
E-mail - achris1@rediffmail.com*

The impact of ultraviolet-B (280-320 nm) radiation and monocrotophos (2.0 and 4.0 ppm) singly and in combination, on growth, photosynthetic pigments, enzymatic and non enzymatic, antioxidants, level of hydrogen peroxide and lipid peroxidation have studied in cyanobacterium *Nostoc muscorum*. Chlorophyll, phycocyanin and carotenoid contents were found to decrease with rising concentration of UV-B and monocrotophos alone and in combinations. Total peroxide content increased with simultaneous increase in lipid peroxidation. The level of non enzymatic antioxidant proline and enzymatic antioxidant superoxide dismutase, peroxidase activity were found to increase with simultaneous decrease in catalase activity following UV-B and monocrotophos treatments. The present findings suggests that UV-B and monocrotophos singly and in combination, have adversely affected growth and pigmentation in the test organism. The interactive effects of both the stresses was however, less than additive.

03-63(P)

PHYSIOLOGICAL ANALYSIS OF DROUGHT TOLERANCE IN GROUNDNUT

C. Raja Babu and Vaidyanathan

*Regional Research Station, Vriddhachalam, Tamilnadu Agricultural University
Tamilnadu, Email; crajababu@yahoo.co.in*

Groundnut is grown widely under rain-fed conditions in the semiarid tropics during *kharif* season. Drought is one of the major constraints, especially during the pod and seed formation stages, and it has been shown to reduce pod yield by 56–85%. Hence to identify the genotypes tolerant to drought ten advanced breeding lines viz., ADRVT1, ADRVT2, ADRVT3, ADRVT4, ADRVT5, ADRVT6, ADRVT7, ADRVT8, ADRVT9, ADRVT10 bred for drought tolerance were evaluated under field condition at Regional Research Station Vriddhachalam during *kharif* 2010 season. The trial was laid out in a (RCBD) with four replications. The same sets of material were evaluated under normal irrigated conditions for as control. Water deficit Stress was imposed by withholding irrigation after 30 DAS for a week. Sampling was done at 35, 65 DAS and at harvest. The results have shown that the groundnut cultivars viz., ADRVT2, ADRVT8, ADRVT5 recorded higher Relative Water Content (RWC), and pod yield under stress condition. ADRVT2 and ADRVT5 recorded higher SPAD values under the stress situation. The study thus indicated that the characters viz., higher root-shoot ratio, lesser shoots, SPAD Value, and RWC is the contributing characters for drought tolerance mechanism in groundnut cultivars.

Session 04

**Plant Tissue Culture, Biotechnology
and Germplasm Conservation**

04-01(L)

CLONING AND SEQUENCE CHARACTERIZATION OF A NOVEL SHN3- LIKE GENE FROM MULBERRY (*MORUS* SPECIES)

R.S. Sajeevan and Karaba N. Nataraja*

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

**For correspondence: Email: nataraja_karaba@yahoo.com*

The *SHINE* (*SHN*) is an upstream transcription factor (TF) associated with leaf surface wax biosynthesis in plants. Over expression of *Arabidopsis SHN* altered leaf epidermal cell structure, increased cuticle permeability, trichome number and showed significant drought tolerance. Transgenic tomato plants expressing *SHN1* showed significant increase in water use efficiency under drought conditions. With an objective to prospect novel *SHN* gene in perennial crop mulberry (*Morus* species), we cloned *SHN3*- like gene from contrasting mulberry genotypes differing in leaf surface wax load. Full length *MiSHN3* CDS (1089 bp) contains an ORF of 819 bp that encodes 272 amino acid residues. The predicted protein contains a single typical AP2/EREBP DNA-binding domain at their N termini, a conserved middle and C-terminal domains. *MiSHN3* gene sequence from contrasting mulberry genotypes showed nucleotide variations with two INDELS and 10 substitutions in the coding sequence. The translated protein sequences showed five amino acid substitutions and two INDELS. It would be interesting to evaluate significance of the observed variations, and the gene might play significant role by regulating the downstream genes associated with wax biosynthesis in mulberry.

04-01(O)

ADVENTITIOUS ORGANOGENESIS IN *AZADIRACHTA INDICA* A. JUSS. (NEEM) USING LEAF EXPLANTS

Fatima Shirin* and Anamika Rai

*Genetics and Plant Propagation Division, Tropical Forest Research Institute, PO RFRC, Mandla Road, Jabalpur-482 021; *e-mail: fatimashirin@yahoo.com*

Organogenesis is the process whereby explants, tissues or cells can be induced to form shoots and/or roots and even whole plantlets by altering the levels of cytokinins and auxins either directly on the surface of the explants or indirectly via callus formation. A factorial randomized design experiment was conducted to study the effect of BA and Adenine hemisulphate (Ads) on callus and shoot formation in *Azadirachta indica* using leaf explants. The leaves were taken from *in vitro* grown shoots and cut into small pieces of appropriate size (0.3 cm²). Each piece was carefully inoculated keeping the abaxial portion on the surface of the media. Leaf curling and elongation of leaves started after 5-7 days of inoculation on media. Callus induction was initiated on the leaf pieces after 15 days of inoculation and the whole surface of the leaf was covered with friable green callus after 30 days of inoculation. The effect of BA, Ads and their interactions on callus formation in leaf pieces was found to be statistically non-significant. Maximum callus formation (66.67%) was obtained on 1.76 μ M BA and 162.86 μ M Ads. Shoot primordia were visible after 30 days of inoculation. The effect of different doses of BA was found to be statistically non-significant for number of shoots per leaf piece. On the other hand, different doses of Ads had statistically significant effect on number of shoots and maximum shoots per leaf piece (1.56) were obtained on 162.86 μ M Ads, which was significantly higher than number of shoots obtained with other doses. Similarly, the interaction between BA and Ads was also found to be statistically significant for number of shoots per leaf piece. Maximum shoots were obtained on the interaction of 0.44 μ M BA and 162.86 μ M Ads, which was significantly higher than number of shoots obtained with any other treatment. These shoots are being further multiplied for rooting experiments.

04-02(O)

CALLUS INDUCTION AND GENE TRANSFORMATION METHOD FOR SALT TOLERANCE IN FINGER MILLET

A.G. Babu^{*1}, V. Manjunatha², A.G. Shankar³ and M. Udayakumar⁴

^{1, 3 & 4}Department of Crop Physiology, University of Agricultural sciences, GKVK, Bangalore-560065, Karnataka, ²Department of Genetics and Plant Breeding, University of Agricultural sciences, GKVK, Bangalore-560065, Karnataka; *email: babusilver@yahoo.co.uk

Development of efficient and genotype-independent tissue regeneration system is an essential prerequisite for successful production of transgenic plants. In this direction we established efficient reproducible protocols for efficient callus induction, in vitro plant regeneration and genetic transformation in finger millet using *PDH45* as a candidate gene to develop transgenic Finger millet for salinity tolerance by *in vitro* gene transfer method by using calli as explants obtained from Finger millet seeds. Seeds were surface sterilized and used as explants for callus induction. Seeds were inoculated in callus induction media, incubated in dark with $26\pm 1^\circ\text{C}$ temperature condition for 3-4 weeks in growth chamber. Later the induced callus was transferred in to the callus growth media containing 2 mg L^{-1} 2, 4-D for callus growth for 2 weeks. After 2 weeks of incubation the compact, green, nodulated sectors of callus were separated from non embryogenic watery callus and then subcultured on MS medium. Obtained calli was co cultivated with *Agrobacterium* Plasmid carrying binary vector pCAMBIA construct containing *PDH45* candidate gene, *nptII* gene as bacterial selection marker, *hptII* gene as plant selectable marker, and *GUS* reporter gene driven by CaMV 35S promoter. Successful transformation at callus stage was initially confirmed by *GUS* histochemical assay. And by PCR amplification genomic DNA of putative transformed calli showed positive for *hptII* primers. Putative regenerated transgenic were confirmed by PCR amplifying the genomic DNA of putative transformed plants.

04-03(O)

MICROPROPAGATION IN KHIRNI (*MANILKARA HEXANDRA* ROXB.)

S.S. Kale, R.M. Patel and B.K. Dhaduk

Department of Biotechnology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari-396 450; Email: rameshpatel1960@yahoo.com

Khirmi is important underutilized fruit crop in India. Among the different uses of khirmi, it is widely used for the rootstock for raising sapota plant. The present investigation was carried out on "Micropropagation in khirmi (*Manilkara hexandra* Roxb.)" with objective to standardize the protocol for micropropagation technique of khirmi during the year 2009-11. A Study was conduct to standardize protocol for *in vitro* propagation of khirmi (*Manilkara hexandra*) using two different explants i.e. shoot tip and axillary bud from seedling plants. Results revealed that surface sterilization treatment HgCl_2 0.1% for 5 minutes was found effective for control of contamination with higher establishment of both types of explants. Among the both types of explants, axillary bud explants performed better response in terms of per cent establishment and formation of multiple shoots. Maximum establishment (83.46 per cent) with minimum days for establishment (9 days) and higher length of shoot (2.22 cm) of axillary bud explants were recorded in treatment SH medium supplemented with 2.0 mg/l BAP. Maximum frequency of multiple shoots (78.00 per cent) was recorded in treatment SH medium supplemented with 2.0 mg/l BAP + 1.0 mg/l GA_3 . Approximately six fold rate of multiplication of axillary bud was achieved at 4th subculture on the same treatment of the multiplication. The best rooting per cent (65.40 per cent) with minimum days for root initiation (23 days) and maximum number of roots per shoot (3.00 nos.) were recorded in treatment half SH + 0.5 mg/l IBA. The maximum survival rate of plantlets (55.44 per cent) with minimum days for new sprouting (13.2 days) was observed in treatment coco peat when placed in a net house individually.

04-01(P)

**EFFECT OF CYTOKININS ON MULTIPLICATION OF CULTURE IN CUSTARD APPLE
(ANNONA SQUAMOSA L.) CV. BALANAGAR**

R.K. Panchal and R.M. Patel

*Department of Biotechnology, ASPEE college of Horticulture and Forestry, Navsari Agricultural University, Navsari Gujarat 396 450
panchal.rajesh18@gmail.com*

The present investigation was carried out on “Micropropagation in custard apple (*Annona squamosa* L.)” with objective to develop commercially feasible and economically viable protocol for micropropagation technique of custard apple during the year 2009-11. While standardization of micropropagation in custard apple, influence of different plant growth regulators on multiplication of culture in custard apple (*Annona squamosa* L.) cv. Balanagar were examined. In order to study the multiplication of culture in shoot tip and axillary bud explants, eight different treatment combinations involving various levels of BAP and kinetin were tested. The result revealed that in axillary bud explants, maximum frequency of multiple shoots (76.17%), length of shoot (1.37cm) and average number of shoots (6.0) were registered in treatment MS medium + 2.0 mg/l BAP with 0.5 mg/l kinetin (M_8) followed by MS medium + 1.5 mg/l BAP with 0.5 mg/l kinetin (M_7) and MS medium + 2.0 mg/l BAP (M_4). Similarly shoot tip explants performed also better for frequency of multiple shoots in treatment M_8 , which registered 59.67 percent. Overall, it could be seen that MS medium + 2.0 mg/l BAP with 0.5 mg/l kinetin (M_8) medium is the best for higher frequency of multiple shoots for both types of explants studied. Among the explants types tested, the axillary bud explants showed better response for frequency of multiple shoots.

04-02(P)

MICROPROPAGATION IN PAPAYA (*CARICA PAPAYA* L.) VAR. RAD LADY

J.R. Patel, R.M. Patel and R.R. Shah

*Department of Biotechnology, ASPEE College of Horticulture and Forestry,
Navsari Agricultural University, Navsari-396 450.
rameshpatel1960@yahoo.com*

Papaya is one of the important fruit crops grown in India. Recently, var. Red Lady is cultivated on large scale in Gujarat due to cent per cent productive plants and good quality of fruits. Papaya var. Red Lady is propagated through seeds. Although, desirable characteristics of var. Red Lady, the major constraint of adoption of this variety is a very high cost of seeds. No other vegetative methods is in vogue. Alternatively, Plant tissue culture technique is usefully for producing true to type and healthy planting material. Hence, the present investigation was carried out on micropropagation in papaya var. Red Lady with objective to standardize the protocol for micropropagation technique of papaya. Results revealed that better response for establishment was reported in shoot tip explants when inoculated in MS medium + 0.05 mg/l BAP + 0.1 mg/l NAA. Multiplication of culture was obtained higher in the same medium. Further, proliferation of shoots was reported in MS medium + 0.1 mg/l NAA + 1.0 mg/l kinetin at 3000 lux light intensity. *In vitro* rooting response in regenerated shoots was found the best with half strength MS medium supplemented with 1.0 mg/l IBA. Acclimatization of plantlets showed better survival in FYM: soil: sand (1:1:1 v/v) in hardening procedure.



04-03(P)

GENETICALLY MODIFIED ORGANISMS AND THEIR IMPACT ON ENVIRONMENT

Satnam Singh Sohal*, Gauri Soman and Sunita S. Hajirnis

**Department of Botany, Maharshi Dayanand College, Mumbai; Department of Botany,
Dnyanasadhana College, Thane
satsohal777@gmail.com, saritasunilhajirnis@yahoo.co.in*

The agricultural revolution has been the most fundamental innovation in the history of the cultural and socio economic development of human kind. Due to expansion of the agricultural frontier through the centuries to provide food and goods for an ever increasing human population, intrinsic destruction of biological diversity took place. Genetically modified organisms or GMO in agriculture to greater extent has been a cause of worry as far as their cultivation, sale in the market and consumption is concerned. This is particularly true when agriculture is practiced in a resource inefficient manner, or when it uses technologies not adapted to the environment characteristics of an area. In this paper we analyze the environmental effects of the release of GMO's into the environment It also discusses the potential environment risks or impacts of the use of transgenic technologies in the present day conventional agricultural practices. So while the portfolio of GM applications is increasing in the near future, we need to deal rather rapidly with some overall questions to ensure that GM crops make an optimal contribution to world food security, food safety and quality, and sustainability and remain to the public at large.

04-04(P)

MICROPROPAGATION AND GERMINATION STUDIES IN *DATURA METEL L.*

V.S. Kale

*Department of Botany, New Arts, Commerce and Science College, Ahmednagar - 414 001
vijayk_nsk@rediffmail.com*

Datura metel L. is an annual indigenous herb. Its narcotic and intoxicating properties are long been familiar to Indians. *Datura* leaves contain about 0.5 per cent alkaloids chiefly scopolamine (hyoscyne) with traces of hyoscyamine and atropine. Atropine and scopolamine are used to a large extent in ophthalmic practice. Atropine is used as antidote. It is also used as an important ingredient in various ayurvedic preparations. Nodal sectors and petiole explants collected from one month old plants grown in green house were inoculated on MS medium supplemented with BAP at a concentration ranging from 1.0 to 3.0 mg/l. Shootlet regeneration was observed on the medium containing BAP 1.8mg/l. Well proliferated shootlets after period of 20 days were excised and cultured on MS medium supplemented with variable concentrations of IBA ranging from 1.0 to 3.0 mg/l for rooting. Rooting response was optimum at 2.1mg/l IBA. Rooted plantlets were transferred to vermiculite for hardening. Unlike other species of the genus, *Datura metel* is not common. There are many causes delimiting the distribution of the species. It germinates with difficulty. In order to undertake systematic cultivation of the species availability of the uniform seed source need to be assured. Present study was aimed in understanding the seed qualities. Germination studies carried out revealed that, with progressive dormancy period germination percentage goes on declining. Three month old seeds of current season have high germination percentage (87%). Six month old seeds showed 57 % germination while one year old seeds showed hardly 23 % germination.

04-05(P)

IN VITRO SCREENING OF *CENCHRUS CILIARIS* (CAZRI-358) EXTRACTS AGAINST SOME MICRO-ORGANISMS

Premlata Singariya¹, Krishan Kumar Mourya² and Padma Kumar³

¹Dr. D.S. Kothari Post Doctoral Fellow, Laboratory of Tissue Culture and Secondary Metabolites, Department of Botany, University of Rajasthan, Jaipur-302004, ²Veterinary Officer & In-charge, Govt. Veterinary hospital, Pahari (Bharatpur) Rajasthan, ³Department of Botany, University of Rajasthan, Jaipur-302004; ¹premlatasingariya@gmail.com, ²mourya07@gmail.com

Cenchrus ciliaris (CAZRI-358) grass is more efficient at gathering Carbon dioxide and utilizing nitrogen from the atmosphere and recycled N in the soil. *C. ciliaris* (Poaceae) is highly nutritious grass and 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. The object of present study is to evaluate the *in vitro* anti microbial properties of Crude extracts of different parts of *C. ciliaris* in different polar solvents by hot extraction method in soxhlet assembly against a few medically important bacteria and yeast with standard gentamycin and ketoconazole. *Staphylococcus aureus* (Gram +ve) is a major causative agent of nosocomial infections along with *Escherichia coli* (Gram-ve). *E. coli* is the culprits for human urinary tract infections it cause nephritis in animals. *Candida albicans* is notorious for causing candidiasis and afungemia called candidemia. Crude extracts were first screened for antimicrobial activity by disc diffusion method against bacteria and fungi. The fraction showing best activity was then used for assay of minimum inhibitory concentration (MIC) by tube dilution method. Results reveal that crude extract was found to be maximum in seed extracts [243±11.56 mg/10gm (dry weight)] in toluene, [199±13.68 mg/10gm (dry weight)] in isopropyl alcohol extracts of leaf. All the crude extracts screened against *S. aureus* (MTCC 87), *E. coli* (MTCC 46) and one fungus as *C. albicans* (MTCC 183) using disc diffusion assay. Maximum antibacterial activity shown by leaf extracts (IZ=35.85±0.24mm; activity index= 2.756) followed by seed extracts (IZ=21.17±0.29mm; AI= 1.628) against *S. aureus* in isopropyl alcohol solvent. Maximum antifungal activity against *C. albicans* (IZ=8.17±0.25mm; AI= 0.681) by root extract in iso propyl alcohol. Therefore, this study has concluded that *S. aureus* was found to be most susceptible organisms followed by *C. albicans* and isopropyl alcohol extracts were showing more potency than toluene extracts. *E. coli* is more resistant than *S. aureus* and *C. albicans*.

04-06(P)

SCREENING OF THE *DIANTHUS CARYOPHYLLUS* L. CULTURES FOR DIANTHIN; A RIBOSOME INACTIVATING PROTEIN

Soniya Khawale, Nutan Malpathak

Department of Botany, University of Pune, Pune; email: khsoniya@gmail.com

Dianthus caryophyllus L. is an important floriculture plant. In addition to their aesthetic value they are medicinally important. The leaves of this plant contain dianthin a ribosome inactivating protein. Dianthin has antiviral properties and it can inhibit HIV in infected cells. As these are single chain RIP's, they lack cell binding moiety and therefore the non-toxic nature make them significantly important. Considering this an effort was made to screen for dianthin, both from *in vivo* and *in vitro* (shoots and callus cultures) plants. The shoot cultures and callus cultures were established for this purpose. Shoot cultures were established from nodal sectors through indirect regeneration. Callus cultures were obtained from leaf explants. SDS PAGE and PCR analysis confirmed the presence of dianthin in *in vivo* plant and *in vitro* cultures. These cultures can serve as a continuous source of dianthin with no further exploitation of the plant.

04-07(P)

PLANT TISSUE CULTURE, BIOTECHNOLOGY AND GERMPLASM CONSERVATION

Bharati Kannamma

Department of Biotechnology, Rajalakshmi Engineering College, Thandalam
bharathikumar1991@gmail.com

The modern biotechnology is applied to various plants conservation techniques that includes germplasm conservation. This technique has been increasing in the present today. Molecular markers technology, molecular diagnostics, tissue culture, cryopreservation are the main areas of biotechnology which can assist the germplasm conservation. Plant tissue culture plays a major role in the germplasm conservation. Many factors such as the temperature, climatic change, humidity, carbon-dioxide supply influence the germplasm. Their merits and demerits have to be discussed in detail. Micropropagation is required for propagating the germplasm and for its maintenance. The first step of in-vitro tissue culture technique is the acquisition of germplasm. It is followed by the selection of tissue culture; media culture establishment, morphogenesis, organogenesis and development of new plant. There are two types of germplasm conservation which are insitu and exsitu, out of which exsitu is more important. Then cryopreservation of plant tissue is viable for long term storage of germplasm of many species. The recovery of plant genetic resources is required for the exploration of plant qualities that are needed and conserved.

04-08(P)

IN VITRO PRODUCTION OF HARMALA ALKALOIDS AND PROPAGATION OF *FAGONIA SCHWEINFURTHII* (HADIDI) EX HADIDI GAFOOR

T.D. Nikam* and A.A. Naik

Department of Botany, University of Pune, Pune-411 007
*Corresponding author E-mail: tdnikam@unipune.ac.in

Fagonia schweinfurthii (Zygophyllaceae) is widely used in traditional system of medicine as anti-inflammatory, analgesic, antipyretic and a constituent of Suryaprabha Vati. In the present investigation we have standardized a protocol for callus initiation and *in vitro* propagation of this medicinal plant using various explants of aseptically germinated seedlings. Cotyledon and hypocotyls segments were inoculated on Murashige and Skoog (MS) medium fortified with various combination and concentrations of auxins (IAA, NAA and 2,4-D) and cytokinins (BA, Kin and TDZ). Maximum multiple shoot regeneration was observed in cotyledon explants on MS containing 1.0 mg/L BA. Combination of NAA and BA produced best results in callus initiation. Most of the induced calluses were green and had a nodular appearance. When subcultured onto the same fresh medium, three fold or more increases in callus mass were obtained in four week of culture. Callus lines sustained growth one year after initiation of subculture were examined for their ability to produce shoots and alkaloids on medium without plant growth regulator (PGR) and a medium containing various concentrations and combinations of auxins and cytokinins. Shoot regeneration was observed in calluses subcultured on Kin and BA (1.0 – 2.0 mg/L) containing medium. The total alkaloid content was higher in callus grown on MS medium fortified with 1.0 mg/L BA + 0.5 mg/L NAA. Most of the regenerative shoots developed into complete plantlets following their transfer to a medium containing 0.5 mg/L NAA. The well rooted plantlets on transfer to glass house conditions for 2 week and then to field conditions showed 98% survival. The regenerated plantlets showed no morphological differences from the parent material. This protocol could be useful for germplasm conservation, cultivation, genetic improvement and *in vitro* production of pharmaceutical metabolites of *Fagonia schweinfurthii*.



04-09(P)

BANANA TISSUE CULTURE FOR SHORTENING CONVENTIONAL MICROPROPAGATION PROTOCOL

Jayeeta Chatterjee and Sabita Bhattacharya

Division of Plant Biology, Bose Institute, 93/1, A. P. C. Road, Kolkata-700 009, West Bengal

Present study reports a high frequency, less time consuming micropropagation protocol for tissue culture-based production of a commercial banana cultivar G9 (*Musa* sp AAA type). The protocol consists of three *in vitro* steps instead of five as used in conventional methods. The first step included regeneration of shoots from excised shoot tip explants cultured under darkness in MS containing BAP 4.0 mg/l, IAA 1.0 mg/l and 3% sucrose (the initiation medium). The 45-days old cultures with 15 shoots on average per culture were exposed to light and subcultured in MS supplemented with BAP 2.0 mg/l and 1% charcoal (the multiplication medium). This condition supported profuse growth of existing and newly regenerated shoots and induction of roots from shoots as well. Thirty days old cultures yielded about 25 plantlets per culture. For further growth and development of the plants, for the roots in particular, the third and final step was taken, which consisted of half strength MS without growth hormone. Gelling agent was replaced by glass beads as matrix. Individual plants grew uniformly and gained weight by about 15-20 g. Cent percent survival of *ex-vitro* grown hardened plants in net pot trays and plastic bags justifies the rationale of the new abridged protocol developed for commercial production of G9 banana saplings using simple formula of media components.

04-10(P)

PLANT TISSUE CULTURE, BIOTECHNOLOGY AND GERMPLASM CONSERVATION

Erica B. Benson, B.D. Singh and Vijaya Geetha

Department of Biotechnology, Rajalakshmi Engineering College, Rajalakshmi Nagar, Thandalam, Chennai-602105; email: admin@rajalakshmi.edu.in, bharathikumar1991@gmail.com

Biotechnology can directly assist plant conservation programmes by molecular markers technology, molecular diagnostics, tissue culture and cryopreservation. The sum, total of hereditary material constitutes the germplasm of a crop which has to be maintained in such a state that there is minimum risk for its loss and that either it can be planted directly called germplasm conservation. It can be conserved either *in situ* or *ex situ*. *In situ* is the one in which the natural habitat or in the area where it grows naturally and *ex situ* is the other one, away from its natural habitat. It is determined by following ways like seed gene banks, shoot tip gene banks, plant or field gene banks, cell organ gene banks and DNA gene banks. Tissue culture had a major impact on the *ex situ* conservation of plant genetic resources. Preservation of plant germplasm can itself be the goal of *in vitro* plant cell and tissue culture by the use of methods, including micropropagation and embryo rescue process. The approach of tissue culture have been vital in the re-establishment of endangered plant species. The five basic stages for micropropagation are germplasm selection, production of axenic and viable cultures, number of propagules is formed, development of germplasm and acclimatization of plantlets. Embryo culture involves the dissection of embryos from seeds and make cross between two species. The various activities in the germplasm conservation can be grouped into the following categories are collection of germplasm, conservation, evaluation, multiplication, distribution and utilizing. Extension of micropropagation technique is the preservation of germplasm. It is achieved by the slow growth method, which is the medium-term germplasm storage and cryopreservation of plant tissue is the long-term storage from species which are vegetatively propagated or produce recalcitrant seeds. The recovery of plant genetic resources is required for the exploration of plant qualities that are needed and conserved.

04-11(P)

IN VITRO SALT STRESS INDUCED PRODUCTION OF GYMNEMIC ACID IN CALLUS CULTURES OF *GYMNEMA SYLVESTRE* R.Br.

Upendra Kumar* and Y. Vimala

Department of Botany, C.C.S. University, Meerut-250004

*Present address: Directorate of Maize Research, IARI, Pusa Campus, New Delhi-110012

[Email: baliyan.upendra@gmail.com]

The use of *Gymnema sylvestre* commonly known as “Gurmar” (destroyer of sugar) or “Periploca of the woods” is well-known to the Indian people since ancient days (“Meshashring”) as a source of antidiabetic drugs. In recent years, it has become one of the important plants the world of herbal medicine. It is a rich source of many bioactive compounds such as gymnemic acid (GA-I-X) quercitol, lupeol, á-amyrin, stigmasterol, gymnemin, gymnemagenin, gurmarin, etc. which are very effective in lowering of blood sugar. The normal propagation method of *G. sylvestre* requires a lot of time (about 6 - 8 months) to grow a developed plantlet from seed. In addition, it requires sufficient field, constant manuring and a constant observation which in turn requires a lot of manpower. Apart from this, getting seeds from the plant is difficult and moreover the chance of getting a disease/contamination free plant is less. On the contrary, a standardized method of micropropagation of *G. sylvestre* can provide a greater percentage of yields of pathogen free plant in a shorter time and in a smaller place. Also, in order to obtain those active compounds, one needs not to regenerate several complete plants. Extracts from pathogen free calli if generated *in vitro* will prove beneficial. In the present study we have described the procedure for the callus induction and culture of *G. sylvestre* following standard plant tissue culture protocol using different meristematically active plant parts, growth regulators and studying their effect on callus induction and gymnemic acid production. *Gymnema sylvestre* was cultured *in vitro* for callus induction using leaf explant. Gymnemic acid content enhancement under the influence of different plant hormones like 2,4-D, BA with or without NaCl supplementation to the MS medium. The highest efficiency of callus formation was observed in the medium containing different concentrations of 2, 4-D. The gymnemic acid content increased with increasing concentration of 2, 4-D along with NaCl.

04-12(P)

TISSUE CULTURE OF *INDIGOFERA TINCTORIA* LINN AND ITS BIOLOGICAL ACTIVITY

M. Bhat, S. Kumthekar, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar

Department of Botany, Ramnarain Ruia College, Matunga, Mumbai -19

shrutika2186@gmail.com

Indigofera tinctoria Linn commonly called as indigo is a medicinally and commercially valuable deciduous leguminous shrub. Though the plant bears seeds profusely, the seeds lose their viability in a short span of time under ambient storage conditions. In the present study attempts were made to standardize a medium for *in vitro* propagation of the plant. Since the plant is rich in metabolites attempts were also made to quantify and study their biological activity. Proliferation of the callus from various vegetative parts of seven-day-old *In vitro* seedlings were observed on Murashige and Skoog (MS) medium supplemented with 0.5 mg l⁻¹ N 6-benzyl adenine (BA) and 0.5 mg l⁻¹ 2,4-Dichlorophenoxy acetic acid(2,4-D). Regeneration of the callus was observed only on MS medium supplemented with 0.1mg l⁻¹ BA. Among the secondary metabolites flavanoids were found to be highest. Leaf, pod, seed and callus extracts were evaluated for their antimicrobial activity. These extracts were also evaluated for their antioxidant potential using 2,2-diphenyl-1-picrylhydrazyl (DPPH). The plant represents promising sources of natural antioxidants.

04-13(P)

AGROBACTERIUM TUMEFACIENS-MEDIATED VPP-ASE GENE TRANSFER AND STRESS TOLERANCE IN NEUROTONIC *BACOPA MONNIERI* (L.) PENNELL.

M.L. Ahire¹, P.B. Kavi Kishor², T.D.Nikam^{1*}

¹Department of Botany, University of Pune, Pune – 411 007.

²Department of Genetics, Osmania University, Hyderabad – 500 007.

*Corresponding author E-mail: tdnikam@unipune.ac.in

Agrobacterium-mediated gene transfer is a powerful tool for plant improvement to introgress genes of desirable characteristics from alien source into existing genome while preserving genetic identity of plants. This issue is of particular importance for *Bacopa monnieri* (L.) Pennell. which is an important neurotonic herb. It offers an alternative approach to introduce salt tolerance in *B. monnieri* which grows in marshy habits and susceptible to salt and drought stress. We developed a reproducible transformation and regeneration system using nodal and leaf explants. *Agrobacterium tumefaciens* strain used was LBA4404 harboring binary vector pCAMBIA 2300 carrying the *VPP-ase* isolated from *Sorghum* under the control of *CaMV 35S* promoter, *nptII* gene for kanamycin resistance as plant selectable marker under the control of the same promoter without reporter gene. Nodal explants were pre-cultured on Murashige and Skoog (MS) medium fortified with 1.0 mg/L BA for 3 days before infection for 10 minutes in liquid MS medium supplemented with 100 μ M acetosyringone. After infection the explants were co-cultivated on MS + 1.0 mg/L BA + 100 μ M acetosyringone for 3 days in dark. Transgenic events were regenerated on MS+1.0 mg/L BA + 100 mg/L kanamycin + 500 mg/L cefotaxime. The regenerated shoots were then rooted on MS liquid medium supplemented with 0.2 mg/L NAA + 50 mg/L kanamycin + 250 mg/L cefotaxime. The molecular confirmation of the gene integration was carried out by polymerase chain reaction. A transformation frequency of 65% was achieved. The shoots of 5 selected transgenic events, when treated with NaCl (150 mM) showed complete tolerance compared to control plants suggesting the expression of *VPP-ase* gene in these transformants. The transgenic plants were cloned by stem cuttings and further molecular analysis is in progress.

04-14(P)

IN VITRO SHOOT CULTURE AND CARDIAC GLYCOSIDES PRODUCTION IN *DIGITALIS PURPUREA* L.

J.G. Patil, M.L. Ahire and T.D. Nikam*

Department of Botany, University of Pune, Pune-411 007

*Corresponding author E-mail: tdnikam@unipune.ac.in

Commercial production of secondary metabolites by traditional agriculture is an inefficient process and affected by climatic and soil conditions. Strategies, based on *in vitro* culture methods, have been extensively studied to improve the production of specific plant derived secondary metabolite. The aim of the present investigation was to establish *in vitro* shoot culture via node, internode and leaf explants and production of cardiac glycosides. The explants were cultured on MS medium supplemented with different concentrations of auxins (2.69 μ M – 18.80 μ M) and cytokinins (2.22 μ M – 13.62 μ M). Adventitious shoots were formed on leaf and nodal explants on MS fortified with 6.66 μ M BA within three weeks of culture. Regenerated shoots were multiplied by subculture on parental fresh medium. Then they were subjected to rooting, the maximum number (35.0 \pm 0.6) of roots per shoots observed on 17.13 μ M NAA as compare to other auxins concentrations. Among the various concentrations and combinations of auxins and cytokinins, MS + 4.65 μ M Kin + 5.71 IAA was best for production of cardiac glycosides (digitoxin and digoxin).

04-15(P)

**PREDICTION OF TEMPERATURE INDUCED MICRORNAs AND THEIR TARGETS IN
ORYZA SATIVA**

B. Sailaja, SR. Voleti, D. Subrahmanyam, N. Sarla, V.P. Bhadana, and Satendra K. Mangrauthia*
*Directorate of Rice Research, Hyderabad-30; email: *Corresponding author: skmdrr@gmail.com*

Environmental stresses constrain rice production, affecting about 30% of the 700 million poor in Asia alone, who live in rain fed rice-growing areas. Due to the climate change, temperature will increase, resulting in more drought and heat stress. High temperature impairs grain filling by inhibiting the deposition of storage materials such as starch and protein. Progress has been made in unraveling the complex stress response mechanisms, particularly in the identification of stress responsive protein-coding genes. In addition to protein coding genes, recently discovered microRNAs (miRNAs) and endogenous small interfering RNAs (siRNAs) have emerged as important players in plant stress responses. The identification of the entire set of miRNAs from a model monocot rice plant is a critical step toward understanding miRNA-guided gene regulation. Discovery of master regulators such as miRNAs having important role in plant metabolism is very much crucial to understand the molecular regulation of heat stress response. These miRNAs can contribute to the repertoire of host factors during heat stress. Despite the existing voluminous data relating the miRNAs, a lot more remains to be known in terms of identification of the unknown miRNAs in diverse systems. Plant miRNAs are near-perfectly complementary to the target mRNAs, which paves the way for the identification of the target mRNAs through computational approaches. In the present study the identification of heat stress related miRNAs in *O. sativa* was done *in silico* by using known temperature regulated miRNAs from *Arabidopsis thaliana*. A total of 154 temperature responsive miRNAs sequences of *A. thaliana* were retrieved from PMRD database. Out of 154 miRNAs, 92 miRNAs were predicted to be novel which were not reported in rice yet (miRbase) and showed potential targets when analyzed for mRNA targets against rice genome by using plant genome information database, TIGR (The rice genome annotation project established by the institute for genome research). A total of 2034 mRNA targets were annotated for 92 miRNAs using miRU data base. Further, the resulting targets were filtered by criteria that are more stringent, the targets were abridged to 375. Many miRNA targeted genes were predicted to regulate genes coding for various transcription factors, metabolic proteins, heat stress related proteins and proteins involving in signaling pathways during stress.

04-16(P)

**IN VITRO INDUCTION OF SHOOTS FROM SEEDLING EXPLANTS OF PLUMBAGO
ZEYLANICA L.**

P.S. Kakade and G.S. Chinchankar*

Department of Botany, University of Pune, Pune-411007, Maharashtra

**Corresponding author – gsc@unipune.ac.in, prachik16@gmail.com*

In the present investigation seeds of *Plumbago zeylanica* L. from Ahemadnagar District, Maharashtra, growing wild were collected and used to raise the seedlings. Seeds, pre-soaked in sterile distilled water for 24 h were germinated *in vitro* on half-MS basal medium. Seedlings (180–200 mm in length) with 7 or 8 nodes were obtained. Nodal segments (10±1mm) from 28 d old *in vitro* seedlings were used. MS basal was supplemented with BAP alone (0.0–6.66 µM), Kn alone (0.0–6.97 µM) and BAP (2.22–8.88 µM) and IAA (1.43 µM) in combination. Cultures were maintained at 25±1°C with 55–60% RH and artificial light 16 h photoperiod (irradiance of 40.54 µmol m⁻²s⁻¹). For each experiment 15 replicates were maintained and the experiment was repeated thrice. Shoots emerged from nodal region after 14 d incubation. Maximum percentage (80%) of cultures showing

shoots (3–5 shoots/explant) was obtained on MS + BAP (4.44 μM) + IAA (1.43 μM) and minimum (43.3%) having 1–2 shoots/explant on MS + Kn alone (1.16 μM) and MS + BAP (8.88 μM) + IAA (1.43 μM). Shoot length (11–51 mm) was recorded after 28 d of incubation. After 28 d these cultures were transferred to fresh medium of same composition. After 28 d more, shoot length (15–69 mm) was recorded. Formation of callus was observed from cut ends of explants on MS with BAP alone and in combination with IAA after 28 d.

04-17(P)

IN VITRO RESPONSE OF LEAF EXPLANTS OF *ADANSONIA DIGITATA* LINN.

M. Mohseni Delarestaghi and G.S. Chinchankar

Department of Botany, University of Pune, Pune – 411007, Maharashtra

Corresponding author: gsc@unipune.ac.in, morteza_mdel@yahoo.com

Adansonia digitata is a multipurpose medicinally important tree. In present work, leaves were collected from the tree growing in University of Pune campus. From the leaf, petiole segments 15 ± 2 mm in length and from lamina $5 \times 10 \pm 2$ mm pieces were used as explants. Murashige and Skoog's (MS) medium supplemented with different concentrations of plant growth regulators 2,4-D (2.2 – 22.6 μM), NAA (2.6 – 26.8 μM), IAA (2.8 – 28.5 μM), BAP (2.2 μM) and Kn (2.3 μM) alone or in combinations were used to raise the *in vitro* cultures. Cultures were maintained at $25 \pm 2^\circ\text{C}$, 16 hours photoperiod (irradiance of $40.54 \mu\text{mol m}^{-2} \text{s}^{-1}$) and 50 – 60% RH. For each experiment 25 replicates were maintained and each experiment was repeated thrice. On MS supplemented 2,4-D (2.2 – 22.6 μM) alone; 2,4-D (2.2 – 22.6 μM) + BAP (2.2 μM) and 2,4-D (2.2 – 22.6 μM) + Kn (2.3 μM) callus initiation was observed within 20–25 d and 18–20 d from petiole and lamina respectively. The cultures were transferred on fresh medium and maintained for 10 days. These were subcultured after every 10 days on same medium twice. Total incubation period was 85 days. Among the 36 combinations used, petiole explants on MS supplemented 18.09 μM 2,4-D showed 90% callus induction with average 4.2 g fresh weight per explant. Lamina explants on MS medium with 13.57 μM 2,4-D showed 80% callusing with average 2.98 g fresh weight per explant.

04-18(P)

IN VITRO RESPONSE OF TUBER EXPLANTS OF *EULOPHIA NUDA* LINDL.

S.P. Bhagat¹ and G.S. Chinchankar*

Department of Botany, University of Pune, Pune- 411007, Maharashtra

*gsc@unipune.ac.in, ¹snl.bhagat1@gmail.com¹

In present study, tubers of *Eulophia nuda* Lindl. maintained in Botanical garden of Department of Botany, University of Pune were used as source of explants. Pieces of tuber of 0.5 – 0.6 cm³ with bud (TB) or without bud (T) were used as explants. Explants were cultured on Murashige and Skoog's (MS) basal medium supplemented with IAA (0.0 – 8.56 μM) and Kn (0.0 – 6.98 μM). Activated charcoal (0.0 – 2.0 g/L) was added to the nutrient medium. MS without any adjuvants was used as control. Cultures were incubated in artificial light for 16 h photoperiod (irradiance of $40.54 \mu\text{mol m}^{-2} \text{s}^{-1}$) at $25 \pm 2^\circ\text{C}$ and 50–60% RH. For each medium explants T 15 replicates and explants TB 2 replicates were maintained and each experiment was repeated thrice. The explants T on MS with 1.0 g/L AC alone showed initiation of callus after 20 d. The explants TB on MS with 2.0 g/L AC alone showed sprouting of bud (1) after 20 d; shoot elongation (5.5 cm in length) and root initiation after 90 d. The explants TB on MS with Kn (4.64 μM) + IAA (5.7 μM) + 2.0 g/L AC showed sprouting of bud (1) after 20 d; shoot elongation (3.1 cm in length) and root initiation after 52 d. The explants TB on MS with Kn (6.98 μM) + IAA (8.56 μM) + 2.0 g/L AC showed sprouting of bud (2) after 23 d; shoot elongation (3.0 cm in length) and root initiation after 63 d. Shoots (2) with roots were successfully transferred to soil; out of these one survived.

Session 05

**Sustainable Agriculture in Relation
to Global Climate Change**

05-01(L)

PLANT PHYSIOLOGICAL PROCESSES ASSOCIATED WITH EMISSION AND TRANSPORT OF GREEN HOUSE GAS N₂O FROM WHEAT AGRICULTURE

K.K. Baruah

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

Experiments were conducted in the alluvial soils of North Bank Plain Agro climatic zone of Assam in order to assess the role of plants in Nitrous oxide (N₂O) emission from soil and transport to the atmosphere. During an investigation with four varieties of wheat (*Triticum aestivum* L.), viz. Sonalika, HUW 468, HUW 234 and DBW 14, plant growth parameters- tiller number, leaf area, leaf number, plant height, root length, root volume, shoot dry weight and root dry weight, physiological parameters -rate of photosynthesis and transpiration, anatomical parameters -stomatal frequency of leaf and leaf sheath were studied to find out a relationship with N₂O flux. Nitrous oxide emission from the varieties were recorded at weekly interval and the cumulative N₂O flux over the entire crop growing season for the varieties were recorded in the form of seasonal integrated flux (E_{sif}). The emission was found to increase with increasing plant growth in terms of plant height, leaf area, root volume and root dry weight. There exists a relationship between N₂O emission and crop photosynthetic rate. The rate of transpiration from the wheat varieties showed a significant correlation with N₂O emission, suggesting the movement of N₂O through wheat plants. Anatomical investigation by Scanning Electron Microscope (SEM) revealed a positive correlation of stomatal frequency of leaf and leaf sheaths with N₂O emission.

05-02(L)

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE, AGRO-BIODIVERSITY AND FOOD SECURITY

Shivadhar Singh

*Division of Environmental Sciences, Indian Agricultural Research Institute, New Delhi 110012
sdsingh14d@yahoo.co.uk*

Now it is established fact that global climate has changed gradually during the last one and half centuries and likely to change substantially in 21st century. Marked increase in the concentration of greenhouse gases in the atmosphere due to anthropogenic activities has finally led to global warming and climate change through greenhouse effect. During the climatic change scenario, the levels of two important climatic components such as carbon dioxide and temperature have elevated which may severely affect both the biotic and abiotic environments directly and indirectly through their interactions with biotic components. Carbon dioxide is plant nutrient, and atmospheric enrichment has the potential to enhance plant productivity. It has been observed that rising CO₂ level in the atmosphere has positive growth and productivity effects on C₃ crop plants mainly through increasing the net photosynthesis owing to reduction in photorespiration, while manifested negative effects on nutritional status/quality of vegetative as well as reproductive organs (seed/grain/fruit etc.) in the same. The rise in atmospheric temperature however showed detrimental effects on growth, yield and quality of both C₃ and C₄ plants mainly through shortening the growth duration and enhancing the dark and photorespiration of crop plants. Increased temperature not only decreases the crop growth and productivity but also posed serious concern on the sustainability of several valuable temperate crops such as apple, cherry, cauliflower, cabbage, basmati rice, and the animals where sex is determined by temperature like crocodile, in other word global warming may cause spatial and temporal loss of biodiversity. Food security is a major problem around the world both in developed and developing

countries with the climate change. In many countries, large area of arable lands are still under rain fed agriculture, so food production in these areas is highly uncertain and risky due to their greater vulnerability to natural calamities such as drought, high temperature etc. Thus, any changes in climatic components may lead to the problem of food security both at regional and national levels. Since most of the experiments on elevated CO₂ and temperature have been conducted under controlled conditions where changes in the levels of temperature and CO₂ may not be resemble to the conditions actually occurs under gradual changing scenario of climate change, thus the magnitude of increase/decrease in crop growth and yield reported under controlled condition can not be compared with the real effects of climate change. Hence experimental conditions under climate change experiments should be created such that could be almost at par to the real climate change /variability scenario to assess the factual effect of climate change on crop.

05-01(O)

IDENTIFICATION OF THERMOTOLERANT INBREDS BY TEMPERATURE INDUCTION RESPONSE (TIR) TECHNIQUE IN MAIZE (*ZEA MAYS* L.)

Rajesh Paladugu¹, Ramesh Thatikunta² and Keshavulu Kesoth¹

Seed Science and Technology¹, Department of Plant Physiology²

College of Agriculture, Rajendranagar, Hyderabad-500 030

thatikunta_r@rediffmail.com

Maize cultivation in India under assured irrigation has increased marginally from ~11% in 1950-51 to ~20% by 2009-10. The crop chiefly grown under rainfed conditions suffers from various abiotic and biotic stresses. High temperature has been the second major abiotic problem after drought stress and annually reduced grain yields by >15 per cent. Therefore, to sustain maize production, it has become imperative to identify inbreds which tolerate high temperature stress so as to utilize them in crossing programmes to develop single cross hybrids which are cheap to produce and also have become popular with farmers. In the present study thermotolerant inbreds were identified by Temperature Induction Response (TIR) Technique, wherein pre imbibed germinated maize seeds of single cross DHM-117 hybrid of 1.0–1.5 cm plumule length were subjected to challenging temperatures (50 to 55°C) for 1, 2 and 3 h and allowed to recover. Optimum lethal temperature of 53°C for 3 h exposure was arrived when 81 per cent seedling mortality was recorded. To assess for stress tolerance, seedlings of fifteen inbreds were exposed to an induction stress (i.e., series of low temperature treatments) before exposure to challenging temperatures. Later seedlings were allowed to recover for 72 hours at room temperatures and seedling survival was recorded. Seedlings exposed to gradual induction temperature (35°C-1hr + 40°C-1hr + 45°C-2 hrs) prior to the challenging temperature exhibited higher seedling survival compared to those exposed to other induction treatments. Seedlings exposed to challenging temperatures without induction served as absolute controls. Stress adapted thermo tolerant lines were identified based on the data on two parameters viz., survival during recovery and the per cent reduction of survival in induced over absolute control. Thermotolerance was further validated by allowing the seedlings of inbreds to grow up to 21 days in plastic containers and assessed for their growth in terms of dry weight and chlorophyll content. Induction treatments accounted for 64 per cent dry weight and revealed superiority of three genotypes namely Kaveri-50, RHM-25 and 30V92 with 78 to 82 per cent increased chlorophyll stability index. TIR Technique was found to be a potential tool to identify thermotolerant inbreds. Present study elicited the variation among the fifteen selected maize inbreds for temperature tolerance. By plotting Z-distribution, tolerant genotypes were characterized into highly tolerant (RHM-25, Kaveri-50, 30V92), moderately tolerant (KHM-225, 30B11, RHM-20, PAC-740, FMH-8899), moderately susceptible (KHM-218, Syngenta-1, RHM-7, RHM-4) and highly susceptible types (GHM-145, GK-3060, BIO-9637).

05-02(O)

EVALUATION OF Bt COTTON HYBRIDS FOR DROUGHT TOLERANCE UNDER RAINFED CONDITION

D.B. Deosarkar, S.S. Bhatade, D.G. Dalvi* and Javed Jani

Marathwada Agricultural University, Cotton Research Station, Nanded-431604

*E-mail: dalvi46@rediffmail.com

A field experiment was conducted during *khari* 2010 at Cotton Research Station, Nanded to study the performance of eight Bt cotton hybrids along with one non Bt cotton hybrid for drought tolerance under rainfed conduction. The NHH-44 Bt, JK Indra Bt, JKCH-99 Bt, NCRH-34 Bt, Kashinath Bt, NCRH-14 Bt, Bunny Bt and JK Durga Bt were tested along with NHH-44 Non Bt hybrid for drought tolerance. The Bt hybrids Bunny Bt followed by NHH-44 Bt and NCRH-14 Bt were recorded significantly highest seed cotton yield (kg/ha), boll wt./plant (g) and harvest Index (%) over other Bt hybrids and Non Bt hybrids whereas, in relation to physiological parameters the Bunny Bt followed by NHH-44 Bt, Kashinath Bt and NCRH-14 Bt were recorded maximum green plant weight (g), total dry matter per plant (g), leaf area index, specific leaf weight (g/dm²) and relative water content (%). The maximum photosynthetic activity and dry matter participation towards boll development were observed in Bunny Bt, NHH-44 Bt, Kashinath Bt and NCRH-14 Bt at 110 days, which was responsible for highest seed cotton yield kg/ha. On the basis of physiological parameters these Bt cotton hybrids were also found superior for drought tolerance under rainfed condition.

05-03(O)

ORYZA RUFIPOGON GRIFF.; A SUCCESSFUL STRESS RESISTANT PLANT IN DIVERSIFIED ECOLOGICAL HABITATS

Ekamber Kariali, Rajendra Kumar Behera and Pravat Kumar Mohapatra

School of Life Sciences, Sambalpur University, Jyotivihar, Sambalpur, 768019, Odisha

ekamberk@rediffmail.com

Oryza rufipogon Griff. is the common wild rice of Asia having several ecotypes grown successfully both under natural condition and also in close sympatric association with cultivated rice due to the presence of many useful traits for survival in stressed environments. The ecotypes of the species can inhabit dryland, medium lowland and deepwater habitats and adaptation of the plant to diversified extreme ecological conditions is unparalleled unlike the cultivated rice. In the present experiment, the plants were studied in their natural habitats of dryland, medium lowland and deepwater, and the ecotypes were also grown in the simulated growth conditions that resembled the natural habitats. The margin of plasticity in assimilate partitioning to different plant organs such as stem, leaf, root and panicle was assessed both in natural and simulated habitats. The results revealed that growth duration, biomass accumulation, grain yield and assimilate concentration of reproductive structures were low in the dryland habitats and high in deepwater habitats irrespective of natural or simulated conditions. Simulated habitats were beneficial for shoot biomass accumulation of dryland ecotype but not true for the other two; shoot biomass did not improve, when deepwater ecotype was grown in simulated habitats. The pattern of distribution of assimilates or dry matter accumulation in different plant organs did not differ between natural and simulated habitats. Thus, difference in morphological attributes of the ecotypes was mostly determined by variations in the environmental parameters irrespective of any variations accrued in the genotype owing to tolerance in stressful habitats. Hence, this stress resistant trait may be useful for genetic manipulation especially for crops grown in widely fluctuating environments.

05-01(P)

INVESTIGATIONS ON PHYSIOLOGICAL EFFICIENCY OF BT COTTON HYBRIDS WITH THEIR NON Bt COUNTER PARTS

K.N. Pawar*, B.C. Patil, A.G. Babu and A.B. Shaheen

Agricultural Research Station, University of Agricultural Sciences, Dharwad-580005, Karnataka

**kasu_pawar@rediffmail.com*

In recent years adoption rate and the number of farmers using Bt cotton hybrids in India increased drastically. An experiment was conducted using 10 cotton genotypes (includes 05 Bt hybrids with their 05 Non Bt counter parts) grown in RBD design at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, India and evaluated for their differences in growth, development, phenology and yield attributes. The highest number of bolls per plant recorded in JK DURGA BG-2 (33.40) and the least in JKCH-99 Non Bt (18.93). The genotype MRC-7351 Bt recorded the highest boll weight (7.27) followed by BUNNY Bt BG-2 (7.0) the least boll weight was recorded by JK DURGA Non Bt (3.68). JKCH-99 Bt and Bunny BG-2 Bt recorded least no of days to 50% squaring (48.33) showing earliness compare to their non Bt counter parts. In general Non Bt genotypes took 2-5 more no of days for 50% flowering and 7-15 more no of days for boll opening. Bt genotypes recorded 15-30cm less plant height compared to Non Bt genotypes showing Bt genotypes are having determinant habit than Non Bt counterparts. The Bt cotton genotypes recorded 2-4 more no of sympodia than Non Bt counterparts. MRC-7301Bt BG-2 recorded highest TDM (19.78 g/plant) while the least TDM was recorded by JK DURGA Non Bt (10.71 g/plant). The genotype MRC-7301Bt BG-2 recorded the highest rate of photosynthesis (14.37 $\mu\text{mol CO}_2/\text{m}^2/\text{s}$) while JK DURGA Non Bt recorded the least (11.40 $\mu\text{mol CO}_2/\text{m}^2/\text{s}$). The highest LAI recorded by JK DURGA Non Bt (5.85) while MRC-7301 BG2 Bt recorded least (3.56). In general Bt genotypes recorded significantly more yield than Non Bt counterparts. The genotype JK DURGA Bt BG-2 recorded significantly more yield (2879 kg/ha) while recorded least in JK DURGA Non Bt (1180 kg/ha) and other hybrids yield in between these values.

05-02(P)

SCREENING FOR HIGH TEMPERATURE TOLERANCE IN RICE GENOTYPES

**D. Subrahmanyam, P. Raghuvver Rao, M. Umamaheshwar Reddy, S. Shivashanker,
N. Sarla and S.R. Voleti**

Directorate of Rice Research, Rajendranagar, Hyderabad-30

Corresponding author: subbu_desiraj@msn.com; srvoleti@drricar.org

Owing to climate change, global warming and greenhouse gas effects it is projected that there could be an increase in global mean air temperatures in the range of 1-6 C by the end of this century. Most of the rice is currently grown in regions where temperatures are already close to optimum rice production. Therefore, any sensitive stage exposed to the high temperatures may reduce rice yields. The objective of the present work was to screen and identify high temperature tolerant rice cultivars using various physiological and biochemical attributes, to link with stage sensitivity through reproductive development and ultimately relate to yield. A total of 23 IET rice cultures and checks i.e., Jaya and Triguna were exposed to terminal heat stress under field conditions. Data on leaf photosynthetic characters, water relations, rate of transpiration, fluorescence, were assessed. Also taken up were the pollen viability, stigma sensitivity of these genotypes. Yield and its components were also recorded. Based on sum of these characters, rice cultures with heat tolerance nature were identified and are being used in developing heat tolerance breeding program.



05-03(P)

ADAPTATION STRATEGIES TO SUSTAIN AGRICULTURE PRODUCTION TOWARDS CLIMATE CHANGE

K.K. Agrawal

Department of Physics and Agrometeorology, J.N. Krishi Vishwa Vidyalaya, Jabalpur-482004
kkagrwal59@gmail.com

Climate change is one of the most important global environmental challenges faced by human beings, and its affects food production. Impact of climate change on agriculture has been one of the major deciding factors influencing the future food security of mankind on the earth .The potential fallouts of this phenomenon have been identified to include rise in temperature, erratic rainfall regimes, increased frequency and intensity of extreme weather events, and general unpredictability of agricultural operations among other effects. These have grave economic, social and ecological consequences for agriculture and food security in many countries particularly, in rainfed ecosystem. Climate change will affect developing countries more severely because of their low capacity for adaptation. The agriculture sector particularly is vulnerable within these countries, putting rural populations at risk. Fourth assessment report (AR4) by Intergovernmental Panel on Climate Change (IPCC) on the extent and impact of climate change clearly shows that the goal of achieving a sustainable agricultural development is going to be severely constrained due to impacts of climate change on agriculture. Unless appropriate mitigation and adaptation measures are taken, because of acute sensitivity of agricultural production to climate, the consequences of climate change on agriculture is most likely to be negative which is certain to further aggravate the problem of food security. Its impact can be especially disastrous for tropical agriculture where sub-optimal crop growing conditions, inherent to such climate, seriously affect agricultural productivity. Detrimental affects of supra-optimum temperatures, through its direct effects on crop growth and development and indirect effects on water losses and incidence of insect-pests, make it very difficult to achieve higher levels of productivity even under high management conditions. In future, such adverse effects are going to be further aggravated by much more frequent occurrence of extreme weather events like drought, flooding, heat waves and cold waves condition Furthermore, climate change is an additional threat that might affect a country's ability to meet urgent rural development demand including the improvement of the food security, poverty reduction, and provision of an adequate standard of living for growing populations. In the quest to provide food and fibre to an expanding human population, the provision of agriculture-based ecosystem services that help to moderate climate change is increasingly under threat. The crop based technologies include growing crops and varieties that fit into new cropping system and seasons, development of varieties with changed duration that can over winter the transient effects of change, development of varieties for high temperature, drought and submergence tolerance; evolving varieties which respond positively in terms of growth and yield to high CO₂. In addition, varieties with high fertilizer and radiation use efficiency and also novel crops and varieties that can tolerate coastal salinity and salt water inundation are needed. Adaptation measures to reduce the negative effects of increased climatic variability may include changing the cropping calendar to take advantage of the wet period and to avoid extreme weather events during the growing season. Agro meteorological research on crop-weather relationship can help to improve the understanding of climate related constrained in achieving the potential productivity. Keeping fact in view present investigation was under taken with the objectives of evaluation of chickpea types under different environment.

05-04(P)

THE POTENTIAL EFFECTS OF CLIMATE CHANGE ON CROP GROWTH

R.W. Bharud

Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722, Dist.: Ahmednagar (M.S.)

Seasonal temperature is an important climatic factor which can have profound effects on the yield of crops. Changes in seasonal temperature affect the grain yield, mainly through phenological development processes. Winter crops are especially vulnerable to high temperature during reproductive stages and differential response of temperature change (rise) to various crops has been noticed under different production environments. Climate change is a concern today, and researchers are engaged in understanding its impact on growth and yield of crops, and also identifying suitable management options to sustain the crops' productivity under the climate change scenarios. Crop growth models can simulate the growth and yield of crops under various biotic and abiotic stresses, and can be conveniently used for climate change studies. However, the response of crops to the seasonal temperature and other weather variations needs to be studied in detail so that it can subsequently be used for evaluating the impact of climate-change by linking with the future climate change scenarios. At the same time, the altered agronomic management practices to help the crop adjust to the changed environment need to be identified as well. This has been interpreted as a consequence of rising temperatures. However, correlated with this rise in temperature is an increase in atmospheric CO₂, which may also modify phenology. Reproductive biomass growth as well as vegetative biomass growth is usually increased by elevated CO₂. However, the harvest index, or the ratio of seed yield to above-ground biomass yield, is typically lower under elevated CO₂ conditions. The number of seed per plant increased slightly with increase of both CO₂ and temperature. Mass per seed decreased sharply with increasing temperature. Although CO₂ enrichment resulted in increased seed yield and above-ground biomass, harvest index was decreased with both CO₂ and temperature. Acute effects of high temperature are most striking when heat stress occurs during anthesis. In rice, heat stress at anthesis prevents anther dehiscence and pollen shed, to reduce pollination and grain numbers. In a subsequent experiment with source-sink relationships altered through grain excision, defoliation and shading treatments, heat stress still reduced grain weight. This result supports the earlier findings that temperature effects on grain weight are direct effects rather than assimilate availability. Furthermore, respiration effects do not appear to be the direct cause of decreased grain size in heat-stressed wheat reviewed the mechanisms by which temperature and CO₂ affect photosynthesis in C₃ species that the interaction of carbon dioxide concentration and temperature causes the temperature optimum of the light-saturated rate of CO₂ uptake to increase as CO₂ increases. Grew crops in field chambers in Phoenix, Arizona, at 300 and 600 μmol/mol CO₂ and summarizes the relative increase in growth (weekly dry matter production, comparing 650 μmol/mol CO₂ with 350 μmol/mol) with mean air temperature, indicating that, at low temperatures, elevated CO₂ actually decreased growth. The plasmalemma and membranes of cell organelles play a vital role in the functioning of cells. Any adverse effect of temperature stress on the membranes leads to disruption of cellular activity or death. Heat injury to the plasmalemma may be measured by ion leakage. Injury to membranes from a sudden heat stress event may result from either denaturation of the membrane proteins or from melting of membrane lipids which leads to membrane rupture and loss of cellular contents. Heat stress may be an oxidative stress. Peroxidation of membrane lipids has been observed at high temperatures, which is a symptom of cellular injury. Enhanced synthesis of an anti-oxidant by plant tissues may increase cell tolerance to heat but no such anti-oxidant has been positively identified. Pointed out that determinate crops with discrete elements to their life cycle develop faster in higher temperatures, and so the stage of seed filling is shortened, limiting the benefits of elevated CO₂.

05-05(P)

GENETIC VARIABILITY IN RICE GENOTYPES FOR HIGH TEMPERATURE TOLERANCE

**Jyoti Jha, R.N. Bahuguna, Sunil Kumar Pandey, Divya Shah, Sangeeta Khetarpal
and Madan Pal Singh***

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

**Email for correspondence: madanpal@yahoo.com*

IPCC (2007) has projected that by the end of the 21st century, the earth's climate will warm up by an average of 2-4°C. This increase in temperature may expose the crops to heat stress during different stages of their life cycle. Rice is the important staple crop of Asia and has been suggested as sensitive to high temperature particularly at flowering stage. High temperature may decrease grain yield in rice by reducing total crop duration as well as period of grain filling. A field experiment was conducted during the year 2010 for screening of rice genotypes for high temperature tolerance. Rice germplasm was obtained from IRRI, Philippines and IARI, New Delhi, which represented a core set of genotypes tolerant to various abiotic stresses. There were total 71 rice lines including N22 as an international check for high temperature tolerance. Majority of the germplasm lines were Nerica type, which are well known for drought tolerance and have originated from different regions of Africa. All the genotypes were sown during the month of March 2010 and transplanted in the field with the aim to expose them to high temperature during vegetative and flowering stages. Maximum mean day temperature during the flowering ranged from 32 to 44°C, which was relatively higher (approx. >10°C) than the normal temperature. As a result of exposure to extremely high temperature, only thirty nine out of seventy one lines survived after transplanting. Yield parameters and spikelet fertility were analysed for the lines which survived. Among the survived lines, Nerica-L-57 showed highest survival rate followed by the check (N22) and Nerica-L-44. Some of the Nerica lines, like L-29, L-49, and L-44 and IR 64 exhibited spikelet fertility higher than the check (N22). This indicated their potential for high temperature tolerance along with drought tolerance. Along with higher spikelet fertility, grain yield was also recorded highest in Nerica-L-44 and it was identified as the best genotype for high temperature tolerance and was recommended for future breeding program of rice for developing heat tolerant varieties.

05-06(P)

A COMPARATIVE STUDY ON VERMICOMPOSTING OF AGRICULTURAL WASTE

P. Singh, D. Shah, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar

Department of Botany, Ramnarain Ruia College, Matunga, Mumbai -19

fairy_8890@rediffmail.com

The production of degradable organic waste and its safe disposal have become a global problem. Most of the organic residues are burnt or are used as land fillings. Vermicomposting is a compatible process with sound environment principles that value conservation of resources and sustainable practices. Vermicompost is known to be the best organic fertilizer. In this paper a comparative study on vermicomposting of three biodegradable agricultural wastes viz. coffee husk, cocoa shell and coconut shell was carried out using *Eisenia foetida*. Vermicompost obtained from all the three agricultural wastes were analyzed for their Biodiversity, biological activities, organic carbon and NPK content.

05-07(P)

ROLE OF APOLPLASTIC CALCIUM IN MITIGATING HIGH TEMPERATURE EFFECTS IN CHICKPEA

Rajeev N. Bahuguna, Sunil Kumar Pandey, Divya Shah, Jyoti Jha, Sadhna Singh, Sangeeta Khetarpal and Madan Pal Singh*

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

** Email for correspondence: madanpal@yahoo.com*

Heat stress is a major factor limiting the growth and yield of cool season plants crops under changing climate. Calcium (Ca^{2+}) has been reported to be involved in imparting tolerance for heat stress in various crop species. Reproductive phase in most crops is considered sensitive to heat stress. Chickpea (*Cicer arietinum*) is the world's third most important pulse crop, currently being grown on about 11 m ha, with 96% cultivation in the developing countries. A field experiment was conducted to analyze the role of Ca^{2+} application in mitigating high temperature effects in two prominent chickpea cultivars viz. Pusa 1105 and Pusa 1053. Plants were treated with CaCl_2 (10 mM) by foliar application, twice a week before flower initiation and then exposed to high temperature during reproductive phase by fixing polychambers over the plants in the field. Physiological parameters like antioxidant enzymes activity, H_2O_2 , MSI and RWC were analysed at reproductive phase and yield attributes were recorded at crop maturity. In Pusa 1105, no significant changes in the antioxidant enzyme activity was observed in Ca treated plants under heat stress, but the activity increased in Ca treated plants, while no changes were observed in antioxidant enzymes activity under any treatments in Pusa 1053. H_2O_2 content was highest in the Ca treated plants of Pusa 1105 and Pusa 1053. In Pusa 1053, the H_2O_2 level was higher in plants treated with Ca under heat stress than the plants under heat stress and without Ca application. MSI and RWC in Ca treated plants were lower than control plants of Pusa 1105. In Pusa 1053, Ca treated plants under heat stress showed lower MSI and RWC than heat stressed plants. Ca treated plants under heat stress showed a decrease in the yield attributes viz. pod number, pod weight, seed number and seed weight in both the varieties. Over all, plants treated with Ca produced lower seed yield than control in both the genotypes. However to confirm the role of Ca application in mitigation of high temperature effects further studies are required with different levels of high temperature exposure.

05-08(P)

PREPARATION OF ACTIVATED CARBON FROM AGRO-INDUSTRIAL WASTE

P. Singh, J. Pius, B.B. Patel, B. Narula and S. Shankhadarwar

Department of Botany, Ramnarain Ruia College, Matunga, Mumbai -19

fairy_8890@rediffmail.com

Activated carbon was prepared from agricultural wastes like cocoa shell, coconut shell and coffee husk by carbonization followed by chemical activation technique that employs Zinc chloride (ZnCl_2) and Phosphoric acid (H_3PO_4) as activation agents. A comparative study was carried out to find out which of the above agro-wastes is the best source for the production of activated carbon (AC) and effectiveness of ZnCl_2 and H_3PO_4 as activation agents. Sorbent activity of AC was evaluated by their adsorption of methylene blue (MB) from aqueous solution. The effect of contact time, pH and biosorbent dosage on MB removal was also investigated.

05-09(P)

IMPACT OF ELEVATED CARBON DIOXIDE (CO₂) ON GROWTH AND YIELD OF RICE CROP AT DIFFERENT NITROGEN (N) LEVELS

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

Division of Environmental Science, IARI, New Delhi-110012

Rise in green house gases (GHG) in the atmosphere has resulted in increased temperature and changes in precipitation pattern on the earth's surface leading to change in the climate. This climate change is likely to affect agriculture and food security of the nations. Carbon dioxide (CO₂) is the most important among the GHGs whose concentration has increased from 280 to 380 ppm. Field experiment was conducted during the *kharif* season of 2009 to assess the impact of elevated CO₂ on growth and yield of rice crop. Rice crop was grown in pots inside the free air CO₂ enrichment (FACE) ring to expose rice plants to high CO₂ level. Three nitrogen (N) levels were maintained i.e. N1=0, N2=3 and N3=5 gm N pot⁻¹. Rice crop was also grown under ambient condition with same N treatments. Inside the FACE ring high CO₂ concentration of 550 ppm was maintained throughout the crop growth period. Results showed that elevated CO₂ condition caused higher photosynthesis rate in rice crop. Photosynthesis rate was found to be maximum in N3 treatment. Higher photosynthesis rate resulted in higher leaf area of rice plant grown inside the FACE ring as compared to control. Grain yield of rice crop increased by 11.5% to 19.6% in high CO₂ treatment. In N1 treatment, harvest index of rice crop decreased at elevated CO₂ condition, while in N2 and N3 treatment it was more than ambient treatment, which shows that although grain yield increased at all N levels, but proportion of grain to straw yield increased only under higher N level.

05-10(P)

URBAN WASTE COMPOSTING FOR AGRICULTURE

Satnam Singh Sohal* and Satish Bhalerao**

**Department of Botany, Maharshi Dayanand College, Mumbai*

***Department of Botany, Wilson College, Mumbai
satsohal777@gmail.com*

Waste generated by cities and towns is one of the prime and intense problems as far as management is concerned. It accounts for huge expenditure of capital and labor. Cities are facing an increasing growth in population, and shares in GDP growth, resulting in, among other things, increasing quantities of waste being generated. Due to varied lifestyles and consumption patterns, the quality and composition of waste has been more varied and changing. Industrialization and economic growth has produced more amounts of waste, including hazardous and toxic wastes. There is a growing realization of the negative impacts that wastes have had on the local environment (air, water, land, human health etc.) Complexity, costs and coordination of waste management has necessitated multi-stakeholder involvement in every stage of the waste stream. This calls for an integrated approach to waste management. Local Governments are now looking at waste as a business opportunity, (a) to extract valuable resources contained within it that can still be used and (b) to safely process and dispose wastes with a minimum impact on the environment. Turning wet waste in cities and towns into compost can be the single most effective intervention to reduce the staggering garbage burden. It will also breathe fresh life into dead agricultural soils. This paper deals with effective methods of composting of urban waste and its application for cultivation of agricultural crops.

05-11(P)

INFLUENCE OF THE ENVIRONMENTAL CONDITIONS ON THE MODULATION OF CELLULAR CONSTITUENTS AND DIFFERENTIAL EXPRESSION OF PROTEINS IN *AZOLLA MICROPHYLLA*

G. Abraham^{1*}, Altaf Ahmad² and Vagish Mishra³

**Centre for Conservation and Utilization of BGA, IARI, New Delhi-110012*

²Molecular Ecology Laboratory, Department of Environmental Botany, Hamdard University, New Delhi-110062, ³National Research Centre for Plant Biotechnology, IARI, New Delhi-110012

Azolla microphylla is an aquatic pteridophyte often found in the rice paddy fields and has been used as biofertilizer for rice due to its potential for nitrogen fixation. Studies conducted in our laboratory showed that changes in the ambient environmental conditions such as high and low temperature lead to changes in the colour of the fronds and cellular constituents in this organism. It was observed that the fronds which remained green in the summer months (March-October) gradually turn to red with the onset of winter (November to February). The change in the colour of the fronds has also been correlated with a distinctly different pattern of cellular constituents such as anthocyanin, carotenoids, flavonoids, protein and lipids. Seasons also had resulted in significant changes in the differential expression pattern of proteins of the organism and we have been able to observe the expression of six new protein spots among the 49 protein spots detected during the winter months. Therefore it is also presumed that the organism is capable of tolerating high as well as low temperature conditions probably through differential expression of some proteins according to the season. High levels of phenolics have been observed in the extracts prepared from plants of the winter season as compared to their counterparts in summer. The crude extracts prepared from the organism from these two different seasons was tested for antimicrobial activity against the fungus *Rhizoctonia solani* and it showed differential response with respect to the seasons. The present study shows the differential response of the nitrogen fixing biofertilizer *Azolla microphylla* to change of seasons with respect to cellular constituents and antimicrobial activity. Further the proteomic approach will be useful to identify the role of key differentially expressed proteins that could be used as biomarkers to understand the changes in response to such environmental stimuli. Further studies are in progress to determine the exact function and role of the differentially expressed proteins in *A. microphylla*.

05-12(P)

EFFECT OF HIGH TEMPERATURE ON SPIKELET STERILITY AND ELECTROPHORETIC PROFILES OF POLYPEPTIDES DURING ANTHESIS IN RICE (*ORYZA SATIVA* L.)

S. Das, P. Krishnan and B. Ramakrishnan

Division of Agricultural Physics, Indian Agricultural Research Institute, New Delhi-110012

The surface air temperature can affect growth and yield of crop plants. Being a tropical crop, rice (*Oryza sativa* L.) is often subjected to vagaries of weather which includes high temperature during its growth period. The predicted increases in temperatures due to global warming can have different effects on different rice cultivars depending on the nature and duration of high temperature stress. The objectives of the present study were (i) to examine the biophysical effects of high temperature, (ii) to perform molecular profiling of polypeptides of rice spikelets, through SDS-PAGE banding pattern, after high temperature exposure at flowering stage, and (iii) to evaluate the usefulness of these observations for screening of rice cultivars for high temperature stress tolerance. Four rice genotypes (cv. N22, Annapurna, Vijeta, and Basmati-370) were exposed to the temperature stress of 30, 35, 40, 45 or 50 °C. Plants of all genotypes were grown in pots at normal atmospheric

temperature conditions and stress was given at the flowering stage. Results showed that the high temperature stress hastened crop development leading to early maturity, shortened the growth period, and, hence, lowered the grain yield, largely due to high spikelet sterility (17.3% at 30 °C and 83.0% at 50 °C, respectively). The impact of high temperature stress on crop growth and yield was largely determined by the duration of exposure of crop to high temperature. In our study an exposure of the plant for 6 hours at different temperatures during flowering stage led to decreases in plant yield (8.46%), starch (35.764%), membrane stability index (9.79%), protein content (35.06%), and grain weight (6.58%), while sugar content (27.02) and spikelet sterility (83%) increased. The developmental stages from panicle initiation to flowering stage were found to be more sensitive to high temperature stress. Incidence of high temperature stress during these developmental stages affected grain yield by reducing dry matter accumulation, productive tillers, number of spikes, and grain weight and by increasing floret sterility. The electrophoretic profiles of polypeptides of leaf tissues of plants under control and different high temperature conditions were characteristically different among different genotypes. In general, less number of protein bands were found in case of temperature stressed plants. Among all the genotypes, cv. N22 and Annapurna were found to be more tolerant to temperature stress. This study clearly showed that anthesis is one of the most sensitive developmental stages of rice to high temperature as pollen sterility is increased and germination of pollen grains on the stigma is reduced. Temperature above 33 °C during anthesis gradually increased pollen sterility in all rice cultivars. Failure of fertilization due to pollen sterility or poor germination of pollen grains is a critical yield-determining factor and high temperature stress at the early reproductive stage and in high-yielding cultivars bearing heavy spikelets will have adverse effects, on spikelet fertility, which can ultimately reduce productivity. The results from the polypeptide profiling also indicated that high temperatures affected spikelet fertility. The sensitivity of pollen grains to high temperature damage can become the most important parameter for predicting rice yield in warmer climates.

05-13(P)

EFFECT OF TREATED DISTILLERY SPENTWASH FERTIGATION ON GROWTH, PHYSIOLOGICAL TRAITS AND YIELD IN GROUNDNUT (*ARACHIS HYPOGAEA* L.)

D. Darmalingaiah, M.B. Doddamani, U.V. Mummigatti, M.B. Chetti, S.K. Gali and S.S. Angadi
College of Agriculture, University of Agricultural Sciences, Dharwad-580 005

Distillery spentwash is produced from renewable resources such as sugarcane biomass and hence it is eco-friendly and is also a very good source of readily available major and micronutrients to sustain the soil fertility and yield of crops. Recently, the presence of appreciable quantity of plant growth promoters *viz.*, gibberellic acid and indole acetic acid have also been detected which further enhance the nutrient value of spentwash. Groundnut cultivation is often plagued by the non availability of soil nutrients during critical stages of its growth. In view of this, an experiment was conducted at main agricultural research station (MARS), University of Agricultural Sciences Dharwad during Kharif 2010. Treated distillery spentwash was fertigated in three splits based on the nitrogen requirement of groundnut. Since treated spentwash contains 0.25-0.3, 0.03-0.06, 0.75-1.0 % of NPK, additional required amount of phosphorous was supplied through spentwash fertigation. Application of 1.5 times recommended dose of nitrogen (RDN) through spentwash significantly increased the plant height, leaf area, leaf area duration, total dry matter, chlorophyll content and nitrate reductase activity. Yield and yield components like number of seeds per pod, number of pods per plant, test weight, harvest index were also favorably influenced with the application of spentwash. Higher seed yield (3100.9 kg ha⁻¹) was recorded with 1.5 N through spentwash which was on par with 1.5 N through fertilizer (3046.6 kg ha⁻¹), indicating the beneficial effect of treated distillery spentwash in groundnut.

05-14(P)

EFFECT OF HIGH TEMPERATURE ON REPRODUCTIVE BEHAVIOUR IN RICE

**N. Sravan Raju, P. Senguttuvel, V.P. Bhadana, S.R. Voleti, A.S. Hariprasad, N. Shobha Rani,
P. Revathi, K.B. Kemparaju, D. Subrahmanyam, and B.C. Viraktamath**

Directorate of Rice Research, Rajendranagar, Hyderabad – 500030, Andhra Pradesh

Rice (*Oryza sativa* L.) is sensitive to high temperature especially during reproductive stage i.e., anthesis to grain filling period. Field experiments were conducted during *Rabi* 2011 wherein 42 genotypes including hybrids were planted in three time intervals of 15 days difference each with three replications to determine the effect of high temperature during flowering and grain filling on different genotypes. The spikelet fertility varied from 33% in Azucena (sensitive) to 86% in N22 (tolerant); Suruchi, PHB 71 (hybrids), RPHR 1005 and SG-27-77 were also observed to be moderately tolerant to heat stress. Other genotypes *viz.*, BPT 5204, IR 58025B, DRR6B were affected adversely when flowering coincided with high temperature. Among the CMS sources APMS 6B showed higher pollen and spikelet fertility and this may be due to the cooling effects provided by robust flag leaf and profuse vegetative growth. The mean temperature during the month of January was 27.5/15.2°C (day/night) during seeding whereas it was 39.2/25.4°C (day/night) at the time of flowering to grain filling (May). The pollen viability did not correlate with spikelet fertility as in N22 which is a tolerant to heat, the pollen fertility was low (62%) but it had high percentage (83%) of seed set (spikelet fertility). Whereas, in Azucena which is sensitive genotype recorded high pollen viability (65%) but spikelet fertility (filled grains) was comparatively very low (16%). Therefore, it may be concluded that high temperature not only affecting pollen viability but also playing inhibitory role in pollen germination, pollen tube growth, fertilization and early stages of embryo development. Better seed set was observed in early morning flowering lines as compared to lines flowered few hours later and coincided with high temperature. The genotypes *viz.*, SG-27-175, DRRH2, KRH2 and CORH3 showed early morning flowering and reached peak anthesis (1-1.5 hrs after dawn) as compared to other test entries which flowered normally 2.5 hrs after dawn (9.30am). Extreme temperature during booting to anthesis resulted in reduction of seed setting rate and partially filled grains. The cultivar N22 was the highly tolerant genotypes and Azucena was most sensitive genotypes in terms of spikelet fertility and grain yield.

Session 06

**Plant Growth Regulators/
Agrochemicals and their Applications,
Allelopathy**

06-01(O)

A COMPARATIVE INFLUENCE OF 28-HOMOBRASSINOLIDE AND 24-EPIBRASSINOLIDE ON ACTIVITIES OF NITRATE REDUCTASE, ANTIOXIDATIVE ENZYMES AND PROLINE CONTENT OF TOMATO

Mohammad Irfan, Sangeeta Yadav, Shamsul Hayat, Arif Shafi Wani, and Aqil Ahmad

Plant Physiology Section, Department of Botany, Aligarh Muslim University, Aligarh 202 002, U.P.

Brassinosteroids (BRs) are a class of polyhydroxysteroids plant hormones. The sensitivity of a crop to abiotic/biotic stress is a functional aspect of its response as regulated by the efficient internal build-up of hormones like BRs. A better understanding of how the brassinosteroid isomers differentially affect plant responses in tomato (*Solanum lycopersicum* L.) is necessary to improve production. Plants of cv. K-21 were grown in a net house and foliage treated with brassinosteroid isomers 28-homobrassinolide (HBL) and 24-epibrassinolide (EBL) at concentrations of 10^{-6} , 10^{-8} or 10^{-10} M. Plants responded more to EBL than to HBL. All treatments increased nitrate reductase activity and the antioxidant system with respect to the control. However, the 10^{-8} M concentration of EBL produced higher nitrate reductase activity and better stimulated the antioxidant system in tomato. In physiological experiments different concentrations/modes of stress/hormone(s) are tested and justified in biosynthetic or signalling mutants to fix the resistant response in transgenically tailored crops. Physiological studies are an integral part of systematic studies of crop improvement and can provide the basis for molecular experiments.

06-02(O)

STUDIES ON APPLICATION OF CHEMICALS TO AMELIORATE LEAF REDDENING IN Bt COTTON HYBRID (RCH-2 Bt)

B.C. Patil*, A.G. Babu, K.N. Pawar and A.B. Shaheen

Agricultural Research Station, University of Agricultural Sciences, Dharwad-580005, Karnataka

**bc_patil@yahoo.com*

Reddening of cotton leaf is a physiological disorder observed in all growing regions of India and other countries. In recent years reddening is becoming major problem in Bt cotton leads to disturbance in plant growth and development reduction in yield. An experiment was conducted using RCH-2 Bt cotton hybrid grown in RBD design with seven treatments at Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka and evaluated for the effect of different 12 different treatments (combination of nutrient application and foliar nutrition of major and minor nutrients) on phenology, numbers of bolls, boll weight, photosynthesis rate, SPAD reading, LAI, yield to ameliorate leaf reddening. The treatments were T_1 : Control (No fertilizer), T_2 : RDF based on soil test values, T_3 : $T_2+5t/10t/ha$ of FYM, T_4 : T_2+1 foliar spray of 2% urea at 60 DAS followed by 1 spray of DAP (2%) after 8 days, T_5 : T_2+2 foliar spray of urea (2%) and DAP (2%) alternatively at 8 days interval from 60 DAS, T_6 : T_3+1 foliar spray of 2% urea at 60 DAS followed by 1 spray of DAP(2%) after 8 days, T_7 : T_3+2 foliar spray of urea (2%) and DAP (2%) alternatively at 8 days interval from 60 DAS, T_8 : T_2+2 spray of KNO_3 (0.5%) at 75 & 90 DAS, T_9 : T_2+2 spray of $MgSO_4$ (5%) at 75 & 90 DAS, T_{10} : $T_2+1\%$ urea+ $ZnSO_4$ (5%) at 75 DAS, T_{11} : T_2 +foliar application of sodium benzoate @ 100 ppm at 75 DAS, T_{12} : T_2 +foliar application of sodium benzoate @ 100 ppm at 90 DAS. No of days for 50% flowering & boll opening did not significantly differed among the treatments. Highest number of bolls per plant recorded by T_9 (27.27) followed by T_5 (26.07) and T_4 (26.15). Significantly least bolls per plant urea recorded by control (20.87).

Highest boll weight was recorded by T₉ followed by T₅. Significantly least boll weight was observed in control (4.27 kg/boll). The Photosynthesis rate significantly differed among the treatments. The treatments T₅, T₈ and T₉ recorded significantly more Photosynthesis rate compare to control. SPAD reading taken at 120 DAS showed significant difference among treatments. The treatments T₅ and T₉ recorded significantly more SPAD readings compared to control. The LAI differed significantly among the treatments. The treatments T₅ and T₉ recorded significantly more LAI compared to control. However, other treatments ranged in between these two values. T₉ recorded significantly high yield (2240.9 kg/ha) followed by T₅. The check with no fertilizer application has recorded significantly least yield (1682 kg/ha). T₂ has recorded 1742 kg/ha. The T₉ recorded significantly more yield & yield components when compared to control.

06-03(O)

BACTERIAL PLANT GROWTH REGULATORS AND THEIR APPLICATIONS

Minu Ali, Ganesh Iyer, Seema Menon and Dipak Vora*

Department of Microbiology, Ramnarain Ruia College, Matunga, Mumbai-400019

**Corresponding Author: Email: dipakvora@vsnl.net*

Medicinal plants are a valuable resource for new pharmaceutical preparations and thus a potential source of new drugs as well as economically viable. The use of natural products with therapeutic properties is as ancient as human civilisation and, for a long time, mineral, plant and animal products were the main sources of drugs. In India, medicinal plants are widely used by all sections of society either directly as folk remedies, in indigenous systems of medicine or indirectly as modern pharmaceutical preparations. The approach through natural products has proved to be the single most successful strategy for the discovery of new drugs. Most herbal medicines need to be studied scientifically, though the experience obtained from their use over the years cannot be ignored. Endophytic bacteria have been found in virtually every plant studied. Endophytic bacteria are harmless in most plant species, known to boost the growth and development of the host plants and can also act as biocontrol agents. Endophytes can also be beneficial to their host by producing a range of natural products that could be harnessed for potential use in medicine, agriculture or industry. In addition, it has been shown that they have the potential to remove soil contaminants by enhancing phytoremediation and may play a role in soil fertility through phosphate solubilization and nitrogen fixation. There is increasing interest in developing the potential biotechnological applications of endophytes for improving phytoremediation and the sustainable production of nonfood crops for biomass and biofuel production.

06-04(O)

EFFECT OF GIBBERELLINS AND CYTOKININS ON GROWTH AND FLOWERING OF *IBERIS UMBELLATA* L.

**Mushtaq Ahmad Bhat, Inayatullah Tahir, Waseem Shahri, Sheikh Tajamul Islam
and Syed Sabhi Ahmad**

*Plant Physiology and Biochemistry Research Laboratory, Department of Botany,
University of Kashmir, Srinagar-190006*

A study was undertaken to investigate the effect of some gibberellins and cytokinins on growth and flowering of *Iberis umbellata* L. Healthy and uniform seedlings of *Iberis umbellata* were transplanted to 25 cm earthenware pots filled with 2:1:1 mixture of garden soil, sand and farmyard manure (FYM). The plants were

sprayed with three concentrations of growth regulators (GA_3 , GA_{4+7} , Kinetin and Thidiazuron-TDZ) viz. 50, 100 and 200 mg/l prepared in 0.1% aqueous Tween 80. For each concentration, there were five pots; besides a set of five pots each represented the distilled water control and 0.1% Tween 80 control. Plant height, fresh & dry mass, number of laterals, leaf area and flowering yield was increased significantly by the spray application of gibberellins (GA_3 and GA_{4+7}). In *Iberis umbellata* the application of gibberellins resulted in early flowering and enhanced flowering period. Kinetin application resulted in increased plant height, fresh & dry mass, number of laterals, leaf area and flowering yield. The application of kinetin resulted in delayed flowering but flowering period was enhanced. Plant height, fresh & dry mass and floral diameter was decreased by the spray application of TDZ but the number of laterals and number of flowers was increased markedly however, TDZ applied at 200mg/l resulted in abortive flowers. TDZ application resulted in delayed flowering but flowering period was markedly enhanced. The present study reveals that gibberellins and cytokinins were effective in enhancing the display value of *Iberis umbellata* plants by modulating the plant height and increasing the flowering yield.

06-01(P)

EFFECTS OF PACLOBUTRAZOL AND KNO_3 ON FLORAL INDUCTION AND ASSOCIATED HORMONAL CHANGES IN MANGO CV. TOTAPURI

K.K. Upreti, Y.T.N. Reddy, H.L. Jayaram, S.R. Shivu Prasad and G.V. Bindu

Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bangalore 560089

kku@ihr.ernet.in

Paclobutrazol in combination with KNO_3 has been suggested effective to induce early flowering for the off-season production in mango. The precise physiological mechanism regulating floral induction are meagerly understood. The objectives of the study is to examine the hormonal relationships associated with floral induction in mango following paclobutrazol and KNO_3 treatments. The paclobutrazol was given as soil drenching treatment @ 3.0 ml/m canopy diameter during the 3rd week of August followed by KNO_3 (2%) application during bud break stage. Observations on C:N ratio and leaf water potential (σ_w) and analysis of phytohormones, Abscisic acid (ABA), indole acetic acid (IAA), cytokinins and gibberellins (GA) were made in the buds and leaves before bud burst and at burst. Paclobutrazol treatment advanced fruit harvest period by 22 days as compared to control by promoting early flowering. The C:N ratio high in leaves was increased by paclobutrazol treatment and with approach of shoot reaching flowering. The σ_w was high in the paclobutrazol treated trees at bud burst when compared to paclobutrazol untreated trees. The KNO_3 did not alter σ_w of paclobutrazol treated trees. At bud burst, the paclobutrazol increased ABA without influencing IAA contents in the leaves and buds when compared with control. The increase was more pronounced in buds than the leaves. The KNO_3 application did influence the ABA content of buds and leaves, but increased bud IAA content when compared with only paclobutrazol treated trees. Cytokinins- zeatin, zeatin riboside and dihydrozeatin riboside at burst increased significantly in buds as compared to untreated controls. The KNO_3 application showed increase in zeatin riboside content in the buds as compared to paclobutrazol treated trees. GA_4 , GA_3 and GA_7 were the prominent GAs in the leaves and buds. The paclobutrazol treatments resulted in profound decrease in GA_4 , GA_3 and GA_7 both in leaves and buds; with buds being more sensitive to paclobutrazol treatment. The effect of KNO_3 were inconsistent with respect to changes in these gibberellins. These results implicated possible roles of hormones in paclobutrazol/ KNO_3 induced flowering in mango.

06-02(P)

ROLE OF ETHYLENE IN ALLEVIATION OF CADMIUM-INDUCED PHOTOSYNTHETIC CAPACITY INHIBITION BY SULFUR IN MUSTARD

Asim Masood, Noushina Iqbal, Rahat Nazar and Nafees A. Khan*
Department of Botany, Aligarh Muslim University, Aligarh-202 002 (UP)
* *asim.bot@gmail.com*

Sulfur (S) alleviates the effects of cadmium (Cd) stress by triggering glutathione (GSH) synthesis formed from cysteine, which also forms ethylene through S-adenosyl methionine. Whether ethylene signaling is involved in S-induced Cd stress alleviation on photosynthesis, the effects of S or ethylene on GSH and ethylene were examined in Varuna (high photosynthetic capacity) and RH30 (low photosynthetic capacity) cvs. of mustard (*Brassica juncea* L.). Sufficient-S at 100 mg S kg⁻¹ soil alleviated Cd-induced photosynthesis inhibition more than excess-S (200 mg S kg⁻¹ soil) via ethylene maximally in Varuna by increased GSH and reducing the negative effects of glucose (Glc) sensitivity. Under Cd stress, plants were less sensitive to ethylene, despite high ethylene evolution and showed photosynthetic inhibition due to increased Glc sensitivity. Ethylene sensitivity of plants increased with ethephon (ethylene source) or sufficient-S with the decrease in Glc sensitivity and triggered the induction of antioxidant system and induced photosynthesis under Cd stress. The effects of ethephon and S under Cd stress were similar. The effects of S were reversed by ethylene biosynthesis inhibitor, aminoethoxyvinylglycine (AVG) in both the cultivars, suggesting that ethylene plays an important role in sulfur-induced alleviation of Cd stress on photosynthesis.

06-03(P)

THE SYNTHESIS OF INDOLE-3-ACETIC-ACID BY AN EDIBLE WHITE-ROT FUNGUS *PLEUROTUS OSTERATUS* USING DEOILED *JATROPHA CURCAS* SEED PRESS CAKE UNDER SUBMERGED CONDITION

Anjali Bose, Dharti Shah and Haresh Keharia
*BRD School of Biosciences, Sardar Patel Maidan, Vadtal Road, P.O.Box 39,
Satellite Campus, Sardar Patel University, Vallabh Vidyanagar 388 120, Gujarat*
adoreanjali@gmail.com, haresh970@gmail.com

The synthesis of phytohormone, indole-3-acetic acid (IAA), is not only confined to flowering plants but bacteria (esp. plant growth promoting rhizobacteria and few pathogens), yeasts and other fungi are also known to produce this hormone and in many cases at higher levels than plants. Three white rot fungi, *Trametes versicolor*, *Pleurotus ostreatus* and *Phanerochaete chrysosporium* were examined for their ability to produce IAA when incubated with L-tryptophan. The main concern of this study was to determine the physical and chemical conditions necessary for optimal biosynthesis of this hormone by *Pleurotus ostreatus*. Maximum IAA production (470.06 µg/mL) was observed at growth period of 18d, 2% (w/v) *Jatropha* oil seed presscake as substrate and pH of 7.0 at 37°C. Agitation increased level of IAA compared to static culture. The IAA produced by *P. ostreatus* was further confirmed and characterized by HPTLC and GC-MS. The biological activity of IAA obtained from the extra-cellular culture of *Pleurotus ostreatus* was determined using wheat coleoptile bioassay.

06-04(P)

PHYSIOLOGICAL AND BIOCHEMICAL EFFECTS OF DIFFERENT GROWTH REGULATING CHEMICALS ON GROUNDNUT (*ARACHIS HYPOGAEA* L.) PRODUCTIVITY UNDER SALT STRESS CONDITION

S. Nithila¹ and D. Durga Devi²

¹Anbil Dharmalingam Agricultural College & Research Institute, TNAU, Trichy

²Tamil Nadu Agricultural University, Coimbatore

Soil salinity and sodicity cause detrimental effects on plant activities, which are likely to alter the yielding potential of the crops. Hence to identify the physiological parameters, which get altered under salt stress conditions and the quantum of damage caused by the stress and also to standardize the method of ameliorating the adverse effects of sodicity, investigations were carried out in groundnut under three conditions viz., laboratory, pot culture and field. In the laboratory experiment, screening of ten groundnut varieties were made at critical salt concentration of 50 mM, 100 mM and 125 mM NaCl and 25 mM, 50 mM and 75 mM NaHCO₃. The results of the investigation revealed that with increasing concentration of the salts, the germination percentage, seedling growth and vigour index were decreased drastically. Both salinity and sodicity stresses at high levels cause similar adverse effects on growth of the seedlings. All the ten varieties displayed their differential responses to these stresses. CO₄ and VRI2 showed high degree of tolerance with high germination percentage and low reduction in vigour index. Therefore, these two varieties along with other four varieties viz. CO₂, CO₃, TMV2 and ALR3 with moderate performance were selected for future evaluation under pot culture condition. The remaining four varieties viz. JL24, TMV7, CO₅ and BSR1 were rejected because of their poor germination and vigour index. Under pot culture condition, the selected six varieties were subjected to two levels of salinity stress with 50 mM and 100 mM NaCl and two levels of sodicity stress with 25 mM and 50 mM NaHCO₃. The results revealed that high salinity (100 mM) and sodicity (50 mM) levels showed greater inhibitory effect on overall growth of all the varieties. However, among the varieties evaluated, CO₄ was found to be the most tolerant variety and ALR3, the most sensitive one. Maintenance of optimum leaf area with high chlorophyll, soluble protein and proline contents along with high TDMP were observed to be the physiological basis for tolerance to both salinity and sodicity stresses. The tolerant (CO₄) and susceptible (ALR3) varieties were further employed in ameliorative study under field condition. To assess the impact of different growth regulating chemicals on mitigating the adverse effects of sodicity stress, a field study was conducted under sodic soil condition. CO₄ and ALR3 were imposed with foliar spray of CaCl₂ 1%, BR 0.5 ppm, BR 1 ppm, SA 50 ppm, SA 100 ppm, KNO₃ 1%, DAP 2% and nutrient mixture at preflowering, pegging and pod formation stages. Among the treatments BR 1 ppm was found effective in alleviating the adverse effects of sodicity stress. The morphological and growth traits such as root length, LAI, LAD, SLW and TDMP were significantly enhanced by this treatment in both the varieties. Similarly the biochemical constituents such as proline content, chlorophyll and soluble protein contents were improved by the treatment with BR 1 ppm. Most of the metabolic enzymes like nitrate reductase, catalase, peroxidase, acid phosphatase, polyphenol oxidase and expression of superoxide dismutase isozyme were also accelerated by this treatment. Leaf nitrogen, phosphorous, potassium, calcium and magnesium contents were also enhanced by BR 1 ppm. Flower production and peg number was also improved by BR treatment in both the varieties. Because of high fertility coefficient, the number of pods produced per plant was also increased considerably. The role of BR in facilitating the partitioning of assimilates could also be revealed through improved seed weight and high harvest index. The overall performance of BR, therefore, reflected on pod yield of groundnut in both the varieties. In CO₄, BR 1 ppm treatment resulted in 15% increase in pod yield, whereas in ALR3, the most sensitive variety, it caused 13% improvement in pod yield over control. Therefore, application of BR 1 ppm through foliar spray at preflowering, pegging and pod formation stages effectively enhanced the overall physiological efficiency of the crop and improved the yield in both tolerant and sensitive varieties of groundnut grown under salt stress conditions.

06-05(P)

EFFECT OF PACLOBUTRAZOL ON PHOTOSYNTHETIC PLANT PIGMENT IN HYDROPONICALLY GROWN MANGO SEEDLING

R. Islam*, S. Mondal, A.K. Ghosh and P.C. Gupta

Department of Plant Physiology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, WB

*E-mail: riyajulislam1987@gmail.com

An experiment was conducted in the laboratory and net house under the department of plant physiology, faculty of agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, during the year 2009-2010 to study effect of paclobutrazol on uptake of nutrient in hydroponically grown mango seedling in half Hoagland solution. The experiment consisted of five treatment: Nutrient solution with out paclobutrazol (P0N), Nutrient solution + 1ppb paclobutrazol (P1N), Nutrient solution + 100ppb paclobutrazol (P100N), Nutrient solution + 500ppb paclobutrazol (P500N), Nutrient solution + 1000ppb paclobutrazol (P1000N), Distilled water + 1ppb paclobutrazol (P1N0), Distilled water + 100ppb paclobutrazol (P100N0), Distilled water + 500ppb paclobutrazol (P500N0), Distilled water + 1000ppb paclobutrazol (P1000N0) in mango seedling. The experiment was laid out complete randomized design with 5 treatment combination in three replication. Chlorophylls and carotenoids are two important groups of photosynthetic plant pigments. The chlorophyll-a and chlorophyll-b contents on an average increased due to paclobutrazol treatments. Chlorophyll-b appeared to increase more prominently than chlorophyll-a. One thing needs to be mentioned here chlorophyll- b content, with few exceptions, was found to be higher than chlorophyll a content. The carotenoid content of the leaves of the mango seedlings under study before and after growing them in different treatment solutions. The carotenoid content of the mango seedlings varied significantly before and after growing them in different culture solution. Increase in carotenoid content in case of seedlings grown in control solution (P0N) was negligible. It was substantially higher in the mango seedlings grown in the paclobutrazol treated culture solutions.

06-06(P)

EFFECT OF BRASSINOLIDES ON PHYSIOLOGICAL ASPECTS OF CHICK PEA (*CICER ARIETINUM* L.) UNDER DROUGHT CONDITIONS

Jyoti Verma, B.L. Kakralya and Santosh Jakhad

Department of Plant Physiology, S.K.N. College of Agriculture, Jobner-303329

A pot experiment was conducted at S.K.N. College of Agriculture, Jobner (Rajasthan) during Rabi season of 2010 to the effect of brassinolides on physiological aspects on chickpea (*Cicer arietinum* L.) under drought conditions. Two chickpea cultivars namely RSG-888 and RSG-895 were grown in ceramic pot under normal conditions till vegetative stage and then plants were sprayed with brassinolides (0.0, 0.1, 0.5 and 1.0 ppm concentration) and then half the plants were subjected to water stress by withholding irrigation as frequently and observations were recorded at 50% flowering and 50% podding stages after sowing. Brassinolides significantly increased relative water content, chlorophyll stability index, photosynthetic rate, transpiration rate, stomatal conductance, specific leaf area, protein, proline and soluble sugar in both cultivars under non-stress and water stress conditions. The 1.0 ppm concentration of brassinolides was most effective under both non-stress and water stress conditions. Yield and yield attributes were significantly increased on account of brassinolide treatment under non-stress and water stress conditions. Most of the physiological parameters are positively and highly correlated with seed yield. It is concluded that between the cultivars studied, RSG-888 was drought tolerant and the tolerance was mediated by physiological characteristics. Brassinolide increased productivity by reducing the adverse effect of drought stress on growth and yield attributes.

06-07(P)

EFFECT OF PLANT GROWTH REGULATOR, DEFOLIATION AND FLOWER DROP ON GROWTH AND YIELD OF SOYBEAN

D.G. Dalvi,* S.S. Kasar, I.A. Madrap and D.B. Deosarkar

Marathwada Agriculture University, Dept. of Agril. Botany, Parbhani – 431 402

*E-mail : dalvi46@rediffmail.com

A field experiment was conducted during *kharif* 2010 in split plot design at department of Agril. Botany, M.A.U., Parbhani to study the effect of defoliation, flower drop and plant growth regulator on physiological parameters and yield of soybean variety MAUS-71. The two foliar sprays of plant growth regulators i.e. GA₃ and NAA (100 PPM) at 40 and 60 DAS were found statistically non significant in respect to yield and yield contributing characters, as well as for physiological parameters. Among the treatments, 97%, 92% and 82% reduction in yield was observed due to 100% defoliation, 100% defoliation + flower drop (without PGR spraying) and 100% defoliation + flower drop respectively. They exhibited 2.36 to 2.82 yield qtl./ha. However, the treatments 75%, 50% and 25% defoliation + flower drop were recorded 15%, 12.8% and 1.2% yield reduction respectively. These treatments were exhibited 15.32 to 20.57 qtl. seed yield / ha. Whereas, the treatment 100% flower drop only exhibited 10% yield reduction with 22 qtl. yield/ha and it was at par with control in respect to yield and yield contributing characters as well as for physiological parameters. It was observed that these treatments were able to recover the yield losses due to favourable moisture condition in field. Among the treatments, 97% to 11.2% reduction in yield was observed due to 100% to 25% defoliation treatments respectively. This was due to reduction in number of leaves/plant, leaf area and leaf area index, which are responsible for lower down the photosynthesis and other metabolic activities resulted to reduction in dry matter / plant, AGR, RGR and CGR.

06-08(P)

24-EPIBRASSINOLIDE AND GLYCINE BETAINE APPLICATION MITIGATED COPPER STRESS IN *BRASSICA JUNCEA*

Priyanka Varshney, Qazi Fariduddin*, Mohd. Yusuf, Aqil Ahmad

Plant Physiology and Biochemistry Section, Department of Botany,

Aligarh Muslim University, Aligarh-202002

*Corresponding author: qazi_farid@yahoo.com

This study was aimed to investigate and compare the effects of exogenously applied 24-epibrassinolide (EBL) and glycine betaine (GB) in *Brassica juncea* L. var. varuna under copper (Cu) stress. The seedlings were raised in the soil amended with Cu (0, 50, 100 or 150 mg of Cu kg⁻¹ soil) at 10 days after sowing and were sprayed with EBL (10⁻⁸ M) or GB (50 mM) at 28 d stage of growth. The plants grown in the presence of Cu alone had reduced growth, leaf chlorophyll content, maximum efficiency of photosystem II, net photosynthetic rate, activities of carbonic anhydrase and nitrate reductase, and yield attributes, whereas, proline level, activities of antioxidant enzymes viz. catalase (E.C. 1.11.1.6), peroxidase (E.C. 1.11.1.7), lipid peroxidation and H₂O₂ content increased in a concentration dependent manner. However, the follow-up treatment of EBL completely neutralized the damage caused by 50 or 100 mg kg⁻¹ of Cu and partially that of 150 mg kg⁻¹ whereas, GB proved effective only for the lowest concentration (50 mg kg⁻¹) of Cu in most of the parameters. The treatment of these Cu stressed plants with EBL or GB further enhanced the activities of antioxidant enzymes and the content of the proline. The present study revealed that EBL or GB counteracted oxidative stress in Cu stressed mustard plants by elevated level of proline and antioxidant enzymes which was manifested in improved growth and yield performance where EBL proved more effective than GB.

06-09(P)

COMPARATIVE EFFECTS OF SALICYLIC ACID DERIVATIVES ON GROWTH PARAMETERS IN *ARACHIS HYPOGAEA* L.

Sunita Jadhav and S.B. Bhamburdekar

*P.G. Department of Botany, Plant Physiology Section, Krishna Mahavidyalaya, Rethare Bk.,
Dist. Satara, 415 110 (MS) India.*

A field experiment was conducted to evaluate the effect of foliar application of different doses of salicylic acid (SA), acetylsalicylic acid (ASA) and 5- Sulfosalicylic acid (5, 50, 100 and 200 ppm) on growth components of groundnut (Cv. SB-11). The results revealed that all the treatments increased chl. a, chl. b, total chlorophyll, carotenoid contents and chlorophyll stability index over control. These parameters were more pronounced at 50 ppm and 100 ppm SSA followed by 5 ppm and 100 ppm ASA and SA. The morphophysiological attributes such as number of leaves, height of plant and leaf area per plant also showed similar performance to exogenously applied SA derivatives. These findings clearly signify the growth promoting role of ASA and SSA in groundnut growth.

06-10(P)

COMPARATIVE EFFICACY OF 24-EPIBRASSINOLIDE AND 28-HOMOBRASSINOLIDE IN AMELIORATION OF NICKEL STRESS IN *VIGNA RADIATA* BY MODULATING ANTIOXIDANT SYSTEM

Mohammad Yusuf

*Plant Physiology and Biochemistry Section, Department of Botany,
Aligarh Muslim University, Aligarh-202002*

**Email: yousuf.alig@gmail.com*

The aim of this study was to explore the best suited exogenously-sourced analogue of brassinosteroids [24-Epibrassinolide (EBL)/28-Homobrassinolide (HBL)] in mitigating the nickel induced oxidative stress in *Vigna radiata* through elevated level of antioxidant system and osmolyte. Two varieties (T-44 and PDM-139) of mung bean (*Vigna radiata*) differing in their tolerance to nickel stress were administered with three different levels of nickel (0, 50, 100, and 150 mg kg⁻¹ soil) fed through soil. At 29 d stage, the foliage of plants raised in nickel fed soil was exogenously applied with water (control) or 0.01 M of EBL or HBL. The plants were harvested at 30 and 45 d stage to assess growth, leaf gas-exchange, and biochemical parameters and also the yield characteristics at 65 d stage of growth. The nickel treatment through soil diminished the growth, water relations and photosynthetic attributes along with nitrate reductase and carbonic anhydrase activity in the concentration dependent manner whereas, it increased electrolyte leakage, proline accumulation, and various antioxidant enzymes in the leaves of mung bean which were more pronounced at higher concentrations of nickel i.e. 150 mg kg⁻¹ soil at both the stages of growth but the effect was more noticeable in variety PDM-139 at early stage of growth i.e. 30 d stage. However, the follow-up application of EBL or HBL to the nickel stressed plants improved growth, water relations and photosynthesis and further enhanced the various 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) and content of proline more prominently in variety T-44 than PDM-139. The elevated level of antioxidant enzymes as well as proline in T-44 could have conferred tolerance to the nickel-stressed plants resulting in improved growth, water relations and photosynthetic attributes at 45 d stage of growth more effectively in variety T-44 and countered the toxicity generated by nickel 50 and 100 mg kg⁻¹ soil. Moreover, the effect of EBL was prominent than HBL in variety T-44.

06-11(P)

INFLUENCE OF THIOUREA ON UNIFORM VEGETATIVE GROWTH, FLOWERING AND FRUITING IN ALPHONSO MANGO

A.K. Shinde, B.B. Jadhav, R.N. Shelke and K.A. Shinde

Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.)

Alphonso mango is grown on more than 1.70 lakh ha area in Konkan region of M.S. The vegetative growth in Alphonso mango take place two to three times in a year during June-July, October-November or March-April. The vegetative growth during October-November delayed the flowering and fruiting due to no shoot maturity at the time of flowering of mango. The thiourea act as a bud breaker at low concentration and act as defoliant at higher concentration. Therefore thiourea was used for defoliation during month of May which could causes uniform and early vegetative growth, flowering and fruiting in mango. The foliar spray of thiourea 2 and 3 % was done in the third week of May. One plot was kept as control (without spray). The experiment was laid out in RBD with 7 replications at Central Experiment Station, Wakawali during May 2009 to May 2010. There was significant difference in per cent vegetative flush, flowering and yield of Alphonso mango due to foliar spray of thiourea. Foliar spray of thiourea in the month of May caused more than 90 % vegetative flush within 10 days. There was significantly less vegetative flush in October due to foliar spray of thiourea. The per cent flowering was significantly higher in thiourea 3% (82.12%) which was at par with thiourea 2% over control (60.0%). Significantly higher yield was observed due to thiourea 3% spray (64.0 kg/tree) over thiourea 2% and control (44.0 kg/tree). Thus foliar spray of thiourea during month of May causes more vegetative growth in May and less vegetative growth in October which increased per cent flowering and yield in mango.

06-12(P)

RESPONSE OF GROWTH MANIPULATION (PINCHING) AND PLANT GROWTH REGULATORS ON GROWTH, SEED YIELD AND ITS QUALITY IN CLUSTER BEAN CV. PUSA NAVBAHAR

B.N. Satodiya, H.C. Patel, A.D. Patel and K.B. Kathiriya

Department of Horticulture, B.A. College of Agriculture, A.A.U. Anand, Gujarat-388110

An experiment was carried out to study the response of source manipulation (pinching) and spraying of plant growth regulators on growth, seed yield and its quality in cluster bean cv. Pusa Navbahar". The experiment was carried out with three source manipulation treatments (pinching) at 70 days after sowing, 90 days after sowing and without pinching and spraying of three plant growth regulators (NAA, GA₃ and Thiourea) at flowering each at two concentrations along with water spray as control in factorial randomized design with three replication at Main Vegetable Research Station, Anand Agricultural University, Anand during summer 2008 and 2009. The results showed significant differences among the growth, seed yield and its quality parameters. Without pinching (P₁) treatment recorded significantly the maximum number of leaves, leaf area and leaf area index of plant at harvest. Pinching at 70 days after sowing (P₂) observed significantly the maximum weight of 1000 seeds and the highest seed yield with better quality seeds. Among the PGRs treatments, spraying of GA₃ 40 mg/l at flowering stage recorded the maximum number of leaves, leaf area and leaf area index of plant at harvest stage. Whereas, spraying of Thiourea 500 mg/l registered maximum weight of 1000 seeds and the highest seed yield however, it remained at par GA₃ 20 mg/l treatment. Spraying of Thiourea 500 mg/l at flowering also produced better quality of seeds (i.e. Vigour index-I and II). Combination of pinching at 70 days after sowing (P₂) and spraying of Thiourea 500 mg/l at flowering stage recorded the maximum weight of 1000 seeds and seed quality parameters i.e. Vigour index-I and II.

06-13(P)

**MORPHO-PHYSIOLOGICAL AND BIOCHEMICAL EFFECTS OF BIOSTIMULANT
(*NovoBac*) ON GROWTH AND YIELD OF MAIZE (*ZEA MAYS* L.)**

S. Prabhakaran, V. Ravichandran*, P. Jeyakumar, N. Sakthivel and C. Vijayalakshmi

*Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu
Email-ravilux@rediffmail.com*

Investigations were carried out during 2010 in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore to study the impact of bacterial formulated biostimulants (*NovoBac*) on morphological, physiological attributes, yield components and yield of pre-released maize hybrid (CMH-08-282) under irrigated ecosystem. The present study revealed that, 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 seedlings⁻¹ g) and root volume (3.6 cc seedlings⁻¹) over control (17.7, 60 and 2.7). The morphological parameters such as plant height, total dry matter production, root shoot ratio, and growth characters like LA, LAI, LAD, LWR, SLW and CGR were favourably influenced by the treatment T₁₀ (*NovoBac* seed treatment @ 2 g/kg of seed + soil drenching @ 500 g/ha on 15 DAS). Considering the gas exchange parameters, the higher photosynthetic rate (58.7 $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), transpiration rate (12.2 mmol H₂O m⁻² s⁻¹) and stomatal conductance (0.60 mmol H₂O m⁻² s⁻¹) was recorded by treatment T₁₀ at silking stage. Regarding biochemical parameters, T₁₀ (*NovoBac* seed treatment @ 2 g/kg of seed soil drenching @ 500 g/ha on 15 DAS) recorded increased total chlorophyll (4.4 mg g⁻¹) and soluble protein (17.6 mg g⁻¹) content at silking stage of the crop. The lower activity of IAA Oxidase (1251 $\mu\text{g g}^{-1} \text{ hr}^{-1}$) was recorded by treatment T₁₀ (*NovoBac* seed treatment @ 2 g/kg of seed + soil drenching @ 500 g/ha on 15 DAS) over control (2206 $\mu\text{g g}^{-1} \text{ hr}^{-1}$). However, the higher activity of acid phosphatase was registered by treatment T₁₀ over control at taseeling and silking (6.7 $\mu\text{mol g}^{-1} \text{ h}^{-1}$) and (8.0 $\mu\text{mol g}^{-1} \text{ h}^{-1}$) stages of the crop. The maximum kernel yield of 6.35 t ha⁻¹ was registered by T₁₀ (*NovoBac* seed treatment @ 2 g/kg of seed + soil drenching @ 500 g/ha on 15 DAS) with an increase of 10.2 % over control. This might be due to the significant increment of major yield components such as cob size, number of kernel per cob and kernel size. Thus the, seed treatment with biostimulant (*NovoBac*) @ 2 g/kg of seed + soil drenching on 15 DAS @ 250 g/ha favoured for better growth and yield in maize by recording high B:C ratio of 1:1.95.

06-14(P)

**RESPONSE OF 28-HOMOBRASSINOLIDE AND 24-EPIBRASSINOLIDE ON THE GROWTH,
CARBONIC ANHYDRASE ACTIVITY AND PHOTOSYNTHETIC EFFICIENCY OF
*LYCOPERSICON ESCULENTUM***

Arif Shafi Wani, Sangeeta Yadav, Mohd. Irfan, Shamsul Hayat and Aqil Ahmad

*Plant Physiology Section, Department of Botany, Aligarh Muslim University, Aligarh 202002, India
Corresponding author: arif_sheen@yahoo.com*

The present piece of work highlights the comparative effects of two active forms of brassinosteroids (BRs), 28-homobrassinolide (HBL) and 24-epibrassinolide (EBL), on growth parameters, carbonic anhydrase activity and photosynthetic parameters in *Lycopersicon esculentum* (cv. K-21) sampled at 45 (24hrs after spray) and 60 days after sowing, under natural conditions. Out of the two active forms of BR, EBL proved better than HBL in improving the above parameters, when applied as foliar spray. Of the three concentrations (10⁻⁶ M, 10⁻⁸ M or 10⁻¹⁰ M) of HBL and EBL, 10⁻⁸ M proved best in both cases.

06-15(P)

ROLE OF BRASSINOSTEROIDS, SALICYLIC ACIDS AND POLYAMINES IN SALINITY INDUCED OXIDATIVE STRESS

Bilal A Mir, Qazi Fariduddin*, Mohammad Yusuf, Tanveer A. Khan and Aqil Ahmad

*Plant Physiology and Biochemistry Section, Department of Botany, Aligarh Muslim University, Aligarh-202002; *Corresponding E-mail: qazi_farid@yahoo.com*

Brassinosteroids, salicylic acid and polyamines play pivotal roles in mitigating adverse effects of various abiotic stresses. Plant growth regulators (PGRs) have been implicated to regulate a wide range of metabolic and physiological activities in plants, ranging from cell division and organogenesis to protection against biotic and abiotic stresses. One of the important factors for plant productivity is their efficiency to overcome the stress conditions. Salt stress is amongst the major abiotic stresses that adversely affect the global crop production. It induces reactive oxygen species, alters the activity of antioxidant system and adversely affects photosynthesis. Various strategies have been employed to mitigate the deleterious effects of salt stress. One of the strategies to counter salt stress is use of PGRs like brassinosteroids, polyamines and salicylic acid, which regulate photosynthesis, anti-oxidant systems and other related aspects, thereby improving overall performance of plants.

06-16(P)

EFFECT OF GROWTH REGULATORS IN SEED QUALITY OF GREEN GRAM (*VIGNA RADIATA* L.) DURING STORAGE UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

Neelu Marmath, Neelam Yadav and V.K. Yadav

Department of Plant Physiology, S.K.N college of Agriculture, Jobner -303329

Experimental findings of present research work were obtained from comprehensive experimentation on RMG-62 and RMG-344 genotypes of green gram (*Vigna radiata* L.) during October-February, 2010-11 at Department of Plant Physiology, S.K.N. College of Agriculture, Jobner. Various treatments were given to the seeds of green gram with specific objectives. The surface sterilized and properly dried seeds were given hormonal treatment using GA₃ (100 ppm) and kinetin (20 ppm) in separate set at room temperature for 2 hours, The seeds were dried back again upto 6.3 per cent moisture level each set of hormone treated seeds was packed in cloth bags and stored under 20°C, 35°C, normal light/dark, 24 hrs light, 24 hrs dark conditions for recording observations at 40, 80 and 120 days after storage. These treatments were evaluated using completely randomized design under laboratory conditions in replication thrice. Appraisal of analyzed data reveals that germination per cent/shoot and root length, fresh and dry weight of seedlings, seed vigour as determined by electrical conductivity (EC) of seed leachates, seedling vigour index and metabolites like soluble sugars, protein, amino acids content and peroxidase activity in seeds gradually decreased with the increase of storage period whereas kinetin treated seeds increased the germination per cent protein, amino acids, ascorbic acids content and peroxidase activity more than GA₃ treated seeds in both types of genotypes, while GA₃ significantly improved the performance of seedlings vigour parameters like shoot and root length, fresh and dry weight of seedlings and total soluble sugars. Both of the hormones showed maximum improvement in the quality of seeds under normal light/dark and at 35°C temperature conditions, while significant reduction in EC was found with kinetin treated seeds under 24 hrs light condition in both types of genotypes. Maximum increase in ascorbic acid content was found under 20°C temperature conditions in both types of genotypes. The genotypes RMG-344 was found superior over RMG-62 with respect to maximum parameters studied under laboratory conditions and may be stored upto 120 days.

06-17(P)

CHANGES IN PHYSIOLOGICAL CHARACTERS AND YIELD OF CHILLI (*CAPSICUM ANNUUM L.*) DUE TO BIOSTIMULANT, *NOVOBAC*

P. Jeyakumar, S. Jidhu Vaishnavi, C.N. Chandrasekhar, N.O. Gopal and C. Vijayalakshmi
Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003
Email: jeyakumar@tnau.ac.in

A field experiment was conducted during November 2010 to May 2011 at Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, to study the effect of biostimulant (*NovoBac*) on growth, physiology and yield of TNAU Chilli hybrid Co1. *NovoBac* is a proprietary product of M/s. Novozymes South Asia, which is natural, soluble, beneficial microbial formulation containing different strains of *Bacillus* sp. *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 days after transplanting (DAT) was found effective in increasing growth attributes such as leaf area index (LAI), leaf area duration (LAD), specific leaf weight (SLW) and crop growth rate (CGR). There were also significant changes in physiological and biochemical parameters like leaf relative water content, chlorophyll fluorescence, photosynthetic rate, stomatal conductance, transpiration rate, chlorophyll pigments, soluble protein and Indole Acetic Acid Oxidase in *NovoBac* treated plants. *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT enhanced the uptake of nitrogen (N), phosphorus (P), potassium (K), soil bacterial population and soil dehydrogenase activity coupled with reduced incidence of pest (aphids, thrips) and disease (leaf curl). The treatment significantly improved the quality of chilli in terms of higher capsaicin, capsanthin, ascorbic acid, total soluble solids and oleoresin. The correlation studies showed that green chilli yield was significant and positively correlated with plant height, root length, transplanting survival rate, LAI, LAD, SLW, CGR, chlorophyll, soluble protein, IAA oxidase, uptake of NPK, soil bacterial population and dehydrogenase activity. The maximum green chilli yield (an increase of nine per cent over control) was registered in plants which had undergone *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT.

06-18(P)

STANDARDIZATION OF SUFOOF-E-MOHAZZIL - A UNANI POLYHERBAL FORMULATION

Avinash Patil, Aqsa Ansari, Swapneel Koli, Darshana Patil*
Department of Botany-Herbal Sciences, Birla College, Kalyan-421 301
** Department of Botany, Smt. C.H.M. College, UNR-3*

Standardization of herbal formulation is essential in order to assess the quality of raw material and the finished product of the drug. Sufoof-e-mohazzil, a unani polyherbal formulation has been used in Unani Pharmacy since antiquity. Sufoof-e-mohazzil is used as anti-obesity agent, digestive and for controlling high cholesterol levels. Therefore in the present study an attempt has been made to standardize Sufoof-e-mohazzil. In-house formulation was prepared as per the method mentioned in Unani formulary. In-house preparation and two marketed samples have been standardized on the basis of organoleptic characters, phyto-chemical analysis, physico-chemical properties and HPTLC fingerprint using Thymol as marker compound. With the growing demand of the herbal drugs in medicinal market, it is suggested that the results obtained from the present work will help in maintaining the quality and batch to batch consistency of Sufoof-e-mohazzil.

06-19(P)

EFFECT OF BIOSTIMULANT (NOVOBAC) ON GROWTH CHARACTERS AND YIELD OF CHILLI (*CAPSICUM ANNUUM* L.)

S. Jidhu Vaishnavi, P. Jeyakumar, C.N. Chandrasekhar, N.O. Gopal and C. Vijayalakshmi
Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003
Email: jeyakumar@tnau.ac.in

An experiment was conducted to assess the biostimulant mediated changes in morphological characters, nutrient uptake, fertility coefficient and yield of TNAU Chilli hybrid Co. The biostimulant, *NovoBac* was given as seed treatment and/ or soil drenching after 15 days of transplanting (DAT). *NovoBac* is a proprietary product of M/s. Novozymes South Asia, which is natural, soluble, beneficial microbial formulation containing different strains of *Bacillus* sp. Application of *NovoBac* as seed treatment showed significant effect on the germination percentage, shoot length, root length, total dry matter production and vigour index. In the field trial, *NovoBac* seed treatment @ 2g/kg enhanced the transplanting survival rate of chilli. The treatment combination of *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT improved the shoot and root characters compared to seed treatment or soil drenching of *NovoBac*. Seed treatment with *NovoBac* @ 2g/kg + soil drenching @ 500g/ha on 15 DAT showed significant changes in morphological characters like plant height, root length, root weight, root volume, root shoot ratio and total dry matter production over the cropping period, compared to other treatments. This increase is due to the enhanced nutrient uptake from the soil and also the phytohormonal changes in the plant system due to the activity of *Bacillus* sp. in the soil rhizosphere. The major yield attributes such as number of flowers, days to 50 per cent flowering, fertility coefficient, number of fruits, fruit length, and fruit girth were also significantly influenced by *NovoBac* and resulted in higher green chilli yield. 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.

06-20(P)

MORPHO - PHYSIOLOGICAL EFFECTS OF BIOSTIMULANT (NOVOBAC) ON YIELD OF VEGETABLE COWPEA (*VIGNA UNGICULATA* L. WALP)

M. Jayalakshmi, P. Jeyakumar, S.Vincent, N.O. Gopal and C. Vijayalakshmi
Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003
Email: jeyakumar@tnau.ac.in

Experiments were conducted at Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during 2010-2011 to study the *physiological effects of biostimulant (NovoBac) on growth and yield of cowpea variety 'VBN 2'*. The morpho-physiological, biochemical, nutritio-physiological and yield parameters of cowpea were significantly influenced by the biostimulant. *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS favourably influenced the plant height. A significant increase in the number of leaves and root length was recorded by *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS. Growth attributes such as leaf area (LA), leaf area index (LAI), leaf area duration (LAD), crop growth rate (CGR) and total dry matter accumulation (TDMA) were significantly improved by the *NovoBac* treatments. Among the treatments, *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS showed its supremacy influencing the growth attributes and physiological traits. The yield and yield components such as days to 50 per cent flowering, number of flowers per plant, number of pods per plant, fertility co-efficient, number of seeds per pod, pod weight per plant, pod length and hundred seed weight were significantly influenced by the biostimulant (*NovoBac*). The quality of seeds was also improved by this treatment through enhanced

protein content. It is concluded from the present study that *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS resulted in higher vegetable pod yield (6.22 t ha⁻¹). However, considering the B:C ratio, (*NovoBac* seed treatment @ 2g/kg + soil drenching @ 250g/ha on 15 DAS was found to record higher ratio of 1: 2.26

06-21(P)

PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN VEGETABLE COWPEA (*VIGNA UNGICULATA* L. WALP) DUE TO BIOSTIMULANT (NOVOBAC)

P. Jeyakumar, M. Jayalakshmi, S.Vincent, N.O. Gopal and C. Vijayalakshmi

Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-641003

Email: jeyakumar@tnau.ac.in

An experiment was conducted at Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during Rabi, 2010 to study the physiological effects of biostimulant (*NovoBac*) on growth and yield in vegetable cowpea var. VBN 2. The experiment had eight levels of biostimulant comprising seed treatments with *NovoBac* @ 1g or 2g, soil drenching with *NovoBac* @ 250g or 500g per ha and their combinations, apart from control. Total dry matter production (TDMP) was conspicuously increased with various levels of biostimulant (*NovoBac*) treatments. Among the different treatments, *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 days after sowing (DAS) recorded high total dry matter production (TDMP) of 30.59 g plant⁻¹ showing an increase of 13 per cent over control. The biochemical observations revealed that the same treatment recorded increased chlorophyll (2.0 mg g⁻¹) and soluble protein (27.4 mg g⁻¹) at flowering stage. The enzyme analysis also revealed that *NovoBac* treatment recorded the lowest IAA oxidase activity by registering highest levels of unoxidised auxin (155.0) at flowering stage. The uptake of nitrogen (N), phosphorus (P) and potassium (K) by plants was found higher in the *NovoBac* treatment at all stages of crop growth. The maximum pod yield of 6.22 t ha⁻¹ was registered in plants those received *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS. A close scrutiny of the data on correlation studies showed that grain yield was significant and positively correlated with the traits such as TDMP chlorophyll, soluble protein, IAA oxidase activity, NPK uptake, soil bacterial population and dehydrogenase activity. It is concluded from the present study that *NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAS resulted in maximum vegetable pod yield. But, *NovoBac* seed treatment @ 2g/kg + soil drenching @ 250 g/ha on 15 DAS) was found to give higher economic returns in terms of B:C ratio.

06-22(P)

ALLELOPATHIC EFFECT OF *CELOSIA ARGENTINA* L. ON SEED GERMINATION, GROWTH AND ENZYME ACTIVITIES OF *PENNISETUM TYPHODES* BURM.

A.B. Kamble and A.A. Inamdar

Department of Botany and Plant Protection, S.G.M. College, Karad (Maharashtra)

Allelopathy refers to beneficial or harmful effect of one plant to another. In agricultural land many unwanted plants produce enormous seeds. These seeds are easily spread and germinate rapidly in the field. The weed species release chemicals from different parts. In Present investigation effect of leachates on seed germination, growth and enzyme activities is studied. General determined effect observed on various parameters of *Pennisetum typhodes* Bunn.



06-23(P)

BRASSINOSTEROIDS–INDISPENSABLE FOR PLANT GROWTH AND SURVIVAL

S. Seeta Ram Rao

Department of Botany, Osmania university-Hyderabad-500 007

Email: ssrrao2002@rediffmail.com

Brassinosteroids are polyhydroxy steroids widely distributed in the plant kingdom. The initial studies in 1970's employing the pollen extracts of rape (*Brassica napus*) on the growth of bean second internodes and subsequent extraction and isolation studies brought to the fore the growth promoting nature of brassinosteroids. The occurrence of this novel group of substances in all taxonomic groups of plant kingdom has been established. As these groups of substances fulfill all the prerequisites to be considered as phytohormones, brassinosteroids are now classified as sixth group of phytohormones. Apart from plant growth promotion (which is by means of both cell division and cell elongation), brassinosteroids regulate diverse developmental process such as seed germination, morphogenesis, maturation, senescence and abscission. Brassinosteroids also implicated in regulation of flowering, fruit set, development and ripening. Their role in root development remains still controversial. The studies employing brassinosteroid deficit and brassinosteroid insensitive mutants of *Arabidopsis* (*brl1*, *cpd1*, *dwf*), pea (*lkb*), tomato (*d*, *dpy*, *curl-3*), faba bean (*bdd*) provided clinching evidence regarding the essentiality of brassinosteroids for normal growth and development. Further, the investigation with brassinazole a specific inhibitor of brassinosteroids provided compelling proof for the indispensability of brassinosteroids for plant growth. Brassinosteroids also confer resistance to plant against abiotic and biotic stress. The abilities of brassinosteroids to alleviate drought stress, amelioration of salinity and to counter act the impact of temperature extremities is proved. Much of the present focus is to explore the possibility of improving the performance of crop plants challenged with metal toxicity and the results of the studies employing lead, cadmium, and aluminum are quite promising. Much headway has been made to unravel the molecular mode of action of brassinosteroids. Fine details of membrane receptor proteins, the binding of brassinosteroids and subsequent cascading events leading to activation of genetic and metabolic machinery are recently brought into light. The paper presents an overview of brassinosteroids research highlights their importance in plant growth, development and metabolism. The presentation also shares latest information on the molecular mode of action. The paper discuss the prospects of large scale use of commercial brassinosteroids for crop improvement and also attempt to annual the apprehension on the use of these chemicals.

Session 07

Physiology of Flowering and Seed

07-01(O)

EFFECT OF EXOGENOUS POLYAMINE AND PRE-ANTHESIS HEAT SHOCK ON EXPRESSION OF SMALL HEAT SHOCK PROTEIN AND STARCH STRUCTURE AGAINST POST-ANTHESIS HEAT STRESS IN WHEAT (*TRITICUM AESTIVUM*)

Ranjeet R. Kumar^{1*}, Suneha Goswami¹, Sushil K. Sharma¹, Khushboo Singh¹, Manorama Singh¹, Kritika A. Gadpyle¹, S. D. Singh², Himanshu Pathak² and Raj D. Rai¹

¹Division of Biochemistry, ²Division of Environmental Science, IARI, New Delhi-110012

*ranjeetranjaniari@gmail.com

Exposure of plants to sub-lethal doses of heat stress activates the defense mechanism to protect the cells from ROS which cause severe damage to the plants. Here, we report cloning of HSP17 from C-306 cultivar of wheat having 573bp with ORF of 162aa. *In silico* characterization showed the presence of alpha crystalline domain in the sequence. Quantitative Real Time PCR analysis of HSP17 showed expression of 16, 34 and 30 fold (C-306) and 18, 28 and 30 fold (Kanchan) during pollination, milky dough and seed hardening stages in response to pre-anthesis treatment of putrescine (2.5mM+HS). Similarly, transcript profiling of HSP17 in HD2329 showed maximum change in expression of 1.3 fold (Put_{1.5mM}+HS), 1.5 fold (HS) and 1.5 fold (Put_{1.5mM}+HS) during pollination, milky dough and seed hardening stages. In case of PBW343, change in expression of 5.2, 4.2 & 4 fold was observed during pollination, milky dough and seed hardening stages in response to treatment of putrescine (2.5 mM+ HS). Western blot analysis showed single band of ~17KDa in both the cultivars (C-306 & PBW343) with constitutive expression against putrescine (1.5 & 2.5mM) and different heat shock treatment. The accumulation of protein was more in case of C-306 compare to PBW343. Scanning electron microscopy of starch granules showed crumbled cell compartments with deformed starch structure, less number of granules and cracks on the surface in case of C-306 & PBW343 against heat shock whereas, well-structured cell compartments with large number of intact starch granules were observed in case of C-306 against pre-anthesis putrescine treatment (2.5mM+ HS). There is a need to further characterize different small HSPs and their expression profile in response to different concentration of polyamines, so that it can be used to enhance the total thermotolerance capacity of the plant against heat stress.

07-02(O)

EFFECT OF HIGH TEMPERATURE ON SPIKELET FERTILITY, HEAT SUSCEPTIBILITY AND GRAIN YIELD OF RICE GENOTYPES

I.M. Khan and O.P. Dhurve

Department of Plant Physiology, JNKVV, College of Agriculture, Rewa 486001 M.P.

imkagcrewa@rediffmail.com

Variation in weather pattern are known to have occurred in recent years found less precipitation and high temperature caused reduction in crop production. Therefore, twenty five rice breeding lines were evaluated for their relative terminal heat tolerance under heat stress (H1) during anthesis (polyethylene tunnel were used) and normal (H2) conditions. All the characters studied were significantly affected by heat stress. Grain yield m⁻² ranged from 225g to 767g with an average of 559g under heat stress conditions where the mean day temperature increased by 3.5°C and mean night temperature was 1.8°C higher than normal environment conditions where, grain yield ranged between 592 g to 942g. The reduction in grain yield in H1 from H2 ranged from 17 g to 417 g m⁻² with an overall reduction of 157g. Number of unfilled grains panicle⁻¹ reduced to the extent of 45.7% from normal environment, whereas number of filled spikelets panicle⁻¹ and higher spikelet sterility resulted in lesser number of grains panicle⁻¹. Mean number of filled grains panicle⁻¹ ranged from 102 to 177 grains with mean of 145 grains in H1 while under normal H2 it was 158 grains. Seven rice breeding lines including Triguna (c) exhibited high spikelet sterility (10 to 26%). Fourteen genotypes medium (5 to 10%) and only three genotype

exhibited less than 5% spikelet sterility. The mean reduction of 3.94% in 1000 grain weight is 17.8% in total dry matter were found in terminal heat stress environment than normal indicating the influence of heat stress. The heat stress susceptibility index (SSI) among genotype ranged from 0.026 to 0.649 indicating great sensitivity of rice breeding lines to terminal heat stress. Four genotype exhibiting tolerance to heat with <0.1 SSI while, ten showing intermediate with 0.1 to 0.2 SSI and remaining eleven were found susceptible to heat stress during anthesis with >1 SSI. Minimum reduction in grain yield of IET-20907, IET-20924, IET-21009 and IET-21523 under terminal heat stress and displaying lower SSI (<0.1) indicated their tolerance with yield stability.

07-03(O)

EVALUATION OF RICE GERMLASM AND INTROGRESSION LINES FOR HEAT TOLERANCE AT GERMINATION AND SEEDLING STAGE

V. Vishnu Prasanth, D.V.N. Chakravarthi, T. Vishnu Kiran, Y. Venkateswara Rao, Madhusmita Panigrahy, S.R. Voleti and N. Sarla

Directorate of Rice Research, Rajendranagar, Hyderabad-500 030

Forty rice lines including 23 introgression lines (IL) derived from BC2F6 of Swarna x *O. nivara* and KMR3 x *O. rufipogon* and 3 mutants of N22 were evaluated for heat tolerance at germination and seedling stage. Three replicates of 10 seeds each were placed in filter paper lined petri dish moistened with sterile distilled water and incubated at 30°C, 35°C and 40°C each in dark. One set maintained at ambient temperature was considered as control and also replicated thrice. Germination began within 24h after incubation and was completed on the 5th day in control and 30°C but delayed upto 9 days at 35 and 40°C. Six ILs, 248, S50, 230K, 3-1S, 463 and 7K showed more than 95 % germination in five days of incubation at 40°C. At 5 days after incubation germination ranged from 53 to 100% at 30°C and 27 to 100% at 40°C. 12 lines including Swarna, Jalmagna and ILs showed 95% germination at 30°C and also at 40°C. The maximum reduction between 30°C and 40°C was 50% observed in IET20935. Four ILs S50, 198, 175-2 and 248 showed 4-8% increase in germination at 40°C compared to 30°C. At 11 days after germination mean shoot length ranged from 6.7 in IL175-2 to 11.1 in IL90-5 at 30°C and from 1.7 in NH 787 to 8.7 in Madhukar at 40°C. Jalmagna, a deep water rice and Nagina22 (N22), a heat tolerant variety had shoot length of 8.3 and 7.9 cm respectively at 40°C. The minimum shoot length of 1.7 and 1.9 cm was observed in N22 mutants NH787 and NH686 respectively. The mean root length ranged from 6.3cm in NH219 to 11.4cm in IL-230K at 30°C. It was more than 10cm in 3 lines IL230K, IL198 and IET 20915. At 40°C, IL3-1S (7.4 cm) and IET20907 (7.2 cm) showed maximum root length. The minimum root length was 0.8 cm in NH686. In general, mean shoot and root length reduced with increase in temperature from 30 to 40°C. The two N22 mutants NH686 and NH787 showed the maximum reduction of 87 to 83% in shoot length. IET20907 showed the least reduction of 10% only. Jalmagna and Madhukar showed 2 to 6 % increase in shoot length correspondingly. Jalmagna and ILs S-117 and 3-1S showed less than 10% reduction in mean root length from 30°C to 40°C. Two way ANOVA, using SAS program revealed a highly significant ($p < 0.05$) difference between the genotypes for the effect of temperature on % germination, and mean shoot and root length. Thus, the deep water rice varieties Jalmagna and Madhukar, an elite line IET20907, Swarna-*O. nivara* ILs 166-2, 175-2, KMR3-*O. rufipogon* ILs 50 and 463 can be considered as heat tolerant or having the capacity to acclimatize to constant high temperature at germination stage and seedling stage compared to N22, a known heat tolerant variety. The two N22 mutants NH686 and NH787 were loss of function mutants for heat tolerance. These were earlier identified as gain of function mutants for phosphorus use efficiency. The other Swarna-*O. nivara* introgression lines 3-1S and 248 and IET 21528 were also heat tolerant but less than N22. Thus, a large number of lines can be screened for heat tolerance at germination and seedling stage using this simple method. It is interesting to note that all the elite lines identified here for heat tolerance are known for their drought, salinity or submergence tolerance indicating considerable overlap of pathways for conferring abiotic stress tolerance. Mechanisms such as ROS scavenging ability are being further investigated in these lines.

07-01(P)

EFFECT OF TEAK PERENNIAL VEGETABLE BASED AGROFORESTRY SYSTEM ON BIOPHYSICAL PARAMETERS OF LEGUMES

H.Y. Patil, M.B. Chetti, S.J. Patil, S.M. Mutanal and B.N Aravind Kumar

Department of Plant Physiology and AICRP on Agroforestry, UAS, Dharwad, Karnataka

Diversity of crop species within a cropping system has been one of the main goals of agroforestry. The importance of agri silviculture in attaining this goal had been clearly shown by several workers. The challenge in agrosilviculture has been to plant optimally spaced trees to produce high output at the same time not compromise on the yield of under storey crops to the extent to which it becomes an uneconomical enterprise. Agroforestry plays a vital role in sustainable production in rainfed agriculture in humid condition. Where in the perennial component is compulsory, teak is the king of timber and can be integrated with perennial vegetables and field crops to meet the ever increasing demand for wood, vegetables and the grain. Ecophysiological changes and microclimate variations have been the object of studies in agrisilvicultural systems in the recent past. Stomatal conductance, transpiration rate, canopy and leaf temperature have been shown to change beneficially for the crop in many tree crop interface experiments. Reduced rate of transpiration with a concomitant increase in resistance to water flow in stomata, increase in relative humidity under tree canopy and effective utilization of photosynthetically active radiation transmitted through the tree canopy for sufficient photosynthetic production throughout the growth stages of annual understorey crops are the important characteristics one has to look for in agrisilvicultural systems. As trees (Mandatory component) mature, apart from changing the microclimate, they create a succession of different opportunities for intercropping thereby reconciling with reduced agricultural productivity and sustainability. Considering all the above aspects the present study was undertaken with the objectives to find out the influence of teak trees on different biophysical parameters of associated legume crops and perennial vegetables in an agroforestry system. Photosynthetic rate was reduced under shade which coincided with mesophyll conductance reflecting the poor carbonization activity in the mesophyll. It clearly indicated that the photosynthetic enzyme RuBp carboxylase might have some limitation under shade to fix carbon dioxide. Lower photosynthetic rate (19% reduction) in rice cultivars under shaded conditions has been reported. The biophysical parameters like photosynthetic rate, stomatal conductance, transpiration rate and light transmission ratio were less in agroforestry system as compared to sole crop treatments; whereas, the relative water content was more in agroforestry system or in shaded condition.

07-02(P)

LOCATION VARIATION IN VEGETATIVE AND FLOWERING BEHAVIOUR OF MANGO IN KONKAN REGION

K.H. Pujari, S.L. Ghawale and K.A. Shinde

Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli ; Email: kiran.shinde48@gmail.com

One year field trial aimed at studying location effect on vegetative and reproductive growth behaviour of Alphonso mango was conducted in Ratnagiri district of Maharashtra during 2009-10. The study was taken at four different locations viz. L_1 – near sea face 0-0.5 km, L_2 – 3-4 km from sea face, L_3 – 10 km away from sea in soil, L_4 – 10 km away from sea in rocks. The investigation was conducted in RBD the observation on new shoot emergence and flowering percentage was recorded. Results indicated that all four locations significantly influenced the vegetative and flowering behaviour of Alphonso mango. The new shoot emergence was significantly higher near sea face (L_1 and L_2) due to high wind velocity and temperature compared to location away from sea (10 km) which showed less shoot emergence (41.6%). Near sea face (0-0.5 km) early (November-January) and profuse flowering (90.8%) was observed.

07-03(P)

PHYSIOLOGICAL BASES OF DORMANCY AND DORMANCY BREAKING BY CHEMICALS, TEMPERATURE AND GROWTH REGULATORS IN GLADIOLUS

K. Pal, A. Bhatt and S.K. Guru

Department of Plant Physiology, G.B.PUA & T, Pant Nagar-263145
kanakvarshney@gmail.com

Dormancy of corm and cormels is one of the major hindrances in the commercial cultivation of gladiolus. The physiological bases of corm and cormels have been ascribed to the accumulation of growth inhibiting substance like ABA and phenolics. A study was conducted to break dormancy of corm and cormels by treatment with different chemicals, growth regulators, cold storage (store in refrigerators at 4°C) and room temperature (store in room at 25-28°C) in varieties Rose supreme and White prosperity. The biochemical parameters such as carbohydrate content, phenolic content and quantification of ABA by ELISA method was estimated from gladiolus corms. Freshly harvested corms had higher contents of ABA (40 n mole/g FW in Rose supreme and 25 n mole/g FW in White prosperity) and phenolics (4.13 mg/g FW in Rose supreme and 6.68 mg/g FW in White prosperity). There was decline in ABA and phenolic content at room temperature or cold storage, GA₃, thiourea and ethrel. Ethrel @ 200 and 400ppm showed earliest sprouting followed by thiourea and GA₃. Breaking dormancy by growth regulators can be correlated to reduction of ABA and phenolic, increase in carbohydrate content in the freshly harvested corms.

07-04(P)

EFFECT OF DESICCATION AND STORAGE TEMPERATURE ON GERMINATION OF LAWSONIA INERMIS

Manisha Sharma, Manish Das* and S. Pramod

Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand -387 310, Gujarat
*manishdas50@gmail.com

Lawsonia inermis commonly known as 'Henna' is a well-known plant used in Indian medicine belongs to the family Lythraceae. The seeds of *L. inermis* have slow and erratic germination particularly during long term storage. Thus, in the present study, the effect of desiccation and storage temperature on germination of *Lawsonia inermis* from two eco-climatic regions of India; viz. DMAPR, Gujarat and IIHR, Bangalore were studied. The seeds from DMAPR showed relatively more germination percentage at 30°C than Bangalore seeds. The effective targeted moisture content (TMC: 5, 10 and 12%) also varied between DMAPR and Bangalore seeds. The former showed highest germination and storability at 10% TMC whereas, the latter had maximum germination percentage at 5% TMC. In all experiments, both Bangalore and DMAPR seeds showed maximum germination at 30°C in those stored at -20 and 20°C upto 9 months, while after 12 months germination percentage was found to be declined in seed stored at -20°C. Although the seeds stored at 30°C showed similar germination behavior upto 3 months, a drastic reduction in germination percentage was noticed after 6 months. In DMAPR seeds, the mean germination time (MGT) was more in the treated seeds compared to control and MGT further increased with storage duration. On the other hand, after 12 months, the MGT of seeds stored at 20°C was relatively lower to control and other treatments. The vigour index (VI) was also higher in seeds stored at -20 and 20°C after 10 and 12% TMC gain. In contrast to DMAPR seeds, Bangalore seeds after 5% and 10% TMC enhancement showed a less MGT compared to control. However, the desiccation of seeds to 12% moisture content resulted in an increase of MGT. The vigour index was also higher in seeds stored at -20 and 20°C after desiccation of seeds down to 5% and 10% moisture content. Our study shows that desiccation to the range of 5-10% moisture content and storage at -20 and 20°C have significant effect on the improvement of seed germination of *Lawsonia inermis* upto one year.

07-05(P)

AN OVERVIEW OF PHYSIOLOGY OF FLOWERING IN CITRUS

A.D. Huchche

National Research Centre for Citrus, Amravati Road, Nagpur - 440 010

The flowering in Citrus is recurrent under tropical and subtropical conditions unless synchronized into a well-defined period of concentrated bloom by external conditions in sub-tropical areas during the winter months, air and soil temperature falls below about 5°C for several weeks which causes growth to cease for three to four months. Such a cessation of growth induces greater tolerance to frost damage and causes changes within the buds which induce flowering when subjected to warmer temperatures. In a typical sub-tropical climate with cool winters, citrus tends to bloom profusely in the spring and set only one major crop which matures in late fall or winter or even the following spring depending on variety and seasonal temperature regime. Flower information in citrus species is promoted by drought or low temperature, followed by restoration of climatic conditions favourable for growth. The flowering can be induced by low temperature or water stress and inhibited by applied gibberellin. Application of GA₃ inhibited the drought induced flowering in Eureka lemons, while growth retardant cycocel could replace water stress treatment and promoted flowering in lemons. The chemical compounds such as CCC, SADH and benzothiazole were observed to promote flowering in lemons. Paclobutrazol, an inhibitor of GA biosynthesis has shown a good promise both as a soil drench and foliar sprays in cultivars like Satsuma and Nagpur mandarin. The other compounds such as NAA and ethchlozate have been practised during heavy “on year” to minimise the recurrence of alternate flowering.

07-06(P)

CHANGES IN SUGARS DURING PETAL SENESCENCE IN CUT FLOWERS OF *COSMOS BIPINNATUS*

Goral Jani and Archana Mankad*

*Department of Botany, School of Sciences, Gujarat University, Ahmedabad-380009, Gujarat

Various parameters of sugar metabolism such as total sugars, reducing sugars and non-reducing sugars metabolites and corresponding enzymic activity of invertase was studied during the shelf-life of cut flowers of three varieties – Sonata White, Sonata Pink and Sonata Carmine of *Cosmos bipinnatus* Cav. The stabilized amount of total sugars in all the three varieties were found to be decreasing during the later phase of post harvest shelf life whereas the reducing sugars had a decreasing trend with a rise before pre-senescent phase. The amount of non-reducing sugars showed increase during the evaluation period with a fall near the pre-senescent stage. The invertase activity in all the three varieties was found to be decreasing. This suggests that the role of some metabolism which maintained the amount of total sugars initially even under the cut conditions when there was no other source of nutrition for the cut flowers. The later drop in the amounts could have acted as a trigger of senescence. The decrease in the reducing sugars was possibly due to their incorporation into non-reducing sugars. The increase in the non-reducing sugars can also be attributed to their accumulation because of lesser activity of catabolic enzyme (invertase). But the trigger of senescence caused the breakdown of non-reducing sugars leading to rise in reducing sugars before pre-senescent period. The lowered activity of invertase was possibly due to inactivation of invertase or increase in invertase inhibitor protein. Among the three varieties, the carmine variety was found to perform better in terms of significant difference in the values of the parameters studied.

07-07(P)

**SEED GERMINATION AND ENZYME ACTIVITY IN *SILYBUM MARIANUM* (L.)
GAERTN: AN IMPORTANT MEDICINAL PLANT**

Manish Das* and Manisha Sharma

Directorate of Medicinal and Aromatic Plants Research, Boriavi – 387310, Anand, Gujarat

Milk thistle (*Silybum marianum* L.) is an ancient medicinal plant belonging to the family Asteraceae used to purify and protect the liver. It positively affects all forms of liver disease, grows natively in the Mediterranean and is widespread in other regions in the world including India. Since ages milk thistle extracts were used as medicine and became a favored remedy for *hepatobiliary* diseases in the 16th century. The silymarin flavonolignans protect liver cells against oxidative stress and tissue damage. Information on various aspects of seed is lacking in this species as it is vitally important for re-generation of plants as well as for *ex-situ* conservation of seeds in seed banks. Further, information about the seed behaviour is less hence studies were conducted on seed morphology, dormancy, germination and seed vigour. Experiments on seed germination and its enzyme activity during imbibition and at the time of onset of germination were also studied. Germination was maximum (75-81%) at 20 and 25 °C with onset and completion of germination possible in 3-5 days and 7-10 days, respectively. There was no dormancy observed in the seeds. Mean germination time (MGT) was recorded in the range of 2.5-3.8. Activity of enzymes ‘ α -amylase’ and ‘ β -amylase’ were also found in *S. marianum* seeds and it was found that α -amylase is present in the dry seeds of silybium and its activity increased rapidly after 12 h of imbibition till onset (here it is 2 days). In cotyledons, α -amylase activity increased after 2 days of onset and thereafter there was sharp decrease in its activity at 4 days after onset and so was the case in growing axis. During germination of *S. marianum* seeds, α -amylase activity decreased while, in contrast, β -amylase activity increased (in the cotyledons and growing axis of germinating seeds). ‘Malate dehydrogenase’ (MDH) activity increased in imbibing seeds till onset of germination. MDH activity also increased in growing cotyledons and in growing axis at 4 days after onset of germination. Increase was significant at 20 °C as compared to 25 and 30 °C. Protein content was also maximum at onset after imbibition and so as in cotyledons and in growing axis, however, at 4 days after onset protein content decreased in both cotyledons and growing axis. It was observed that seeds could be stored without losing viability after two years of storage with seed germination upto 60%.

07-08(P)

**EFFECT OF STORAGE PERIOD ON THE GERMINATION OF FOXTAIL MILLET (*SETARIA
ITALICA* (L.) BEAUV.) GERMPLASM IN LABORATORY CONDITIONS**

Vandana Bhakuni and Rajendra Prasad

*Department of Seed Science & Technology, College of Forestry & Hill Agriculture, Hill Campus
Ranichauri- 249199. G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India*

In the present study quantification of the response of germination rate to storage period of different genotypes of foxtail millet was recorded at the Seed Testing Laboratory at Department of Seed Sci. and Tech., Hill Campus, Ranichauri. Forty-six genotypes of foxtail millet were harvested at the end of Sep. 2010. Seeds were threshed and stored in normal paper bags for six months in room conditions. After six months three replications of each genotype were planted on moist blotter paper as per ISTA. The closed petriplates were placed in a germinator at 25±1 for 10 days. Results indicated that germplasm GS-1914 showed highest germination %. Genotype GS-1911 showed the highest value for vigour index II whereas highest value was recorded in ISC-1183 for vigour index I. This information can be used in evaluation of appropriate sowing time for different genotypes, or other objectives such as prediction of storage period.

Session 08

**Post Harvest Physiology of
Perishables and Senescence**

08LI-01 (L)

PHYSIOLOGICAL AND BIOCHEMICAL BASIS OF SENESCENCE IN CUT FLOWERS

V.P. Singh and Ajay Arora

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

Email: drsinghvp@yahoo.com

Flowers are highly perishable in nature and it is estimated that nearly 30% are rendered unmarketable because of post harvest quality losses. High rate of metabolism in harvested flowers leads to rapid deterioration and loss of vase life and quality. Major factors which determine storage and vase life of floral crops are temperature, water relations, membrane properties (lipids/proteins), carbohydrate supply and growth regulators. Loss is very high in tropical regions with scarce facilities for refrigeration. Floral senescence in many species is regulated by ethylene biosynthesis. However, in other species flower senescence is not initiated or progressed by exogenous ethylene. Flower senescence operates independently of ethylene production in these species. It remains unclear in these species how senescence process is initiated and importantly, how the process is regulated. Flowers of *Gladiolus* are insensitive to ethylene. *Gladiolus* flowers show visible signs of senescence/degradation just 24 h after flower opening. This is preceded by increases in ion leakage. Since losses of membrane differential permeability have been linked to reactive oxygen species (ROS), we are hypothesizing that senescence of *gladiolus* flower is controlled in part by reactions associated with ROS. Antioxidants protect cell against active oxygen species by scavenging them. Application of 5-sulfosalicylic acid, alpha lipoic acid, polyamine (spermine), and polyols (Inositol) enhance the vase life of cut flowers by delaying the flower senescence by retaining fresh weight and MSI for longer time, decreased lipid peroxidation by reducing lipoxygenase activity and TBARS, retaining activity of SOD, Catalase, GR and AP - part of antioxidant system against oxidative damage by free radicals. These parameters lead to less damage to membrane and it can be said that above chemicals act as free radical scavengers hence delayed the senescence. Molecular evidences also support these results. ABA hormone perhaps provides signals that initiate the degradative changes during senescence.

08-01(O)

INFLUENCE OF PACLOBUTRAZOL ON FRUITING OF JACKFRUITS (*ARTOCARPUS HETEROPHYLLUS*)

A.K. Shinde, B.B. Jadhav, R.N. Shelke and S.G. Mahadik

Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.)

The Jackfruits (*Artocarpus heterophyllus*) are grown in Konkan region of Maharashtra, generally get matured in the month of June and July. The rains during June-July causes losses of most of the Jackfruits and fetches less prices every year. To increase the yield and hasten the maturity of fruit, the effect of Paclobutrazol was studied for 3 years during 2008-2011. Paclobutrazol has been known for inducing regular and early flowering-fruitletting in mango and many other fruit crops by inhibiting the GA biosynthesis. The soil drenching of Paclobutrazol @ 3.75 and 7.50 g a.i./tree near manuring ring was done in the month of August for jackfruits. Three years study revealed that, soil application of Paclobutrazol @ 3.75 g a.i./tree was found promising treatment for increasing the no. of fruits, yield of Jackfruit and induced early fruitletting by 4 weeks. There was no significant difference in fruit length, circumference and individual weight of jackfruit due to application of Paclobutrazol.

08-02(O)

DETERMINATION OF GLYCOALKALOIDS IN INDIAN POTATO CULTIVARS

Brajesh Singh, R. Ezekiel and Suruchi Sharma

Central Potato Research Institute, Shimla -171 001, HP
birju16@gmail.com

The potato tubers are known to contain natural bitter-tasting steroidal toxicants, called Glycoalkaloids and about 95% of the total glycoalkaloids (TGA) is comprised of α -solanine and α -chaconine. These are unwanted potato constituents for consumers because they are highly toxic in nature and give bitter-taste. Glycoalkaloids are mostly concentrated in the outer layer of the tubers and the green parts of the tuber have been reported to contain high amount of TGA. Indian potato cultivars have not been analyzed for the presence of glycoalkaloids in them, therefore, it was pertinent to determine glycoalkaloids concentration in the Indian potatoes being grown and consumed in the country. In the present study a method was validated for the analysis of glycoalkaloids using high performance liquid chromatography (HPLC) and this method was used for the estimation of α -solanine and α -chaconine in the peels and peeled tubers of 22 Indian potato cultivars which are being grown in the different parts of the country. Freshly harvested tubers from north-western hills (Kufri, Shimla) were procured and the replicated samples of peels and peeled tubers were analyzed for α -solanine and α -chaconine. The concentration of glycoalkaloids was higher in peels compared to peeled tuber samples. The highest concentration of α -solanine and also α -chaconine was found in the peels of cv. Kufri Megha (5.6 and 13.1 mg/100g fresh wt, respectively). The TGA content in peels was therefore, maximum in Kufri Megha (18.7 mg/100g fresh wt). The common table potato cultivars viz. Kufri Jyoti (5.8 mg/100g fresh wt), Kufri Chandramukhi (4.0 mg/100g fresh wt), Kufri Bahar (5.9 mg/100g fresh wt.) and Kufri Pukhraj (3.4 mg/100g fresh wt) had comparatively lower TGA content in the peels. Similarly, the processing potato cultivars viz. Kufri Chipsona-1 and Kufri Chipsona-2 also had low TGA content in the peels (6.8 and 1.7 mg/100g fresh wt, respectively). The TGA content in peeled tubers in these cultivars was detected to be very low, ranging from 0.8 to 3.5 mg/100g fresh wt. The glycoalkaloids concentration of less than 20 mg/100g fresh wt is generally considered safe for human consumption. In all the analyzed cultivars the levels of TGA was within this acceptable range in peels and was further low in the peeled tubers. This clearly showed that Indian potato cultivars are safe for consumption as far as the glycoalkaloids are concerned.

08-03(O)

EFFECT OF CARBON DIOXIDE CONCENTRATION IN THE STORAGE ATMOSPHERE ON SUGAR ACCUMULATION AND CHIP COLOUR IN POTATOES OF FOUR CULTIVARS STORED AT THREE TEMPERATURES

R. Ezekiel¹, A. Kaul², P. Kumar², A. Sonkusare², A. Mehta¹ and P. Kapur²

¹Central Potato Research Institute, Shimla-171001

²Central Scientific Instrumentation Organisation, Chandigarh -160030

Potatoes of four cultivars viz. Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti, and Kufri Pukhraj were stored at three temperatures viz. 8, 10 and 12°C with 95% relative humidity. Three carbon dioxide (CO₂) concentrations viz. 800 ppm, 1200 ppm and 3000 ppm were used. Reducing sugar, sucrose and chip colour were determined at 30 days interval up to 240 days of storage (DOS). Differences in the reducing sugar levels were observed due to CO₂ concentrations. The reducing sugar level was generally lower at 800 ppm and 1200 ppm

and the differences were not much between these two concentrations. However, at 3000 ppm CO₂ concentration, a clear increase in reducing sugar level was observed. A reducing sugar level of 150 mg/100 g FW, is considered acceptable as generally the colour of chips prepared from potatoes containing reducing sugar less than this limit is acceptable. During storage, the sucrose accumulation followed a trend similar to that of reducing sugar. The sucrose accumulation in potatoes stored at 3000 ppm was lower and the pattern of sucrose accumulation at 1200 ppm and 800 ppm CO₂ concentrations was similar. Chip colour showed a highly positive and significant correlation with reducing sugar (0.82**) and the level of reducing sugar accumulation in stored potatoes had a profound effect on the colour of chips prepared from those potatoes. Irrespective of the storage temperature and CO₂ concentration, chip colour score was generally higher than the acceptable limit (chip colour score of 4 and above) after 30 DOS in Kufri Jyoti and Kufri Pukhraj. In Kufri Chipsona-1 and Kufri Chipsona-2, the chip colour was acceptable for a longer part of the storage period. In Kufri Chipsona-1 stored at 12°C, the chip colour was acceptable up to 180 DOS at 800 ppm, up to 210 DOS at 1200 ppm, and up to 60 DOS at 3000 ppm CO₂ concentration. It was observed that potato chip colour was affected by both temperature and CO₂ concentrations, and the chip colour deteriorated faster at lower storage temperature of 8°C and at a higher CO₂ concentration of 3000 ppm.

08-04(O)

REGULATION OF FRUIT RIPENING THROUGH POST HARVEST TREATMENTS OF GIBBERELIC ACID (GA₃) AND OTHER CHEMICALS ON QUALITY AND SHELF-LIFE OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) CV. ANAND TOMATO-3

Amarjeet Singh Thounaojam and A.D. Patel

Department of Plant Physiology, Anand Agricultural University, Anand-388110

The study was conducted at the main vegetable research station of the Anand Agricultural University, Anand during the period *Kharif-Rabi* 2009-10 with the objective to determine the effects of different concentrations of GA₃ and chemicals on quality and shelf-life of tomato. The experiment consisted of two main factors, factor A with two levels [Breaker stage (S₁) and Red ripe stage (S₂)] and factor B with nine treatments [GA₃ @ 20 and 40 mg/l; KNO₃ @ 2000 and 4000mg/l; KHCO₃ @ 2000 and 4000 mg/l; Boric acid @ 100 and 200mg/l with the control (without spray)] was arranged in 2 x 9 factorial RBD with three replications. The quality parameters *viz.*, total soluble solid (TSS), physiological loss in weight (PLW), decay or rotting, acidity, lycopene, ascorbic acid and carotenoid content influenced by stages of picking and post harvest treatments of GA₃ and chemicals had significant and positive effect over the control. The fruit harvested at red-ripe stage (S₂) exhibited significantly the higher effect on various qualitative parameters. However, significantly the lowest PLW and decay loss were recorded under the fruits harvested at breaker stage (S₁) as compared to the red-ripe stage. The post harvest treatments of GA₃ @ 40mg/l (T₂) recorded significantly the highest TSS (4.23 and 4.62%), acidity (1.43 and 0.95%), lycopene (6.40 and 8.75mg), ascorbic acid (8.52 and 10.05 mg) and carotenoid content (17.33 and 19.25 mg) at initial (after harvest) as well as 6th day of storage, respectively. On the other hand, significantly the lowest PLW (0.18%) and decay loss (33.47%) were observed in the treatment T₂ (GA₃ @ 40 mg/l) and T₁ (GA₃ @ 20mg/l) at 12th day of storage, respectively. While, the interaction effect between the harvesting stages (S) and post harvest treatments (T) had non-significant effects in all the parameters except PLW and decay loss during the storage of tomato fruit cv. 'Anand Tomato-3'.

08-05(O)

**PHYSIOLOGICAL STUDIES ON EFFECT OF PACKAGING MATERIAL FOR STORAGE OF
GROUNDNUT (*ARACHIS HYPOGAEA* L.) PODS**

A.K. Shinde, A.H. Bodare, B.B. Jadhav and R.N. Shelke

Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.)

The groundnut seed of Rabi summer season harvested during April-May do not remain viable for sowing during next Rabi season in Konkan region of Maharashtra. This may be due to high temperature (25-35°C) and humidity (90-95%) during Kharif season i.e. June to September. Therefore for improving storage period, pods were dried at 6% and 8% moisture level and packed in different packaging materials viz Polylined Jute canvas bags, Polylined HDPE bags, Polylined cotton bags, Aluminium foil bags, Aluminium foil bags (seed) and storage bins with moisture absorbent (CaCl_2). The experiment was conducted during may 2010 to January 2011. The seed dried at 6% moisture and stored in aluminium foil bag showed germination above minimum seed certification standard (70%) upto 7 months of storage. The maximum field emergence was showed in pods stored in aluminium foil bags during this storage period. The germination and field emergence were observed higher at 6 per cent moisture level than 8% moisture level. Electrical conductivity of groundnut seed increased with advancement of storage period irrespective of packaging material. Lower EC and sugar percentage was noticed in aluminium foil (pods) bags throughout storage period which indicated that no leaching of sugar and electrolytes during storage in these bags. There was no pest incidence and disease infestation in pods stored in aluminium foil bags and seed stored in aluminium foil bags. Thus, study revealed that pods stored in aluminium foil bag at 6% moisture level by using moisture absorbent were found suitable for storage of groundnut seed which showed higher seed germination, field emergence and low incidence of pest and diseases in hot and humid condition of Konkan region.

08-01(P)

**PREPARATION OF CONCRETE FROM FLOWERS OF *COUROUPITA GUIANENSIS* AND TO
STUDY ITS AROMATIC AND ANTIBACTERIAL PROPERTIES**

Nilima Lankeshwar, Neha Sawakhande and Pritam Nanoskar

Department of Life Sciences, Ramnarain Ruia College, Matunga, Mumbai-400019

India is blessed with many positive factors, which enable it to stand at unique position in agriculture based products. In present study concrete was prepared from flowers of *Couroupita guianensis*. After the plant material has been treated with the solvent, it produces a waxy aromatic compound referred to as a "concrete" Solvent-Methanol. The separation of the aromatic components using Headspace Gas chromatography was done. The separated components were identified and quantified using Mass spectrometry. The essential oil of the cannonball flowers contains various chemical constituents like Limonene, Geraniol, Nerol etc. that are used as Flavouring agents in various industries. The identification of components was done using Aroma Chemicals Library. Comparative study of aromatic components were done using HPTLC Method. Mobile phase used was n-Hexane and ethyl acetate in the ratio 10:10. Stationary phase used was Silica gel 60 F₂₅₄. Three extracts of Cannonball flowers were prepared and run alongwith Lavender oil, rose oil and Jasmine oil. After spotting and detection a comparative study was done between the oils and each of the extracts. The study showed that the extracts may contain the constituents present in Jasmine as well as Rose oil. The antimicrobial properties of flower extracts were carried out. Flowers of varying weights were crushed individually in 1 ml of 10% Methanol and extracts were prepared. Antibacterial activity of the respective extracts and the concrete were found using Agar Cup Method. The microorganism used was *S.aureus*. The zone of inhibition was found to be in increasing order as the concentration of the flower increased. Even the concrete containing a little amount of essential oil showed antibacterial activity.

08-02(P)

NON-APOPTOTIC PROGRAMMED CELL DEATH IN RICE (*ORYZA SATIVA* L.) ROOT DURING AERENCHYMA FORMATION

Rohit Joshi¹, Alok Shukla¹ and Pramod Kumar²

¹Department of Plant Physiology, College of Basic Sciences and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand-263145

²Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012
Corresponding author e-mail: pramodk63@yahoo.com

During soil flooding or waterlogging, diffusion of O₂ from air into the soil is effectively blocked. In waterlogged soil, respiratory consumption by plant roots, soil fauna and microorganisms totally depletes the oxygen. Long term oxygen deficiency triggers functional and developmental responses to promote acclimation to hypoxic or anoxic conditions. These conditions lead to long-term anatomical adaptations such as development of aerenchyma in roots. It is produced by the predictable collapse of root cortex cells, indicating a programmed cell death (PCD) and facilitates gas diffusion between root and the aerial environment. Our ultrastructural studies showed that cell death is constitutive and no characteristic cell structural differentiation takes place in the dying cells than surrounding cells. Cell collapse initiation was observed in the center of the cortical tissues. Collapsed cells were characterized by shorter with radically enlarged diameter. Later, cell death was started by rupturing of plasma membrane, loss of cellular contents and cell wall degradation, while cells nuclei were noted intact. In rice (*Oryza sativa* L.) several features of root aerenchyma formation were noted analogous to programmed cell death (PCD), namely specific cortical cell death, obligate production of aerenchyma under excess water stress and early changes in nuclear structure which included clumping of chromatin, fragmentation, disruption of nuclear membrane and apparent engulfment by the vacuole. These processes were followed by crenulations of plasma membrane, formation of electron-lucent regions in the cytoplasm, tonoplast disintegration, organellar swelling and disruption, loss of cytoplasmic contents, and collapse of cell. Many processes in lysing cells were analyzed similar to structural features of apoptosis, but certain characteristics of apoptosis were found lacking and thus it was classified as non-apoptotic PCD during root aerenchyma development in rice.

08-03(P)

POST HARVEST CARE AND PAPAYA (*CARICA PAPAYA*)

Kavita Rambal

Dept. of Botany, Maharshi Dayanand College of Arts, Science & Commerce Parel, Mumbai 400012

Papaya (*Carica papaya*) is commonly available and is regarded as worlds healthiest fruits. Its ease of propagation, popularity and versatility and relatively short period from planting to production have made it an important food item of many countries. Fruits available in the market get bruised during transportation and handling and are piled over one another. These get readily contaminated with rot or spoilage fungi and can cause severe economic losses. To avoid this problem several techniques have been used. In the present study some cheaply available and ecofriendly materials were tried as preventive measures for post harvest decay control besides extending shelf life of the fruit.

08-04(P)

VARIATION IN ANTIOXIDANTS, CARBOHYDRATES AND THEIR RELATED ENZYMES OF MUSKMELON (CV. MADURI) FRUIT AT DIFFERENT STAGES OF DEVELOPMENT AND RIPENING

Soumya V. Menon and T.V. Ramana Rao*

B.R. Doshi School of Biosciences, Sardar Patel University, Vallabh Vidyanagar, Gujarat – 388120

**E-mail: tadapanenirao@yahoo.com*

Muskmelon (*Cucumis melo* L.) is one of the economically important vegetable crops in the world and the important quality determining parameters of the fruit are carbohydrates and antioxidants. In the present study antioxidants such as phenols, polyphenols, flavanols, anthocyanins, ascorbic acid, carotenoids as well as sweetness related compounds like reducing, non-reducing and total sugars and activities of various enzymes related to these biochemical components in five different stages of development and ripening of muskmelon fruit were evaluated. Although with the advanced ripening of muskmelon fruit, its sugars, phenolics, ascorbic acid and carotenoids increased, other antioxidant compounds like flavanols, anthocyanins and total antioxidant activity, however, decreased. The activities of antioxidant enzymes such as polyphenol oxidase and superoxide dismutase increased gradually towards ripening with their maximum of it in the pre-ripened stage, whereas peroxidase displayed inconsistency in its activity. Sugar metabolizing enzyme, sucrose phosphate synthase, exhibited increased activity whereas sucrose synthase, acid invertase and neutral invertase activities decreased towards ripening of the muskmelon fruit. Softening enzymes were assayed, among which α -galactosidase, pectin methyl esterase showed positive correlation, while polygalacturonase exhibited negative correlation in the softening process. Collectively our data determined the existence of wide variation in the carbohydrates and antioxidants in different stages of development and ripening of muskmelon fruit. Thus the results of the present study are valuable in understanding the pattern of sugar synthesis and accumulation of antioxidants in muskmelon fruit, which in turn help in designing the experiments to dissect out the biosynthetic pathways of these metabolites in muskmelon.

08-05(P)

BIOCHEMICAL AND ORGANOLEPTIC ANALYSIS ON HIBISCUS-ROSA-SINENSIS

Vidhi Shah and Rini Ravindran and Jyoti D. Vora

Department of Biochemistry and Food Science & Quality Control, Ramnarain Ruia College, Matunga, Mumbai-400019

In the quest for novel bio molecules to serve as complementary health care back up in the contemporary sense researchers are now targeting, hitherto less explored options in a plant. Interestingly, the significance of flowers or flowering parts of the plant as Nutraceuticals is both promising and productive. In keeping with the geographic and climatic distribution of Malvacea family in the Indian context, Hibiscus holds immense research potential. Subjects with kidney dysfunction use the nascent floral extract as a natural diuretic. The homogenate of flowers and leaves is topically applied to tackle hair-fall and dandruff. Hibiscus is not only a natural emollient, used for softening or healing the skin but also a very effective antifungal agent, emmanagogue and refrigerant. This research endeavor aims at the quantitative composition of Hibiscus-rosa-sinensis with the view of proximate analysis of protein, fats, fiber, and minerals. The possibility of utilization of the flower as a bio manure was high lighted by studying the effect of it on the germination profile of moong beans. Promising results have been obtained for the same. This research has provided a new dimension to the use of Hibiscus as a good pH indicator in the form of pH paper. This would be of great use as a practical tool to substitute the synthetic pH papers and provide an eco friendly method of testing pH of various solutions. In order to re-emphasize the medicinal quality of hibiscus, an oil preparation for topical application was actualized. This preparation was utilized by a voluntary panel over a defined period of time and the panel endorsed its aesthetic and utilitarian efficacy. Summing up, this endeavor highlighted the multi faceted profile of Hibiscus-rosa-sinensis as a fulcrum for fruitful research methodology.

Session 09

**Biotic Stress, Genomics, Proteomics
and Metabolomics**

09-01(O)

ENHANCEMENT OF SHEATH BLIGHT TOLERANCE IN RICE THROUGH TRANSGENIC APPROACH

R. Saikrishna, G. Chaitanya Kumar and G.J.N. Rao

Crop Improvement Division, CRRI, Cuttack.753006, Orissa; email: repallisaikrishna@gmail.com

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 biotic and abiotic stresses. Enhancement of host plant resistance is the best option to deal with various biotic stresses. The existing germplasm collections of rice may not possess resistance against the target trait. In such cases, genetic engineering methods can help in transfer of specific resistant/tolerant genes from any source into desired genotypes which can effectively provide a solution against these economically important stresses. Significant improvements in the area of transgenics through incorporation of several agronomic traits through various gene transfer approaches have been reported in rice. Sheath blight of rice is regarded as one of the most widely distributed disease of rice. Depending upon the age of the plant, time of infection and severity, it can cause yield losses to the extent of 5.9 to 69 per cent. To address the problem, incorporation of Chitinase (PR-3 group) proteins which are produced in the plant during infection as host defensive mechanism is a promising solution against sheath blight. This present study reports the generation of transgenic rice through introduction of Chitinase 11 gene. PCR assays confirm the incorporation of the gene and the transgenic lines were stable over generations and the transgene is inherited in Mendelian fashion. Transgenic lines in fourth generation were confirmed by Southern blotting and presence of the gene is further confirmed through Reverse Transcription analysis. Further, the attempts to transfer the transgene from Pusa Basmati-1 into Swarna, a mega variety through marker assisted backcross breeding approach is in final stage. The results of the development, inheritance, transgene transfer and the bioassays will be presented.

09-02(O)

IDENTIFICATION OF SUITABLE RICE VARIETIES BASED ON PHYSIOLOGICAL PARAMETERS AND YIELD COMPONENTS SUITABLE FOR RAINFED UPLAND CONDITIONS

V. Raja Rajeswari, P. Pranusha and P. Sudhakar

S.V. Agricultural College, Tirupati-517 502, Andhra Pradesh

Fifteen cultures of rice including four released varieties were evaluated for their suitability to rainfed upland conditions at the wet land farm, S.V. Agricultural College, Tirupati during Kharif, 2010. Among the rice cultures MTU3 followed by MTU-4, MTU-1 and NLR-34449 have recorded higher grain yield (1.70 to 2.17 t/ha). The high grain yielding cultures have also recorded more number of filled grains/plant. MTU3, NLR-34449 and MTU 4 have recorded higher SCMR values at 40 DAS indicating their tolerance to moisture stress during seedling stage. Among the four high grain yielding cultures NLR-34449 recorded higher values for physiological parameters viz. photosynthetic rate, transpiration rate and Stomatal conductance ratio. The cultures viz. MTU 10, MTU 9, MTU 2, MTU 5, MTU 6, BPT 5204 though recorded higher photosynthetic rate, transpiration rate and stomatal conductance ratio, but were found to be low grain yielders because of low harvest index, more number of ill filled grains/plant.

09-03(O)

**VARIETAL IDENTIFICATION OF COTTON CULTIVARS BY SDS PAGE ELECTROPHORESIS
/ ELECTROPHORETIC TECHNIQUE**

Kavita P. Kumari and S. Madan

*Department of Genetics and Plant Breeding, Cotton Section, CCS Haryana Agricultural University,
Hisar-125004, Haryana*

Six cultivars of cotton (RCH-134, Bio-6488, H-1236, HHH-223, HD-123 and AAH-1) were grown in screen house having four salinity levels as control, 4, 8 and 12 dSm⁻¹ and samplings were done at two stages i.e. 30 days after sowing and 60 days after sowing. Results revealed that with progressive increase in salinity levels (4 to 12 dSm⁻¹) there was decrease in various physiological parameters viz. seed germination, vigour index, relative water content of leaves, osmotic potential, stomatal conductance, transpiration rate as well as K⁺ content of leaves. However, on the contrary there was enhanced activity of catalase, peroxidase enzyme and Na⁺ content of leaves with the increase in salinity levels. Maximum reduction in seed germination was recorded in *desi* cotton cultivar HD-123 at highest level (12 dSm⁻¹) of salinity. The maximum enhancement in both the enzyme activity was recorded in *Bt.* cotton cultivars at both the sampling stages. The Na⁺ content in leaves of all the cultivars of cotton increased with increasing salinity level. The maximum accumulation of Na⁺ content in leaves was maximum in *desi* cotton cultivars HD-123 followed by American cotton cultivars. However, potassium content of all cotton cultivars showed decreasing trend with increasing salinity levels. K⁺/Na⁺ ratio in leaves of all cotton cultivars also decreased with increasing salinity levels; decrease being highest in *Bt.* cotton cultivars and minimum was recorded in *desi* cotton cultivars AAH-1. On the basis of work done, observations recorded on the score-card revealed that *Bt.* cotton cultivars RCH-134 and Bio-6488 were found tolerant to salinity. Both *Bt.* cotton cultivars (RCH-134 and Bio-6488) showed maximum number of polypeptide bands i.e. fourteen in SDS-PAGE electrophoretic technique, while *American* cultivar showed total number of thirteen polypeptide bands while *desi* cultivars had twelve in AAH-1 and fourteen in HD-123.

09-01(P)

AEROMYCOLOGICAL STUDIES OF GROUNDNUT FIELD AT NASHIK (MAHARASHTRA)

M.D. Sonawane and S.G. Kotwal

K.T.H.M. College, P.G. Dept. of Botany, Nashik-422 002

Present investigations deals with aeromycological studies over groundnut (*Arachis hypogae* L.) Field at Nashik. Groundnut is an important oil seed crop in many tropical and subtropical regions of the world. During investigations total 48 fungal spore types were recorded. The period of investigations was from August 2004 to November 2004, the studies were carried out by using Tilak Air Sampler. The incidence and percentage contribution of individual spores was recorded separately. Maximum percentage contribution of following spores were observed. *Cladosporium* Contributed in highest number 9.23% to the total airspora. It was followed by *Alternaria* 7.45%, Uredospores 5.79%, *Cercospora* 5.27%, *Leptosphaeria* 4.54%, *Curvularia* 3.34%, *Helminthosporium* 2.86%, *Pithomyces* 3.71% to the total aerospora. Rust disease of groundnut caused by (Uredospores) *Puccinia arachidis* and Tikka disease caused by *Cercospora arachidicola*. These diseases are responsible for losses in yield of groundnut crop. These studies are helpful to provide information towards disease forecasting system.

09-02(P)

SOIL SOLARIZATION: AN ECO-FRIENDLY METHOD OF MANAGEMENT OF SOIL BORNE DISEASE

Satish A. Bhalerao

Environmental Sciences Research Laboratory, Department of Botany,
Wilson College, Mumbai - 400007

Soil solarization is one of the soil disinfestations methods of disease control. Soil solarization was developed for the first time in Israel and has been used successfully to reduce pollution of certain soil borne diseases. It's a natural hydrothermal process of disinfecting soil from plant pests that is accomplished through passive solar heating. Solarization occurs through a combination of physical, chemical and biological mechanisms and is compatible with any other disinfestations methods to proven integrated pest management. Soil solarization has been mainly used for disinfecting soils in areas where air temperature is very high during summer and much of crop land is rotated out of production due to excess heat. Solar energy can be used to kill weeds, weed seeds and pathogen. It involves trapping of solar heat energy through polythene covering to raise the soil temperature to the levels where it becomes lethal to temperature sensitive or mesophilic soil organisms. It is non-chemical technique, controls many soil-borne pathogens and pests. Soil solarization also improves plant nutrition by increasing the availability of nitrogen and other essential nutrients. Reduction in disease incidence in solarized soil depends on the host, pathogens and surrounding environments as well as physical and chemical environments, which affect the activity and interrelationships of the organisms which acts as a mechanism of disease control. It can be done only where climate is hot, expensive because of no possibilities of reusing plastic, heat tolerant pathogens may evolve due to repeated solarization, and some time may harm useful fungal population.

09-03(P)

MANAGEMENT OF *PARTHENIUM HYSTEROPHORUS* THROUGH NATURAL COMPETITORS

Jai Knox¹ and M.S. Paul²

¹Department of Botany, Wilson College, Mumbai-400 007

²Department of Botany, St. John's College, Agra-282002

Parthenium hysterophorus L. one of the worst weed of the world has now spread throughout India except extreme deserts of Rajasthan and higher altitudes of Himalaya and posing a serious threat to animal/human health, crop production, biodiversity of indigenous vegetation and ecotourism. Surveys were conducted during 2004-09 in Northern U.P. to find out the potential of natural enemies for suppression in this noxious weed. Phytosociological studies revealed that the occurrence of *Parthenium* was highly reduced in the area occupied by *Calotropis procera* to the tune of 70% and was found to be significant ($P < 0.05$) which was closely followed by *Croton bonplandianum*. Biochemical studies revealed that *C. procera* reduced the chlorophyll nitrogen and proteinto a remarkable extent. An attempt was made to evaluate the competitive ability of natural competitors on biomass of *Parthenium*. The results revealed that the foliar extract of *C. procera* reduced the biomass significantly.



09-04(P)

PROFILING OF PHENOLIC CONTENT OF RICE GENOTYPES AND ITS RELATIONSHIP TO THEIR COMPETITIVENESS AGAINST WEEDS

Babita Patni, and S. K. Guru

Department of Plant Physiology, C. B. S. H., G. B. Pant University of Agriculture and Technology,
Pantnagar. (U. S. Nagar). Uttarakhand. Pin – 263145
e-mail: babita28paatni@rediffmail.com

Weed infestation is a major problem in rice cultivation worldwide causing severe yield losses. Weed management by herbicides constitutes a major input in rice production systems. In order to reduce the herbicide load into the environment competitive rice cultivars can be a suitable component of integrated weed management programme of rice/rice based cropping systems. In the present study, ten rice genotypes were evaluated for their phenolic acid profile in response to weed pressure in a field experiment, which was conducted in the Norman Borlaug Crop Research Center, G. B. Pant University of Agriculture and Technology, Pantnagar. Phenolic acid profiling was done by HPLC using methanol: water as mobile phase and detection was done at 254 nm. A total of 8 phenolic acids were detected in the rice genotypes. The results obtained showed that highest number of phenolic acids were identified in the rice genotype UPR 2962-6-2-1 followed by Govind. Among all the phenolic compounds, 8-hydroxy quinoline and caffeic acid were found to be present in most of the genotypes, and contribute to their competitiveness. Rice genotypes UPR 2962-6-2-1 and Govind, which were found to be more competitive against weeds under field conditions had higher values for morphological and yield parameters.

09-05(P)

COMPARATIVE EFFICACY STUDY OF ANTIDIABETIC ACTIVITY OF *SALACIA RETICULATA*

Manjusha V. Nikale, R.M. Mulani

Seth L.U. Jhaveri College of Arts and Sir M.V. College of Science & Commerce,
Andheri (E), Mumbai-400069

Aqueous extracts of roots of *Salacia reticulata* (Sr), *Salacia macrosperma* (Sc), *Salacia chinensis* (Sc), and two market samples (MS1, MS 2) sold under the traditional name-*Saptarangi* were used to compare their antidiabetic activity in Streptozotocin induced diabetic rats at the concentrations of 500 mg/kg in different groups of six diabetic rats each orally once a day for three days. Glibenclamide (Gleb), a known standard antidiabetic drug, was also given to one of the groups to support the result at the concentration of 500 µg/kg body weight, orally once a day for three days. 72 hours post STZ treatment, the plasma samples were collected for its glucose levels at 0 hr, then at the intervals of 1 hr, 2 hr, 3 hr, 4 hr, 5 hr, 6 hr and 24 hr. At the termination of the study, Glucose level of the animals treated with Sr and Sc were significantly low at 4 hr, however the glucose level of the animals treated with (Gleb) showed a significant decrease at 3rd hr. Whereas the animals treated with MS1 and MS2 did not show any significant decrease even after 4 hr.

Session 10

**Physiology of Plantation, Horticultural
Crops and Medicinal Plants, Natural
Resources Management, Biodiversity
and Pharmacognosy**

10-01(O)

EFFECT OF GENOTYPE AND METHOD OF CURING ON AROMA CONSTITUENTS OF CHEWING TOBACCO (*NICOTIANA TABACUM*) GROWN IN TAMIL NADU

K. Siva Raju and V. Krishnamurthy

Central Tobacco Research Institute, Rajahmundry-533 105, Andhra Pradesh

Major objectives of curing tobacco are to maintain and enhance the potential quality embodied in the harvested leaf and to provide an environment conducive to the transformation of leaf into a high quality cured product. Chewing tobacco grown in Tamil Nadu is subjected to three types of curing viz., sun, pit and smoke-curing to obtain desired quality leaf. In the present study, effects of the genotype and the curing methods on aroma compounds of chewing tobacco grown in Tamil Nadu were investigated. Seven varieties of chewing tobacco were grown under recommended cultural practices and subjected to three curing methods viz., sun-curing, pit-curing and smoke-curing. The sun-cured tobacco contained significantly higher levels of organic acids, protein and carotenoids whereas significantly lower levels of petroleum ether extractives (PEE) and free fatty acids (FFA) compared to pit and smoke-cured tobacco. Pit-cured tobacco showed significantly higher content of PEE and FFA and lower levels of carotenoids, organic acids and carbonyl compounds. Smoke-cured tobacco showed significantly higher levels of carbonyl compounds and lower levels of protein. The FFA contents varied from 8.66 to 68.63 $\mu\text{moles}/5\text{ g}$ among the varieties under different methods of curing. The variety Vairam showed significantly higher content of FFA. The popular variety Abirami showed significantly higher content of carbonyl compounds whereas the variety Bhagyalakshmi showed lower levels. The variety Meenakshi showed 2.34 and 1.8 times more PEE in pit curing compared to sun and smoke-cured tobacco respectively. The varieties I-64, Bhagyalakshmi and Abirami meant for sun-curing showed higher levels of protein, carotenoids, PEE and organic acids when subjected to sun-curing compared to the pit or smoke-curing. There was a significant variation in the content of aroma compounds in the varieties when they were subjected to different curing methods. The study revealed that, in case of chewing tobacco, the method of curing significantly affects the of major aroma compounds viz., PEE and carbonyls compared to the genotype.

10-02(O)

CURCUMINOIDS AND ANTI-OXIDATIVE COMPONENTS IN *CURCUMA LONGA* AND *CURCUMA CAESIA* GROWN IN MANIPUR

Kananbala Sarangthem, Th. N.K. Singh and M.J. Haokip

Plant Physiology Section, Dept. of Life Sciences, Manipur University, Canchipur, Imphal 795003
kananbala_s@rediffmail.com

Curcuma longa and *Curcuma caesia* are well-known indigenous medicine. They are used in traditional medicine for the treatment of various ailments and metabolic disorders. The bioactive components are responsible for several pharmacological activities and medicinal applications. Curcumin, the main yellow bioactive component of *Curcuma* has been shown to have a wide spectrum of biological actions. In the present study, the bioactive components such as curcuminoids content, phenolics, flavonoids and anti oxidant activities, volatile oil, fiber content, protein, amino acids and alkaloids were determined in the rhizomes of *Curcuma longa* and *Curcuma caesia* found in Manipur. Further studies for structural elucidation of these secondary metabolites are still in progress.

10-03(O)

INFLUENCE OF TEAK – PERENNIAL VEGETABLE BASED AGROFORESTRY SYSTEM ON BIOCHEMICAL PARAMETERS OF LEGUMES

H.Y. Patil, S.J. Patil, M.B. Chetti, S.M. Mutanal and B.N. Aravind Kumar

Department of Plant Physiology and AICRP on Agroforestry, University of Agricultural Sciences, Dharwad-5, Karnataka

Legumes are large group of plants second to cereals, proteinaceous source of food for human and as a forage crop for cattle. The demand of legume crops is increasing rapidly due to the ever increasing human population. Hence, it is necessary to increase the production and productivity of legumes. One of the possible ways of increasing the production of legume crops is growing them in association with trees as legumes are potential intercrops when grown with tall trees. Legumes when grown in association with teak or perennial vegetables will interact with them for different resources. The interaction may be positive or negative or complex. The competition would be mostly for light, moisture, nutrients and space. Teak and perennial vegetables being perennial in nature and with well established deep root systems have upper hand over other crops, especially under rainfed situations. The interaction effects could be due to different components in the agroforestry system, proximity to tree line and their interactions for various resources. The interaction between the field crops (legumes) and perennial component is inevitable when they are grown in a agroforestry systems. The results of the present investigations involving teak as a base crop and perennial vegetables as base crops along with two legumes. Chlorophyll content is one of the important biochemical parameters which is used as the index of production capacity. There was a reduction in chlorophyll 'a', chlorophyll 'b', and total chlorophyll contents at 40 DAS, probably due to leaf senescence in legumes. Among the two legumes studied, greater reduction in chlorophyll content was noticed in greengram compared to soybean. Further, with increase in distance from 2 m to 4 m from the teak alley, decrease in chlorophyll 'a', chlorophyll 'b', and total chlorophyll content was noticed due to shading effect and reduced light interception.

10-01(P)

IDENTIFICATION OF SUITABLE GENOTYPE OF FINGER MILLET (*ELEUSINE CORACANA* GAERTN.) FOR MANGO BASED AGROFORESTRY SYSTEM

A.K. Shinde, B.B. Jadhav, J.K. Yadav and V.V. Dalvi

Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.)

Finger millet is a minor cereal in world food grain production but is an important food crop of the poor marginal farmers especially tribal people of India. For fulfilling the increasing demand of food grains of growing population it is necessary to use limited land resource scientifically and technically. Under such condition the introduction of finger millet under agroforestry system (Agri-Horti system) is helpful for better utilization of this limited land resource. Field experiment was conducted to identify the suitable genotype of finger millet under mango based agroforestry system. Nineteen genotypes of finger millet were studied with thirteen characters under mango tree canopy and open canopy. From the study it was revealed that the genotypes L 481 and ED 8 of Nagli were suitable for mango based agroforestry system which showed less reduction in grain yield/plant and better performance for characters viz. chlorophyll content, plant height, no. of fingers, finger length and straw yield studied under mango tree canopy as compared to open canopy.

10-02(P)

PHYSIOLOGICAL STUDIES OF UNDER UTILIZED GRASSES OF SOUTH INDIA

R. Hari Babu and N. Savithramma

Department of Botany, S.V. University, Tirupati-517502
harisan82@gmail.com

India is the world's seventh largest and one of the most populated countries, 18% of the cattle population found in India. Our Nation occupies number one position, in milk production (133.5 million tones in 2010, USDA report) in the world, but the per capita production is very low. The main reason for such low productivity of our livestock is malnutrition. Most animal feed composed of some forage (Grasses, legumes or silage), Oil and pelleted feeds in mixed ratios. Grasses is the great majority of their diet. The Indian subcontinent has a wide range of indigenous grasses. These are tropical/sub tropical in nature and can grow even under adverse agro-climatic conditions. Most of these grass species belong to the families Poaceae and Cyperaceae. A few species are cultivating for fodder and majority of the grasses are collecting from the wild to feed the live stocks. Most of the grasses have high nutritive values and some species are used in medicine. In spite of these qualities attributes most have not under grown any conscious phase of domestication and human selection. There cultivation is restricted and they grow mainly wild especially in rain fed that is in dry lands. Has India is aimed to produced more milk of is inevitable to feed the live stock with nutritive valued grass species. Hence the present studies on few grass species found in South India were selected to screen the nutritive values. Thirty wild grasses commonly fed to livestock in the semi-hilly arid zone of Andhra Pradesh. The samples of wild grasses were analyzed for proximate components like total dry matter production, chlorophyll content, crude protein, carbohydrates and calorific values. The results of the present work indicate that the species having potentialities for domestication to enrich the nutritive values of the cattle and for recommendation of cultivation to the formers under irrigation. The results will be discussed in detail.

10-03(P)

BIOCHEMICAL VARIATION IN ACCESSIONS OF *DOLICHOS BIFLORUS* LINN.

Sachin B. Palekar, Vinaya A. Rane and Behnaz B. Patel

Department of Botany, Ramnarain Ruia College, Matunga, Mumbai-19

Dolichos biflorus Linn. is an important crop in the Konkan region of Maharashtra. The plant is traditionally used in the treatment of dysuria, sores, tumours and many other diseases. In the present study six accessions of *Dolichos biflorus*, procured from NBPGR, Delhi were evaluated for their biochemical profile. Proximate analysis of all the varieties was carried out. Total protein and DNA content, was determined using spectrophotometric assays. Total proteins were extracted and subjected to fractionation based on differential solubility of albumins and globulins. Extracted proteins were subjected to SDS-PAGE for prediction of molecular weight and for generating seed protein profile of each accession. Other metabolites like total sugars, reducing sugars, polyphenols, Total fats, dietary fiber etc were quantified by various gravimetric and spectrophotometric methods. Considerable variation was observed in protein content, proportion of albumin and globulins and protein profile, and so also for the other metabolites between all accessions. The genetic similarity matrix was calculated using Jaccard's co efficient and the dendrogram was based on Jaccard's similarity Index was obtained using UPGMA. A phylogeny tree for the accessions was prepared based on the polypeptide profile.

10-04(P)

AGRO-MORPHOLOGICAL CLASSIFICATION AND DIVERSITY ANALYSIS OF SOYBEAN MUTANTS

D.D. Ahire, R.A. Tambe and S.G. Auti

Post Graduate Department of Botany, H.P.T. Arts and R.Y.K. Science College Nashik-422005, MS
digambar12@rediffmail.com

Soybean (*Glycine max* (L.) Merrill,) is an annual leguminous species cultivated mainly for its seed. The present day soybean cultivars are derived from narrow genetic base. The genetic variability present in any crop is of vital importance in the formulation of effective breeding programme. Fifty six stable mutant lines were selected from M_5 generation to evaluate significant variability among the mutant using twenty morphological and agronomic traits and 72 morphological markers. A dendrogram of 56 lines was constructed on the basis of qualitative traits by Hierarchical cluster analysis using between groups linkage cluster method with Squared Euclidean Distance interval. The 56 mutant lines with parent cultivar 'MACS 450' were clustered into 9 main groups with similarity matrix ranging from 0.09-1.00%. A mutant line DI-3-4 was grouped separately from rest of mutant lines followed by P-5-1, CII-93-5 and DI-130-34. The highest similarity (1.0%) was observed between mutant lines BII-61(45) and BII-90-9; CII-26-6 and DII-9-1; DI-1-4 and DI-8-4, DII-21-4. Very less similarity was observed between mutant lines DI-3-4 and CII-13-5, P-44-1, J-5-27 (0.10, 0.09 and 0.10 respectively). The lines Q-9-3, R-10-1 and P-54-4 were very close to parent thus had less alterations for morphological and agronomic characters considered here. Based on the present study the mutants DI-3-4, DI-130-34 and P-5-1 were found to be distinct and diverse and can be utilized in the breeding programme for developing better varieties of soybean.

10-05(P)

INFLUENCE OF PRE HARVEST TREATMENTS OF GIBBERELIC ACID (GA_3) AND OTHER CHEMICALS ON GROWTH AND YIELD ATTRIBUTING CHARACTERS OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) CV. ANAND TOMATO-3

A.D. Patel and Amarjeet Singh Thounaojam

Department of Plant Physiology, Anand Agricultural University, Anand-388 110

The study was conducted at the main vegetable research station of the Anand Agricultural University, Anand during the period *khariif-Rabi* 2009-10 to determine the effects of different concentrations of GA_3 and chemicals on growth and yield of tomato. The treatments comprised of GA_3 at two levels (20 and 40 mg/l); KNO_3 (2000 and 4000 mg/l); $KHCO_3$ (2000 and 4000 mg/l); Boric acid (100 and 200 mg/l) with the control (without spray). The growth and yield contributing parameters were significantly differed. The results revealed that the pre harvest treatments of GA_3 @ 40 mg/l (T_2) had significant effect on plant height (114.77 cm), number of leaves (80.10), branches (12.13) per plant recorded at 75 DATP. Similar trends were also observed for minimized the days required for the breaker stage (78.03 days) and the red-ripe stage (86.47 days) under the treatment (T_2). It was also observed that the pre harvest treatments of GA_3 @ 40 mg/l had significant effect on yield and yield attributing characters *viz.*, number of fruits per plant (30.70) and total yield (384.77 q/ha).

10-06(P)

DIE-BACK AND RELATED DISEASES OF CITRUS: A CASE STUDY BASED ON SURVEILLANCE, DETECTION AND DEVELOPMENT OF MANAGEMENT STRATEGY

Satya Prakash¹, C.S. Bhor² and Sushama Chaphalkar^{1*}

¹Vidya Pratishthan's School of Biotechnology, Vidyanagari, MIDC, Baramati-413 133, Pune (MS)

²Agriculture Department, Government of Maharashtra, Market Yard, Baramati

*Corresponding author (E-mail: director.vsb@gmail.com)

Die-back and related diseases of citrus are considered to be damaging to citrus industry throughout the world due to their systemic invasion and common spread by infected bud-wood, vegetatively propagated seedlings and by insect vectors. Citrus in India is grown in 0.8 million ha area with a total production of 8.80 million tones. Extensive cultivation of this commodity is practiced in Maharashtra, Andhra Pradesh, Karnataka and Punjab. Yield losses due to infected mother plants are encountered annually: as citrus is a host to at least 3 viruses (citrus tristeza virus, citrus mosaic virus and Indian citrus ringspot virus), 2 viroids (citrus exocortis and citrus corky vein viroids), 1 greening bacterium and 2 phytoplasmas (citrus witches' broom and citrus rubbery wood). Effective management of these diseases includes: 1.) Identification and characterization using biotechnological methods at nursery and 2.) Cultivation of mother plants from disease-free saplings. The present study deals with survey and surveillance of mother plants of Mosambi in 25 citrus nurseries and 8 orchards of Mosambi and orange in Baramati, Daund, Indapur and Purandar Tehsils of Pune to know the severity of die-back and related diseases in citrus. The survey revealed that all the nurseries are having Mosambi (Mother plants) and Kagzi lime (*C. aurantifolia*) seedlings grown in open fields and were exhibiting virus and virus-like symptoms viz. Yellowing, chlorosis, green Islands on leaves, defoliation, growth stunting, decline and die-back of plants. In orchards, most of the plants of Mosambi and orange were declined and the farmers of Purandar Tehsil have started up-rooting the orange plants as for last few years fruit yield has been reduced considerably. Non-availability of disease-free planting materials of citrus species to the farmers for cultivation is serious threat in horticulture. There are nurseries which are involved in the business of propagation and selling of citrus seedlings but most of them are selecting bud-wood materials from the open field grown plants that are not indexed against virus and virus-like pathogens. Immediate attention is needed to provide virus and virus-like pathogen-free planting materials to citrus growers and that is possible through raising tissue culture plants which are free from these pathogens. Pathogen-free plants of citrus species can be obtained through tissue culture by selecting meristematic tissues from the shoot tip of the citrus mother plants which are kept under well protected conditions and are indexed regularly for virus and virus-like pathogens by PCR.

10-07(P)

BIODIVERSITY OF FUNGI FROM SOIL AND WATER SAMPLES FROM WALDHUNI RIVER

Deepak Pardeshi and Sharda Vaidya

Waldhuni is a small river originating at Kakole Lake near Ambarnath and unites with Ulhas River near Kalyan with its total length of 31.8 Km. The river is so much polluted that it is now referred to as Waldhuni Nallah. The soil and water samples (surface and deep water) were collected frequently from four locations of the river. The soil samples were dried and used for culturing. The water samples were used immediately for culturing. The medium used for culturing all the samples was Potato dextrose Agar. A number of fungi were isolated such as *Trichoderma*, *Aspergillus*, *Penicillium*, *Auriobasidium*, etc.

10-08(P)

PHYSIOLOGICAL STUDIES ON WEED CONTROL EFFICIENCY IN TURMERIC

V. Babu, B.B. Channappagoudar and M.B. Chetti

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

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences Dharwad during *kharif* season to study the influence of herbicide on growth, biochemical and biophysical parameters of turmeric. The experiment was laid out in randomised block design (RBD). The treatments consisted of five herbicides each with two concentrations along with weed free check and unweeded control. The soil of experimental plot was medium black with PH 7.6. The major weed flora of the of experimental plot was *Cynodon dactylon*, *Cyprus rutundus*, *Denebra rostrofluxa*, *Parthenium hysterophorus*, *Amaranthus viridis*, *Commelina benghalensis*, *Alternanthera sessilis*, *Digeria arvensis*, *Euphobia jeniculata*, *Legasca mollis* and *Phylantus niruri*. Among the herbicides studied pre-emergent application of Oxyfluorfen @ 0.3 kg a.i./ha found phytotoxic to turmeric crop compared to Alachlor, Butachlor Pendimethalin, and Pretilachlor at different concentrations. The minimum number of monocot and dicot weed were found in Pendimethalin treatment at 1.0 and 1.5 kg a.i./ha while the highest number of weeds were noticed in unweeded control. The weed biomass was significantly reduced by the application of Pendimethalin @ 1.0 and 1.5 kg a.i./ha, while the higher weed biomass was recorded in Oxyfluorfen at both the concentrations. All the growth parameters significantly influenced by the herbicides application. In general the higher values of growth parameters noticed in Pendimethalin treatment and in weed free check. Among the biochemical parameters highest chlorophyll a and chlorophyll b content was recorded in weed free check followed by Pendimethalin @ 1.0 and 1.5 kg a.i./ha. The nitrate reductase activity estimated at different stages of the crop growth was significantly higher in Pendimethalin treatment at both the concentrations while it was lowest in unweeded control followed by Oxyfluorfen compared to other treatments. The Photosynthetic rate was significantly highest in weed free check closely followed by Pendimethalin treatments. The stomatal frequency also varied with different herbicide treatments. The maximum yield was recorded in weed free check followed by Pendimethalin @ 1.0 and 1.5 kg a.i./ha. Among the herbicides studied by pre emergence application of Pendimethalin @ 1.0 kg a.i./ha has been found more effective and economic for control of weeds in turmeric.

10-09(P)

EFFECT OF MYCORRHIZAL FUNGI (GM, GF) ON GROWTH OF *GYMNEMA SYLVESTRE* R. BR. EX SCHULT

Saurabha B. Zimare and Nutan P. Malpathak

Department of Botany, University of pune-411007
mpathak@unipune.ac.in, saurabhabot@gmail.com

Gymnema sylvestre belonging to the Asclepiadaceae family is a vulnerable slow growing medicinal plant. In the present study effect of two species of Mycorrhizal fungi (*Gf*, *Gm*) on the growth of *Gymnema* were studied. Different growth parameters were used to analyse growth response of *Gymnema* inoculated with Mycorrhizal fungi. In the present study percent increment in root length of *Gymnema* inoculated with *Gf* was 82.25 % followed by *Gm* (52.06 %) as compared to non mycorrhizal *Gymnema* plants. For shoot length and fresh weight percent increment was for and *Gf* and *Gm* was 231% 108 %, and 540 %, 314 % respectively. Percent Mycorrhizal colonization was found to be higher in *Gm* inoculated plants as compared to *Gf* inoculated *Gymnema* plants.

10-10(P)

PHYTOCHEMICAL STUDY IN THE DIMORPHIC LEAVES OF SOME AQUATIC PTERIDOPHYTES

M.V. Kale

Department of Botany, Jaysingpur College, Jaysingpur-416101

The present paper concerns the phytochemical levels in the vegetative and reproductive stages of aquatic pteridophytes viz; *Ceratopteris thalictroides* (L.) Brong, *Azolla pinnata* L., *Salvinia molesta* Mitch. and *Marsilea quadrifolia* L. from South Western Ghats. The parameters studied are phenols, proline, proteins and amino acids. The vegetative and reproductive stages show differences in the amount of phytochemical status of the species. In our results, phenol contents are more in the reproductive stage than the vegetative except *C. thalictroides*. It is well established that phenolic compounds has its antimicrobial activity. The pteridophytes are usually not damaged by fungus or insects due to presence of polyphenolic acids in fronds. Maximum amount of phenols were recorded in the reproductive stage of *M. quadrifolia*. Proline, the most stable amino acid resisting oxidative damage and least inhibitory has some correlation with stress metabolism. Proline contents are variable in all the species studied. Reproductive stage contains more amounts of proline and total free amino acids. Maximum amount of proline were found in *A. pinnata* and amino acids in *C. thalictroides*. Protein contents are more in the vegetative stage than the reproductive stage in all the species studied. *A. pinnata* shows maximum proteins in both the stages than the other. It is observed that protein contents might be used during sporangial development. Our present study shows that the levels of phytochemical constituents were different during vegetative and reproductive condition of the plant. This may be due to the nature of the soil, the age of the plant at the time collection, seasonal and climatic changes.

10-11(P)

BIODIVERSITY OF ALGAE FROM CHAVADAR TALE, MAHAD

Latika Mehta and Sharda Vaidya

Chavadar Tale is a small lake from Mahad, Dist. Raigad. It is famous for the Drinking Water Satyagraha of Dr. Babasaheb Ambedkar for the Dalits. At one time the lake water was potable but now it is highly polluted. There are about twelve potholes in the lake which are the main sources of water. Frequent visits were made to these potholes and the water samples were collected. These samples were tested for their algal components. About twelve algae were found. The main algal types were Spirogyra, Zygnema, Pediastrum, etc.

10-12(P)

BIODIVERSITY OF MACROFUNGI FROM MATHERAN

Prashant Patil and Sharda Vaidya

India contributes to about 8% of world's biodiversity. Fungi share a major proportion of this. Macrofungi have the largest history of biodiversity studies of any mycota. Due to short life cycle of many of the members, taxonomic obstacles, and absence of long term studies, many of these fungi are unnoticed. Matheran is a small hill station situated near Neral on central Railway 90 km away from Mumbai and 120 Km away from Pune. It is surrounded by many deciduous forests. In the present studies, an attempt was done to study such macrofungi from the forests of Matheran. The prominent genera include *Marasmius*, *Cyphella*, *Polyporus*, *Ganoderma*, *Fomitopsis*, *Clavaria*, *Coprinus*, *Trametes*, *Agaricus* and *Dactylophora*.

10-13(P)

NITRATE REDUCTASE ACTIVITY AND GAS EXCHANGE IN PINEAPPLE PLANTS (*ANANAS COMOSUS* L. MERILL.) IN RESPONSE TO SEASONAL CHANGE

S. Roy Chowdhury, Ashwani Kumar, O.P. Verma, P.S.B. Anand and Swagatika Panda

Directorate of Water Management, P.O. Chandrasekharpur, Bhubaneswar-751 023

When the pineapple has to fit in a rice-based cropping system in rainfed areas, the crop is likely to experience seasonal changes in temperature, day length and moisture regime before harvest in June/July (before paddy cultivation). The changes in CO₂ fixation pattern and simultaneous changes in trend of assimilatory nitrate reductase activity in pineapple plant were studied from January to April month in post-monsoon period. Study was designed to understand the effect of seasonal change on CO₂ fixation pattern over the period of these four months. In general from late afternoon from 15.00 hrs there was increase in net CO₂ fixation rate. This increase was significant at 18.00 hrs during January, at 19.00 hrs in the month of February and at 20.00 hrs in March and April month. Therefore it was apparent that net CO₂ fixation rate increased substantially after onset of dark period. The identical trends of net CO₂ fixation rate and stomatal conductance over the period of a day in all these four months period strongly suggested that net exogenous CO₂ fixation rate was predominantly under stomatal control. Simultaneous changes in assimilatory nitrate reductase activity during the same period was also studied. The nitrate reductase activity (NR) showed a diurnal periodicity. The NR activity significantly increased from 9.00 hrs to show its peak at 12.00 hrs before declining steadily till evening in the month of February-April. But nitrate reductase activity was clearly at higher level in the month of April more so during morning and late afternoon hours. Increased net CO₂ fixation rate with onset of darkness confirmed the existence of (CAM) in pineapple plants in present seasonal regime. However higher net CO₂ fixation rate and Higher WUE and higher NR activity in March-April than in January-February, suggested that growth of pine apple would be better in warmer months (of March-April) rather than cooler season of January or February and suggested suitability of the crop in post monsoon rainfed scenario in rice based cropping system.

10-14(P)

THE OPTIMIZATION OF ANTIOXIDANTS IN COMPLEX MIXTURES OF *MENTHA ARVENSIS* L. IN VITRO PRODUCED

Rashmi Bariya and H.A. Pandya

Department of Botany, University School of Sciences, Gujarat University Ahmedabad- 380009

e-mail: hapandya@gmail.com

Antioxidants are used as scavengers for promising regulations of many functional disorders (Pandya, 2007). Corn mint (*Mentha arvensis* L.) is an important medicinal and aromatic herb from *Lamiaceae*. It is used to prepare herbal formulation to cure diseases. A protocol for *in vitro* mass multiplication is established. Multiple shoot production was achieved from slightly modified MS media supplemented with BAP and NAA. This was further developed using choice of PGRs like IAA, BAP, GA₃ and NAA alone or in combination. Mass multiplication of *in vitro* produced plantlets was established and acclimatized within 45-50 days of frequent subculture culture. The screening and optimization of important promising antioxidants was performed using TLC and HPTLC. The quality evaluation and simultaneous determination of several antioxidant properties were identified, compared and isolated as raw (mixture) and pure form for laboratory as well as large scale utilization.

10-15(P)

INFLUENCE OF IRRIGATION METHODS ON GROWTH AND YIELD OF MATURE RUBBER CLONE RR1105 UNDER SUBHUMID CLIMATE OF NORTH KONKAN REGION

Meena Singh¹, James Jacob², K Annamalaiathan² and S. Ravichandran¹

¹Rubber Research Station, RR11, Dapchhari, Thane, Maharashtra

²Rubber Research Institute of India, Kottayam, Kerala

North Konkan region of west coast of India is conditionally suitable for rubber (*Hevea brasiliensis*) cultivation. The region characterized by sub humid dry climate with annual rainfall ranging from 2300–2800 mm (June-September) with non satisfactory contribution due to its unimodal pattern. High day temperature, extended soil moisture stress, low atmospheric humidity and frequent heat shocks make the summer season in North Konkan very distinct. A field experiment was undertaken at RRS, Dapchhari (20.04° N, 72.04° E, 48 MSL) to quantify the optimum irrigation requirement for summer period and to study the influence of irrigation methods (basin and drip) on growth and yield of mature rubber clone RR1105 under subhumid climate of North Konkan region. The treatments comprised of two contrasting moisture regimes (basin irrigation 1.0, 0.25 •! 0.75, 0.50 and drip irrigation 0.75, 0.25 •! 0.50, 0.25 ET_c) and rainfed condition (water stress). Irrigation during summer can significantly improve the growth and yield of mature rubber. Pooled data on yield for 8 yrs revealed a significant difference among irrigation at varying moisture regimes and rainfed treatments. Basin irrigation at all moisture regimes recorded higher growth and yield as compared to drip irrigation method. A significant low growth and yield was noticed in rainfed treatment. Result indicated that under water scarcity, a mature rubber can be irrigated at 25 per cent of crop evapotranspiration with saving of 75 per cent water. In North Konkan region with limited water resources, a drip irrigation can be used as a strategy to manage water more efficiently while maintaining good production without significant yield reduction. The water productivity, amount of water used and economic feasibility of basin and drip irrigation at varying moisture regimes was also studied. Drip irrigation was found to be more economical and cost effective when compared with conventional basin irrigation method. The yield loss in drip irrigation can be compensated by cost incurred towards the application charges in basin method of irrigation. This study is expected to provide the information for scientific management of irrigation practices.

10-16(P)

BIODIVERSITY AND ETHNOMEDICINAL STUDIES OF SOME WEEDS OF ULHASNAGAR

Neelam Parab and Sharda Vaidya

Smt. C.H.M. College Ulhasnagar

The aim of the present work was the identification and documentation of ethnomedicinal studies of weeds growing on barren land in Ulhasnagar region of Thane district. Our survey was also aimed at the possibility of discovering new ways by which such plants could be better utilized for the welfare of human health. A total of 75 species of plants representing 55 Genera and 23 families were collected. In addition to the first hand collection of ethnomedicinal information from the inhabitants of the area, additional traditional uses were obtained through a study of the pertinent literature. Our results suggest the weeds (treated as nuisance by the farmers) of these fields were mostly the ones which were common, and easily grown in any place. However, our results also show that there are many ways of properly utilizing such weedy species in the promotion of human welfare. Moreover, the collection of these medicinal weeds may provide farmers with a most welcomed additional income.

10-17(P)

**COMPARATIVE KARYOMORPHOLOGICAL STUDIES IN ELEVEN ACCESSIONS OF
ALLIUM CEPA LINN.**

Pankti Gosar¹, Behnaz B Patel¹, Vinaya Rane¹, Jacinta George¹, Anil Khar², V. Mahajan², Bhavna Narula¹, Sunil Shankhadarwar¹ and Jessy Pius¹

¹Department of Botany, Ruia College, Matunga, Mumbai 400 019

²Directorate of Onion & Garlic Research, Rajgurunagar, Pune, 410 505

Allium cepa Linn. (onion), the delicious ingredient enjoyed all over the world is also renowned for its medicinal properties. The employment of various breeding techniques has resulted in improved strains, with respect to yield, nutritive value and disease resistance. Karyological studies were carried out on eleven accessions of Onion – two commonly available in the market as regular large Pink and Madras (Sambar) varieties and nine accessions procured from the Directorate of Onion & Garlic Research, Rajgurunagar, Pune. All the eleven accessions studied had $2n$ chromosome number = 16. This suggests that all of them have evolved from a common ancestor forming a homogenous assemblage from a basic set of $x=8$. None of the eleven accessions analysed, had eight pairs of homologous chromosomes. Hence the accessions could be considered as aneuploids – $[2n-a+a']$ (where a and a' stand for the same number of chromosomes but specific chromosome number being different), or they are diploids ($2n$), but the chromosomes have undergone aberrations like deletions, duplications, inversions and translocations, leading to loss of homology. The presence of majority of chromosomes with sub median and a few with sub terminal constrictions indicate that the karyotypes of all the varieties studied were asymmetrical. A detailed study of the karyomorphological analysis revealed that amongst the accessions studied the karyotype of the *Arka Pitambar* variety was the most symmetrical while that of *Bhima Shakti* variety was the most asymmetrical. The karyotype of *Arka Pitambar* accession is the most primitive; *Bhima Super*, *Madras*, *Regular Pink* and *Phule Safed* are intermediate while *Bhima Raj*, *Bhima Shakti*, *Bhima Red*, *Bhima Kiran* and *W - 302* and *W - 448* are evolved, with *Bhima Shakti* being the most evolved.

10-18(P)

**DIVERSITY OF ETHNOMEDICINAL PLANTS OF KARNALA FOREST, MAHARASHTRA,
INDIA**

Gauri S. Soman and Satnamsingh Sohal

Dept. of Botany, Maharashi Dayanand College, Parel, Mumbai – 400012, Maharashtra
drgssoman@rediffmail.com

Karnala forest lies in the Raigad district of Maharashtra state $18^{\circ}75'o''$ N and $70^{\circ}07'o''$ E. It is characterized by average rainfall of 3000 mm, black rocky basalt to reddish yellow coloured soil. Karnala is a combination of moist deciduous and semi evergreen forest. The tribals of these region are Katkaries, Thakars and Mahadev Koli. The paper deals with medicinal plants used by these tribals for treatment of common diseases and local ailments. The data on ethnomedicinal plants is on the verge of extinction and special efforts are required for documentation, conservation and sustainable utilization of these plants. So a survey was carried out to collect valuable information on traditional medicinal plants. The information regarding use of plants, their botanical names and local names is described in this paper.



10-19(P)

BIOMASS PRODUCTION AND BIOLOGICAL ACTIVITY OF CYANOBACTERIUM *NOSTOC CALCICOLA*

Y.R. Gahile¹, M.L. Ahire¹, K.M. Nitnaware¹, R.S. Shinde¹, B.N. Joshi², N.K. Jawali³
and T.D. Nikam^{1*}

¹Department of Botany, University of Pune, Pune-411 007

²Biometry and Nutritional group, Agharkar Research Institute, Pune-411 004

³Molecular Biology Division, BARC, Mumbai-400 085

*Corresponding author E-mail: tdnikam@unipune.ac.in

Most of the human population of the world rely on traditional, herbal medicines to meet their healthcare needs. It has created an increasing demand (approximately 430 tons/year) in the Indian subcontinent, estimated to increase 12% annually. On the other hand many medicinal plant species becoming rare, endangered, threatened and some are extinct due to overexploitation, habitat destruction and change in climate. The sufficient biomass of certain species is not available to satisfy the needs of overgrowing population. This has necessitates the establishment of alternate sources. In the present investigation, the strain of cyanobacterium *Nostoc calcicola* was isolated from the algal samples collected from various locations of Western ghat region of Pune district, Maharashtra. The cultures were established in laboratory and protocol developed for biomass production. Different constituents of BG-11 were varied and the biomass production and changes in biochemical compositions was recorded. The dried biomass was extracted in different solvents (hexane, chloroform, methanol and water) and antioxidant properties and total phenolic content was measured. It was found that methanol extract of *Nostoc calcicola* contains more antioxidant property and total phenolic content. Methanol extract also showed the strong antibacterial and antifungal activity. The results obtained in the present investigation showed that *Nostoc calcicola* has potential of producing the bioactive metabolites. The characterization of different column fractions is in progress.

10-20(P)

PHYSIOLOGICAL APPROACHES FOR IN VITRO PRODUCTION OF PHARMACEUTICALLY IMPORTANT METABOLITES OF SOME IMPORTANT MEDICINAL PLANTS

T.D. Nikam

Department of Botany, University of Pune, Pune – 411 007.

*Corresponding author E-mail: tdnikam@unipune.ac.in

As the population of the world exponentially increasing we can no longer assume that natural finite resources will be available to meet global needs for energy, food, clothing, shelter, medicine, biomass and industrial raw materials. And we must achieve this without further damage to earths delicate climate. Medicinal plants have been used since the inception of civilization but human influence on natural ecosystems, over exploitation, habitat destruction and unsustainable harvesting coupled with illegal practices have driven severely depleting these critical resources without initiatives to commercialize their cultivation. In the present scenario, there is an urgent need to adopt new approaches using contemporary technology which will result in drugs being regarded as a sustainable commodity irrespective of their sources. Plant tissue culture has opened up new vistas in the production of medicinally important metabolites. Plants produce various secondary metabolites of pharmaceutical interest but biosynthesized in smaller quantities. In this presentation, several physiological approaches to enhancing and sustaining the availability of pharmaceutical metabolites using *in vitro* culture will be discussed, including the intermediates and enzymes of basic physiological pathways, sources of cell biomass, *in vitro* growth conditions, use of elicitors and nano particles in some important medicinal plants *Datura metel*, *Tribulus terrestris*, *Phyllanthus amarus*, *Digitalis purpurea*, *Catharanthus roseus*, *Dicentra* sp., *Carthamus tinctorius*.

10-21(P)

PHARMACOGNOSTIC STANDARDS FOR AN ETHNOMEDICINALLY IMPORTANT FOOD CROP: *PARKIA BIGLANDULOSA* WIGHT & ARN.

Sunita Shailajan^{1*}, Neelam Sayed¹, Suhas Pednekar¹, Naresh Chandra²

¹ F – 13, Herbal Research Lab, Ramnarain Ruia College, Matunga (E), Mumbai 400 019, India.

² Department of Botany, Birla College of Arts, Science and Commerce, Birla College road, Kalyan (W) – 421304.

*Corresponding authors e-mail: sunitashailajan@yahoo.co.in/sunitashailajan@gmail.com

Parkia biglandulosa (Leguminosae, Chenduphool) is used as an edible fruit crop worldwide and is also an important ingredient of many herbal formulations. Even though the plant is highly medicinal and economically very important, there are no monographs available in any of the pharmacopeias. Reports on the pharmacological activities and chemical constituents of leaves of *Parkia biglandulosa* are very less, though it is a potent anti-tumour agent. The fernaceous pulp of the fruit is reported to be anti-secretory and anti-ulcerogenic. Seeds are used as common flavoring additive in food production in most West African countries. The bark has astringent properties and is widely used for tanning. In the present paper, quality of leaves of *Parkia biglandulosa* was assessed using modern analytical tools. Optimization of extraction of phytochemicals, proximate analysis and pharmacognostical characterization was carried out to establish quality control parameters for *Parkia biglandulosa* leaves. HPTLC and HPLC methods were developed and validated for phytochemical characterization and simultaneous quantitation of two pharmacologically active markers viz. Lupeol and β -sitosterol. Both methods were applied to elucidate the variations in leaves collected from different geographical regions in terms of content of these bioactive markers. Safety of the leaf powder was evaluated by heavy metal analysis and toxicity studies. The developed HPTLC and RP-HPLC methods can be applied as routine quality control tool for simultaneous quantitation of these markers from plant raw materials and related herbal formulations. Results of current findings can be adopted to lay down new pharmacopoeial standards for quality evaluation of *Parkia biglandulosa* leaves.

10-22(P)

DIVERSITY OF ORCHIDS IN THE SAHYADRI-A GRAVE CONCERN

N. Surve Sameer, Sanghamitra R. Matil and M.S. Mulgaonkar

Department of Botany, B. N. Bandodkar College of Science, Thane 400 601, M.S

India is one amongst the most diverse biogeographic regions of the world and it displays significant biodiversity. It hosts two major biodiversity hotspots. These hotspots are full of numerous endemic species of plants including orchids. In India, Orchids are found throughout from sea level to snow covered alpine regions. For the present study from the Western Ghats, Maharashtra, 24 genera and 70 species of orchids along with habitat, flowering and non-flowering conditions and their endemic status is enumerated. Among them 36 species are epiphytic where as 34 are terrestrial. 28 species are endemic to India. As a result of this work 44 species in 19 genera were collected from various localities from the Western Ghats of Maharashtra. It was found that out of 19 genera, 12 genera were represented by single species each and highest species diversity was found in the genus *Habenaria* Willd.(11 species). Other dominating genera were *Dendrobium* Sw.(7 species). *Eria* Lindl.(4 species), *Aerides* Lour.(3 species), *Oberonia* Lindl., *Porpax* Lindl. and *Vanda* Jones ex R. Brown(2 species).

Bulbophyllum Thouars, *Peristylus* Bl., *Rhyncostylis* Bl., *Acampe* Lindl., *Cottonia* Wight, *Cymbidium* Sw., *Eulophia* R. Brown ex Lindl., *Nervilia* Commerson ex Gaudchaud-Beaupre, *Trias* Lindl., *Zeuxine* Lindl., *Spathoglottis* Bl. (1 species) each. Orchids fail to withstand the pressures of habitat because of their habitat specificity, slow growing nature and specificity to pollinators. The region has undergone tremendous physiognomic changes and the forests have succumbed to heavy urbanization pressures as a result many orchids are threatened of survival. This factor has enforced to reinvestigate the orchids and thus during the study it has been found that most of the taxa recorded in the past are no more and many are on the verge of extinction. This present enumeration of Orchids from the Western Ghats of Maharashtra will provide useful data on the status of Orchid diversity and also act as a base line record for carrying out studies in future.

10-23(P)

EFFECT OF CUSTOMERISED FERTILIZER ON YIELD AND QUALITY OF ALPHONSO MANGO

A.K. Shinde, B.B. Jadhav and R.N. Shelke

Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri (M.S.)

Alphonso is most delicious mango variety due to excellent texture, attractive colour, highly appreciable flavour, taste and long keeping quality. However it has major drawbacks of alternate bearing habit and existence of spongy tissue in ripe fruit. For improving yield and quality of Alphonso mango Customerised fertilizer grade N, P, K, S, Mg, Zn B and Fe @ 10, 20, 20, 3, 2, 0.8, 0.3 and 0.2% was used for 35 years Alphonso mango trees at Central Experiment Station, Wakawali during June 2009. The soil application of paclobutrazol @ 0.75 g a.i./tree canopy diameter was applied in first fortnight of August 2009. The recommended package of practices for insecticide/fungicides were followed. There was no significant difference in flowering due to application of Customerised fertilizers on Alphonso mango. The fruit set at marble stage, No. of fruits and yield varied significantly due to application of customerised fertilizers. Treatment CF-5 kg showed significantly higher fruit set i.e. 2.02 marble fruits/panicle over other treatments. The number of fruits were significantly higher in CF-5 kg (268.1 fruits/tree) which was at par with Rec. NPK-MOP (251.29 fruits/tree). Similarly there was significant difference in fruit yield. CF 5 kg exhibited significantly higher fruit yield (72.67 kg/tree) which was at par with Rec. NPK-MOP (67.33 kg/tree) over control (55.57 kg/tree). There was no significant difference in fruit weight of Alphonso mango due to application of customerised fertilizer grade. Maximum individual fruit weight was observed in CF-5 kg (262 gm) over control i.e. 233 gm. All treatments showed TSS in the range of 16.15 to 17.09% and acidity in the range of 0.30 to 0.32 %. There was significant difference in occurrence of spongy tissue due to different treatments. Treatment CF-5 kg showed significantly minimum occurrence of spongy tissue (5.71 %) over other treatments. Maximum spongy tissue occurrence was observed in Rec. NPK-MOP (12.38 %). Thus from above experimentation revealed that soil application of customerised fertilizer- 5 kg during the first fortnight of July is found promising treatment for increasing yield and quality of Alphonso mango.

Young Scientist Session

01

DIFFERENTIAL ACCUMULATION OF POTASSIUM, SODIUM, CALCIUM AND EXPRESSION OF SOS PATHWAY GENES IN *BRASSICA* SPP. UNDER SALINITY STRESS

K. Chakraborty*[#], R.K. Sairam¹ and R.C. Bhattacharya²

*#Directorate of Groundnut Research, Ivnagar Road, P.B. No. 5, Junagadh-362001

¹Division of Plant Physiology, IARI, New Delhi-110012

²National Research Center on Plant Biotechnology, Pusa Campus, New Delhi-110012
koushik_iari@rediffmail.com, koushik@nrcg.res.in

Soil salinity is a serious problem affecting crop production. It has been further aggravated by agricultural practices such as indiscriminate irrigation. Today, nearly 20% of the world's cultivated land and nearly half of all irrigated lands are affected by salinity. Increased soil salinity negatively affects the growth of many crop plants, and the continued salinization of arable land provides an increasing threat to global crop production, especially in irrigated systems. High salinity adversely affects germination, growth, physiology and productivity by causing ionic and osmotic stresses. Therefore a study was conducted to examine the role of SOS pathway in sodium exclusion and thus salinity tolerance in *Brassica* spp. The present experiment was conducted in pot culture with seven *Brassica* genotypes viz. 'CS 52', 'CS 54', 'Varuna', 'Pusa Jagannath', 'Pusa Agrani', 'T 9' and 'Sagam' with two different levels of salt treatment i.e. 50 and 100 mM NaCl and untreated plants as control. The study showed salinity treatment significantly reduced the potassium and calcium content in leaf, stem and root of the seven cultivars. In contrast, the sodium content increased in all the plant parts under salt stress. However, the decrease in potassium and calcium, and increase in sodium content was less in tolerant genotypes like, CS 52 and CS 54, which also showed higher K/Na and Ca/Na ratios and thus more favourable cellular environment. Gene expression study revealed the existence of a more efficient salt overly sensitive pathway composed of *SOS1*, *SOS2*, *SOS3* and vacuolar Na^+/H^+ antiporter in tolerant genotypes CS 52 and CS 54 compared to Varuna and T 9.

02

COMPARISON OF SUGAR METABOLISM IN SWEET SORGHUM AND GRAIN SORGHUM

Hilal Ahmad Oazi and Sujata Bhargava*

Department of Botany, University of Pune, Pune-411007; *Email: sujata@unipune.ac.in

Some aspects of sugar metabolism were studied in two varieties of sorghum, namely grain sorghum (SPV1616) and sweet sorghum (SSV74). At boot and grain filling stages the total sugar levels at the first internode and fifth internode were about 2.5 fold higher in sweet sorghum as compared to grain sorghum and reducing sugars constituted a significant proportion of the increased sugar content. Activities of enzymes involved in sugar metabolism, sucrose synthase, sucrose phosphate synthase and cytoplasmic and vacuolar invertases were also studied. At boot stage, sweet sorghum showed higher activities of sucrose synthase and sucrose phosphate synthase in the first internode as compared to grain sorghum, while at the grain filling stage, the activities of these enzymes decreased to levels that were significantly lower than those observed in grain sorghum. At the lower maturing internode, sweet sorghum showed higher activity of sucrose synthase and invertases as compared to grain sorghum at the boot stage, while at grain filling stage the levels of sucrose phosphate and neutral invertase were higher in sweet sorghum. Transcriptional expression of the genes coding for various isozymes of the sugar metabolizing enzymes and five sugar transporter genes also differed in sweet and grain sorghum. The greater productivity of sweet sorghum can be attributed to higher sink strength provided by the panicle and lower internodes, which probably drive photosynthetic assimilate production.

03

EFFECT OF PGPR APPLICATION ON GRAIN ZINC CONTENT AND ITS LOCALIZATION IN RICE (*ORYZA SATIVA* L.)

Ashish Sharma, Babita Patni and S. C. Shankhdhar

Department of Plant Physiology, College of Basic Sciences and Humanities, G.B. Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar), Uttarakhand-263145
ashish9113@rediffmail.com

Rice is one of the most important food grains for human population around the world, hence known as “Global Grain”. Polished rice grain is remarkably low in zinc concentration leading to severe Zn deficiency disorders in millions around the world. Zn is mainly present in outer layer of rice which is removed during polishing thereby rendering rice grain low in Zn content. Increasing Zn content in endosperm is one of the premier goals of the scientists working in this field and is also the main objective of this study. In a field experiment with three rice genotypes viz. Jaya, PA 6444 and Pusa basmati-1 under eight treatments of bacterial (*P. putida*, *P. fluorescens*, *A. brasilense*, B15, B17, B19, BN17 and BN30) inoculation and an uninoculated control, Zn concentration in grains and husks were analyzed by atomic absorption spectroscopy. The data showed a clear cut enhancement of Zn content in grains of treated plants in comparison to control. Amongst the treatments following trend was found BN17> B19> B15> B17> BN30> *A. brasilense*> *P. putida*> *P. fluorescens*. The treatment BN17 was best which showed the values of 9.7, 9.1 and 8.9 ppm Zn/g seeds in the genotypes Jaya, PA6444 and Pusa basmati-1 respectively. Whereas, among the genotypes PA6444 (a hybrid) was most responsive for high Zn accumulation. Besides these all the treatments showed an increased SOD activity and enhanced growth in comparison to control. These and other results conclude that the PGPR application enhanced the grain Zn content. Hence, it can be suggested that application of PGPR can be an alternate strategy to modify grain Zn content and upon judicious selection, it can also affect many other elemental concentrations and plant processes.

04

LEAF GAS EXCHANGE PARAMETERS AS CRITERIA FOR SELECTION UNDER STRESSED ENVIRONMENTS – EXPERIMENTS WITH PORTABLE PHOTOSYNTHESIS SYSTEM

V. Krishnapriya, C.N. Chandrasekhar, P. Jeyakumar, L. Pugalendhi, and C. Vijayalakshmi

Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore- 641003
krishnapriya_9885@iari.res.in

Stomatal conductance (g_s), Intrinsic WUE (A/g_s), Photosynthetic rate (A) and Transpiration rate (E) which might serve as criteria for selection of crop varieties for sustained productivity under stressed environments, has been studied by many workers in various crops. To ascertain the effects of salinity on leaf gas exchange parameters in tomato genotypes, a pot-culture experiment was conducted in the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore from December 2009 to April 2010. Salinity stress was imposed on the plants by irrigating with saline solution containing NaCl, CaCl₂ and MgCl₂ in the ratio 3:1(3+1). Increasing salinity levels caused a marked reduction in the leaf gas exchange parameters at different phenological stages of crop growth. Correlation analysis between key parameters like A vs g_s , A vs E , A vs C_i , A vs Yield *etc.*, revealed that tolerant genotypes exhibiting optimal gas exchange characteristics under salinity stress, accumulated higher biomass, yielded better and ultimately possessed a higher Harvest Index as compared to susceptible genotypes. Similar work done in other agriculturally important crops has also been reviewed, to emphasise upon the usage of leaf gas exchange parameters as a reliable tool for screening plants for better performance under various environmental stress conditions.

05

EXPRESSION OF ANTIOXIDANT DEFENCE GENES IN MUNG BEAN (*VIGNA RADIATA* L.) ROOTS UNDER WATER-LOGGING IS ASSOCIATED WITH HYPOXIA TOLERANCE

Rohit Joshi¹, R.K. Sairam¹, Piyali Bhattacharya¹, S. Lekshmy¹ and V. Chinnusamy²

¹Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110 012

²Department of Botany and Plant Sciences, University of California, Riverside, CA 92521, USA

* Corresponding author e-mail: rks_ppl@yahoo.co.uk

This study was conducted to examine the extent of oxidative stress and the role of antioxidant enzymes on hypoxia tolerance in highly tolerant wild species *Vigna luteola*, and mung bean (*Vigna radiata*) cvs. T44 (tolerant) and Pusa Baisakhi (susceptible). Two days of water-logging caused about 40 to 50% decline in superoxide radical ($O_2^{\cdot-}$) and hydrogen peroxide (H_2O_2) contents in all the genotypes, however, further water-logging to 8 days caused significant increase in $O_2^{\cdot-}$ and H_2O_2 contents, and the values were 80-90% of the control values. In control and revived plants $O_2^{\cdot-}$ and H_2O_2 contents were higher in Pusa Baisakhi, while under water-logging stress T44 and *V. luteola* showed greater increases in the $O_2^{\cdot-}$ and H_2O_2 contents. Hypoxia induced increase in superoxide dismutase, ascorbate peroxidase and glutathione reductase activities were higher in T44 and *V. luteola* compared with Pusa Baisakhi; and the increases in T44 and *V. luteola* continued up to 8th day of water-logging while in case of Pusa Baisakhi, the maximum increase was observed only on the 2nd day of water-logging. Gene expression studies showed enhanced expression of *cytosolic-Cu/Zn-superoxide dismutase (SOD)* and *cytosolic-ascorbate peroxidase (APX)* in the roots of waterlogged *V. luteola* and T44, while little expression was observed in control or treated plants of Pusa Baisakhi. PCR band products were cloned and sequenced, and partial cDNAs of *Cu/Zn-SOD* and *APX*, respectively were obtained. Results suggest that increase in the activity of antioxidant enzymes is to scavenge ROS produced both during and after relief from water-logging stress.

06

RICE VARIETIES ARE VARIABLE IN EXPRESSION OF GENES FOR SALINITY INDUCED OXIDATIVE STRESS TOLERANCE

N. Ghosh, S.P. Das, C. Mandal, K. Das, S. Das, M.K. Adak

Plant Physiology and Plant Molecular Biology Research Unit, Department of Botany, University of Kalyani, Nadia, Kalyani- 741235, West Bengal

In an assessment of salinity tolerance as well as its concomitantly induced oxidative stress in plant system. We have evaluated two rice cultivars (namely Pokkali and Swarna), tolerant and sensitive respectively. In this experimental setup the plants were grown under simulated salinity (200 mM NaCl for 72 hours) with the treatment of an elicitor (1mM of Putrescine) a significant variation in expression profiles of response was recorded, whereas Pokkali were marked with considerable amount of Lipid peroxidation and Protein oxidation and that was more moderated by Putrescine. Swarna was recorded to be susceptible. Induction of salinity was evident through a significant accumulation of Reactive Oxygen Species (ROS) ($O_2^{\cdot-}$, H_2O_2 , etc.) regardless in both the cultivars. Putrescine had effectively downregulated salinity stress more in Pokkali than Swarna. Loss of Potassium ion and accumulation of Sodium ion was more favoured with impaired activity of H^+ ATPase which recorded more in Pokkali than Swarna. Variation in expression profile of transporter protein was monitored by RT-PCR method for HKT-1 gene. In an antioxidising system, plants were upregulated for Glutathione Peroxidase (GPX), Catalase (CAT) and Glutathione Reductase (GR) as displayed in their *in-vitro* assays and isoenzymic expression as well. Upfolded activity of polyamine biosynthetic enzymes like SAM-DC was also detected at mRNA level as well as by Western techniques. Plants were also characterized to be induced by Abscisic acid induced gene (RAB) as well as one of its related transcription factor OSBZ8.

07

PULSED MAGNETIC FIELD SEED TREATMENT FOR IMPROVING VIGOUR IN AGED GARDEN PEA SEEDS

Jyotsna Bharadwaj¹, Shantha Nagarajan², V.K. Pandita³ and Anjali Anand⁴

^{1,4}Division of Plant Physiology, ²NRL, IARI, New Delhi, ³Regional Station, IARI, Karnal

Ageing is a natural phenomenon which is generally irreversible resulting in seed deterioration. Even with the advent of controlled storage facilities, sometimes, the seed germination and vigour falls below the minimum standard resulting in rejection of costly breeder seeds. Pre sowing magnetic field seed treatment enhances seed performance in many crops and was used for treating naturally aged carry over breeder seeds of garden pea (2003 produce) stored under controlled storage facility (20°C & 40% RH). Germination percentage of these seeds was 80% but the seedling vigour index had reduced to 32.76 under prolonged storage. Seeds exposed to pulsed magnetic field of 100mT for 1 h in pulsed mode with 6 min on and off, showed significant improvement in germination and vigour (8.5% and 90 % increase respectively) over aged seeds. Hydrogen peroxide production increased by 52% in treated than aged seeds. The antioxidant defense system was activated in response to higher hydrogen peroxide levels. The activity of SOD was found to be 57 % more at 36 hrs of imbibition in treated seeds that led to the generation of hydrogen peroxide. CAT activity was more or less similar till 36 hrs of imbibition even after treatment. GR activity and total antioxidants also scavenged the free radicals as an increase was observed in treated seeds over untreated aged seeds. Lipoxxygenase was found to help in the germination process by mobilizing lipids to the growing embryo in more vigorous treated seeds. Antioxidants produced as a result of magnetopriming with pulsed magnetic field did not cause the lipid peroxidation of the membranes as malondialdehyde content was low in treated seeds. Pulsed magnetic field can effectively improve the vigor of the naturally aged pea seeds that may be controlled by the antioxidant defense system.

08

INFLUENCE OF OSMOTIC STRESS AND AMINO ACIDS ON SOMATIC EMBRYOGENESIS IN CALLUS OF OILSEED CROP NIGER (*G. ABYSSINICA* CASS.).

S.G. Ghane and T.D. Nikam*

Department of Botany, University of Pune, Pune-411 007

*Corresponding author Email: tdnikam@unipune.ac.in

In vitro regeneration protocol via somatic embryogenesis for *Guizotia abyssinica* Cass. cv. IGP 76 has been established. The cotyledon explants inoculated on MS medium amended with 6.66 µM BA and 2.69 µM NAA showed maximum callus induction and proliferation. Several auxin/cytokinin combinations, age of calli, various physical conditions (light and pH), induced osmotic stresses (NaCl, PEG-8000, mannitol, sorbitol, sugars and strength of MS medium) and other additional components like amino acids (proline, glycine, arginine, asparagine and glutamine) and casein hydrolysate were tested for induction of embryogenic callus. The higher frequency of embryogenic calli (73.7%) and twenty two somatic embryos per culture were achieved on callus induction and proliferation medium containing 90 mM NaCl. In histological analyses, typical globular embryos were observed. Embryogenic calli was transferred to MS media with and without cytokinins where MS basal medium performed better for embryo germination (53.4%) and plantlet formation (65.4%). About 62% plantlets survived under natural conditions and developed into normal plants.

09

EFFECT OF ZINC FERTILIZATION ON GRAIN YIELD AND PHYTIC ACID CONCENTRATION IN DIFFERENT GENOTYPES OF WHEAT (*TRITICUM AESTIVUM* L.)

Kiran Bharti[#], Rahul Tyagi, Deepti Shankhdhar, P.C Srivastava* and S.C Shankhdhar

**Department of Soil Science, College of Agriculture*

Department of Plant Physiology, College of Basic Science & Humanities

G.B Pant University of Agriculture & Technology, Pantnagar-263145 (Uttarakhand)

[#]nishu68@gmail.com

Zinc deficiency is the most important micronutrient deficiency in cereal crops. Cereals are not only low in zinc content but also rich in antinutrient compounds such as phytic acid, fibre etc., decreasing bioavailability of zinc to humans. A field experiment was conducted to study the effects of different zinc levels (0 kg Zn ha⁻¹, 20 kg Zn ha⁻¹ soil application and 20 kg Zn ha⁻¹ along with foliar application of 0.5 % solution of ZnSO₄) on phytic acid concentration, phytate to zinc molar ratio, grain yield in some wheat varieties such as UP-262, UP-2338, UP-2382, UP-2572, UP-2554. Phytic acid concentration decreased with increased levels of zinc in all the five varieties. The maximum phytic acid 23.98 mg g⁻¹ at 0 kg Zn ha⁻¹ and minimum 19.19 mg g⁻¹ at 20 kg Zn ha⁻¹ along with foliar spray was reported in UP-262. The minimum phytate to zinc molar ratio (48.69) was observed in UP-2572 at 20 kg Zn ha⁻¹ along with foliar spray while maximum (128.44) was observed in UP-262 at 0 kg Zn ha⁻¹. Phytate to zinc molar ratio in wheat genotypes was in the following order at 20 kg Zn ha⁻¹ along with foliar spray: UP-2572 < UP-2338 < UP-2382 < UP-262 < UP-2554. The grain yield increased with increasing zinc levels. The maximum grain yield (4.8 t ha⁻¹) at 20 kg Zn ha⁻¹ and the minimum (3.23 t ha⁻¹) at 0 kg Zn ha⁻¹ was observed in UP-262. Among the three different zinc levels, 20 kg Zn ha⁻¹ along with foliar application of 0.5 % solution of ZnSO₄ was found to be most effective in decreasing phytic acid concentration and phytate to zinc molar ratio for zinc biofortification in wheat.

10

SALVINIA PLANTS (*SALVINIA NATANS* LINN.) ARE A SUCCESSFUL HYPER ACCUMULATOR FOR ALUMINIUM AND ITS EVALUATION ON PHYSIOLOGICAL BASIS

C. Mondal, N. Ghosh, S. Das, Saswati Das, K. Das, Sudha Gupta and M.K. Adak**

Plant Physiology and Molecular Biology Research Unit, Department of Botany

University of Kalyani, Kalyani 74 1235, Nadia, West Bengal

***Corresponding author: mkadak09@gmail.com*

Salvinia plant an aquatic weed belonging to the class of pteridophyta have been evaluated for their potential of hyper accumulation of heavy metals like aluminium (Al). Plants were grown under varying concentrations (0, 240, 360 and 480 μM) of Al along with 1mM of putrescine (put). Following treatment of Al some of the physiological and biochemical responses in relation to oxidative stress there recorded a linear relationship with the accumulated Aluminium and a concomitant generation of reactive oxygen intermediate like O₂⁻, H₂O₂, lipid peroxidation, protein oxidation. In response to antioxidative pathway plants recorded significant variation in anti-oxidizing enzymes like Guaiacol peroxidase (GPX), catalase (CAT), Glutathione reductase (GR) etc. Moreover, there observed a clear disintegration of the DNA as recorded by Comet Assay. In a dose responsive manner reactive oxygen intermediates (ROI/ROS) were correlated with the activity of extra cellular generated NAD(P)H oxidase activity. Thus these findings suggest that Al could be inducing in oxidative stress at the cellular level that also undergone modulation by elicitor like putrescine.

11

EFFECT OF WATER STRESS ON PROLINE CONTENT AND PROTEINS OF THE WILD *RICINUS COMMUNIS L.*

Yogesh Pawar*, Yash Gupte, Samruddha Phadnis, Seema Menon and Ganesh Iyer
Department of Life Science, Ramnarain Ruia College, Matunga, Mumbai-400019
yogeshpawar44@gmail.com, ipomoeabiloba@yahoo.com

Drought stress is one of the most important abiotic stresses in agricultural crop plantation. As the water supply to the plant terminates or by some reasons if the plants are unable to translocate water throughout its system, proline overcomes the stress by increasing the concentration via proline biosynthesis pathway. The traditionally important medicinal and oil seed plant *Ricinus communis L.* (Castor plant) is found throughout the year profoundly growing near waste decomposing places. Polyethylene glycol is polymer of high molecular weight which is used to block uptake of water. Leaves of this plant were subjected to Polyethylene glycol stress to find out the effect on proline and protein content. When Leaves were taken and cut at the petiole and then immersed in various concentrations of Polyethylene glycol, control was maintained in tap water. Polyethylene glycol induces water stress. Polyethylene glycol solution passes through the cylinder (pith) and induces stress. Proline, an amino acid, also included in the class of compatible osmolytes, is found to be in the elevated levels during stress. Morphologically leaves show bending characteristics in a gradient pattern from lower to higher concentration of PEG. Proline content analysis using Bates method (1973) was performed and found out that increases in PEG concentration increases the proline. Recovery from the stressed condition was also performed and it was found out that the least stressed leaves recover slower than that of highly stressed leaves. Leaves regain their normal shape. SDS-PAGE electrophoresis of the proteins extracted from stressed and control leaves was carried out and stained with silver stain. 11 protein bands were observed in stressed leaf samples in a gradient manner whereas only 3 protein bands were observed in control. This clearly shows that proteins and proline protect the cells from osmotic damage due to low water content.

12

EFFECT OF ZINC ON ROOT ENDODERMIS

Yash Gupte, Yogesh Pawar, Samruddha Phadnis, Bhupinder Madavi, Kanchan Chitnis, Seema Menon and Ganesh Iyer
Department of Life Science, Ramnarain Ruia College, Matunga, Mumbai-400019

Aquatic plant *Pistia Stratiotes L.* was used to study the effect of Zinc on endodermis of the root. The endodermis prevents water, and any solutes dissolved in the water, from passing through this layer via the apoplast pathway. Water can only pass through the endodermis by crossing the membrane of endodermal cells twice (once to enter and a second time to exit). Water moving into or out of the xylem, which is part of the apoplast, can thereby be regulated since it must enter the symplast way in the endodermis. This allows the plant to control to some degree the movement of water and to selectively uptake or prevent the passage of ions or other molecules. Electron microscopy was done to study the changes and effects of zinc on endodermal cells. The endodermal cells had a three time increase in their size when treated with 80 ppm of zinc acetate. Elemental analysis illustrated that the endodermal cells, possessing the Casparian strips are weakened for their solute permeability under stress of zinc and thus there was an increase of other metals in the endodermal cells. It indicates that zinc increases the permeability of other elements by weakening the endodermis. The mechanical strength of root was reduced to a considerable extent. Lower concentration of zinc did not have much effect on endodermis.

13

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

G. Vijayakumar, G. Lakshminarayana Reddy, S.S. Rao and J.V. Patil

Directorate of Sorghum Research, Rajendranagar, Hyderabad-500 030 (A.P.)

Chickpea is the important food legume crop grown during *rabi* season in the semi-arid tropics of India. Terminal drought stress is an important constraint decreasing chickpea yields. The objective of the 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 during *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 such as plant height, number of productive branches, root length, root volume, root: shoot ratio and number and dry weight of nodules were significantly influenced by stress treatments and foliar sprays of kinetin @ 5 ppm and homobrassinolide @ 1ppm. Stress from vegetative stage with homobrassinolide spray recorded higher root volume (19.2%) and root: shoot ratio (13.5%) over the control. In physiological parameters, unstressed plants recorded an increase in relative growth rate (17.5%), net assimilation rate (39.1%) and leaf moisture retention index (17.2%) over the plants subjected to 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, use of homobrassinolide @ 1ppm resulted higher seed yield (20.9%) over no spray and it was on par with kinetin spray @ 5ppm. Seed yield was significantly positively correlated with primary branches, specific leaf area, relative growth rate, net assimilation rate, SCMR and harvest 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.

14

RESPONSES OF WHEAT (*TRITICUM AESTIVUM* L.) GENOTYPES UNDER DIFFERENT DATES OF SOWING

Pratap Singh*, Padmanabh Dwivedi and J.P. Srivastava

Department of Plant Physiology, Institute of Agricultural Sciences, BHU, Varanasi-221005 (UP)

**pphbhu@gmail.com*

The present investigation was carried out in the northern part of India, Institute of Agricultural Sciences, and Banaras Hindu University Varanasi during *rabi* (winter) season 2009-2010. In Indian condition the problem of late sowing of wheat is influenced by elevated atmospheric temperature during reproductive phase. Biochemical and yield responses in two wheat genotypes HUW-468 and HUW-510, under three date of sowing viz., 20 November, 10 December and 30 December were studied. The parameters were evaluated at initiation of flowering Stage (i.e. 60 DAS), which is critical stage of growth and highly influenced by rising temperature during crop growth and yield. Significant variation was observed in biochemical attributes i.e. sugar, proline accumulation,

protein, chlorophyll (SPAD unit) and yield in both the genotypes, due to different dates of sowing. Sugar and proline accumulated ranged between 4.83-11.73 [mg g^{-1} (f.wt.)] and 0.17-1.53 [mg g^{-1} (f.wt.)], respectively. Maximum sugar (11.73) and proline (1.53) accumulation was at IInd date of sowing in case of HUW- 468. The protein content was recorded maximum [10.68 mg g^{-1} (f.wt.)] in HUW-510, after IInd sowing. Maximum chlorophyll in term of SPAD unit was recorded in HUW-510 (48.50) at IIIrd date of sowing. Yield was significantly different in both the genotypes in respect to sowing dates. The highest grain yield plant⁻¹ was recorded in HUW-468 (2.22 g) compared to HUW-510(1.46 g). In this experiment, HUW- 468 appears to have higher osmotic adjustment capacity due to greater accumulation of sugar and proline. The result revealed that IInd date of sowing was optimum for growth and development, and HUW-468 performed better in terms of yield.

15

IMPACT OF RISING CO₂ ON PHYSIOLOGICAL CHARACTERISTICS OF *DESI* AND *KABULI* CHICKPEA

Puja Rai¹, Madan Pal Singh², V. Chinnusamy², S. Khetrpal², Divya Shah²

¹Directorate of Floricultural Research, ²Division of Plant Physiology, IARI, New Delhi-110012
pujaiari@gmail.com

During present climate change scenario rising atmospheric CO₂ and temperature have been well documented to affect agriculture productivity worldwide. Chickpea (*Cicer arietinum*) is one of the important pulse crops of India that occupies 31% of pulse growing area (7.29 mha) and contributes up to 40% to total pulse yield (5.77 mt) of the country. The present study was planned to analyse the impact of elevated CO₂ on physiological and biochemical characteristics of two Chickpea genotypes viz. Pusa1103 (*Desi*) and Pusa1105 (*Kabuli*). Both Chickpea genotypes were grown inside open top chamber (OTC) under ambient ($380 \pm 30 \mu\text{mol mol}^{-1}$) and elevated ($570 \pm 50 \mu\text{mol mol}^{-1}$) CO₂ concentrations. Elevated CO₂ enhanced growth and yield of both the chickpea genotypes. Among the two genotypes, 1105 (*Kabuli*) responded better to elevated CO₂ (E CO₂) in terms of growth and biomass accumulation. Increased seed yield under high CO₂ was due to partitioning of more dry matter towards pods. The plants grown under E CO₂ showed higher net photosynthetic rate and lower stomatal conductance compared with the plants grown under A CO₂. Number of nodules increased in both the genotypes but nitrogen fixation activity was not affected significantly either at flowering or podding stage under high CO₂. Lower glutamine synthetase activity was observed under high CO₂ that indicates lower release of ammonia during photorespiration. Variable impact of high CO₂ observed on nutrients composition in shoot and seeds. Reductions in activities of antioxidant enzymes under high CO₂ indicates lower photorespiration and generation of less oxidative metabolites. The study concludes that rising atmospheric CO₂ in future climate change may enhance plant growth and seed yield in chickpea due to enhanced photosynthesis and suppression of photorespiratory losses but may not be able to improve the biological nitrogen fixing ability.

16

ROLE OF EXOGENOUS APPLICATION OF PLANT GROWTH REGULATORS ON GROWTH PARAMETERS AND PRODUCTIVITY OF BAMBOO SEEDLINGS

Preetmaninder Kaur¹, Richa² and M.L. Sharma³

Botany Department, Panjab University, Chandigarh; E-mail: preetychahal@rediffmail.com

Propagation of bamboo by seed, is the most successful and easier than other methods such as cutting and air layering but may not always be feasible because of the non-availability of seeds due to long flowering cycles and poor viability of bamboo seed. The present study was aimed to ensure the causes of loss of viability and enhance seedling growth and yield component by the exogenous application of plant growth regulators (PGRs). The plant growth regulators used in the present study were: Gibberellic acid (GA_3) Indole-3-Butyric acid (IBA), Resorcinol(R) (1, 3- Dihydroxybenzene) and 1, 2, 4 - acid (1-amino-4-sulphonate- α -naphthol) on seedling of two species of bamboos namely; *Dendrocalamus strictus* (Roxb.) Nees and *Dendrocalamus membranaceus* Munro. In both the species, growth parameters showed varying response to PGR treatments probably due to varying time of ageing (as *D. strictus* seedlings were 5 and 11 months old while *D. membranaceus* where 24 and 30 months old during this study) and the genotypic difference in species. In *D. strictus* seedlings, various productivity parameters were maximally increased by the foliar treatment with IBA (50 ppm) whereas R (50 ppm) treatment produced maximum seedling height in 5 months old seedlings. While in seedlings raised from 11 months old seeds of *D. strictus*, IBA (25 ppm) + GA_3 (25 ppm) combination treatment became more effective in increasing productivity parameters and by a greater degree at this stage of ageing. In *D. membranaceus* seedlings, R (50 ppm) proved to be the best treatment for all the parameters studied at 24 months of ageing while at 30 months of ageing, the trend remained the same but the effectiveness of the various PGR treatments increased.

17

EFFECT OF POLYSACCHARIDE BASED EDIBLE COATINGS ON THE QUALITY CHARACTERISTICS AND THE ACTIVITIES OF SOFTENING ENZYMES OF JAMUN (*SYZYIUM CUMINI* L.) FRUIT

Neeta B. Gol and T.V. Ramana Rao*

B.R. Doshi School of Biosciences, Sardar Patel University, Vallabh Vidyanagar 388 120, Gujarat

The effect of polysaccharide based edible coatings such as chitosan (1.5% and 1%), alginate (1.5% and 1%) and carboxymethyl cellulose (1.5% and 1%) on the physicochemical characteristics and softening enzyme activities of jamun fruits stored at $10 \pm 1^\circ C$ and 70-75% relative humidity (RH) were evaluated at 0, 4, 8, 12 and 16 days of their storage period. The obtained results indicated that coated jamun fruits had delay in the changes of their weight loss, decay percentage, titrable acidity (TA), pH, quantitative changes of total soluble solids (TSS), sugar accumulation and pigment degradation as compared to uncoated control fruits. In addition, the polysaccharide based edible coatings showed a positive effect on maintaining higher concentration of total phenolics and ascorbic acid. The data of the present study may be an indicative that the lower enzyme activities of polygalacturonase (PG), pectin methyl esterase (PME), cellulase and α -galactosidase in the coated jamun fruits might have been associated with a high integrity of the cell membrane and few changes in the cell wall constituents, which contributed to high levels of firmness in the jamun fruits during storage. Coating of different concentrations of chitosan, alginate and CMC prolonged the storage life by delaying the softening processes and thereby maintaining the quality of jamun fruits. Thus it may be concluded that the 1.5% chitosan and 1.5% CMC coatings which can be used commercially as they aid in extending the storage life, delaying the softening process, enhancing the keeping quality while retaining the nutritional quality of jamun fruits more than that of control fruits and other coating treatments.

AUTHOR INDEX

A		Bahuguna, Rajeev N.	106	C	
Abraham, G.	108	Baig, M.J.	25,77	Chakrabarti, B.	107
Adak, M.K.	30,46,171,173	Bairagya, M.D.	36	Chakraborty, K.	62
Afria, B.S.	49	Balakrishna, Reddy K.	4	Chakraborty, K.	169
Agarwal, V.P.	61	Barik, M.	77	Chakravarthi, D.V.N.	132
Agarwal, K.K.	103	Bariya, Rashmi	160	Chalkoo, Shaista	38
Aher, R.K.	77	Baruah, K.K.	99	Chandra, A.	15,48
Ahire, D.D.	80,156	Basavaraj, B.	24	Chandra, Naresh	164
Ahire, M.L.	93,163	Basu, P.S.	50,64,70	Chandrashankar, C.N.	73,124,125, 170
Ahirwar, N.K.	34	Behdarvand, P.	33	Channappagoudar, B.B.	21,27,158
Ahmad, Altaf	108	Behera, Rajendra Kumar	101	Chaphalkar, Sushama	157
Ahmad, Aqil	58,113,119, 122,123	Benson, Erica B.	91	Chatterjee, Jayeeta	91
Ahmad, Syed Sabhi	114	Bera, S.K.	76	Chaturvedi, G.S.	79
Ahuja, Sumedha	14	Bhadana, V.P.	94,110	Chaturvedi, S.K.	50
Aivale, Mayuri S.	45	Bhagat, S.P.	95	Chauhan, J.S.	74
Ajay	34	Bhakuni, Vandana	136	Chetti, M.B.	21,27,109,133, 154,158
Ajit Kumar, R. Beena	3	Bhalerao, Satish	107	Chinchanikar, G.S.	33,34,94,95
Alagupalamuthirsolli	70	Bhalerao, Satish A.	13,149	Chinnusamy, V.	32,51,53,66, 171,176
Ali, Minu	114	Bhamburdekar, S.B.	35,120	Chitnis, Kanchan	174
Anand, Anjali	172	Bhandari, Kratika	33	Choudhary, Alka	49
Anand, P.S.B.	160	Bharadwaj, Jyotsna	172	Choudhury, H.	8
Anantbi, K.	52,8,54	Bhardwaj, S.	4	Choudhury, S. Roy	46,160
Angadi, S.S.	109	Bhargav, R.	4	Chris, Abhishek	81
Annamalainathan, K	161	Bhargava, Sujata	169		
Ansari, Aqsa	124	Bharti, Kiran	19,173	D	
Anuradha, M.	5	Bharud, R.W.	104	Dalvi, D.G.	22,71,101,119
Aochen, Chubasenla	65	Bhat, M.	92	Dalvi, V.V.	154
Arahanashi, C.S.	21	Bhat, Mushtaq Ahmad	114	Darash, R.	59
Arora, Vinita	57	Bhatade, S.S.	22,71,101	Darash, Rama	15
Arora, Ajay	73,139	Bhatt, A.	134	Darmalingaiah, D.	109
Arora, Vinita	68	Bhatt, R.K.	50	Das Pallab, Kumar	44
Arya, Namita	59	Bhattacharya, Piyali	32,66,171	Das, K.	30,171,173
Arya, R.R.	7	Bhattacharya, R.C.	169	Das, M.K.	39
Auti, S.G.	80,156	Bhattacharya, Sabita	91	Das, Manish	134,136
		Bhattacharya, S.G.	3,7	Das, S.	
		Bhor, C.S.	157	71,108,171,173	
B		Bindu, G.V.	115	Das, S.P.	30,171
Babalad, H.B.	24	Birbal	4	Das, Saswati	173
Babu, A.G.	58,85,102,113	Biswas, A.K.	34	Das, Susmita	30
Babu, C. Raja	81	Bodake, K.K.	10	Delarestaghi, M. Mohseni	95
Babu, R. Hari	155	Bodare, A.H.	142	Deosarkar, D.B.	22,71,101,119
Babu, S.M.	36	Boominathan, P.	75	Desai, Neetin S.	45
Babu, V.	158	Borde, Mahesh	28,48		
Badole, S.P.	44	Bose, Anjali	116		
Bahuguna, R.N.	105	Burman, Uday	64		
		Burondkar, M.M.	3,7		

Krishnamurthy, P.	29	Malpathak, Nutan	89	Nikam, T.D.	90,93,163,172
Krishnamurthy, V.	5,153	Malpathak, Nutan P.	45,158	Ningnur, B.T.	21
Krishnan, P.	71,108	Mandal, C.	30,171	Nirmal Kumar, A.R.	4
Krishnapriya, V.	170	Mangrauthia, Satendra K.	94	Nithila, S.	117
Kshirsagar, P.J.	37	Manjunatha, V.	85	Nitnaware, K.M.	163
Kulkarni, M.B.	11	Mankad, Archana	135		
Kumar, Ashok	63,70	Marmath, Neelu	123	P	
Kumar, Ashwani	160	Masood, Asim	116	Pachauri, S.P.	19
Kumar, Awadhesh	67	Mathpal, Bhupendra	19	Pal, A.K.	44
Kumar, B.N Aravind	133,154	Matil, Sanghamitra R.	164	Pal, K.	134
Kumar, G. Chaitanya	147	Medhi, J.	39	Paladugu, Rajesh	100
Kumar, G. Krishna	69	Meena, Deepak	9	Palekar, Sachin B.	155
Kumar, Mukund	60,70,78	Meena, Lalit	27	Panchal, R.K.	87
Kumar, Narendra	23	Mehta, A.	140	Panda, Swagatika	160
Kumar, P.	140	Mehta, Latika	159	Pandey, Sunil Kumar	105,106
Kumar, Padma	89	Mehta, P.S.	7	Pandita, V.K.	172
Kumar, Pramod	13,143	Melavenki, V.C.	11	Pandiyani, M.	6
Kumar, R. Sai	43	Menon, Seema	67,114,174	Pandya, H.A.	160
Kumar, Ranjeet R.	131	Menon, Soumya V.	144	Panigrahy, Madhusmita	29,132
Kumar, Sudhir	68	Mir, Bilal A.	123	Pant, Bhawna	23
Kumar, Sunil	72	Mishra, Brajesh Kumar	79	Parab, Neelam	161
Kumar, Upendra	92	Mishra, Seema	31	Parab, Nikita	31
Kumar, V.	11	Mishra, Vagish	108	Parashar, Renu	52
Kumar, Vinod	107	Mohapatra, Pravat Kumar	101	Pardeshi, Deepak	157
Kumari, Anita	23,29,56	Mondal, C.	46,173	Patel, A.D.	20,121, 141,156
Kumari, Aradhna	24,69	Mondal, S.	35,118	Patel, B.B.	92,105,106
Kumari, J.	36	Mourya, Krishan Kumar	89	Patel, Behnaz B.	155,162
Kumari, Kavita P.	148	Mulani, R.M.	150	Patel, H.C.	121
Kumari, Swati	67	Mulgaonkar, M.S.	164	Patel, J.R.	87
Kumthekar, S.	92	Mummigatti, U.V.	24,109	Patel, K.P.	20
Kureel, R.S.	26	Munjali, Renu	57,68	Patel, Pradeep Kumar	45
Kushwaha, S.R.	25	Murthy, T.G.K.	5	Patel, R.M.	86,87
		Mutanal, S.M.	133,154	Patel, S.R.	11,56
L				Patel, Tanmay	20
Lankeshwar, Nilima	142	N		Pathak, Himanshu	131
Latha, P.	19,75	Nagar, Shivani	73	Patil, Avinash	124
Laxmi, Vijay	72	Nagarajan, Shantha	172	Patil, B.A.	77
Lekshmy, S	24,25,32,51, 66,69,171	Naik, A.A.	90	Patil, B.C.	58,102,113
Lokhande, Vinayak H.	45	Nanoskar, Pritam	142	Patil, Darshana	124
		Narula, B.	92,105,106	Patil, H.Y.	133,154
M		Narula, Bhavna	162	Patil, J.G.	93
Madan, S.	148	Narwade, A.	11	Patil, J.V.	175
Madavi, Bhupinder	174	Nataraja, Karaba N.	85	Patil, N.S.	62
Madrap, I.A.	37,119	Nathawat, N.S.	4	Patil, Prashant	159
Mahadik, S.G.	139	Nautiyal, Nirmala	22,32	Patil, R.G.	56
Mahajan, V.	162	Nawalkar, D.P.	11	Patil, S.J.	133,154
Maiti, Saborni	30	Nazar, Rahat	116	Patni, Babita	150,170
Mall, A.K.	47	Negi, K.S.	7	Paul, M.S.	149
		Nikale, Manjusha V.	150		

Pavaghadi, C.B.	56	Ramesha, M.S.	66	Sarangthem, Kananbala	153
Pawar, G.S.	37	Rane, Vinaya	162	Sarkar, S.	35
Pawar, K.N.	58,102,113	Rane, Vinaya A.	155	Sarla, N.	10,29,94, 102,132
Pawar, Yogesh	174	Ranganathan, S.	36	Sarma, B.K.	45
Pednekar, Suhas	164	Rani N., Shobha	10,110	Sarma, M.K.	8
Phadnis, Samruddha	174	Rao Ch., Mukunda	6	Satodiya, B.N.	121
Phogat, B.S.	77	Rao K., Veerabhadra	6	Savithramma, N.	155
Pius, J.	92,105,106	Rao K., Prasada	6	Sawakhande, Neha	142
Pius, Jessy	162	Rao, D. Nageswara	29,66	Sawant, Sudha A.	37
Prabha, Chandra	53	Rao, D.N.	36	Saxena, D.C.	52
Prabhakaran, S.	122	Rao, G.J.N.	147	Sayed, Neelam	164
Pradhan, Alok Kumar	51	Rao, P. Raghuveer	3,66,102	Senguttuvel, P.	110
Prakash, Pravin	65	Rao, R.N.	25	Setter, T.L.	78
Prakash, Satya	157	Rao, S.	9	Shah, D.	105
Pramod, S.	134	Rao, S. Seeta Ram	127	Shah, Dharti	116
Pranusha, P.	75,147	Rao, S.S.	175	Shah, Divya	105,106,176
Prasad, Rajendra	136	Rao, T.V. Ramana	144,178	Shah, R.R.	87
Prasad, S.R. Shivu	115	Rao, Y. Venkateswara	132	Shah, Vidhi	144
Prasad, S.V. Sai	52	Rao, Y.V.	10	Shaheen, A.B.	58,102,113
Prasad, T.N.V.K.V.	19	Rathore, V.S.	4	Shahri, Waseem	114
Prasanth, V. Vishnu	132	Ratnakar, Anjali	47	Shailajan, Sunita	164
Pratima, S. Jadhav	28	Raval, Rinni B.	76	Shankar, A.G.	86
Pugalendhi, L.	170	Ravichandran, S.	36,161	Shankdhar, S.C.	3
Pujari, K.H.	7,133	Ravichandran, V.	122	Shankhadarwar, S.	92,105,106
		Ravikesavan, R.	8	Shankhadarwar, Sunil	162
		Ravindran, Rini	144	Shankhdhar, S.C.	49
Q		Reddy, D. Damodar	5	Shankhdhar, Deepti	23,49,173
Qazi Hilal, Ahmad	169	Reddy, D. Mohan	75	Shankhdhar, S.C.	19,23,170,173
		Reddy, G. Lakshminarayana	175	Sharma, Ashish	170
		Reddy, K. Raja	19	Sharma, Deepika	49
R		Reddy, M. Umamaheshwar	102	Sharma, K.D.	63,70,72
Raghavendra, T.R.	24	Reddy, Y.T.N.	115	Sharma, M.L.	177
Rai, A.K.	36	Revathi, P.	110	Sharma, Manisha	134,136
Rai, Anamika	85	Richa	177	Sharma, Suruchi	140
Rai, Aruna	47	Roy, Samarпита	38	Sharma, Sushil K.	131
Rai, Denish	44			Shebin, M.	73
Rai, Puja	176	S		Shekhar, Navendu	12,14
Rai, R.K.	59	Sachdev, Archana	67	Shekhawat, Kapila	74
Rai, Raj D.	131	Sahay, Seema	38	Shelke, R.N.	121,139, 142,165
Rai, Rama Kant	15	Saikrishna, R.	147	Sheokand, Sunita	23,29,56
Rai, S.N.	25	Sailaja, B.	3,94	Shinde, A.K.	121,139,142, 154,165
Rajeswari, V. Raja	75,147	Sairam, R.K.	24,25,32,51, 66,68,69, 169,171	Shinde, K.A.	3,7,121,133
Raju, K. Siva	153	Sajeevan, R.S.	85	Shinde, R.S.	163
Raju, N. Sravan	110	Sakthivel, N.	122	Shirin, Fatima	85
Rakshe, M.V.	3	Salehabadi, A.	34	Shital	72
Rama, Rao G.	4	Samaiya, R.K.	9	Shitole, S.M.	60
Ramakrishnan, B.	108	Sameer, N. Surve	164		
Ramana, S.	34				
Rambal, Kavita	143				
Ramesh, Thatikunta	100				

