NATIONAL CONFERENCE OF PLANT PHYSIOLOGY - 2021

NCPP-2021

Frontiers of Plant Physiology for Climate Smart Agriculture

Souvenir cum Abstract Book

9-11th DECEMBER, 2021

Organized by

राअस्ट्रेप्रसं
NIASM

ICAR-National Institute of Abiotic Stress Management, Pune
Indian Socieity of Plant Physiology, New Delhi

NATIONAL CONFERENCE OF PLANT PHYSIOLOGY - 2021

Frontiers of Plant Physiology for Climate Smart Agriculture

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NCPP-2021

NATIONAL CONFERENCE OF PLANT PHYSIOLOGY - 2021

Frontiers of Plant Physiology for Climate Smart Agriculture

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Himanshu Pathak, *ICAR-NIASM, Pune*

9-11th DECEMBER, 2021

ICAR-National Institute of Abiotic Stress Management, Pune
Indian Socieity of Plant Physiology, New Delhi

भारतीय कृषि अनुसंधान परिषद
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New Delhi 110001, India

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उप महानिदेशक (फसल विज्ञान)

Dr. T. R. Sharma, Ph.D
FNA, FNAAS, FNASc, JC Bose National Fellow
Deputy Director General (Crop Science)

MESSAGE

I am happy to know that the Indian Society for Plant Physiology is organizing a **National Conference** in association with **ICAR- National Institute of Abiotic Stress Management, Baramati, Pune on "*Frontiers of Plant Physiology for Climate-smart Agriculture*"** during December 09-11, 2021 at ICAR-NIASM, Baramati, India.

The Conference has great relevance for the 21st century for augmenting food productivity and its sustainability through physiological, genetic and biotechnological approaches. Plant physiologists have a key role to play by providing deeper understanding of the physiological processes during stress conditions and their effective manipulation for improving the productivity of crops.

I hope that the Conference will address such important issues and come out with new directions for researchers for tailoring productive plant types to help in breaking the yield barrier and thereby ensuring sustained food and nutrition security.
I wish the Conference all success.

(T.R. Sharma)

Place :New Delhi
Dated: 1.12.21

E-mail: ddgcs.icar@nic.in **Phone: 91-11-23382545** **Fax: 91-11-23097003**

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डॉ. सुरेश कुमार चौधरी
उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Dr. Suresh Kumar Chaudhari
Deputy Director General (Natural Resources Management)

01.12.2021

Message

The National Conference on "Frontiers of Plant Physiology for Climate Smart Agriculture" is being jointly organized by Indian Society of Plant Physiology and ICAR-National Institute of Abiotic Stress Management, Baramati, Pune during 9-11 December 2021. The theme of the conference is quite relevant in context of climate change since plant physiology has a great role in eco-adaptation mechanism of the plant is diverse climatic conditions.

I hope that the conference would focus on countering stress physiology as a tool for climate change mitigation strategy involving multidisciplinary group of scientists. This would lead to improvement in productivity of various crops especially in challenged ecologies of the country.

I wish a grand success to the organizers for successful outcome of the event.

01/12/21

(S.K. Chaudhari)

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MESSAGE

I am glad to know that the **National Conference of Plant Physiology** on ***"Frontiers of Plant Physiology for Climate Smart Agriculture"*** is being organized by **National Institute of Abiotic Stress Management, Baramati, Pune** in association with **Indian Society for Plant Physiology (ISPP)** during **09-11 December, 2021.**

The theme of the Conference on **"Frontiers of Plant Physiology for Climate Smart Agriculture"** is appropriate and calls for immediate attention by Plant Physiologists and other scientists across the disciplines. An understanding of the mechanisms underlying the physiological processes and effective manipulation of these processes to tailor plant types with improved resource use efficiency, stress tolerance, quality and productivity of crops is the need of the hour.

I am confident that the scientific deliberations of the conference will provide a road map for the future strategies in overcoming the challenges faced by the agricultural sector in order to provide food and nutritional security at the national level.

I wish the Conference a great success.

AKSH
(A K Singh)

Dr M B Chetti
President ISPP &
Vice-Chancellor
UAS, Dharward,
Karnataka.

28th November 2021

MESSAGE

I am very happy to know that the **Indian Society for Plant Physiology (ISPP), New Delhi** is organizing **National Conference** on "***Frontiers of Plant Physiology for Climate Smart Agriculture***" collaboration with **ICAR- National Institute of Abiotic Stress Management, Baramati, Pune** during **December 09-11, 2021.**

The research areas proposed in the Conference suits to the changing climate scenario. In the recent past with climate change, productivity of many crops has reached a plateau under drought, high temperature and salinity conditions. Now it is the time to consider physiological traits in breeding programmes to break the yield barriers, which has been proven already in few crops. This occasion will provide an opportunity to all young faculty and students to have scientific gains from the senior experts in the subject.

I am sure that the deliberations of the Conference would provide new insights of research and strategies to improve the agricultural production in the country.

I wish all the participants of this Conference a happy and scientific get-together.

(**M B Chetti**)

राअस्ट्रैप्रसं
NIASM

Dr Himanshu Pathak
Director, ICAR-NIASM
Baramati, Pune,
Maharashtra

26th November 2021

MESSAGE

It is heartening to learn that the **National Conference on Plant Physiology-2021 (NCPP-2021)** on "***Frontiers of Plant Physiology for Climate Smart Agriculture***" is being organized by **Indian Society for Plant Physiology (ISPP), New Delhi** in association with **ICAR-National Institute of Abiotic Stress Management, Baramati, Pune** during **December 09-11, 2021.**

The theme of the Conference on "***Frontiers of Plant Physiology for Climate Smart Agriculture***" is very appropriate, timely and calls for pressing attention by all concerned including agricultural scientists across the disciplines. Keeping in view of the dwindling natural resource base and climate change, plant physiologists along with natural resource management scientists and biologists form a cohesive group that is entrusted with the rcsponsibility of improving crop and farm productivity on a sustainable manner. A better understanding of the mechanisms underlying the physiological processes and effective manipulation of these processes to tailor plant types with improved resources use efficiency, stress tolerance, quality and productivity of crops is the need of the hour.

I am confident that the scientific deliberations of the Conference will provide a road map with appropriate milestones enabling appropriate strategies in overcoming the challenges faced by the agricultural sector in order to realize both food and nutritional security and sustainability of natural resources.

I wish the Conference a great success.

(**H. Pathak**)

Dr V Chinnusamy
Hon. Secretary,
ISPP, New Delhi

26th November 2021

MESSAGE

It is a matter of immense pleasure in organizing the **National Conference of Plant Physiology** on ***"Frontiers of Plant Physiology for Climate Smart Agriculture"*** at **ICAR-National Institute of Abiotic Stress Management, Baramati** association with **Indian Society for Plant Physiology (ISPP), New Delhi**.

The theme of the conference ***"Frontiers of Plant Physiology for Climate Smart Agriculture"*** is highly appropriate and calls for immediate attention by the Plant Physiologists and other scientists across the nation. Plant Physiologists along with breeders and molecular biologists form a cohesive group that is entrusted with the responsibility of improving the productivity of our present-day crop plants keeping in view the depleting natural resources and constantly changing environment. An understanding of the mechanisms underlying the physiological processes, the effective manipulation of these processes to improve the quality and quantity of the produce and tailoring of productive eco-specific plant types is the need of the hour.

I hope this Conference will provide an excellent forum to discuss some of these issues and evolve future strategies that will enable us to deal with the problem of food and nutritional security at the national level, keeping pace with international scenario.

I wish this conference a grand success.

(**V Chinnusamy**)

NATIONAL CONFERENCE OF PLANT PHYSIOLOGY - 2021

Frontiers of Plant Physiology for Climate Smart Agriculture

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NATIONAL CONFERENCE OF PLANT PHYSIOLOGY - 2021

Frontiers of Plant Physiology for Climate Smart Agriculture

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Gurumurthy, Santosh Khomane

Technical Session

Jagadish Rane, Vinay Hegade, Krishna Jangid, Om Khandave

Felicitation

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Poster Session

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KM Boraiah, Pooja Patole, Poonam Jagtap
Basavraj PS, Supriya Thorat, Siddesh Sadashiva

National Conference of Plant Physiology-2021

December 09-11, 2021

Frontiers of Plant Physiology for Climate Smart Agriculture

ICAR-National Institute of Abiotic Stress Management, Baramati, Pune- 413115, Maharashtra

Tentative Scientific Programme (*Hybrid Mode*)

10th December, 2021

Day 1: December 09, 2021		
08:00	**Breakfast:** Amphitheatre (In front of Auditorium)	
08:30-09:30	**Registration:** Venue: Auditorium, NIASM	
09:30-11:00	**Inaugural Session (Auditorium, NIASM)** Welcome Address: **Jagadish Rane** About the Society and the Awards: **V Chinnusamy**, Hon. Secretary, ISPP, New Delhi Remarks by President, ISPP: **M B Chetti**, VC, UAS, Dharwad ISPP Awards Ceremony: **V Chinnusamy** Inaugural Address by Chief Guest: **A K Singh, Director,** ICAR-IARI, New Delhi Chairman's Remarks: **Himanshu Pathak**, Director, ICAR-NIASM, Pune Vote of Thanks: **Madan Pal**, Treasurer, ISPP, New Delhi	
11:00-11:30	**Conference Group Photo and High tea (Amphitheatre)**	
11:30-13:15	**PLENARY SESSION I**	
11:30-12:15 12:15-13:00	**Memorial Award Lectures** **Chair: Akhilesh Tyagi**, University of Delhi **Co-chair: V Chinnusamy,** ICAR-IARI, New Delhi **Rapporteurs: Satish Kumar,** ICAR-NIASM, Pune and **Sudhir Kumar**, ICAR-IARI, New Delhi **Professor S.K. Sinha Memorial Award Lecture** **Speaker:** Deepak Pental, University of Delhi South Campus, New Delhi **Topic:** Genetics, Genomics and Breeding of Oilseed Mustard **Professor K.K. Nanda Memorial Award Lecture** **Speaker:** Prabodh K. Trivedi, CSIR-Central Institute of Medicinal & Aromatic Plants, Lucknow **Topic**: Regulatory network comprising small molecules plays bigger role in plant growth and development	
13:15-14:00	**Lunch Break**	
14:00-15:00	**Keynote Address** **Chair: Ashwani Pareek,** NABI, New Delhi **Co-chair: Madan Pal,** ICAR-IARI, New Delhi **Raporteurs: Vinutha T,** ICAR-IARI, New Delhi and **Khapte PS**, ICAR-NIASM, Pune **Speaker: Christine Foyer**, University of Birmingham, Birmingham, UK **Topic:** Effects of high CO_2 on the growth and stress tolerance	
15:00-17:00	**Concurrent Technical Sessions**	
	Session I (Auditorium) Abiotic and Biotic Stresses: Physiology, Genetic Improvement and Management	**Session II** (Dr B P Pal Conference Room) Photosynthesis, Metabolomics and Plant Metabolism, Plant Growth Regulators and Mineral nutrition
	Chair: Nataraja N Karaba, UAS, Bangalore **Co-chair: Jagadish Rane,** ICAR-NIASM, Pune **Rapporteurs: Pinky Raigond**, NRCP, Solapur and **Aliza Pradhan**, ICAR-NIASM, Pune	**Chair: S. R. Gadhak,** MPKV, Rahuri **Co-chair: Ajay Arora,** ICAR-IARI, New Delhi **Rapporteurs: SK Meena,** ICAR-IIPR and **Harisha C B,** ICAR-NIASM, Pune
Lead Speakers (15 Min. each)		
15:00-15:15	**Muthappa Senthil Kumar,** NIPGR, New Delhi Dry root rot pathogen likes it dry and hot: a tale of combined stresses in chickpea	**Manoj K Sharma**, JNU, New Delhi Comparative transcriptomic analysis highlights mechanisms associated with sugar accumulation in sweet sorghum
	M Raveendran, TNAU, Coimbatore,	**Jitender Giri**, NIPGR, New Delhi

	Developing rice genotypes adapted to warming climate	Membrane lipid remodelling for improving phosphate use efficiency in rice
	Mirza Hasanuzzaman, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh Biochar and chitosan regulate antioxidant defense and methylglyoxal detoxification systems and enhance salt tolerance in jute (*Corchorus olitorius* L.)	**R Elanchezhian**, ICAR-IISS, Bhopal Plant nutrient management for enhancing nutrient use efficiency of crops
Session Speakers (10 Min. each)		
	Ramesh Shankar Bhadane, MPKV, Pandharpur New Cowpea Variety Phule Sonali for Irrigated and Dry land Conditions	**Vinutha T**, ICAR-IARI, New Delhi Efficient processing technology of "hydro, hydro-thermal and thermal near infrared rays treatments to reduce rancidity in pearl millet flour.
	R.G. Vyashnavi, ICAR-NIASM, Pune *Kharif* Chickpea for additional income and generation advancement/speed breeding	**Lekshmy S,** ICAR-IARI, New Delhi Impact of environmental variables on nitrogen metabolism of cereals
	Ambadas Huchche, ICAR-CCRI, Nagpur Etiology of fruit physiological disorders in citrus	**Satish Kumar**, ICAR-NIASM, Pune Integrative application of plant bio-regulators and deficit irrigation enhanced crop stress tolerance, productivity and quality in water scarce semi-arid regions
	Jagadish Hosamani, UAS, Dharwad Seed development, acquisition and loss of desiccation tolerance in barnyard millet [*Echinochloa frumentacea* (Robx.) Link] varieties	**Supriya Sambhaji Chougale**, Shivaji University, Kolhapur Effect of Green Synthesized Silver Nanoparticles on Seed Germination in Amaranthus paniculatus and Wheat under Different Salinity Levels.
	Ashish Kumar Srivastava, IRRI, Varanasi Physiological and biochemical traits associated with enhanced crop survival of rainfed lowland rice varieties under complete submergence	**Vijaysinha Kakade**, ICAR-NIASM, Pune Micro-blasting and soil-mix technique for guava cultivation in abiotic-stressed basaltic terrain
	A. K. Trivedi, ICAR-CIHS, Lucknow Moisture stress management in mango through melatonin application	**Mahesh R. Ghule**, Pune, Maharashtra Effect of potentized Cynodondactylon extract on seed germination and seedling growth in Wheat (*Triticum aestivum* cv. Jaora) under control and saline condition
17:00-18:00	**Tea and Poster Session** **(All the posters to be displayed on 9th Dec 2021 at 8-30 am)**	
18:00-19:00	**ISPP Annual General Body Meeting**	
19:00-20:30	**Cultural Programme**	
20:30	**Dinner**	

Day 2: December 10, 2021		
08:00-09:00	**Breakfast**	
09:00-11:00	**PLENARY SESSION II**	
	Invited Lectures	
	Chair: S K Chaudhary, DDG, ICAR, New Delhi **Co-chair: P.C. Sharma** ICAR-CSSRI, Karnal **Rapporteurs: Pranjali Ghodke,** ICAR- DOGR, Pune and **KM Boraiah**, ICAR-NIASM, Pune	
09:05-09:40	Speaker**: Kadambot Siddique,** The University of Western Australia Topic: Breeding for heat stress tolerance in canola (*Brassica napus*)	
09:40-10:15	Speaker**: Bettina Berger,** The University of Adelaide, Australia Topic: High-throughput phenotyping to screen for climate resilient crops	
10:15-10:50	Speaker**: P.V. Vara Prasad,** Kansas State University, USA Topic: Climate smart agricultural practices to enhance productivity, nutrition and resilience of agri-food systems **Discussion**	
11:00-11:15	**Tea**	
11:15-13:15	**Concurrent Technical Sessions**	
	Session III (Auditorium) Climate Change, Crop Modelling & Phenotyping	**Session IV** (Dr B P Pal Conference Room) Genome Editing, Biostimulants and Fruit Physiology
	Chair: M Maheshwari, ICAR-CRIDA, Hyderabad **Co-chair: RS Wagh**, MPKV, Rahuri **Rapporteurs: Dhandapani R**, ICAR-IARI, and **Ganesh Kadam**, ICAR-DFR, Pune	**Chair: Valliyodan Babu**, Lincoln University, USA **Co-chair: C Murumkar**, TC College, Baramati **Rapporteurs: NV Singh**, NRCP, Solapur and **Basavaraj PS**, ICAR-NIASM
	Lead Speakers (15 Min. each)	
	Anjali Anand, ICAR-IARI, New Delhi Seed priming through physical energies can improve stress tolerance in crops	**V. Chinnusamy,** ICAR-IARI, New Delhi Advances in genome editing for crop improvement
	M Vanaja, ICAR-CRIDA, Hyderabad Assessing the response of crop plants to elevated temperature and CO2- Issues and concerns	**Ajay Kumar Singh**, ICAR-NIASM, Pune Overexpression of GmFAD3A enhances drought and salinity stress tolerance in soybean
	R. Gomathi, ICAR-SBI**,** Coimbatore Physiological Adaptations and Management Strategies for Abiotic Stresses in Sugarcane	**Renu Munjal,** CCSHAU, Hisar Investigation of metabolic changes modulated by the environmental changes
	Harsh Nayyar, Panjab University, Chandigarh Molecular, physiological and anatomical mechanisms of reproductive cold tolerance in Chickpea	**Ajay Arora,** ICAR-IARI, New Delhi Phytohormones in ripening and senescence: Signal perception & transduction
	Session Speakers (10 Min. each)	
	Ratna Kumar Pasala, ICAR-IIOR, Hyderabad Harnessing resilience in sesame and safflower to the effect of drought: a route towards a sustainable agriculture	**Hima R. Vadera**, Bhavnagar University Biochemical Analysis from *Momordica charantia* L. leaf (Source) and developmental stages of fruit (Sink)
	M G Jadhav, VNMKV, Parbhani Validation of OILCROP SUN (DSSAT) model for Sunflower (*Helianthus annuus* L.) in Middle Gujarat region	**N V Singh,** ICAR-NRC, Pomegranate Aril Browning and fruit cracking in pomegranate: unravelling mechanism and devising mitigation strategy

	Kiran B O, UAS, Dharwad Assessment of Chlorophyll Content in Sorghum (*Sorghum bicolor* L.) Based Pigeon Pea Intercropping in Northern Dry Zone of Karnataka	**Suneha Goswami**, ICAR-IARI, New Delhi Comparative study of pearl millet landraces vs. biofortified variety for nutritional quality and flour shelf life
	Brahmesh Reddy B R, UAS, Dharwad Morphophysiological and phenological traits contributing to drought tolerance in rabi Sorghum (*Sorghum bicolor* L Monech) genotypes	**Supriya Tukaram Thorat**, ICAR-NIASM, Pune Silencing of Ethelene Insensitive 2(GmEIN2) gene enhances water stress tolerance in soybean
	S Narayanan, Greenstar fertilizers Ltd. Bio-stimulants for climate resilient agriculture **Prashant Nandargikar**, Isha Agro Science Pvt Ltd.	**M.K Adak**, Kalyani University, Kolkatta Chemical elicitation for regulation of redox & ethylene metabolism in post-harvest shelf life increment of capsicum fruit (*Capsicum annum*)
	Shashi Meena, ICAR-IARI, New Delhi Combined effects of drought and heat on the morphophysiological, biochemical and yield traits in wheat (*Triticum aestivum* L.)	**Ira Vashisht**, Munirka Comparative transcriptomic analysis highlights mechanisms associated with heterosis in sweet sorghum hybrid "CSH22SS"
	BB Gaikwad, ICAR-NIASM, Pune A quick method for spectral delineation and model calibration for prediction of instantaneous relative water content in plant leaves using hyperspectral spectroscopy	**Jay B. Pandya**, SRV, Gujarat Nutritional composition of underutilized fruit *Salvadora persica* L. Sp. during its sequential stages of development
13:15-14:15	**Lunch**	
14:15-15:15	**PLENARY SESSION III**	
	Chair: Sanjeev Gupta, ADG, ICAR, New Delhi **Co-chair: Jagadish Rane,** ICAR-NIASM, Pune **Rapporteurs: Hanamant M Halli,** ICAR-NIASM, Pune and **Kiran Bhagat,** ICAR-DFR, Pune	
14:15-14:45	Speaker**: Valliyodan Babu,** Lincoln University, USA Topic: Legume Pangenomics for Crop Improvement	
	Professor G. V. Joshi Memorial Award Lecture	
14:45-15:15	**Speaker: Jagadish Rane,** ICAR-NIASM, Pune **Topic:** Imaging for Abiotic Stress Tolerance in Crop Plants: Progress and scope for making crops climate resilient	
15:15-17:15	**Young Scientist Session**	
	Chair: Manoj K Sharma, JNU, New Delhi **Co-chair: Chandan Kumar Gupta,** ICAR-IISR, Lucknow **Rapporteurs: Rahul Damale**, NRCP, Solapur and **Kiran B.O.,** UAS, Dharwad	
	Participants	
	Sangram Bhanudas Chavan, ICAR-NIASM, Pune Estimating carbon sequestration potential of agroforestry systems in India	
	Khapte Pratapsingh Suresh, ICAR-NIASM, Pune Elucidating the influence of rootstocks on drought response of grafted tomato under high through-put phenomics	
	Aliza Pradhan, ICAR-NIASM, Pune Inherent capacity to maintain canopy temperature is critical for drought and heat stress induced physiological responses in young sorghum plants	
	Basavaraja, T, ICAR-IIPR, Kanpur Evaluation and identification of climate smart extra early maturing germplasm sources for common bean improvement	

	Yadukrishnan P, IISc, Bengaluru Shedding 'light' on ABA: A COP1-HY5-ABI5 regulatory module optimizes ABA-mediated inhibition of early seedling development
	Patil Mahesh, NIPGR, New Delhi *CaProDH2* imparts resistance against *Ascochyta rabiei* infection in chickpea through fine modulation of the proline-P5C cycle under drought stress
	Krishnapriya Vengavasi, ICAR-SBI, Coimbatore Physiological traits and pathways regulating carboxylate efflux for enhanced phosphorus acquisition in soybean
	Harmeet Kaur, ICAR- NIPB, New Delhi A novel E3 Ubiquitin ligase PUB63 from rice plays significant roles in heat stress response in transgenic Arabidopsis.
	Sushma M Awaji, ICAR-NRRI, Cuttack Characterization of Novel Wheat Genotypes for Drought Stress Tolerance
	Sushmita Singh, ICAR- DGR, Junagadh A novel genetic stock identified and characterized for tolerance to Iron deficiency chlorosis at early growth stages
17:15–18:45	**Tea and Poster Session** **(All posters to be displayed on 9th Dec 2021 at 8:30 am)**
19:00-20:00	**Cultural Programme**
20:00	**Dinner**

Day 3 : December 11, 2021	
08:00-09:00	**Breakfast**
09:00-10:20	**PLENARY SESSION IV**
	Invited Lectures
	Chair: K.C. Bansal, New Delhi **Co-chair: Padmini Swain,** ICAR-NRRI, Cuttak **Rapporteurs: Mahesh Kumar,** ICAR-NIASM, Pune and **Ramesh Badne,** MPKV, Rahuri
09:05-9:30	Speaker**: O.P. Dhankher** The University of Massachusetts Amherst Topic: Strategies for Arsenic Phytoremediation and Limiting Arsenic Accumulation in Rice
09:30-09:55	Speaker**: S.V Krishna Jagadish** University, Kansas, USA Topic: A pragmatic framework for combining heat tolerance and high yield in rice varieties
9:55-10:20	Speaker**: Ramanjulu Sunkar,** Oklahoma State University, USA Topic: The role of m6A RNA methylation in cold tolerance of Arabidopsis
	Discussion
10:20-10-30	**Tea**
10:30-12-30	**Young Researcher's Presentation**
	Chair: R Gomathi, ICAR-SBI, Coimbatore **Co-chair: A.V. Mane,** BSKKV, Dapoli **Rapporteurs: Suneha Goswamy**, ICAR-IARI, New Delhi and **Karthikeyan N**, ICAR-NIASM, Pune **Participants:** **Raviraj Chandrakant Shinde,** National Reference Laboratory Development of fit-for-purpose and new analytical methods for plant growth regulators, mycotoxins and pesticide residue analysis in various food matrices **Vadivelmurugan Irulappan,** NIPGR, New Delhi Mechanistic understanding of tolerance to combined drought and dry root rot in chickpea **M. Umapathi,** Krishnagiri, Tamil Nadu Evaluating the Influence of Endophytic Microbes on the Physiological Function of Sorghum Under Drought **Santosh Tukaram Yadav,** Pune, Maharashtra Evaluation of Crop Syst model for yield and water productivity of rainfed groundnut *(Arachis hypogaea* L.) **Supriya P Kusale,** Kolhapur, Maharashtra Cost effective production of phytase producing bio-inoculant and its efficacy in field **Sinto Antoo,** Yelahanka, Bengaluru Can reproductive stage nitrogen application alleviate the negative effects of elevated CO_2on grain protein content in bread wheat? **Manu Khajuria,** CSIR-IIIM, Jammu Photochemical efficiency is negatively correlated with the Δ9-tetrahydrocannabinol content in *Cannabis sativa* L. **Chandan Roy,** University of Calcutta, Kolkata A mechanistic insight into the role of rice r40c1 protein in imparting drought stress tolerance **Jagadesh M,** Nilgiris, Tamil Nadu Carbon footprints in different blocks of agro ecosystems of Nilgiri hill region in Southern Western ghats – An insight to keep the soils of Zestern ghats alive and to combat climate change **Suraj Sharad Gadakh,** Ahmednagar, Maharashtra Phenotyping of *rabi* sorghum for root and physiological traits associated with drought tolerance **Brindha. C,** ICAR-SBI, Coimbatore Sugarcane responses from cellular to whole plant level at higher salinity conditions **Krishna Kumar Jangid,** ICAR-NIASM, Pune Implications of leaf senescence pattern based phenomics approach for differentiating field performances of chickpea genotypes under soil moisture stress in field conditions

12:30–13:30	**Panel Discussion / Science Quiz Session**	
	Panel Discussion (Auditorium)	**Science Quiz Session** (Dr B P Pal Conference Room)
	Chair: Nilesh Nalawade, Principal, College of Agriculture, Baramati. **Co-chair: S. D. Ramteke**, NRCG, Pune. **Rapporteurs: Sangram Chavan**, ICAR-NIASM, Pune and **A K. Singh**, ICAR-NIASM, Pune ***"Scientists, Industries, Progressive Farmers interaction"***	**Convener: Ajay Arora,** ICAR-IARI, New Delhi **Co-convener: Mahesh Kumar,** ICAR-NIASM, Pune **Rapporteurs: Vijaysinha Kakade**, ICAR-NIASM, Pune and **Jagadish Hosamani**, UAS, Dharwad **Pawan Kumar Mohanty,** JNKVV- Jabalpur, Madhya Pradesh **Vinay Mahadev Hegde,** ICAR-NIASM, Pune **Sagar P,** ICAR-NIASM, Pune **Sinto Antoo,** Yelahanka, Bengaluru, **Nageshkumar Sakharam Pachpor,** Nashik, Maharastra **R.G Vyshnavi,** JNKVV- Jabalpur, Madhya Pradesh **Mamatha B C,** ICAR-NIASM, Pune **Nidhi Chaturvedi,** Varanasi, Uttar Pradesh **Tamilselvan A,** ICAR-NIASM, Pune **Tamanna Arif,** Karnataka **Umesha. D,** GKVK Bengaluru
13:30-14:00	**Valedictory function**	
14:00-14:30	**Lunch**	

Zoom Link (All the sessions except Technical Session II and Session IV):
https://zoom.us/j/97113113516?pwd=Yzdybm9rMTJyU1lBT1dva0xES0ZsUT09

Meeting ID: 971 1311 3516 | Password: ncpp2021

Zoom Link (Technical Session II and Session IV):
https://us02web.zoom.us/j/85711261021?pwd=ZkVyOGNmM1ozWXRGWm5MUjZHdU82dz09

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Professor KK Nanda Memorial Lecture

Regulatory network comprising small molecules plays bigger role in plant growth and development

Prabodh Kumar Trivedi
CSIR-Central Institute of Medicinal and Aromatic Plants (CSIR-CIMAP), Lucknow-226015, India
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Secondary plant products play important roles throughout plant life, regulate development and are beneficial for human health. Out of different secondary plant products, biosynthesis and accumulation of flavonoids fluctuate depending upon the cellular, climatic and developmental conditions that limit their proper industrial utilization. We identified and used various regulatory components to engineer plants with enhanced flavonoid biosynthesis. Our study suggests an involvement of the light-regulated miR858 and associated pri-miRNA-Encoded-Peptide (miPEP858) in the flavonoid biosynthesis as well as plant growth and development. CRISPR-based miR858a/miPEP858a-edited plants and miPEP858a overexpressing lines showed altered plant development and accumulated modulated levels of flavonoids. Transcriptome datasets from tissues of miR858 overexpressing lines and miR858a/miPEP858a-edited plants suggest modulation in the expression of a set of genes, including the member of PSK gene family (AtPSK4), a small peptide. Promoter:reporter assays reflected the positive correlation for the expression between PSK4 and miR858/miPEP858. To further establish a network between miR858/miPEP858 and PSK4, PSK4 was edited using the CRISPR/Cas9 approach in wild-type and miR858OX as well as constitutively over-expressed in wild-type and miR858 mutant plants. Edited PSK4 plants displayed a substantial reduction in plant growth, and the further analysis suggested a significant alteration in the root cell elongation in PSK4-overexpression and PSK4-edited plants. The over-expression of PSK4 in miR858^{CR} background complemented the growth, while mutation in PSK4 in miR858-overexpressing plants led to a substantial reduction in plant growth, including delayed flowering. The study reveals the importance of growth-related expansins and auxin signalling in PSK4-mediated plant growth. Together, the study demonstrates the successful targeting of small plant peptides using the CRISPR/Cas9 and provides an essential insight into the molecular control of growth regulated by cross-talk between miRNA, small peptides, and MYB transcription factor.

Professor G.V. Joshi Memorial Lecture

Imaging for abiotic stress tolerance in crop plants: Progress and scope for making crops climate resilient

Jagadish Rane
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While the increase in crop production is the key for food security, the sustainability of agriculture will rely on achievements per unit area, time and resources consumed. These factors are increasingly challenged by climate change that can amplify abiotic stresses such as soil moisture deficit or excess, sub or supra optimal temperature, salinity, extreme level of micronutrients, etc. Yield losses caused by these abiotic stresses can range from 40-90% in crop plants, depending on the intensity and time of occurrence during crop growth. Hence, crop breeding pipelines aim at augmenting abiotic stress tolerance efforts through introgressing genes associated with relevant traits in new cultivars. Continuous research in this regard has provided insights into various mechanisms at cellular and whole plant levels. However, much of this knowledge is yet to be utilized to identify stress tolerance traits or phenotyping cultivars for those specific traits. Therefore, any efforts to bridge this gap can significantly contribute to climate-resilient and sustainable agriculture. There has been remarkable progress in understanding genes or developing genotyping tools for dissecting the genetic makeup of plants. However, high throughput phenotyping that can deal with many genotypes can accelerate the identification of genes associated with stress tolerance. This necessity has paved the way for plant phenomics, which has emerged as complementary science for genomics-supported crop improvement.

Phenomics that relies on imaging science and data analytics can deal with difficult-to-measure plant traits directly or indirectly. They help monitor the plant responses to abiotic stress with more frequency through sensors, automation, and data science. Hence, imaging science is being employed to understand the plant responses to various abiotic stresses both in controlled and field conditions. Phenotyping protocols involving various imaging systems that capture a different range of electromagnetic spectrum have provided clues about key processes of plants such as leaf senescence, canopy cooling, water relations, while chlorophyll fluorescence imaging systems could reveal the photosynthetic health of plants. These tools have helped in identification of promising genotypes that can serve as donors for development of stress tolerant cultivars. Studies with hyperspectral imaging have yielded several indices explaining plant stress in field and controlled environmental conditions. However, the influence of environmental factors that include weather and soil make it necessary to optimize the phenomics protocol for each crop for a specific agro-ecosystem and hence provide broad scope for research. While data generated through phenomics can help improve the inherent capacity of plants to tolerate abiotic stress, the same information can also help fine-tune precision agriculture to optimize agricultural inputs. Thus both the stress-tolerant crop cultivars and the climate-smart crop production practices can significantly contribute in making the agriculture sustainable in the scenarios predicted due to climate change.

Keynote Address

Effects of high CO_2 on the growth and stress tolerance

Christine H. Foyer

School of Biosciences, College of Life and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

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High atmospheric CO_2 concentrations (eCO_2) have positive effects on the productivity and yield of through effects on photosynthesis (Ainsworth & Long, 2021 *Global Change Biology* 27, 27–49.). However, eCO_2 is likely to alter the redox balance and signalling of plant cells in ways that alter biotic and abiotic stress tolerance. In this talk, I will firstly address how growth under eCO_2 is predicted to alter cellular redox processes and associated signalling and whether plants perceive eCO_2 as a stress in itself. Thereafter, I will discuss recent results from studies on the effects of (eCO_2) on pea development and susceptibility to the pea aphid (*Acyrthosiphon pisum*). We studied aphid fecundity in wild type peas and mutants defective in either strigolactone (SL) synthesis or signalling. Plants were grown in air or under eCO_2. Growth under eCO_2 significantly increased the height and the branching of the wild type shoots. The mutant shoots had significantly higher fresh weight/dry weight ratios than the wild type under both growth conditions. No direct of eCO_2 on aphid fecundity was observed but aphid numbers were increased in the SL mutants under both ambient and eCO_2 conditions. SL-dependent regulation of aphid fecundity is related to effects on shoot phytohormone levels, which were modified in the SL mutants.

Plenary Lecture

Breeding for heat stress tolerance in canola (*Brassica napus*)

Sheng Chen, Katia Stefanova, Wallace A. Cowling and **Kadambot H. M. Siddique***
The UWA Institute of Agriculture, The University of Western Australia, Perth 6001, WA, Australia
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This research is developing methodology to facilitate large-scale screening of heat stress tolerance in canola at flowering stage, and will identify heat tolerant germplasm for Australian plant breeders. The new methods and heat tolerant germplasm will be transferred to canola breeders, which will accelerate the future commercial release of heat tolerant varieties. Our aim is to help Australian growers to maintain canola productivity as temperatures rise in response to climate change. Timing of heat stress: The critical period for heat stress in canola begins one week before first flower and continues during the flowering period. Flowers subject to heat stress produce fewer pods and seeds. Intensity and duration of heat stress: A heat wave of three days with a maximum temperature of 32°C from midday for four hours, and an overnight minimum temperature of 22°C, is sufficient to reduce canola yield. Genotypic variation in heat tolerance: Genotypes vary in heat stress tolerance, based on their ability to set seed after heat stress during flowering. We are developing breeder-friendly methods for genetic improvement of heat tolerance in canola. Heat stress, in the absence of moisture stress, reduced seed yield significantly after 3 d, 5d and 7d of heat treatment from one week before first flower and during the flowering period. A heat wave of three days with a maximum temperature of 32°C from midday for four hours, and an overnight minimum temperature of 22°C, was sufficient to reduce canola yield. Heat treatments reduced seed yield (SYM) and pod number (PNM) on the main stem or lateral branches, depending on when heat stress was applied. Heat stress sensitivity began one week before first open flower on the main stem. We screened >250 canola lines for heat tolerance for two years under field conditions followed by one year in a controlled environment room, and found significant genetic variation for heat stress tolerance. Significant genetic variation exists among canola varieties for tolerance to heat stress. Our research provides promising germplasm and breeder-friendly procedures to accelerate the future commercial release of heat tolerant varieties. We are developing a prototype pre-breeding facility for heat stress tolerance that could be incorporated into commercial canola breeding programs. In our experience, simulated heat waves of 32°C daily maximum and 22°C minimum are suitable for large-scale screening for heat tolerance in canola. We recommend assessing canola heat tolerance by measuring pod and seed formation on the main stem.

Plenary Lecture

Climate smart agricultural practices to enhance productivity, nutrition and resilience of agri-food systems

P.V. Vara Prasad
University Distinguished Professor and Director
Feed the Future Sustainable Intensification Innovation Lab; and Department of Agronomy, Kansas State University, Manhattan, Kansas 66506, USA
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Our agri-food systems are highly sensitive to changing climatic conditions. Current knowledge on effects of climate change factors on yield of major grain crops (e.g., rice, wheat, sorghum, and groundnut). Elevated carbon dioxide concentration will increase photosynthesis and vegetative growth of major food crops. There are strong interactions between elevated carbon dioxide concentrations in major food grain crops. The beneficial effects of elevated carbon dioxide mediated through increased photosynthesis will be negated by rising temperatures resulting in lower seed yields. Above optimum temperatures will have negative impacts on reproductive processes (such as pollen production, pollen germination, fertilization, seed numbers and individual seed weight) resulting in lower seed yield. Grain crops are most sensitive to high temperature stress during gametogenesis flowering and early stages of grain filling. Stress during these stages leads to loss of gamete fertility, poor pollination, decreased fertilization, embryo abortion, delay in start of grain filling and shorter grain filling duration, ultimately resulting in fewer seed numbers, smaller seed size and lower yields. There is urgent need to develop climate smart agricultural practices with systems perspective to enhance productivity, nutrition and build resilience of our cropping systems to climate change. This should include exploring genetic, agronomic and ecological innovations to increase resilience through both adaptation and mitigation strategies using systems and transdisciplinary approaches. There is need for stronger collaboration between biophysical and social scientists to build resilience. Focus should be on broader one-health, end-to-end agri-food systems with emphasis of circularity. Future research focus should be on better understanding the interactions between various climatic change factors on yield and nutritional composition of food grain crops. In addition, a better understanding of interaction of climate change factors on biotic pests (e.g., diseases, insects and weeds) and on host plant susceptibility is essential to quantify the overall impact on food production and developing best management practices. Continued collaboration between physiologists, biotechnologists, molecular biologists, breeders, plant pathologists, entomologists, agronomists, economists and social scientists are essential for developing strategies to combat effects of climate change and management practices on productivity of food grain crops, but also to ensure that these innovations can be adopted by farmers at scale to have positive impacts on food and nutritional security and environmental outcomes.

Plenary Lecture

High-throughput phenotyping to screen for climate resilient crops

Bettina Berger
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The identification of climate resilient crops is becoming more and more urgent, with abiotic stress predicted to increase in coming decades. Phenotyping technology, such as cameras, sensors and robotics, has the ability to aid scientists and breeders screening large numbers of lines to identify those with improved genetics and tolerance to stresses, such as heat, drought or salinity. These technologies can be applied in the early stages of fundamental research in controlled environments, all the way to screening of advanced breeding lines in the field. This talk will provide an overview of some of the tools available for high-throughput phenotyping and their application in screening for abiotic stress tolerance.

Plenary Lecture

A pragmatic framework for combining heat tolerance and high yield in rice varieties

Krishna Jagadish SV
Professor, Crop Physiology, Department of Agronomy, Kansas State University, Manhattan, Kansas, 66506, USA
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A differential increase in day and night temperature is observed and the same is projected to continue into the future, with increased divergence. Although, recent evidence points to a rapid increase in night-time temperature (HNT), high day-time temperature (HDT) continues to pose a serious threat in certain locations. Comparatively, HNT is considered to impact rice on a much wider geographic scales and over different growth and developmental stages. This clearly demonstrates the need to address both HDT and HNT stress impacts on rice productivity and quality. The first part of my talk will focus on the rationale for combining heat tolerance with escape for increased resilience to HDT in rice cultivars. The second part will discuss the advances in HNT responses and finally provide a framework to develop rice varieties that can overcome heat stress induced damage, combined with increased genetic gain even under future warming climate.

Lead Speaker

Comparative transcriptomic analysis highlights mechanisms associated with sugar accumulation in sweet sorghum

Supriya Mathur[1], Ira Vashisht[1], Vinay Singh[1], A.V. Umakanth[2], Rita Sharma[3] and **Manoj K. Sharma[1]***

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[2]Indian Council of Agricultural Research-Indian Institute of Millet Research, Hyderabad, India
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Sorghum bicolor is a C4 grass, which is a promising biofuel feedstock. Its grain and stem juice can be used to synthesize bioethanol. Sorghum has remarkable potential to thrive on the marginal land with minimum agricultural inputs. Though, there is a huge scope for yield improvement of sorghum with respect to fermentable sugars and biomass, very little is known about the molecular players regulating its growth and development. In this study, we explored the whole genome transcriptomic changes related to sugar accumulation in the stem internodes of three diverse sorghum cultivars along the course of development as well as in response to progressive water limiting conditions. Approximately 3.4 billion high-quality paired-end reads derived from 42 libraries were aligned against *Sorghum bicolor* genome and differentially expressed genes were annotated. The study revealed systematic changes that occur in pathways affecting stem sugar accumulation and adaptation to drought stress response. It specifically highlighted the significant role of carbohydrate transport and sugar metabolism, cellular signalling components and phytohormones. Under the water limiting conditions, pathways associated with osmotic stress response, oxidative stress, phytohormone and carbohydrate metabolism, were differentially regulated. Further, it highlights the contribution of transcription factors towards stem sugar accumulation and drought stress response. Remarkably high proportion of TFs showing gene expression modulation belonged to three TF families namely ERF, MYB and NAC. Particularly, ERF TF family was revealed to be involved in both these physiological pathways and play an important role in maintaining the plant's health under drought stress.

Lead Speaker

Membrane lipid remodeling for improving phosphate use efficiency in rice

Jitender Giri
National Institute of Plant Genome Research, Aruna Asaf Ali Marg, New Delhi-110067, India
Presenting author: jitender@nipgr.ac.in

Membrane lipid remodeling, which involves the hydrolysis of phospholipids (P-lipids) to release Pi for essential cellular processes, and concomitantly, synthesis of non-Pi lipids like galactolipids and sulpholipids to compensate for a loss of phospholipids is essential for survival under Pi deficiency. We report here, that lipid remolding is a conserved strategy in diverse rice genotypes to cope with P deficiency. Monongalactosyl diacylglycerol (MGDG) and digalactosyl diacylglycerol (DGDG) represent the most abundant galactolipids in the chloroplast and aid in membrane lipid remodeling, allowing the Pi utilization from the phospholipids' hydrolysis. A Pi deficiency responsive rice MGDG synthase gene, *OsMGD3* was characterized for its roles in Pi deficiency adaptation. Here, we show that Pi status of the plant and a transcription factor, OsPHR2 are involved in the transcriptional regulation of *OsMGD3*. We used overexpression (OE) and CRISPR/Cas9 generated knockout (KO) lines of *OsMGD3* to explore its potential role in rice adaptation to Pi deficiency. *OsMGD3* KO lines displayed a poor Pi deficiency tolerance while OE lines had improved PUE compared to WT. Both OE and KO lines have changed root architecture and altered membrane lipid remodeling, especially in roots. Our study revealed that OsMGD3 is involved in Pi deficiency-induced membrane lipid remodeling and also influences root architecture for Pi acquisition.

Lead Speaker

Biochar and chitosan regulate antioxidant defense and methylglyoxal detoxification systems and enhance salt tolerance in jute (*Corchorus olitorius* L.)

Mirza Hasanuzzaman* and Md. Rakib Hossain Raihan
Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh
*Presenting author: mhzsauag@yahoo.com

We investigated the role of biochar and chitosan in mitigating salt stress in jute (*Corchorus olitorius* L. cv. O-9897) by exposing twenty-day-old seedlings to three doses of salt (50, 100, and 150 mM NaCl). Biochar was pre-mixed with the soil at 2.0 g kg^{-1} soil and chitosan-100 was applied through irrigation at 100 mg L^{-1}. Exposure to salt stress notably increased lipid peroxidation, hydrogen peroxide content, superoxide radical levels, electrolyte leakage, lipoxygenase activity, and methylglyoxal content, indicating oxidative damage in the jute plants. Consequently, the salt-stressed plants showed reduced growth, biomass accumulation, and disrupted water balance. A profound increase in proline content was observed in response to salt stress. Biochar and chitosan supplementation significantly mitigated the deleterious effects of salt-induced reactive oxygen species (ROS) in jute by stimulating both non-enzymatic (e.g., ascorbate and glutathione) and enzymatic (e.g., ascorbate peroxidase, dehydroascorbate reductase, monodehydroascorbate reductase, glutathione reductase superoxide dismutase, catalase, peroxidase, glutathione *S*-transferase, glutathione peroxidase) antioxidant systems and enhancing glyoxalase enzyme activities (glyoxalase I and glyoxalase II) to ameliorate ROS damage and methylglyoxal toxicity, respectively. Biochar and chitosan supplementation increased oxidative stress tolerance and improved the growth and physiology of salt-affected jute plants, while also significantly reducing Na^+ accumulation and toxicity and decreasing the Na^+/K^+ ratio. These findings support a protective role for biochar and chitosan against salt-induced damage in jute plants.

Lead Speaker

Assessing the responses of crop plants to elevated temperature and CO_2 - Issues and concerns

M. Vanaja*, S.K. Yadav, N. Jyothi Lakshmi, B. Sarkar, P. Sathish, M. Srinivasa Rao, M. Prabhakar, K. Sammi Reddy, V.K. Singh

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The predicted increased atmospheric temperature, changed rainfall pattern and enhanced CO_2 concentration are the challenges to sustain the agricultural productivity in the future. To assess the response of different crops to these variations many research programmes are initiated all over the world with different confined as well as field facilities. We initiated field experiments at ICAR-CRIDA with OTCs, FATE and CTGC facilities to evaluate major rainfed crops to elevated CO_2 (550ppm, eCO_2), elevated temperature (+3°C above ambient, eT) and their combination. The results indicated that the influence of eCO_2 differed with C3 and C4 crop plants for physiological parameters like Anet, gs, Tr and WUE as well as biomass and yield with higher response of C3 crop plants. However, it is interesting to record that even C4 crop plant like maize registered improved performance when they were exposed to moisture deficit stress. The increased temperature negatively impacted the growth of all the crops and the presence of eCO_2 ameliorated the ill effects of eT. The degree of reduction of different parameters with eT and responsiveness to eCO_2 was observed to be not only specific to crop but also depend on the genotype. The other variables such as season, nutrient and moisture status also influenced the crop response to these conditions. Hence it is suggested that when quantifying the response of any crop to these climate change parameters, one need to take sufficient care about other influencing variables.

Lead Speaker

Physiological adaptations and management strategies for abiotic stresses in sugarcane

R. Gomathi
ICAR-Sugarcane Breeding Institute, Coimbatore -641007
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Sugarcane is one the most important industrial crops in global agriculture and it has come out as a multi-product crop profiting producers and consumers (Kumar et al.2020). Sugarcane provides about 80% of the world's sugar production and it is cultivated in more than 90 countries encompassing nearly half of the world for both sugar and bioenergy. Sugarcane is a C_4 plant (i.e. produce first product of CO_2 fixation as 4 carbon compound) belongs to the family, producing high biomass compared to any other cultivated crop. Its stem is considered as the most useful economic product globally accounting nearly 80% for sugar production. Compared to the rice and wheat generally the sugarcane cultivation needs a complete year encompassed with different phenophases *viz*., germination phase (0-60 days), formative phase (60-150 days), grand growth phase (150-240 days) and maturity phase (240-365 days) and owing to its inherent capacity it generally withstand harsh high temperature, drought and other abiotic stresses too. Integrated understanding of all the physiological adaptive components for growth and productivity which passes several times scale (phenophases) through physio-biochemical processes is necessary for the combating different stresses faced by the sugarcane grown under changing climate. Hence, physiological adaptations for drought, salinity, temperature etreams and waterlogging stress in sugarcane is deliberated precisely which are essential for sustaining sugarcane productivity.

Lead Speaker

Molecular, physiological and anatomical mechanisms of reproductive cold tolerance in chickpea

Harsh Nayyar[1]* and Kamal Dev Sharma[2]
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Chickpea is a cool-season food legume, which is sensitive to chilling temperatures (<20/10C), especially at its reproductive stage, leading to abortion of flowers to substantially reduce the podding potential. The underlying molecular mechanisms governing cold tolerance in reproductive components of chickpea are not known, which are imperative to be examined to address cold tolerance in this legume. In the present study, we investigated various physiological, biochemical and molecular mechanisms in leaves and anthers in chickpea genotypes contrasting for cold sensitivity. The findings revealed that maintenance of a stable sucrose metabolism in anthers is a vital mechanism affecting pollen development during cold stress in cold-tolerant genotypes. Investigations on the regulation of expression of differentially expressed genes in anthers of cold-tolerant genotypes under cold stress revealed two important features that govern cold tolerance in anthers i) differential expression of less number of genes and ii) up-regulation of majority of the differentially expressed genes. The main categories of genes governing cold tolerance in anthers were carbohydrate/triacylglycerol metabolism, signal transduction, pollen development and transport. Almost all the genes in these categories were up-regulated. Regulation of gene expression suggests that chickpea anthers use a dual cold tolerance mechanism wherein anthers sustain their development under cold by enhancing triacylglycerol and carbohydrate metabolism while pollen grains maintain normal development by regulating pollen development genes.

Lead Speaker

Overexpression of *GmFAD3A* enhances drought and salinity stress tolerance in soybean

Ajay Kumar Singh[1]*, Mamta Mahendra Bhute, Supriya Tukaram Thorat, Mahesh Kumar[1], Jagadish Rane[1], Said A. Ghabrial[2] and Aardra Kachroo[2]

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Fatty acid desaturases (FADs) are enzymes that involved in desaturation of fatty acids by introducing double bonds. They play crucial role in maintaining membrane fluidity in response to various abiotic stresses. However, a comprehensive analysis of FAD3 in drought and salinity stress tolerance is lacking. We used Bean Pod Mottle Virus (BPMV)-based vector for achieving rapid and efficient over-expression of *omega-3 Fatty Acid Desaturase A* gene from *Glycine max* (*GmFAD3A*) to assess the functional role of FAD3in abiotic stress responses in soybean. Higher levels of recombinant BPMV-GmFAD3A transcripts were detected in overexpressing soybean plants. Overexpression of *GmFAD3A* in soybean resulted in increased levels of jasmonic acid and higher expression of *GmWRKY54* as compared to mock-inoculated, vector-infected soybean plants under drought and salinity stress conditions. FAD3 overexpressing (OE-FAD3) plants showed higher levels of chlorophyll content, relative water content, efficient photosystem-II, transpiration rate, carbon assimilation rate, proline content and also cooler canopy under drought and salinity stress conditions as compared to mock-inoculated, vector-infected soybean plants. Results from the current study revealed that GmFAD3A overexpressing soybean plants exhibited tolerance to drought and salinity stresses.

Lead Speaker

Investigation of metabolic changes modulated by the environmental changes

Renu Munjal[1]*, Pooja Swami[1], Anita Kumari[1] and Vitthal T. Barvkar[2]

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High temperature stress decreases bread wheat (*Triticum aestivum* L) productivity which is a stable food and nourishes billion of people. Yield of wheat is expected to decline by 6% for 1 °C rise in temperature thus there is dire need to increase wheat production up to 60% by 2050 to fulfill global demand of burgeoning global population (Asseng *et al*. 2015). Metabolomics is the new and effective biotechnological tool which open new vista to identify metabolites which could be used as promising biomarkers for stress tolerance and genetic dissection for metabolic pathways involved in stress response. The objective of this study was to demonstrate genetic variability in altered metabolic levels in the roots of six Indian wheat genotypes (WH147, WH711, WH1021, WH1105 and WH1184 and HD2967) in contrasting sowing environment i.e. timely sown (TS), late sown (LS) and very late sown (VLS) and to identify potential metabolite associated with heat stress through targeted metabolite profiling using a Liquid Chromatography Quadrupole Time of Flight Mass Spectrometry (LC-qTOF- MS).Total 129 metabolites were expressed in all genotypes and three environmental conditions. Out of these 58 found in TS, 36 under LS and 35 under VLS. Most expressed were exclusive to environment, TS (50), LS (28) and VLS (27). Genotypes also showed wide variability WH147 (24), WH711 (22), WH1021 (26), WH1105 (25), WH1184 (12) and HD2967 (20). The results of the study could provide a framework to understand plant mechanism governing heat stress and promising biomarkers for improving high temperature stress tolerance in wheat, genetic dissection for metabolic pathways involved.

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R.S. Bhadane[1]*, V.R. Patil[2] and S.I. Tambe[3]

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Cowpea is one of the important drought hardy multi-season and multipurpose pulse crop requires low inputs. The productivity of *kharif* cowpea is very low. The present improved varieties have lower yield potential and disease susceptibility. There is need to develop high yielding variety combined with early, determinate, synchronize maturity, better quality and resistance/tolerance to major pests and diseases. Phule Sonali is a white seeded cowpea genotype derived through the pedigree selection method from a cross between RC 101 X Phule Vithai at Pulse & Oilseed Crops Research and Training Centre, MPKV, Pandharpur. The selections were made in F_2 population and evaluated for yield and disease resistance for subsequent generations. It was tested in station trials, University multilocation varietal trials and All India Coordinated Initial Varietal Trial under the name PCP 1123 for several locations and environments for its stability performance under field conditions along with existing released varieties. The new variety Phule Sonali reported average grain yield of 1392 kg/ha which is 28.08%, 13.07% and 23.27 percent higher than the check varieties Phule Rakhumai, Phule Vithai and RC-101 respectively. It is white bold seeded having early maturity, moderately resistance to major diseases like yellow mosaic virus under field conditions. Considering consistent performance, the cowpea genotype PCP 1123 has been released for cultivation for Western Maharashtra under the name of Phule Sonali in Joint Agresco during 29-30 October, 2020 held at Dr PDKV, Akola and State Seed Sub Committee Meeting held online on 2nd September, 2021.

SS-02

Kharif chickpea for additional income and generation advancement/speed breeding

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Chickpea crop is widely cultivated throughout India primarily in the *rabi* season (October-February). There is a very good potential of growing chickpea in the *kharif* season (June-August) in Western Maharashtra, due to the average temperature ranging between 20-30^{o}C with average rainfall of 200-250 mm during June to August along with well-drained soil availability at the time of flowering and pod setting. Consequently, by the virtue of suitable critical components for chickpea cultivation *i.e.,* rainfall and temperature makes it possible for cultivation of *kharif* chickpea in this region. Preliminary investigations, which were carried out to explore feasibility of *kharif* chickpea have enabled us to identify some of the promising chickpea genotypes such as IPCO-6-11, ICE 15654-A, JG-11, Vishal, JG-16, ICCV 92944, JG-14, ICC 4958 and Vijay. Studies revealed that *kharif* chickpea can be harvested by 60-70 days under rainfed condition. The raw green pods yielded about 3.0-3.5 t ha^{-1} while the raw green plants with pods yield ranged between 11 to 13 t ha^{-1}. *Kharif* chickpea has advantages such as additional yield and income within a short duration, seed production and rapid genetic advancement/speed breeding. It is possible to get five generation under natural climatic conditions. This implies for progressive speed breeding with less time, space and resources for the extensive development of chickpea cultivars. However, there is a need to bridge the knowledge gaps with respect to adaptability, cost benefit ratio, extension and policy to promote *kharif* chickpea.

SS-03

Etiology of fruit physiological disorders in citrus

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Citrus fruits are grown in wider ecological conditions across the Indian sub-continent. Contrary to the short gestation period of 5-6 months in other fruit crops post flowering and fruit set, the important citrus fruits like mandarins and sweet oranges go through a long gestation period of 9-10 months and hence they are exposed to various biotic and abiotic stresses leading to various physiological and entomo-pathological disorders. The most important abiotic stress associated citrus fruit disorders encountered commonly in India are citrus creasing, granulation, sunscald, stylar end breakdown, rough skin, oblong or blotchy skin fruits (locally called as *waywar, cockbund* or *magari*) etc. leading to heavy fruit drop or poor marketability of fruits. These disorders are attributed to various weather aberrations and injudicious management of nutrient and water management practices. The strategies to manage these fruit disorders have to be throughout the growth period of the fruit development and at specific fruit growth stages. Timely use of growth regulators like GA_3 and 2,4-D and nutrient salt combinations involving skeletal nutrients have proved useful in the experimental studies at ICAR-Central Citrus Research Institute, Nagpur. Various fruit disorders as above are discussed with viable amelioration techniques.

SS-04

Seed development, acquisition and loss of desiccation tolerance in barnyard millet [*Echinochloa frumentacea* (Robx.) Link] varieties

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Studies on seed development, acquisition and loss of desiccation tolerance in barnyard millet varieties were conducted during *kharif*, 2019. Five varieties of barnyard millet *viz*., DHBM-93-3, CO-2, PRJ-1, VL-172 and VL-207 were harvested 7, 14, 21, 28, 35 and 42 days after anthesis (DAA). With the advancement of seed development, seed coat colour changed from grayed yellow to grayed orange group with different grades which persisted up to last date of harvesting (42 DAA). Maximum germination occurred around 35 DAA in Co-2, DHBM 93-3, VL-172 and VL-207 varieties except PRJ-1 which occurred at 28 DAA when physiological maturity and maximum seedling dry weight were attained. This stage of seed development was marked by drastic reductions in seed leachate conductivity and seed moisture content. Total soluble sugars increased from 7 to 35 DAA in Co-2, DHBM 93-3, VL-172 and VL-207 varieties except PRJ-1 which increased from 7 to 28 DAA and non-reducing sugars increased drastically more at 35 DAA in Co-2, DHBM 93-3, VL-172 and VL-207 varieties except PRJ-1 which was noticed at 28 DAA, concomitant to the stage at which desiccation tolerance occurred. Loss of desiccation tolerance was studied with the different treatments like dry seeds, 3 hr imbibed seeds, 1 mm and 3 mm radicle emergence in all the five varieties. The release of volatile aldehydes and malondialdehyde produced were significantly higher in dry seeds and 3 hr imbibed seeds which indicated the role of lipid peroxidation. During the loss of desiccation tolerance, the activity of antioxidant enzymes like peroxidase, catalase, superoxide dismutase were significantly higher in seeds with 3 mm radicle length and it was initiated with 1 mm radicle protrusion as compared to dry seeds and 3 hr imbibed seeds which indicated the free radical scavenging mechanism.

SS-05

Physiological and biochemical traits associated with enhanced crop survival of rainfed lowland rice varieties under complete submergence

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Over 16 million ha of rice in South and Southeast Asia are annually affected by flash-floods. Assessing physiological and biochemical traits associated with tolerance will guide proper phenotyping and accelerate breeding tolerant varieties. Twenty-one-days-old seedlings of 4 tolerant (FR13A, Swarna-Sub1, NDR9730018, NDR9930111) and 2 sensitive (Swarna and IR42) lowland rice varieties were submerged for 10 days in an outdoor deep-water tank under natural conditions. Enzyme activities of the Halliwell-Asada pathway (SOD, APX, GR) were assessed before submergence (0 day, Bs) and at 2, 4, 6, and 24th hours after de-submergence (As). Enzyme activity (SOD, CAT, APX, GR), concentration of antioxidants (AsA and GSH), membrane lipid peroxidation (MDA content), and total chlorophyll concentration were assessed at Bs and As. SOD activity increased (3-4-fold in tolerant vs 1-1.5-fold in susceptible varieties) up to 4th hr after de-submergence and subsequently declined through to the24th hr. Successive increase in APX and GR activities were recorded up to 24th hr in all varieties, except GR in IR42. Tolerant varieties depicted higher CAT activities (48.8-58.2%) at As than susceptible varieties (28.4-38.3%). AsA and GSH contents showed opposite trends at As, IR42 and Swarna showed 7.6 and 14.7% increase in AsA values and more than 80% reduction in GSH concentrations. MDA was 5.5-6.5 times higher in the susceptible varieties compared with 2.5-2.6 times in the tolerant ones. Tolerant and susceptible varieties depicted 46-60% and 36-44% chlorophyll retention, respectively, at As. Plant survival was also higher (ranged of 62 to 85%) in in the tolerant varieties compared to Swarna and IR42(42%).

SS-06

Moisture stress management in mango through melatonin application

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Moisture is essential to ensure optimum and consistent fruit productivity. Water deficit is the most pervasive impact of environmental stress on productivity and quality of mango. The increasing water shortage has caused to investigate the sustainable and effective water-saving techniques without detrimental effect on fruit production and quality. To manage the moisture stress foliar spray of melatonin @ 00, 20, 50, 100 and 150 µM were applied at three phenological stages (fruit set, pea and marble stage) in sixteen year old mango trees. To compare with irrigation a set of trees was given 3 irrigations and un-irrigated trees were maintained as negative control. Impact of moisture stress was comparatively more on new flush of leaves as compared to old leaves. Total chlorophyll content in mature leaves of un-irrigated trees was 7.67 mg/g as compared to 12.58 mg/g fresh weight in leaves of melatonin treated trees. Activities of catalase, peroxidase, superoxidase dismutase and glutathione reductase in leaves varied from 34.33 µmol/min/mg protein, 0.687 µmol/min/mg, 834.78 U/mg and 7.89 µmol/min/mg in trees treated with melatonin @ 100 µM to 79.55 µmol/min/mg protein, 1.478 µmol/min/mg, 1013.77 U/mg and 15.33 µmol/min/mg in un-irrigated trees. Non-significant difference was observed in activities of these enzymes in irrigated and melatonin treated plants. Yield of 'A' grade fruits (fruit weight ≥ 250g) was also more (37%) in melatonin treated trees (@ 100 µM) as compared to negative control (un-irrigated) (15%). Variation in fruits of irrigated and melatonin treated (@ 100 µM melatonin trees was non-significant. Study support that melatonin may be a useful cast effective treatment for moisture stress management in perennial fruit crops like mango.

SS-07

Efficient processing technology of "hydro, hydro-thermal and thermal near infrared rays treatments to reduce rancidity in pearl millet flour"

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Pearl millet is considered as a highly nutritious food crop having unlimited health benefits. Despite being nutrient dense, use of pearl millet is limited due to rancidity and off-odour development during storage. Pearl millet flour-compositions that are high in unsaturated fats and lipids (5-6%) renders them to prone to a short shelf life due to the development of rancidity, which hinders the commercialization of pearl millet and its products. The present invented technology of "hydro treatment (HT) for 2 hr, hydrothermal (HTh) and thermal near infrared rays (thNIR) treatments for 5 min each" which guard against the development of oxidative rancidity in pearl millet flour. Rancidity causing enzymes viz., lipase, lipoxygenase (LOX), peroxidase (POX) and polyphenoloxidase (PPO) activities were measured in pearl millet flour after combined HT + Hth + thNIR processing treatment. Results showed significant decrease in activities of lipase by 47.9%, LOX by 84.7%, POX by 98.2% and PPO by 100% (by showing zero activity) as compared to control. Further results showed that the combined HT + Hth + thNIR processing treatment was found to be more effective in the reduction of rancidity development by 67.8% (CAV) and 66.34% (CPV) in processed pearl millet flour upon long term storage of 90 days at room temperature. Thus, the pearl millet flour processed through the proposed technology can be widely used in commercial food industries related to bakery and infant foods, which are increasing its demand globally owing to drive the growth of global millet flour market.

SS-08

Integrative application of plant bio-regulators and deficit irrigation enhanced crop stress tolerance, productivity and quality in water scarce semi-arid regions

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Defining use of plant bio-regulators (PBRs) and deficit irrigation (DI) on yield formation is essential for irrigation planning and alleviating the negative impact of water stress under semi-arid environment. Therefore, series of field experiments were conducted in last eight years (2012−2020) to evaluate the interactive effects of PBRs and DI on growth, yields and water productivity of major crops (wheat, sorghum, soybean, onion and eggplants). Potential PBRs included: salicylic acid, sodium benzoate (SB), thiourea (TU), potassium nitrate (KNO3), gibberellin (GA3), ortho-silicic acid (OSA) were applied exogenously at 3-4 critical growth stages of specific crop as main treatments. Line source sprinkler system (LSS); a unique sprinkler system designed to apply seven levels of irrigation water (IW) ranged between 0-1.0 times the CPE (cumulative open pan evaporation) as sub-treatments. The foliar application of PBRs mitigated water stress and significantly improved yields (4.2-25.0%), water productivity (1.02-9.60 kg/m^3) and reduced water usage. PBRs maintained higher leaf water content, lower canopy temperature, modulated the stomatal opening and ultimately the source-sink relations thereby improving the yield and productivity under DI. Particularly PBRs like TU (10 mM), SB (100 mg L^{-1}), KNO3 (1.5%) and SA (10 µM) were found effective to mitigate water stress in wheat, sorghum, onion, soybean and eggplant, respectively. Thus relative response of PBRs is highly specific to crop and varies with environment. PBRs also helped to improve significantly physicochemical and functional quality characteristics viz., rehydration ratio, protein content, total soluble sugar, total phenolics content and pyruvic acid in water deficits. It is concluded that conjunctive use of PBRs along with DI seems to viable option for improving crop yield, quality and water productivity under water scarce environments.

SS-09

Effect of green synthesized silver nanoparticles on seed germination in *amaranthus paniculatus* and wheat under different salinity levels

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Salinity is a major abiotic stress that affects crop yield and reduces the economy of farmers. A study was conducted to analyze the effect of green synthesized silver nanoparticles on seed germination in *Amaranthus paniculatus* and wheat under different salinity levels. Silver nanoparticles were synthesized using leaf extract of *Amaranthus spinosus* a spiny pigweed. The biologically synthesized silver nanoparticles were then employed to evaluate their effect on seed germination. Under different levels of salinity (50mM, 100mM, 150mM, 200mM) the germination parameters decreased in both cases but in the case of *Amaranthus paniculatus* the effect was severe than the Wheat. Seeds, when treated with different concentrations of AgNPs (25ppm, 50ppm, 75ppm and 100ppm), showed best results for seed germination than control (non treated) in *A. paniculatus* while in Wheat the effect was not so good than control (non treated). When the seeds were treated with AgNPs before undergoing salinity stress, in *A. Paniculatus* an increased germination percentage was observed than the seeds growing in salinity without nanoparticle treatment(control) but only for low levels of salinity (50mM, 100mM) While in case of Wheat the treatment was not proved much beneficial to improve salinity tolerance.

SS-10

Micro-blasting and soil-mix technique for guava cultivation in abiotic-stressed basaltic terrain

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Guava orchard has been established on land developed from barren and uncultivable terrain basalt rocks. It was porous, shallow in depth, gravelly, low in organic matter, high bulk density and poor water retention capacity in nature. Hence the planting of guava was done by improving the pit sites by digging pits with different sizes and filling them with varying filling mixtures. Results revealed that pits of 2x1x1 m dimensions and pits of same dimensions but were further modified with micro blasting and filled with mixture of native *murrum* soil with black soil at 1:1 ratio,20 kg FYM and 500g SSP performed better. Guava is medium rooting crop, hence performed well under these modified pit having mixed soils as filling mixture. Modified pits gave opportunity for better development of roots under gravelly and *murrum* soils. Use of mixed soil resulted in to improved soil moisture hold; nutrient retention ultimately resulted in to good establishment of plants on abiotic stressed land. This technology has resulted in achieving more than 18 and 22 t ha^{-1} yields without and with micro-blasting, respectively.

SS-11

Effect of potentized *Cynodon dactylon* extract on seed germination and seedling growth in Wheat (*Triticum aestivum* cv. Jaora) under control and saline condition

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Effects of treatment with potentised extract of durva grass (*Cynodon dactylon*) on wheat (*Triticum aestivum* cv. Jaora) seed germination under normal and saline (6 dsm^{-1}) conditions were studied. Wheat seeds were soaked in potentised durva extract for 60 minutes and then incubated at room temperature 25±3°C. After 5 days of incubation the percent of germination, root and shoot length, fresh and dry weight of seedlings were recorded. Results showed the potentised durva extract at concentration 0.2 to 0.8% have positive effect germination, seedling height and total biomass. Among all concentration 0.2% showed highest rate of germination (17.81%), seedling height (36.66 %) and total biomass (4.52%) compared to water control while under saline condition (9.86%), (12.84%) and (1.38%) respectively. It is concluded that priming of seed with potentised durva grass extract improved germination and seedling growth under normal and high salt stress condition.

SS-12

Harnessing resilience in sesame and safflower to the effect of drought: a route towards a sustainable agriculture

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Sesame and safflower are important oilseed crops and sources of edible oils. The domestic oilseeds production is not in pace in meeting the demand for vegetable oils driven by consumption pattern of the burgeoning Indian population. Low productivity of oilseeds particularly sesame and safflower is mainly attributed to their cultivation with sub-optimal management practices under resource scarce agro-ecologies. Approximately 64% of the area under oilseeds is rainfed and the oilseed production in the country is dependent on the weather aberrations particularly rainfall. Sesame is predominantly cultivated under marginal soils under rainfed situations during *kharif* season and safflower in residual moisture conditions during *rabi*. Often these oilseed crops get exposed to varied degrees and frequencies of intermittent drought during *kharif* season and/or terminal drought during *rabi* season. Screening, characterization and identification of promising lines from the germplasm and breeding material, development of transgenic materials, integration of molecular tools such as MAS and bio-regulatory microbial consortia may accelerate these crops besides imparting tolerance to drought. Varieties with high WUE with better seed yield may fit in the water scare zones. The identified genotypes may better perform and adapted to adverse weather conditions. Defined functional plant phenotype (FPP), or in other words, ideotype development may bring the acceleration in sesame crop towards climate resilience. Incorporation of efficient traits from wild species and indigenous germplasm into cultivated types may bring tolerance to drought further. Safflower grows on residual moisture in vertisols, due to sudden rise in temperature, often the crop gets exposed to drought. Early maturing and non-spiny varieties to adapt to drought situation and for easy harvest are the need of the hour for vertical/horizontal intensification. Exploiting, utilizing the available germplasm, integration of modern biotechnological tools, use of mitigation and management strategies may bring success towards both in developing high yielding cultivars and improve productivity.

SS-13

Validation of OILCROP SUN (DSSAT) model for sunflower (*Helianthus annuus* L.) in middle Gujarat region

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The studies on validation of OILCROP SUN (DSSAT) model for sunflower (*Helianthus annuus* L.) cultivars under different plant densities in middle Gujarat region was carried out during *kharif* season of year 2015 and 2016. The results revealed that significant differences in the seed yield of sunflower were observed during both the years individually and also in pooled. However, the seed yields were higher for plant spacing S_1 (1463 Kg ha^{-1}) than S_2 (1187 kg ha^{-1}) and S_3 (788 kg ha^{-1}) during 2015. Whereas, during 2016 seed yield of sunflower sown in S_1 (1267 kg ha^{-1}) was high followed by S_2 (1062 kg ha^{-1}) and S_3 (766 kg ha^{-1}). Significantly highest seed yield (1365 kg ha^{-1}) was recorded under S_1 plant spacing treatment in pooled conditions. The cultivar, LSFH 171 recorded significantly high seed yield (1248 kg ha^{-1}) and (1075 kg ha^{-1}) than cultivar LSFH 35. Similar result was recorded when data pooled over the years. The overall performance of the model for phenological and yield attributes of three plant spacing S_1 (60 x 10 cm), S_2 (60 x 20 cm) and S_3 (60 x 30 cm) and two cultivars LSFH 35 and LSFH 171 clearly indicated that simulation for seed yield was better with reasonable error. The model output showed that the simulated values of phenology and seed yield of sunflower were close to the corresponding observed values. However, the model simulated poor LAI and above ground biomass for both genotypes.

SS-14

Assessment of chlorophyll content in sorghum based pigeon pea intercropping in northern dry zone of Karnataka

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Chlorophyll content plays an important role in photosynthetic activity. Sever water deficit conditions cause's changes in total chlorophyll content and reduce the production of photosynthates. Field experiment was conducted to study the physiological interventions in three sorghum hybrids and varieties with pigeon pea intercropping at Regional Agricultural Research Station Vijayapur during kharif 2021. The result indicated that, the total chlorophyll content was comparatively higher in hybrids compared to varieties. Among hybrids CSH-35 recorded higher chlorophyll content (2.209 mg/g/fr.wt) followed by CSH-14 (2.204 mg/g/fr.wt). Among varieties, CSV 20 recorded higher chlorophyll content (2.903 mg/g/fr.wt) followed by CSV-17 (2.395 mg/g/fr.wt). However, intercropping based CSV-20 with pigeon pea recorded higher chlorophyll content (3.687 mg/g/fr.wt) followed by CSH-14 with pigeon pea (3.560mg/g/fr.wt). Further, chlorophyll content was higher in (2.154 mg/g/fr.wt) followed by CSH-14 (2.328 mg/g/fr.wt) at 50% flowering. The chlorophyll *b* was recorded higher in CSV 20 with pigeon pea intercropping (1.533 mg/g/fr.wt) followed by CSH 35 intercropping (1.297 mg/g/fr.wt). The sole pigeon pea recorded maximum total chlorophyll content (2.352 mg/g/fr.wt), chl*a* (1.654 mg/g/fr.wt and chl*b* (0.698mg/g/fr.wt). Furthermore, maximum chlorophyll *a/b* ratio was recorded in genotype CSH-13 (3.418 mg/g/fr.wt) followed by intercropped based CSH-17 (3.381 mg/g/fr.wt). The data represented that, there was no significant reduction in total chlorophyll content with sorghum base pigeon pea intercropping. The total mean chlorophyll recorded was relatively higher under hybrids based intercropping compared to varieties.

SS-15

Morpho-physiological and phenological traits contributing to drought tolerance in *rabi* sorghum genotypes

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Identifying advance breeding lines and formulating the screening parameters platformed on growth physiology plays a major role to build a future proof agriculture. A rhizotron study was conducted at RARS, Vijayapur using 18 genotypes including checks. The study concentrated on identifying major plant attributes that led to better performance in the drought stress comparing their performance to growth under unstress condition. CRS 98 recorded 50 percent flowering earlier than others indicating its ability to dedicate degree days to grain filling under drought. Genotypes VJP 2740 and RSV 1945 showed 85% of relative water content under drought. RSV 1945 and CRS 93 (51.85 and 51.77 respectively) were having highest SPAD chlorophyll values under drought stress comparable to RSV 1876 (54.71) under irrigated conditions while CRS 99 could maintain high leaf area index (3.24) at 50% flowering under stress. The root to shoot ratio was significantly higher in P. Suchitra (29) followed by RSV 2371 (28) under stress condition at physiological maturity. Genotypes VJP 2704 and RSV 1876 (43.56 and 43.42) however recorded harvest index which was significantly higher than the checks under same drought conditions. CRS 99 and CRS 93 maintained higher leaf area (22.61 and 21.90 cm^2 per plant) under drought stress. RSV 1850 had root length of 45 cm which was higher than that of M-35-1 indicating ability for deeper mining of stored soil moisture. CRS 93 (33.55 gm) recorded highest test weight and was comparable to check P. Suchitra (33.85) under the stress condition. The experiment concluded that CRS 93 and CRS 99 had good adaptability to drought and followed by CRS98, VJP 2740 and RSV 1945. The relative water content, root length, leaf area and days to 50% flowering were identified to be the major physiological and phenological parameters for breeding in drought adaptation.

SS-16

Combined Effects of drought and heat on the morphophysiological, biochemical and yield traits in wheat

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Plants being sessile and continuously encounter multiple environmental stresses during their life cycles that adversely affect the growth and productivity of plants by increasing the production of oxygen free radicals, thus are major threats to sustainable agricultural productivity and ecological purposes worldwide. Due to its cultivation in rainfed conditions, wheat faces high temperature combined with irregular water supply during the grain filling period which results in yield reduction. We observed that independent and combined drought and heat stress adversely affect the yield and physiological growth of wheat plants. The present study was investigated to quantify the effects of drought (D, 50% field capacity), heat (H, 37-38 °C/30 °C, with normal irrigation), and combined heat and drought (HD, with 37-38 °C/30 °C day/night temperature and moisture content was maintained at 50% field capacity) stresses during reproductive stage on yield, morpho-physiological and biochemical traits of wheat which were strongly associated with improved heat and drought tolerance in wheat. Four wheat genotypes (C306, HD2967, Raj3765 & WL711) were evaluated under (H), (D), and (HD) stress from heading till maturity. The stress treatments were applied 10 days before anthesis till harvesting. These stresses caused oxidative damage by the overproduction of reactive radicals (H_2O_2) and enhanced malondialdehyde contents (MDA) and increased transpiration rate, which resulted in reduced photosynthetic rate, stomatal conduction, Fv/Fm ratio, and yield attributes in all four wheat genotypes. We observed that the combination of stresses (HD) was more detrimental for the yield and other physio-biochemical parameters as compared to the individual stress treatment. However, (H), (D), and (HD) stresses induced the accumulation of proline, and enzymatic antioxidants to prevent the damage caused by reactive oxygen species (ROS). Finally, this study indicated that the greater tolerance of the genotypes to heat, drought, and combined stresses were attributed to activation of enzymatic antioxidants, accumulation of higher osmolyte, and maintenance of chlorophyll pigments, stability of the membrane, and relative water content.

SS-17

A quick method for spectral delineation and model calibration for prediction of instantaneous relative water content in plant leaves using hyperspectral spectroscopy

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The changes in spectral signatures of leaf sample caused due to loss of water content can correlate strongly, however establishing such correlations require sufficient observations that takes significant longer time, due to manual methods involved. Moreover since the calibration of such models are generally genotype specific, a quick method to generate sufficient datasets capturing variability in a genotype would be required to be useful for practical utility. An experiment therefore conducted to explore if the instantaneous relative water content of a grape leaf can be found using reflectance spectroscopy and a quick model calibration method, which can also delineate the spectral bands affected by the water content of leaf was explored. This involved lab setup for instantaneous heating and synced acquisition of leaf spectra and weight measurement using spectroradiometer and digital weighing scale, respectively. The measurement of spectra was carried out using ASD Fieldspec4 Hi-res spectroradiometer in a dark room setup. This setup has provision to provide sufficient illumination using two ASD illuminator reflectance lamps which were geometrically arranged to cause gradual heating of target sample and subsequent loss of water content. The target placement plane was calibrated using white spectral on reference with bare OFC (25^0 FOV) placed vertically above the target for every sample run. The reflectance spectra thus obtained was correlated with the instantaneous relative water content. The λ / λ contour plot of spectral bands combinations delineated on basis of R^2 values show good linear correlation (R^2= 0.94) of two-band indices for practical use. However the generation of larger datasets also allowed improving correlations by fitting several machine learning models wherein the model performance improved close to R^2= 0.99. The Bayesian ridge, Ridge CV and LassoLars CV were the top three performing algorithms with lowest RMSE among the 37 machine learning models tested.

SS-18

Biochemical Analysis from *Momordica charantia* L. leaf (Source) and developmental stages of fruit (Sink)

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Momordica charantia L. is widely grown in India as a source of food and medicine. The use of any plant is based on the presence of nutrients and biomolecules present/ incorporate in fruit. Food formation is taken place in leaves (source) and accumulate in fruit (sink). The quantitative analysis in leaf and developmental stages of fruit was carried out in Momordica charantia. Analysis of physical parameters such as length, width, colour, shape was carried out in the current experiment. The physico-chemical parameters like pH, acidity and total soluble solid also considered in leaf and fruit. Pigments such as chlorophyll a, b, carotene, lycopene and anthocyanin found in higher amount in leaf than the stages of fruit. On the other hand, leaf and developmental stages of fruit showed significant difference in the amount of carbohydrate such as reducing sugar, non-reducing sugar, total sugar and starch as well as amino acid content. While the amount of total phenol and Protein found higher in the leaf. Concentrations of enzymes such as Amylase, Invertase, Catalase and Peroxidase also varies in leaf along with development of fruit. Different stages of fruit were also subjected to anatomically study. The knowledge of source to sink relationship in plant which can help to improve quality of fruits.

SS-19

Aril browning and fruit cracking in pomegranate: Unraveling mechanism and devising mitigation strategies

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Pomegranate (*Punica granatum* L.) occupies a prime position in ensuring livelihood security of farmers in arid and semi-arid regions of India. It is one of potential fruit crops which hold the promise to achieve the goal of Doubling Farmers' Income in natural resource challenged areas marred with climatic and edaphic challenges. Though, the pomegranate production, acreage, productivity and export of pomegranate have registered impressive growth of more than 300, 100, 60 and 250%, respectively during the last ten years but physiological challenges like aril browning and fruit cracking have been aggravated during last few years due to various climate change issues. To understand the prominent physiological, biochemical and nutritional factors affecting the aril browning and fruit cracking, a comprehensive screening of pomegranate germplasm under field conditions has been initiated and supported with various observations related to plant canopy and fruit traits/parameters. The average aril browning and fruit cracking ranged between 0-16.69% and 0-40.26%, respectively among the germplasm (exotic, indigenous and cultivated varieties) screened during the last three years. During last two years, excessive rains in Solapur had resulted into staggered or highly unsynchronized flowering, irregularity in harvesting and enhanced incidence of fruit cracking and aril browning. The peduncle diameter, leaf chlorophyll content, fruit rind to aril ratio and rind nitrogen contents have been found to be significantly correlated with cracking at fruit maturity stage. Similarly, fruit aril 'Mg' content was also found be positively correlated with aril browning. Among cracked and healthy fruits, fruit weight and rind moisture were varying significantly suggesting their role in influencing cracking.

SS-20

Comparative study of pearl millet landraces vs. biofortified variety for nutritional quality and flour shelf life

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Pearl millet is considered to be one of the most important nutricereals due to its excellent nutritional quality, but at the same time its poor shelf life and rancidity or off-flavor development in flour within 7-10 days after milling is the major limitation, which affects nutritional and sensory properties and thus discourages consumer acceptance. One of the main causes for the development of rancidity in pearl millet flour is its fatty acid composition and the endogenous lipase and lipoxygenase enzyme activity. We have examined the four PM landraces (Chanana Bajra-2, Jafrabadi, Damodara Bajriand Chadi Bajri) for their rancid behaviour and nutritional quality and compared them with the bio fortified PM variety (Dhanshakti). All four landraces were found to be less rancid and have better shelf life. The fatty acid profiling showed that the linoleic acid, which is the main substrate for the lipoxygenase enzyme, was 20 to 38% less in landraces than in Dhanshakti. Due to the lower availability of the substrate, it was observed that the LOX activity in landraces was 30-50% lesser than in Dhanshakti. In terms of starch content, protein content and protein quality landraces are nutritionally on par with Dhanshakti.

SS-21

Silencing of ethelene insensitive *2*(*GmEIN2*) gene enhances water stress tolerance in soybean

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Crops particularly under rainfed conditions are highly prone to soil moisture deficits caused by sub-optimal and erratic rainfall events. Hence, water stress tolerance in crops is highly essential to ensure food security. We investigated candidate genes that can help in modulating the response of plant to water deficit. Ethylene insensitive (EIN), an integral membrane protein in the endoplasmic reticulum, is a central regulator of the ethylene signaling pathway. Down-regulation of EIN gene reduces sensitivity of plants to ethylene that regulates many aspects of plant growth and development, from seed germination, leaf expansion, and floral transition to organ senescence, fruit ripening, and the response to abiotic stresses, such as drought, high temperature, freezing, shading, and nutrient deficiency. For regulation of process associated with water stress tolerance, *Ethylene insensitive2* (*EIN2*) gene was silenced by employing Bean Pod Mottle Virus (BPMV)-based viral vector in soybean. We report that silencing of *GmEIN2* gene increased level of *DELLA* protein gene that positively regulate ABA level. EIN-silenced soybean plants exhibited a drought-tolerant related phenotype characterized by low levels of transpirational water loss, high leaf temperatures, increased stomatal closure, and enhanced expression levels of drought-responsive genes. EIN2-silenced soybean plants showed water stress tolerance as compared to mock-treated plants and vector-infected plants when subjected to water stress for 7 days in green house. Thus, a *GmEIN2* mediated water stress mechanism seems functional in soybean and could be effectively explored for enhancing water stress tolerance in crop plants.

SS-22

Chemical elicitation for regulation of redox and ethylene metabolism in post harvest shelf life increment of capsicum fruit

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In an experiment the application of different chemical elicitors (metabolic bulk silver, hydrogen peroxide, and polyamine) were applied in non-climacteric *Capsicum* fruit to determine the efficacy on ripening specific genes in an ambient postharvest storage condition. silver was more efficient in reducing the endogenous ethylene level and in downstream cell wall hydrolysing metabolism of fruit coat. PME (Pectin Methyl esterase) was most targeted genes to be affected in order of Silver > putrescine> H_2O_2. Contrarily, putrescine, a diamine was more effective in modulation of apoplastic ROS (Reactive Oxygen Species) metabolism with $O_2^{\cdot-}$& H_2O_2 accumulation. H_2O_2 treatment also induces some genes like peroxidases and mono/dehydroascorbate reductase to sustain ascorbic acid metabolism and a sustaining sugar-organic acid interconversion. In another experiment a combination of hydrophobic polymer as chitosan (CHT) & putrescine had revealed significant finding in ROS metabolism through by regulation of ethylene. The treatment in combination & individual revealed that ethylene metabolizing gene ACC synthase, ACC oxidase have direct relations with ROS metabolism through antioxidation cascades. On the other hand, CHT treatment had reduced the ethylene sensitivity by down regulation of ETR1 & ETR2 isoforms of ethylene signaling. The involvement of polyamines was more formed by oxidation of DAO (Diamine oxidase) & PAO (Polyamine oxidase) enzymes to release more H_2O_2 that induced other antioxidizing genes. As a whole the study concludes the effectivity of Putrescine & CHT for delaying of physiological activities related to ripening with special reference to ROS & ethylene metabolism during post harvest storage in *Capsicum* fruit.

SS-23

Comparative transcriptomic analysis highlights mechanisms associated with heterosis in sweet sorghum hybrid "CSH22SS"

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Heterosis is a widely exploited phenomenon for trait optimization and yield improvement in hybrids. Although CSH22SS (NSSH104) is the only sweet sorghum hybrid approved for commercialization in India, its underlying basis of heterosis remains unexplored. In this study, we investigate the molecular components associated with superior performance of hybrid, relative to its parental lines. Whole transcriptome analysis was performed on three distinct developmental stages of inflorescence to identify and assess genes significantly altered in hybrid vs parent. Approximately 872 million high-quality paired-end reads derived from developmental stages in three varieties were aligned against *Sorghum bicolor* genome. 2267, 2808 and 1744 genes showed differential expression at booting, milky to soft dough and physiological maturity stages, respectively in hybrid vs parents. Differential expression dynamics, d/a analysis and pathway mapping revealed enrichment of carbohydrate metabolism (cell wall biosynthesis, starch and sucrose metabolism), nitrogen assimilation and plant-pathogen interaction pathways in hybrid. The study provides insight into candidate genes contributing towards superior sugar accumulation and biotic stress tolerance in hybrid.

SS-24

Nutritional composition of underutilized fruit *Salvadora persica* L. Sp. Pl. during its sequential stages of development

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Salvadora persica L. Sp. Pl. is commonly known as miswak or pilu. Although its use as a tool of oral hygiene the fruit of this plant is underutilized. To overcome the higher demand of nutritional fruits, it is necessary to promote the use of underutilized fruits. Thus, Fruits of *Salvadora persica* L. Sp. Pl. were subjected to physical as well as biochemical analysis at successive developmental stages such as young, pre- mature, mature, pre-ripened, Ripened. Morphological and physico-chemical parameters such as Length, Diameter, Volume, Moisture content, Ash content, pH and Total acidity of fruits has been measured. The biochemical analysis of carbohydrates, proteins, phenols and enzymes has been observed during the successive stages of fruit development. pH was high at young stage while total acidity is high at ripened stage. Moisture content was high at the young stage while ash content was high at ripened stage. Chlorophyll – a, b and total chlorophyll was high at mature stage while Carotene and Anthocyanins were high at ripened stage. Reducing, total sugar and starch were high at ripened stage and non- reducing sugar was high in young stage. Proteins and phenol were high at ripened stage. Amylase activity was high at mature stage and Invertase activity was high at pre-ripened stage while Catalase activity was high at ripened stage. Also, the histological observations were made during the successive stages of development.

SS-25

Estimation of biochemical components and fatty acid profiling in grape seeds and their modulation in different grape rootstock for nutraceutical merit

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Grape seeds are rich source of phenols, flavanoids and fatty acids which attracts interests of scientific and research communities. To explore the influence of varying rootstocks on phenols, flavonoids and fatty acids composition of grape seeds, an experiment was conducted with Cabernet Sauvignon grafted on seven different rootstocks (110R, 140Ru, 1103P, SO4, 101.14 MGT, Fercal and Gravesac). The study revealed that among the different rootstocks, the concentration of total phenols and total flavonoids were higher in Fercal rootstock (30.53% and 23.41%, respectively) and antioxidant activities- cupraic activity was higher in Gravesac rootstock (30.71%) and DPPH activity was higher in 1103P rootstock (53.15%). Further, fatty acids were identified and quantified by gas chromatography equipped with a flame ionization detector. The identification of fatty acids was further confirmed by using gas chromatography with mass selective detector. The results revealed that the palmitate (16C) and methyl eicosatrienoate (omega-6) fatty acids were significantly higher in grape seed of Cabernet Sauvignon grafted on 101.14 MGT rootstock, whereas linoleate (omega-3) fatty acid was found significantly higher in Fercal grafted vines. Secondary metabolites and fatty acids play a paramount role in promoting several health benefits. Therefore, results of present study suggest optimal rootstock-scion combination in the preparation of need based concentration of phenols and flavonoids, omega-3 and omega-6 fatty acids derived from grape seeds in the supplementary nutraceutical merit products for maintaining human health.

SS-26

Phenotyping for drought tolerance in chickpea using Thermal Imaging

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Chickpea (*Cicer arietinum* L.) is the third most important grain legume crop largely grown in arid and semiarid environments. Terminal drought is one of the major stresses that can cause up to 50% crop yield loss in chickpea. Stability of seed yield under drought is governed by the numerous mechanisms which are essential for growth and development under deficit soil moisture. Cooler canopy is one of the strategies of drought avoidance in crop and hence canopy temperature of the crops has been a candidate trait for improving tolerance to drought and high temperature in crop plants. Hence, our objectives were to optimise the screening method for assessing canopy temperature by employing thermal imaging system and to use these observations for explaining genetic variation in seed yield in chickpea germplasm. Field experiments were conducted at NIASM experimental farm, Baramati, Maharashtra. The study consisted of 64 accessions including Digvijay, a locally adapted genotype, were evaluated under irrigated and moisture limited environment. In each environment, genotypes were planted in plots arranged in a lattice block design with 3 replications in plots of 1.8 m X 1 m (4 rows 0.45 m apart). Thermal images of all the plots were acquired between 10.00 and 14.00 h on sunny, cloudless days in both sufficient and deficit moisture environments. Method for acquisition of images was optimised in a way that it is applicable to all the measurements. There was a large range of variation among the genotypes for CTD of chickpea from flowering to pod filling stage. It was apparent that genotypes with cooler canopy had higher yield relative to others. Association of CTD with yield was more prominent during 2-3 week of days to 50 % flowering under drought. Prediction of seed yield appeared to be more reliable when canopy temperature was measured at 3rd week of 50% flowering which occurs around 58-66 days after sowing. At this stage, each 1◦C change in CTD can result in reduction of yield by 117 kg per ha in chickpea. We report here that thermal imaging system can be effectively used for screening chickpea germplasm for drought tolerance.

Key words: Chickpea, IR thermography, CTD, Reproductive stage.

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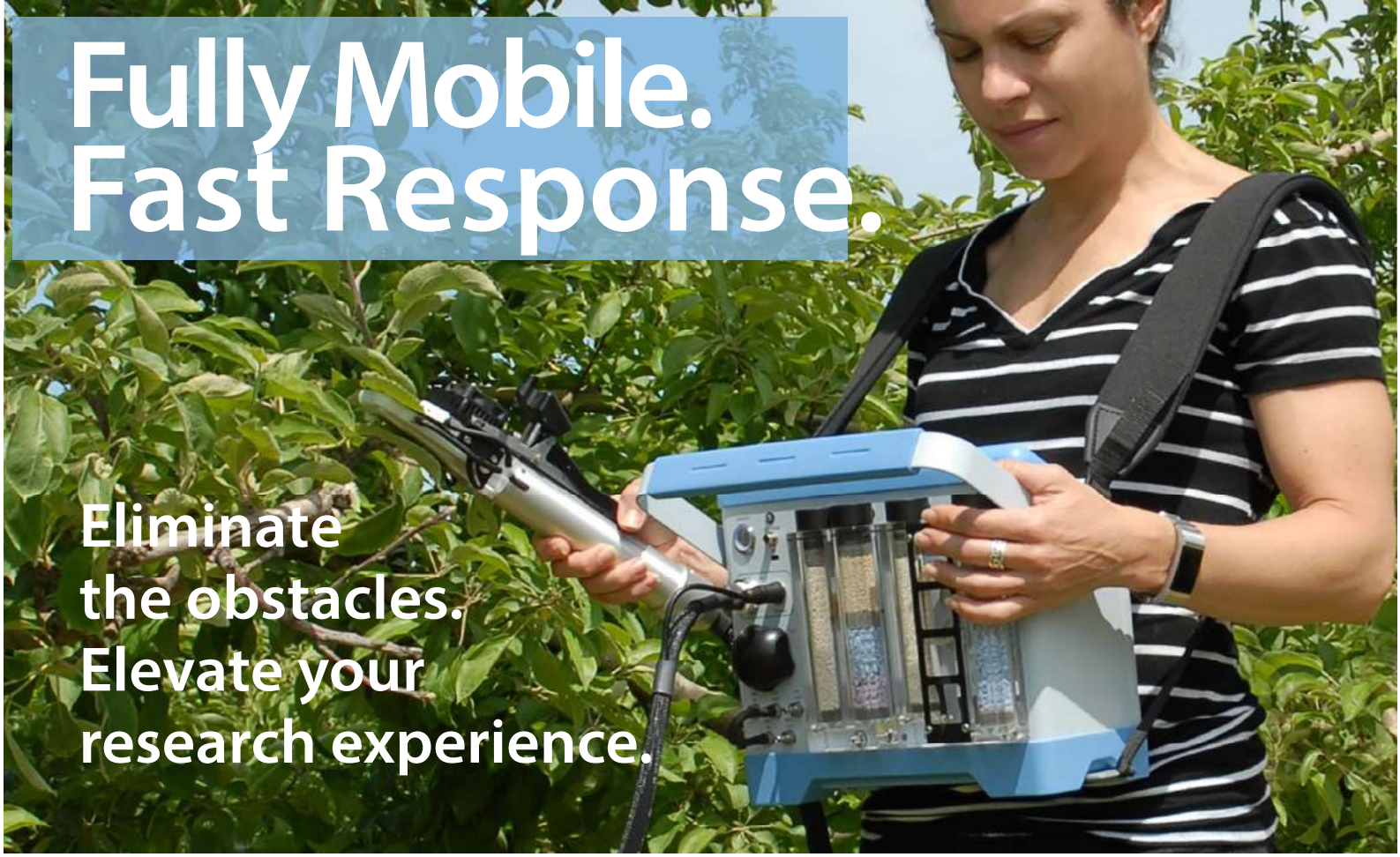

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YSS-01

Estimating carbon sequestration potential of agroforestry systems in India

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India had promised to reduce its greenhouse gas emissions per unit of GDP— by 33 to 35 percent below 2005 levels by the year 2030 through creating carbon sink equivalent to 2.5 to 3 billion tonnes of carbon dioxide under Paris Agreement. To achieve this target, precise quantification quantifying existing biomass & carbon stored in tree species will help to achieve NDC targets. Hence ICAR-CAFRI, Jhansi has come up with national estimates on agroforestry area and their carbon sequestration potential from 17 states of country. The average estimated carbon sequestration potential of the AFS, representing varying edaphic climatic conditions, on farmer's field at country level is 0.35 Mg ha^{-1} yr^{-1}. At national level, existing agroforestry systems are estimated to sequesters about 29.86 MT CO_2eq annually from 23.25 million ha, which could mitigate 1.63% of the total GHG emissions from agriculture sector of India (1831.64 million tonnes). Therefore, agroforestry systems provide 'win-win' opportunity to bridge-up the adaptation and mitigation strategies, which helps to reduce the impact of climate change. In addition to this, the adoption of various forms of agroforestry by farmers helping out accelerates their livelihood security. Agroforestry in India has transformed radically through various government interventions like Green India Mission, National Agroforestry Policy 2014, 8s mission of NAPCC and SMAF etc. This study provides light on India's carbon sequestration potential to achieve the targets of Paris agreements with special reference to ground level estimation of carbon sequestration.

YSS-02

Marker assisted backcross to introgress late leaf spot and rust resistance in groundnut

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Targets were aimed to improve the released promising groundnut variety, ICGV 00350 by introgression of the traits for resistance to late leaf spot and rust. A marker assisted backcross breeding (MABC) programme was undertaken in an elite but foliar disease susceptible variety of groundnut, ICGV 00350 for developing backcross lines using the donor, GPDB 4 by employing late leaf spot (LLS) and rust resistance-linked QTL markers. A set of eight novel genomic SSR markers linked to disease resistant QTL were utilized for foreground analysis. Similarly, a set of 217 SSR markers that span the whole groundnut genome were used to screen the plants for background analysis. Moreover, artificial disease epiphytotics were created to provide adequate disease pressure during phenotypic screening in BC_3F_3 generation. The elite cultivar ICGV 00350 was crossed with the donor GPBD 4 and the positive plants were confirmed by foreground analysis. After three backcrosses and one turn of selfing, a segregating BC_3F_2 lines were developed from the cross ICGV 00350 × GPBD 4 and were subjected to selection of homozygotes and disease screening. Evaluation of advanced backcross lines (BC_3F_2) identified five genotypes (B3-F2-8-7, B3-F2-34-6, B3-F2-34-12, B3-F2-36-5 and B3-F2-36-6) were significantly superior for late leaf spot and rust resistance that showed more than 90% genome similarity with ICGV 00350 with resistant QTL regions. This study unequivocally improved the groundnut genotype (ICGV 00350) with resistance to late leaf spot and rust diseases through marker assisted backcross breeding approach. These improved ILs identified will now be evaluated in target locations to identify promising lines for further testing and commercial release for farmer's adoption in near future.

YSS-03

Elucidating the influence of rootstocks on drought response of grafted tomato under high through-put phenomics

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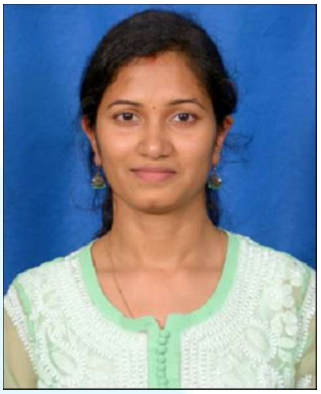
Tomato is one of the most important vegetable crops due to its manifold uses and high nutritive value. The water shortage during the drought period has significant implications on the production leading up to 50% loss in tomato which makes it imperative to develop strategies to mitigate the adverse effects of drought. The roots are the primary and utmost important part of the plant system which act as a source to maintain soil-water-plant continuum. In the present study, we used a high through-put phenomics facility to assess the efficiency of tomato, grafted on the rootstocks of different genetic backgrounds, at different levels of moisture in the soil. Rootstocks included tomato cultivars and the hybrids, derived from the crosses involving wild relatives as donor parents. Among the rootstocks, an interspecific derivative RF4A was highly efficient in terms of productive use of water. The RF4A rootstock-grafted plants were more conservative in water use with higher plant water status through relatively better stomatal regulation and hence were more efficient in generating more biomass under water stress conditions. These plants could maintain a higher level of PS-II efficiency signifying better photosynthetic efficiency even under water stress. The distinct response of interspecific rootstock, RF4A, to water stress can be attributed to the effective root system acquired from a wild parent (*S. pennellii*), and hence efficient water uptake. Overall, we could demonstrate the efficient use of a phenomics platform and could develop a protocol to identify promising rootstock-scion combinations of tomato for optimization of water use.

YSS-04

Inherent capacity to maintain canopy temperature is critical for drought and heat stress induced physiological responses in young sorghum plants



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In the present study, individual and combined effects of drought and heat stress were investigated on key physiological parameters (canopy temperature, membrane stability index, chlorophyll content, relative water content, and chlorophyll fluorescence) in two popular sorghum cultivars (*Sorghum bicolor* cvs. Phule Revati and Phule Vasudha) during the seedling stage. Estimating canopy temperature through pixel-wise analysis of thermal images of plants differentiated the stress responses of sorghum cultivars more effectively than the conventional way of recording canopy temperature. Cultivar difference in maintaining the canopy temperature was also responsible for much of the variation found in critical plant physiological parameters such as cell membrane stability, chlorophyll content, and chlorophyll fluorescence in plants exposed to stress. Hence, the combined stress of drought and heat was more adverse than their individual impacts. The continued loss of water coupled with high-temperature exposure exacerbated the adverse effect of stresses with a remarkable increase in canopy temperature. However, Phule Vasudha, being a drought-tolerant variety, was relatively less affected by the imposed stress conditions than Phule Revati. Besides, the methodology of measuring and reporting plant canopy temperature, which emerged from this study, can effectively differentiate the sorghum genotypes under the combined stress of drought and heat. It can help select promising genotypes among the breeding lines and integrating the concept in the protocol for precision water management in crops like sorghum.

YSS-05

Evaluation and identification of climate smart extra early maturing germplasm sources for common bean improvement

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The development of early-maturity genotypes helps common bean to avoid terminal heat and drought stress and increases its adaptation especially in plains and hilly valleys of Himalayan region of India. The main objectives of this study was to assess the relationship between grain yield and its attributing traits such as pods/plant, 100 seed weight and maturity duration under diverse bean production environment and also to assess the agronomic performance of the selected set of super early maturing germplasm lines based on multiple traits under two environments. A total of twenty nine promising germplasm lines and three checks (Uady, HUR15 and Arun) were evaluated at two bean production environment (ICAR-IIPR, Kanpur & NBPGR, Regional station, Shimla, Himachal Pradesh) during 2019-20 and 2020-21. Both agronomic and yield-component traits were recorded. The results exhibited that wide range genetic variability were observed among germplasm lines and traits correlation coefficients were estimated. From this study we identified few super early flowering accessions such as EC931970, EC931971, EC932047 and EC932167 (super early flowering, <50 days) and super early maturing accessions such as EC932189, EC932021, EC931971, EC931833 (super early maturing, <90 days). These promising accessions valuable germplasm source and the information generated would be useful for breeding extra-early cultivars in common bean improvement programme.

YSS-06

Shedding 'light' on ABA: A COP1-HY5-ABI5 regulatory module optimizes ABA-mediated inhibition of early seedling development

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Abscisic acid (ABA) is a phytohormone that plays a crucial role in optimizing early plant development under stress conditions. To maximize the survival under stress, ABA inhibits seed germination and also controls the subsequent post-germination seedling growth that leads to autotrophy. Light is an environmental signal that has tremendous influence on early seedling development. However, the effect of light on ABA-induced post-germination growth arrest has not been clearly understood. Here, we have identified the interaction between light and ABA signaling pathways during post-germination seedling development in Arabidopsis. ABA-mediated inhibition of early seedling development is greater in darkness as compared to light conditions. CONSTITUTIVELY PHOTOMORPHOGENIC1 (COP1), a protein that suppresses light signaling, was found responsible for the enhanced ABA-sensitivity in dark. The COP1 ortholog from the moss *Physcomitrella patens* fully complemented the post-germination ABA-hyposensitivity of *cop1* mutant, indicating that the ability of COP1 to regulate this process might be evolutionarily conserved. Genetically, *COP1* acts downstream of the key ABA signaling gene *ABSCISIC ACID INSENSITIVE5* (*ABI5*). COP1 promotes the binding of ABI5 on its target promoters thereby positively regulating ABA-responsive gene expression. COP1 interacts with the master light signaling factor ELONGATED HYPOCOTYL5 (HY5) and mediates its proteasome-mediated degradation. Examining various *hy5* mutants and, *cop1 hy5* and *hy5 abi5* double mutants for their ABA-sensitivity showed that HY5 suppresses ABA response during post-germination seedling development in an ABI5-dependent manner, acting downstream to COP1.

YSS-07

CaProDH2 imparts resistance against *Ascochyta rabiei* infection in chickpea through fine modulation of the proline-P5C cycle under drought stress

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Chickpea plants are exposed to diverse abiotic and biotic stress combinations in the field. Drought and Ascochyta blight caused by *Ascochyta rabiei*, the two main stressors affecting chickpea production worldwide, have been shown to co-occur in chickpea-producing areas. Plant response to individual drought and *A. rabiei* infection has been extensively studied; however, the effect of their combination on plant defense pathways is unknown. Fine modulation of stress-induced signaling pathways under combined stress is an important mechanism of stress adaptation. Our research showed that drought endures *A. rabiei* infection in chickpea. We performed a meta-analysis of two independent transcriptomes under drought and A. rabiei infection to study the mechanistic pathway. Our analysis leadstothe identification of *CaProDH2* as an important candidate gene. The CaProDH2 gene was silenced using the miRNA-induced gene silencing (MIGS) approach for effective and targeted gene silencing. *CaProDH2* silenced plants showed higher disease incidence and increased *in-planta* fungal growth than wild-type plants indicating loss of drought-induced resistance against *A. rabiei* infection. Transcript expression of proline pathway genes, proline, and mitochondrial specific P5C quantification, showed a fine modulation of a proline-P5C cycle between cytosol and mitochondria is crucial, and reactive oxygen species (ROS) molecules generated during the conversion of proline to P5C in mitochondria determines the combined stress tolerance. Therefore, we conclude that drought-induced proline production in the cytosol, which helps maintain cell turgor and enhanced mitochondrial P5C production by*CaProDH20,* generates ROS molecules that mount defense response and provides resistance against *A. rabiei* infection in chickpea.

YSS-08

Physiological traits and pathways regulating carboxylate efflux for enhanced phosphorus acquisition in soybean

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Root exudation of carboxylic acids is one of the important strategies in leguminous crops to mobilise phosphorus (P) fixed in soil, thereby enhancing the P acquisition efficiency. The variability in root exudation potential existing among soybean (Glycine max (L.) Merr.) genotypes was evaluated using isotope labelling (14CO2), to identify contrasting types (P-efficient: EC-232019, P-inefficient: EC-113396). The proportion of carboxylic acids (oxalate, citrate, succinate and fumarate) was highest among root exudates of P-efficient genotypes. Improved root length, surface area and volume coupled with higher activity of TCA cycle enzymes was attributed to higher carboxylate efflux. Photo-biochemical processes such as electron transport rate and quantum efficiency of photosystem II contributed to greater biomass and growth of P-efficient soybean genotype under low soil P availability. Comparative proteomic analysis of root tissues of contrasting soybean genotypes revealed 105 (32%) differentially abundant proteins (DAPs) between sufficient (250 µM) and low P (4 µM) levels. The DAPs were involved in a myriad of functions including carbohydrate, protein and lipid metabolism, suggesting the cross-talk between various metabolic pathways conferring superior P acquisition efficiency in soybean. Functional characterisation of the novel proteins may be used as potential candidates to enhance P acquisition. Genotypes characterised for P acquisition efficiency may be used as donor parents for QTL identification, as well as to develop high yielding P-efficient soybean cultivars.

YSS-09

A novel E3 Ubiquitin ligase PUB63 from rice plays significant roles in heat stress response in transgenic Arabidopsis

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Plant U Box ligases (PUB) are a class of E3 ligases and function in the ubiquitin proteasome pathway. Rice has around 77 PUB genes and many of them are implicated in various functions like growth and development, biotic and abiotic stress. PUB63 is one such abiotic stress responsive PUB gene which encodes for a CDS of 1032bp with a predicted protein of 344 amino acid residues and was shown to be upregulated during heat and dehydration stress treatments in rice. *In-silico* prediction of subcellular localization revealed a high probability of cytosolic and nuclear localization which was confirmed by sub-cellular localization experimentally. Localization was performed in onion peel via agroinfiltration and the results revealed the PUB63 protein to be localised in the cytosol as well as nucleus. A yeast 2-hybrid library was prepared and PUB63 was used as a bait to screen the possible proteins interacting with this E3 ligase. Our preliminary analysis reveals a heat shock transcription factor as a probable interacting partner among others. Transgenic Arabidopsis plants expressing PUB63 were found to be tolerant towards heat stress at germination stage. Thus, our preliminary work suggests the role of PUB63 in heat stress response in rice which might be mediated by the heat shock family transcription factor, HSFB2A.

YSS-10

Characterization of novel wheat genotypes for drought stress tolerance

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Wheat is the world's second most widely grown staple food crop and accounts for more than 35% of the human population. India, a major contributor to the world's wheat production after China has witnessed reduction in yield due to major abiotic stresses like drought, high temperature and salinity. Hence, there is a need to develop wheat cultivars which efficiently combat major abiotic stresses with minimum yield penalty. With this background, the present study was carried out for precise assessing of the drought stress tolerance capacity of ten selected promising wheat genotypes from previous field experiments at vegetative and reproductive stage, through physiological, biochemical and molecular analysis under controlled conditions. The experiment was conducted in the climate controlled green house where all the genotypes (along with checks) were sown in pots. Various Physiological and biochemical parameters such as chlorophyll content, relative water content (RWC), membrane permeability, MDA, proline content and catalase enzyme activity were measured. Further to dissect the molecular mechanisms underlying in the selected genotypes, qRT-PCR analysis was carried out with previously validated stress responsive genes in wheat viz., *TaDREB6, TaMn-SOD, TaWRKY44, TaPAL*, *TaAPX* and *TaSHN1* which are involved in abiotic stress tolerance. For reproductive stage drought tolerance, stress was imposed at maximum tillering stage till harvest by withholding irrigation and various growth and yield components were analyzed. Among the genotypes studied, RW5 showed higher RWC (75.2%), higher chlorophyll stability index (68%) and Fv/Fm ratio (0.79), and higher catalase enzyme activity (0.002 µmol/min/mg FW) it also showed higher (1.5 fold increase) expression of *MnSOD* gene which is involved in ROS scavenging mechanism compared to checks.

YSS-11

A novel genetic stock identified and characterized for tolerance to Iron deficiency chlorosis at early growth stages

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Iron deficiency chlorosis (IDC) is a persistent problem for calcareous soils with high pH. The most pertinent solution is to find suitable cultivars showing remarkable tolerance to low iron (Fe) availability in the soil. An experiment was conducted with 114 advanced breeding lines (ABLs) of groundnut for four consecutive years, based on visual chlorotic rating (VCR). However, the chlorosis is a delayed symptom of already existing Fe deficiency in plants, resulting in severe yield losses. Thus, six ABLs with VCR rating of 1 and 4/5 for consecutive years were selected as tolerant and sensitive lines respectively, for their characterization at early growth stages (30-40 DAS), with NRCG 7472 and ICGV 86031 as the sensitive and tolerant control lines respectively. There was significant reduction in chlorophyll content, maximum photochemical yield (Fv/Fm) and photosynthetic rate (Pn) in sensitive lines (NRCG 7472, PBS 12185 and PBS 12215), while the tolerant lines (ICGV 86031, PBS 22040 and PBS 29192) showed greater photosynthetic efficiency and chlorophyll content. The Fe unavailability caused elevated production of reactive oxygen species (ROS) and membrane leakage in the sensitive lines as indicated by increased malondialdehyde (MDA) and hydrogen peroxide content. The ROS detoxifying enzymes, Ascorbate peroxidase (APX) and Peroxidase (POX) activity recorded a significant increase in sensitive lines. However, the tolerant ABLs showed a differential response with greater increase in APX activity with respect to POX. PBS 22040 outperformed with maximum membrane stability, carotenoid content, greater rhizospheric pH reduction and least ROS scavenging enzyme accumulation indicating its tolerance to IDC at early growth stage. Furthermore, the pod yield and 100 kernel weight of PBS 22040 was also superior to ICGV 86031. Thus, PBS 22040, a novel genetic stock, marks immense potential for cultivation in soils with low Fe availability with reduced yield losses.

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YRS-01

Development of fit-for-purpose and new analytical methods for plant growth regulators, mycotoxins and pesticide residue analysis in various food matrices

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India is the world's largest producer of fruits, cereals, pulses, nuts and their processed products. Monitoring of plant growth regulators, mycotoxins and pesticide residues is a priority for food-safety to avert the possible risk to human-health as well as to promote international trade. However, monitoring of the residues of some analytes suffers from limitations/challenges due to their degradation at sample- preparation or instrumental analysis. Therefore, the objective of this study was to develop effective and simple analytical methods for the analysis of plant growth regulators, highly-polar herbicides (paraquat and diquat) and thermally-unstable fungicides (captan, captafol, folpet, iprodione) by LC-ESI-MS/MS without any degradation. Besides, a large-scale multi-residue analytical method was optimized for the analysis of pesticides and mycotoxins in challenging matrices, e.g. nuts. The liquid chromatography coupled with tandem mass spectrometry was used for analysis. The chromatographic separation was achieved using HILIC (for polar compounds) and C18 column (for mid-to non-polarcompounds). The chromatography-free atmospheric pressure matrix-assisted laser desorption/ionization-high resolution mass spectrometry (AP-MALDI-HRMS) was used for screening of the PGRs and polar-herbicides. The optimized sample preparation-workflow and chromatographic methods provided an LOQ of 0.01 mg/kg for all the targeted compounds. The performances of the developed methods are aligned with SANTE/12682/2019 and AOAC guidelines. The optimized methods comply with the national (FSSAI) as well as International (EU) MRLs. these methods are fit-for-purpose for regulatory testing of pesticide residues. This will help to improve the export of agricultural goods, enhance the economy of farmers and protect the health of human beings from hazardous chemical residues.

YRS-02

Mechanistic understanding of tolerance to combined drought and dry root rotin chickpea

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Chickpea experience combined drought stress and dry root rot (DRR) caused by *Macrophomina phaseolina* (*Rhizoctonia bataticola*). A field study (2014-2020) was conducted in chickpea growing regions across India showed the predominant occurrence of drought and DRR combinations. Drought increased DRR incidence and severity in both field and greenhouse conditions. We found that the drought and DRR combination resulted in significant yield reduction. We isolated the fungal strain (ITCC 8635) and confirmed its identity using the internal transcribed spacer (ITS) sequence. In a sick pot experiment, plants exposed to combined stress had a severe infection and fewer lateral roots indicating drought aggravated DRR severity. Root water potential, relative water content, photosynthetic rate, transpiration rate, and stomatal conductance were less in combined stress exposed plants. Our result showed that the initial infection was established by microsclerotia attachment, germination, germ tube formation, inter-and intracellular fungal movement under a well-watered condition. However, infection progress was arrested at the endodermal layer. In contrast, under combined stress, infection progress breached the endodermal layer and colonized the stele. Illumina RNAseq was employed in identifying genes imparting combined stress tolerance in susceptible genotype. Genes associated with Jasmonic acid (JA)-mediated defense were downregulated under combined stress compared to pathogen-only conditions. A potential candidate, *CaMYC2*, a basic-helix-loop-helix transcription factor, was identified under combined stress using hairy root, RNAi, and overexpression approaches. *myc2* silenced lines showed higher DRR severity under combined stress than wild-type. In contrast, *CaMYC2* overexpression lines showed less DRR severity under pathogen and combined stress than wild-type ones.

YRS-03

Evaluating the influence of endophytic microbes on the physiological function of sorghum under drought

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Drought stress affects crop production throughout the world. Plant interaction with endophytic bacteria as a novel and cost-effective technology to cope with the stressful environment and increase the plant growth and yield under drought conditions was attempted in the present investigation. To understand the sorghum root bacterial community, drought tolerance capacity, and bacterial producing PGP traits, the root sap of the sorghum plant was collected from different sorghum varieties. Different types of ten bacterial strains could be identified namely VR1, VR2, VR3, VR4, VR5, SR1, SR2, SR3, SR4, and SR5, and subjected for the drought-tolerant screening, and bacterial strains were subjected to a different level of osmotic potential stress (-0.5 MPa to -1.2 MPa) through polyethylene glycols (PEG-6000). All the ten isolates produced a considerable quantity of proline, protein, phytohormones, EPS, and ACC deaminase. Among them, only five promising strains were sequenced and three (*Acinetobacter pittii*, *Bacillus* sp. and *Pseudacidovorax intermedius*) advantageous strains were selected for the preliminary laboratory experiment to assess endophytes effect on seedling health characters. In pot culture experiment, among the inoculants, *Bacillus* sp. inoculated plants performed well in the morphological, physiological, biochemical, yield and quality parameters when compared to uninoculated control plants. The metabolites expression was more in the *Bacillus* sp. inoculated plants during drought conditions. The scanning electron microscopic result proved that bacterial inoculation successfully formed a bacterial community on the surface and also inside the root but there is no colonization effect in uninoculated control root. The present experiment could conclude that inoculation of *Bacillus* sp. poses favorable interaction with plants to improve the growth and yield characters of sorghum under drought-induced conditions.

YRS-04

Evaluation of CropSyst model for yield and water productivity of rainfed groundnut

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The experiment was conducted at Anand Agriculture University, Anand, during *kharif* season of 2019 and 2020. The treatments consisted of three sowing dates *viz;* first date of sowing - onset of monsoon, second date of sowing - 10 days after onset of monsoon and third date of sowing - 20 days after onset of monsoon with three varieties *viz;* GG 20, GJG 34 and TAG 37A. The experiment was replicated four times in randomized block design (factorial). Results revealed that first sowing date significantly superior to other dates of sowing in respect of pod yield. Significantly high pod yield (2176 kg ha^{-1} and 1862 kg ha^{-1}) was recorded during 2019 and 2020 under first date of sowing, respectively which was statistically at par with second sowing and significantly higher than the third sowing. Among the varieties, significantly higher pod yield (2043 and 1701 kg ha^{-1}) was recorded under GG 20 over other varieties during both the years. CropSyst model showed that total water received was ranged from 1132 mm to 1168 mm and 769.6 mm to 889.8 mm in 2019 and 2020, respectively. Out of total water, evapotranspiration (ET) constituted ranged from 13.7 % to 20.9 % with water productivity of 0.81 kg m^{-3} to 1.13 kg m^{-3} during 2019. Whereas, in the year 2020, ET used from 18.1 % to 22.4 % with water productivity of 0.98 kg m^{-3} to 1.00 kg m^{-3}.

YRS-05

Cost effective production of phytase producing bio-inoculant and its efficacy in field

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In the market, separate biofertilizers are available for Nitrogen fixation, P and K solubilization. They are prepared by traditional methods using synthetic media and carrier-based (solid) so have drawbacks like the viability of microbes, bulkiness, and carrier sterilization, which affects their final cost. So, there is a need to formulate Bioinoculant, which can be used for all in one and produced by the low-cost method. We focused on bacteria that produced phytase and exploited it in the agricultural field for organic P utilization. The organic form of P (Phytate) is less focused, contributing almost 50 -80% in soil. Non-pathogenic isolate having multiple plant growth-promoting traits from a local area is essential as it is well adapted to the local agro-climatic conditions. Keeping all these aspects in mind, we selected PGPR bacteria from indigenous flora of soil in Kolhapur district, which produces phytase. Out of 34 isolates, N6 showing the abundant amount of phytase, IAA, and P, K and Fe solubilization indicates multiple bioactive potentials. The ability of this isolate to promote seed germination, development of shoot, and root elongation in maize and wheat reflected its bio-efficacy as PGPR. The production of phytase producing bioinoculant was achieved in a newly designed and optimized medium with agricultural waste, which is cost-effective. The field trials of it revealed that using two lit/acre for four times is beneficial for sugarcane. It increases the average yield of by 15.9 tons/ acre. It also positively affects the net income by reducing chemical fertilizers.

YRS-06

Can reproductive stage nitrogen application alleviate the negative effects of elevated CO_2 on grain protein content in bread wheat?

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Wheat crops grown under elevated CO_2 (EC) have reduced concentrations of grain nitrogen (N) and protein content. The purpose of this study was to investigate how the reproductive stage N application affected NUE and grain yield of wheat genotypes under EC. Another objective was to apprehend the combined effects of EC and N dosages on change in the expression profile of genes related to N and ROS metabolism (source and sink), and grain size (sink). The study included three N levels (Low N: 30 kg/ha^{-1} (0:30:0), Optimal N: 120 kg/ha^{-1} (60:30:30), High N: 150 kg/ha^{-1} (60:45:45) at basal: booting: post-anthesis stages) and CO_2 enrichment to study the changes in growth, yield parameters, grain ionome, and grain protein content in six wheat varieties during *rabi* 2020 and two varieties in *rabi* 2021. Under EC, the decline in the activity of GS and GOGAT with a prominent reduction in leaf nitrogen metabolism and grain protein content was observed. Genes like *TaYSL*/ *TaNAMB1* also showed altered transcript abundance indicating the negative effect on grain ionome, and thus suggesting transcriptional reprogramming under EC. The accumulation of ROS and RNS at High N reinstated the uselessness of applying high N under EC. Altering of germination rate and crop phenology in the *rabi* 2021 suggested that multigenerational exposure to EC will have major implications in crop establishment and performance. Thus, the reproductive stage N application could reduce the grain protein decline under EC. The fertilizer recommendations under EC have to be revised based on the NUE of cultivars.

YRS-07

Photochemical efficiency is negatively correlated with the Δ9-tetrahydrocannabinol content in *Cannabis sativa* L.

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Cannabis sativa L. is an important plant, which is a source of durable fibers, nutritious seeds, and medicinally important phytocannabinoids including Δ9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Light has shown to be a key modulator of biomass and cannabinoid yield suggesting responsive photochemical machinery. The present study was envisaged to understand the effect of the increasing levels of metabolic THC on the photochemical efficiency in *Cannabis*. The chlorophyll *a* fluorescence kinetics, photosynthetic pigments and immunodetection of the photosynthetic machinery was analyzed on seven accessions from different environments, in conjunction with the cannabinoid content. All the accessions were clearly divided into three groups based on their relative content of CBD and THC. Group I with (CBD/THC > 1) had a clear advantage in terms of the damage to the D1, RbCL and Lhc1 protein holo-complex. Performance indicators of photochemistry based on the OJIP kinetics suggested a stoichiometrically negative correlation with the THC content. Zeaxanthin-dependent quenching is primarily responsible for lower NPQ in Group III with high THC content (THC > 6%). The THC treatment on *Arabidopsis thaliana* also suggested dose-dependent decrease in the photochemical efficiency suggesting the exclusivity of THC in causing the response. This resulted in the damage of photosynthetic machinery and the generation of free radicals, thereby compromising the yield. The study also opens a new screening method for *Cannabis*, based on cannabinoid content

YRS-08

A mechanistic insight into the role of rice r40c1 protein in imparting drought stress tolerance

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In plants, lectins play a crucial role in regulating biotic and abiotic stress tolerance in plants. Previously, it was reported that the rice lectin protein *Os*r40c1 was up regulated in response to drought stress, yet its underlying molecular mechanisms was poorly understood. Here, we showed that the expression of *Osr40c1* was positively correlated with the degree of drought tolerance of various rice cultivars. The *Osr40c1* overexpressing rice plants exhibited improved drought stress tolerance over the wild-type plants. In addition, the ectopic expression of *Osr40c1* in tobacco also showed a similar result. The protein displayed a nucleo-cytoplasmic localization. Furthermore, several drought-responsive proteins such as S-adenosylmethionine synthase 2 (*Os*SAM2), stress-associated protein 8 (*Os*SAP8), DNA-binding protein MNB1B (*Os*MNB1B), and histone 4 (*Os*H4) along with two uncharacterized proteins were found to interact with *Os*r40c1 protein and formed a multi-protein complex to impart drought stress tolerance in plants. Moreover, each protein partner was found to be essential for the *Os*r40c1-mediated drought tolerance mechanism in planta because silencing of each of these protein partners led to drought sensitivity in otherwise tolerant *Osr40c1*-expressing transgenic tobacco plants. These findings demonstrated a novel role of *Os*r40c1 in imparting drought tolerance by forming a complex with *Os*MNB1B, *Os*SAM2, and *Os*H4 protein and two uncharacterized proteins which presumably enables *Os*SAP8 to induce downstream gene expression.

YRS-09

Carbon footprints in different blocks of agro ecosystems of Nilgiri hill region in southern western ghats – an insight to keep the soils of western Ghats alive and to combat climate change

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Ever since the beginning of settled agriculture, soil and terrestrial ecosystem have been a source of atmospheric CO_2. Conversion of ecosystem from natural to agriculture has decreased the soil organic carbon pool by 30-75% in the last 100 years. Amongst the most fragile ecosystems in the world, the Nilgiris in Tamil Nadu is bearing the brunt of climate change, evident in the increasingly erratic rainfall and higher temperatures. Hence delineation of carbon under major ecosystems is an essential prerequisite. The Nilgiris (Southern Western Ghats Tamil Nadu, India) situated between 11.4916° N, 76.7337° E and at elevations ranging between 2000 and 2400 m. A ground truth soil survey was carried with geo referenced data to collect soil samples covering all the four blocks of Nilgiris district. The collected samples were processed to calculate the soil carbon stock for each ecosystem. The study shows that cultivated land can decrease the organic carbon upon continued farming activities. Decrease in organic carbon with increase in depth may be due to minimum leaching of dissolved organic content and thus lower accumulation with depth. Therefore it is important to increase the carbon stock by prioritising appropriate land use strategy and practicing sustainable land management which was recognised under the United Nations Sustainable Development Goal (SDG 15) in order to curb the menace of climate change events in western ghats.

YRS-10

Phenotyping of *rabi* sorghum for root and physiological traits associated with drought tolerance

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Plant roots play a significant role in plant growth by exploiting soil resources via the uptake of water and nutrients. Root traits such as fine root diameter, specific root length, specific root area, root angle, and root length density are considered to be useful traits for improving plant productivity under drought conditions. In this context, an experiment was conducted during *rabi* 2020-2021 to evaluate the genotypic variations for root traits in *rabi* sorghum under drought condition. Eleven *rabi* sorghum genotypes including three checks were evaluated for key root parameters that help surviving under drought stress. Genotypes were planted in newly constructed root box structure which was filled by medium type of soil before post rainy season for residual moisture conservation. Crop was sowed on receding soil moisture. Root length at maturity of genotypes varied from 40-70 cm. The sorghum genotype RSV 1986 was significantly superior for root length (70.00 cm.), Phule Suchitra for root number (51), Phule Suchitra and RSV 1986 fresh root mass (65 gm/plant) and Phule Suchitra and RSV 1910 for root volume (44 ml). Significantly higher canopy temperature difference and RLWC was observed in RSV 1910. Sorghum genotype RSV 1910 reported significantly higher grain and fodder yield. Root number, root length and root fresh mass showed positive correlation with the grain yield. Root traits associated with maintaining plant productivity under drought include small fine root diameters, long specific root length and considerable root length density, especially at depths in soil with available water. Hence geneticists and breeders are positioned to breed plants with root and physiological traits which improve productivity under drought.

YRS-11

Salinity responsive genes and their functional analysis in the commercial variety of sugarcane (*Saccharum officinarum*)

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Sugarcane is one of the important commercial crops grown in India with more than 5 million hectare. Due to change in climate nowadays the salinity area has been on rise as the costal inundated areas are becoming saline. Major sugarcane producing states include Maharashtra and Tamil Nadu, Karnataka and Andhra Pradesh are affected by salinity. It is estimated that 33% of cane area in Tamil Nadu, 40% of cane area in Andhra Pradesh and 48% in Karnataka experience either soil salinity or saline irrigation water and yield losses reported were about 40 percent. The salinity affects the cane yield and quality adversely. Salinity stress has a profound impact on sugarcane crop and the crop is rated moderately sensitive. Sustaining the sugarcane production under the saline stress is one of the major concerns and ICAR-SBI has screened many sugarcane genotypes for salt tolerance. Salt overly sensitive (SOS 1 to 3) pathway genes, DREB2, superoxide dismutase (SOD) and peroxidase (POX) isolated from *Saccharum* hybrid Co 85019 were functionally analysed by docking tool. It contains protein-protein interaction (SOS pathway genes), protein-nucleic acid (DNA) interaction and protein (enzyme)-ligand interactions. The putative proteins of the six genes indicated their functional significance based on the higher values (64 to 94%) residues in the favoured region by Ramachandran plot. Molecular docking was done using ClusPro and AutoDock tools. The data predicted a strong complex of protein-protein, protein-DNA and protein-ligand interaction suggesting to the possible complex formation. Binding energies ranged from −5.01 to −5.58 kcal/mol. Thus, they are believed to have better functional role in salinity tolerance. All the six genes (SOS 1 to 3, DREB2, SOD and POX) have been registered with NCBI Gen bank.

YRS-12

Implications of leaf senescence pattern based phenomics approach for classification of chickpea genotypes in response to soil moisture stress in field conditions

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Leaf senescence is the systematic and unavoidable life event of plant which influenced by its inner physiological and biological experience according to external growth environment. A better understanding of the relationship between senescence pattern and yield potential of plant under different environment condition can help in identification of relevant traits for genetic improvement in drought tolerance of crops. Though several attempts have been made to employ high throughput phenotyping under controlled conditions for abiotic stresses yet drought attempts to relate the outcome to field performance of crops are very rare. To bridge this gap, experiments were conducted with 22 genotypes with sufficient and limited water conditions in phenomics platform. The responses of plants were captured regularly with high resolution cameras particular for senescence pattern under depleting soil moisture conditions. RGB values derived from images of plants were used to classify genotypes for interpretation of their senescence pattern. The group performances were compared with grain yield performance in field trials at different locations. The phenomics parameters derived for leaf senescence could classify poor and better performers under field. Thus we could establish relationship between senescence patterns captured through high throughput phenotyping and yield potential of genotypes at different environmental condition.

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PA-01

Response of cluster bean genotypes for morph physiological traits under drought stress

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Cluster bean (*Cyamopsis tetragonoloba* L.) is an important vegetable crop of arid and semi-arid regions of India. These regions often face drought situations leading to severe yield losses and crop failure. Since, there is a successive vegetative and reproductive growth in cluster bean, water stress during these stages leads to severe loss in yield. Therefore, screening and identifying drought tolerant genotype for such regions is crucial for optimum production. In vegetable type cluster bean, there is a meagre information about the impact of drought on morphophysiological traits. In view of this, we assessed the drought responses of cluster bean genotypes at morphophysiological level in 25 genotypes including check variety Phule Guar. Water stress was imposed by withholding the watering after 40 days of sowing, for 12 days and then plants were re-watered to check their recovery capacity. The observations were recorded on morphophysiological parameters such as plant height, leaf area, dry biomass and relative water content (RWC). Significant differences were noted in the genotypes for these parameters under drought stress conditions. Genotype RHRCB08 showed maximum plant height under drought stress conditions followed by Phule Guar. Leaf area was highest in genotypes RHRCB15 and RHRCB11 under drought stress conditions. Genotype RHRCB15, RHRCB14, RHRCB11 and RHRCB01 exhibited higher dry biomass than check variety under drought stress. The genotypes RHRCB15, RHRCB01, RHRCB08 and RHRCB11 maintained higher RWC than check Phule Guar under drought stress. Hence, these selective genotypes were identified for drought tolerance in vegetable type cluster bean.

PA-02

Over expression of a Jacalin domain-containing protein *OsSalT* confers drought tolerance by interacting with *OsDREB2A* and *OsNAC1*

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Drought is the major devastating factor among all abiotic stress that affects the rice plant growth and development. It has been reported that jacalin domain-containing protein *OsSalT* involves in drought and salinity tolerance in different plant species. However the functional mechanism of drought tolerance still remains unclear. Here, we reported that *OsSalT* gene expression is induced by drought and the expression of *OsSalT* was positively correlated with the degree of drought tolerance of two *indica* rice cultivars i.e. tolerant cultivar, *Vandana* and susceptible cultivar, *MTU1010* respectively. Over expression of *OsSalT* in rice and ectopic expression in tobacco significantly enhanced tolerance to drought stress. Moreover, the transgenic lines accumulated higher osmolyte and significantly improved growth over the wild-type (WT) and vector control (VC) plants under drought stress. Furthermore, two drought-responsive transcription factors (TFs), *OsNAC1* and *OsDREB2A* were identified as the interacting protein partners of *OsSalT* protein by the yeast two-hybrid assay. Their interaction was also confirmed by the bimolecular fluorescence complementation (BiFC) analysis. In addition, *in silico* analysis revealed that the C-terminal domains of both *OsDREB2A* and *OsNAC1* partners interacted with the *OsSalT* protein. Taken together, our data showed that *OsSalT* functions as a positive regulator of the drought stress responses in rice and unraveled a novel model for *OsSalT*-mediated regulation of drought stress tolerance in plants.

PA-03

Effect of salinity on eucalyptus plants by soil irrigation: water status, photosynthetic capacity and yield characteristics

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Soil salinity is one of the more serious environmental factors limiting the plant productivity because most of the crops are sensitive to salinity stress caused by excess concentrations of salts in the rhizospheric soil, and the area of cultivated land affected by it is enhancing day by day. For major crops, average productivity are only a fraction – somewhere between 20- 50% of record output; these losses are mainly due to unfavorable environmental variables which will worsen in various regions due to dynamic era of climate change. The influence of salinity on growth, leaf photosynthetic leaf gas exchange and biomass yield of seedlings of *Eucalyptus hybrid*, *E. FRI-4* and *E. FRI-5* were studied by imposing different concentrations such as 0, 50, 100, 150, 200 and 300 mM of NaCl in pot culture. Salinity up to 50 mM did not affect plant survival, but did affect plant growth, development and biomass yield depends upon the species and salt concentration. NaCl decreased the number of leaves-area expansion and dry mass of all the plant organs. Growth and chlorophyll content of the plants fell at all the levels of NaCl, except at 50 mM, where stimulation in the photosynthetic CO_2 assimilation rate of the plants occurred. The study indicated that low salt levels generally stimulated growth, biomass and photosynthetic capacity in all cultivars. A wide range of adaptations and alleviation approaches are required to cope with such impacts. Efficient resource management and crops improvement for evolving potential breeds can assist to overcome salinity stress.

PA-04

Performance of advanced chickpea genotypes to cold stress at reproductive stage

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Temperature is a crucial environmental element for chickpea blooming and its productivity. The present research evaluated performance of thirteen advanced lines to reproductive cold stress based on pollen viability and yield attributes. The advanced lines exhibited differential thermotolerance to cold stress. Pollen viability varied significantly from 62.9-89.6% among the genotypes. In comparison to check cultivars (GPF-2, PBG-5 and PBG-7), only one advanced line GL29183 had significantly higher viability and pollen load. This feature of GL29183 promotes its pollination success under cold stress in early flowering chickpea. Pooled analysis of yield attributes also reflected better performance of GL29183 than other tested entries (GL27059, GL28202). Highest yield/plant was reported in cultivar PBG-5 which was significantly higher than GL29183.

PA-05

Exploring genetic resources of pearl millet for heat tolerance

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High-temperature stress due to global warming is leading to a reduction in crop production. On the other hand, population blast is resulting in increased food demand which is ultimately leading to extraordinarily high food prices. Pearl millet commonly known as 'Bajra' in India, is well adapted to arid and semi-arid regions of Asia and Africa. This C_4 cereal is a highly nutritive, multipurpose, and low-input crop. Pearl millet has diverse germplasm which is poorly explored for thermotolerance. We screened pearl millet genotypes for heat-tolerance at the seedling stage on the basis of germination percentage, seedling survival, seedling thermotolerance index, seed to seedling thermotolerance index, shoot length, root length, fresh weight, dry weight, relative water content, chlorophyll and carotenoids contents, membrane thermostability along with visual changes in leaves. Among 112 screened genotypes, we have selected 15 tolerant ones. Most of these tolerant genotypes are traditional landraces grown by farmers of western Rajasthan. Further screening and characterization of these genotypes are under process. From our studies, we suggest membrane thermostability, relative water content and visual screening as important tools for identifying heat-tolerant genotypes.

PA-06

Studying the studies of plant signaling responses under Abiotic stress condition

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Plants live in constantly changing environments that are often unfavorable or stressful for growth and development. These adverse environmental conditions include biotic stress, such as pathogen infection and herbivore attack, and abiotic stress, such as drought, heat, cold, nutrient deficiency, and excess of salt or toxic metals like aluminum, arsenate, and cadmium in the soil. Drought, salt, and temperature stresses are major environmental factors that affect the geographical distribution of plants in nature, limit plant productivity in agriculture, and threaten food security. Drought stress is a major cause of yield instability in crops across diverse eco-geographic regions worldwide. A variety of biochemical, molecular, and physiological changes are manifested by plants in response to drought stress. As mechanistic understanding has increased during the last decades, discovery-oriented approaches have begun to identify genetic determinants of salt tolerance. In addition to osmolytes, osmoprotectants, radical detoxification, ion transport systems, and changes in hormone levels and hormone-guided communications, the Salt Overly Sensitive (SOS) pathway has emerged to be a major defense mechanism. To elucidate signal transduction events leading to the cellular response to heavy metal stress we analyzed protein phosphorylation induced by elevated levels of copper and cadmium ions as examples for heavy metals with different physiochemical properties and functions. In this review, we will analyze the components of the SOS pathways, with emphasis on the integration of components recognized as hallmarks of a plant lifestyle under abiotic stress condition.

PA-07

A mechanistic insight into the role of rice r40c1 protein in imparting drought stress tolerance

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In plants, lectins play a crucial role in regulating biotic and abiotic stress tolerance in plants. Previously, it was reported that the rice lectin protein *Os*r40c1 was up regulated in response to drought stress, yet its underlying molecular mechanisms was poorly understood. Here, we showed that the expression of *Osr40c1* was positively correlated with the degree of drought tolerance of various rice cultivars. The *Osr40c1* overexpressing rice plants exhibited improved drought stress tolerance over the wild-type plants. In addition, the ectopic expression of *Osr40c1* in tobacco also showed a similar result. The protein displayed a nucleo-cytoplasmic localization. Furthermore, several drought-responsive proteins such as S-adenosylmethionine synthase 2 (*Os*SAM2), stress-associated protein 8 (*Os*SAP8), DNA-binding protein MNB1B (*Os*MNB1B), and histone 4 (*Os*H4) along with two uncharacterized proteins were found to interact with *Os*r40c1 protein and formed a multi-protein complex to impart drought stress tolerance in plants. Moreover, each protein partner was found to be essential for the *Os*r40c1-mediated drought tolerance mechanism in planta because silencing of each of these protein partners led to drought sensitivity in otherwise tolerant *Osr40c1*-expressing transgenic tobacco plants. These findings demonstrated a novel role of *Os*r40c1 in imparting drought tolerance by forming a complex with*Os*MNB1B, *Os*SAM2, and *Os*H4 protein and two uncharacterized proteins which presumably enables *Os*SAP8 to induce downstream gene expression.

PA-08

Sugarcane clones suitable for moisture stress / drought conditions under early planting (December / January)

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Fifteen pre release sugarcane clones were tested against sugarcane variety Co 6907 for their suitability to early planted conditions (December / January planting) under moisture stress / drought at Regional Agricultural Research Station, Anakapalle during 2018-19 and 2019-20. Among fifteen pre release clones tested sugarcane clones 2009A 107 (80.2 t/ha), 2006A 223 (79.50 t/ha), 2009A 252 (76.42 t/ha), 2011A 313 (72.64 t/ha) and 2011A 252 (71.48 t/ha) recorded higher cane yield over other clones tested. The standards 87A 298 and 83V 15 recorded a cane yield of 71.08 t/ha and 58.13 t/ha which are lower than the superior clones. These clones also recorded significantly low SLA which indicates more photosynthetic assimilates per unit area. SPAD / SCMR values at 120 DAP under stress conditions (Summer). These sugarcane clones also recorded significantly higher SPAD/ SCMR values with standard 87A 298. The ancillary data denoting stress tolerance like sheath moisture per cent, root spread area, total bio mass production per stool under stress and physiological parameters like leaf proline content is also high in these sugarcane clones. Based on two years findings, sugarcane clones 2009A 107, 2006A 223, 2009A 252, 2011A 313 and 2011A 252 were found to be suitable for drought / soil moisture stress condition of cane cultivation based on cane yield, ancillary data and physiological traits in relation to moisture stress tolerance. The drought tolerance efficiency per cent was high in 2009A 107 (95.37%) followed by 2009A 252 (86.39%) and 2011A 252 (84.92%) over other clones tested.

PA-09

Phytohormones: Growth and development in plants

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Growth in plants are regulated by chemical substances called as phytohormones. It can be growth promoter or growth inhibitor based on their mode of action. The auxins were the first hormones discovered in plants and the term auxin is used to denote substances that promote elongation of coleoptiles tissues. Indoleacetic acid is an auxin that occurs naturally in plants while indole-3-propionic acid and indole-3-butyric acid are synthetic. Some auxins lack indole ring (naphthaleneacetic and 2,4-dichlorophenoxyacetic acid) but are biologically active. Physiological effects of auxin include cell elongation, apical bud dominance, root initiation, prevention of abscission, parthenocarpy, callus formation and vascular differentiation. Gibberellins, biosynthesized in apical tissue effects seed germination, dormancy of buds, root growth, elongation of internodes, bolting and flowering, parthenocarpy and light inhibited stem growth. Cytokinins are important growth promoting substance where, zeatin is the most abundant and widely distributed natural cytokinin in higher plants and in some bacteria. It influences plant growth by its kinetin like activity which includes, cell division, cell enlargement, initiation of inter-fascicular cambium, morphogenesis, dormancy of seeds, delay of senescence and promotion of chloroplast development. The most widely distributed growth retardants are abscisic acid (ABA) and ethylene. ABA plays important role in seed dormancy, stomatal regulation and leaf abscission, while ethylene regulates fruit ripening, plumula hook formation, triple response, formation of adventitious roots, root inhibition, leaf epinasty and flowering. Brassinosteroids are polyhydroxysteroids that are recognized as sixth class of plant hormones and are involved in wide range of growth promoting activities.

PA-10

Genes responsible for deploying for abiotic stress resilience in horticulture crops

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Breeding for improved performance under environmental stresses involves activities which accumulate favourable alleles (different forms of a gene) that contribute to stress tolerance. Biotechnological tools focus on providing the ability to directly detect and transfer genes of interest from other plant lines or organisms into the crop of interest without the continuing need to use the appearance or stress response of the plant (its' phenotype) as a proxy for the presence of that gene. Plants respond to abiotic stresses in a variety of mechanisms which trigger the cell signaling process, transcriptional controls and production of a number of stress conditions related tolerant proteins, antioxidants and osmotic solutes to maintain homeostasis and to protect and repair the damaged integral proteins. To combat the negative effects of various abiotic stresses, it is pre-requisite to identify potential candidate genes or QTLs (Quantitative Trait Loci's)/gene networks associated with broad spectrum multiple abiotic stress tolerance. Some notable candidate genes identified for enhancing stress tolerance in horticulture plants are group 3 LEA gene (drought tolerance in *Brassica napus*), Osmyb4 (cold tolerance in apple and *Osteospermum ecklonis*), OsLTP (cold tolerance in *Phalaenopsis amabilis*), EgWRKY (abiotic stress tolerance in *Elaeis guineensis*)

PA-11

Defining the individual and combined stress response on Zingiber officinale Rosc. cv- varada on the basis of growth parameters and gingerol content

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Globally environmental stress plays a significant role in the growth and development of plants. Every stress alters the signal system and eventually resulting in an end response. Combination of stress treatments can both negatively or positively affect the plant. A few studies were conducted in combination of stress treatments in ginger. In the present study the effect of different individual stress treatments and their combined treatments on the concentrations of gingerols in improved ginger variety (*Zingiber officinale cv*-varada) were analyzed. The different stress treatments were attempted using Salicylic acid and Zinc Sulphate. Along with these two, drought is also taken as a third stress. The results of Individual and combination of stress treatments were obtained. The present study highlights the effect of individual as well as combined stress treatments in both morphological (yield and growth parameters) and the gingerol content. This also gives a clear picture about cross tolerance in which one stress influenced the effect of another. The present results also emphasized that the individual and combined stress treatments improves the growth potential as well as gingerol content in the selected ginger variety in as remarkable percentage.

PA-12

Combination of abiotic and biotic stresses alter plant's function

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In nature, plants are simultaneously encounter the combination of biotic and abiotic stresses that control crop yields. Being sessile, they have developed specific mechanisms that allow them to detect environmental changes and counter complex stress conditions, diminishing damage while conserving valuable resources for growth and reproduction. A combination of abiotic stress with pathogen infection likely disturbs hormone and systemic ROS homeostasis. Pathogen infection has been shown to impair stomata closure under non-stress conditions, Systemic ROS signals generated after pathogen encounter may change water relation and salt uptake through their effects in root hydraulic conductance and ion transport. Abiotic stress through ABA signalling negatively affects signals that trigger systemic acquired resistance, enhancing pathogen spread from the initial site of infection. Ion accumulation (Na^+, Cl^-) under salt stress can have a direct toxic effect on pathogen growth. Unlike several biotic and abiotic stress combinations, the occurrence of drought stress and pathogen is one of the well-studied combinations. The effects of abiotic stress with simultaneous effect of a pathogen or herbivore, both positive and negative interactions have been observed depending on the nature, timing and extremity of each stress. In wheat, higher mean temperatures observed over a 6-year experimental period correlated with increase susceptibility to the fungus *Cochliobolus sativus.* In tobacco hypersensitive response (HR) and *R*-gene-mediated defence responses to *Pseudomonas syringae* and viral elicitors are compromised at high temperatures, allowing increased growth of these pathogens. The response of plants to a combination of biotic and abiotic stresses is complex involving interaction of various signalling pathways.

PA-13

Performance of Phule Chetak (PM-707-05) mung bean variety under rainfed condition of semi-arid region

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Mung Bean ((*Vigna radiata* (L.) Wilczek) is also called as green gram; it is widely grown leguminous crop in India, ranked 3rd after chickpea and pigeon pea. In Maharashtra, mung bean cultivated in two seasons *Kharif* and summer, short duration legume crop that can be used as catch crop in wheat, sorghum and rice cropping system. Phule chetak green gram recently released in 2020 is early maturing, bold seeded, resistant to major diseases and tolerance to pod borer pest. At ICAR-NIASM, Baramati Phule chetak variety was sown by tractor drawn seed drill under the climate smart integrated farming system (CIFS) of 1000 m^2 area in black soil during the *Kharif* season. The initial physico- chemical properties of the soil were pH 8.3, EC151.7 (dSm^{-1}), 37.31 kg N ha^{-1}, 9.33 kg P ha^{-1}, 741.44 kg K ha^{-1} and organic carbon 0.43 %. On the basis of soil properties and with respective to recommended dose of fertilizer 20 kg N ha^{-1} and 40 Kg P ha^{-1} applied and standard cultivation practices followed during the cropping period. The performance of this variety under rainfed condition of semi-arid region was assessed. With respect to yield aspect seed index was recorded as 4.65 g, number of pods per plant (28.0), and number of seeds per pod (13.0). Grain yield and dry biomass yield was recorded as 98 and 96 kg/1000 m^2 area i.e., 9.8 quintal ha^{-1} and 9.6 quintal ha^{-1} respectively.

PA-14

Sunflower yield response under changing rainfall situations in medium deep soil of scarcity zone of Maharashtra

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The investigation entitled "Sunflower yield response under changing rainfall situations in medium deep soil of scarcity zone of Maharashtra." was carried out during 2015-20 at Zonal Agricultural Research Station, Solapur, Maharashtra (India). The experiment was conducted in split plot design with three replications. Nine treatment combinations were formed considering different cultivars viz., V_1 Bhanu, V_2 MSFH-17 and V_3 Phule Bhaskar and sowing windows viz., (S_1) 2nd fortnight of June (25th-June), (S_2)- 2nd fortnight of July (27th-July), ($S_{3)}$-2nd fortnight of August (24th-August). Among the three sowing window sunflower crop sown in second fortnight of July (S_2) produced significantly highest grain yield (1377.9 kg ha^{-1}) and total monetary returns (52154/- kg ha^{-1}), CUM (326.6 mm), MUE (4.33 Kg ha^{-1} mm), GDD (1917^0 days), and RUE July (1.79g MJ^{-1}) than other dates of sowing. Among the cultivars Phule Bhaskar produced significantly higher grain yield (1200.0kg ha^{-1}), total monetary returns (Rs. 44675/-ha^{-1}), CUM (314.8 mm), MUE (4.23 Kg ha^{-1} mm), mean number of days to attain physiological stages (92 days), GDD (1815^0 days) than other cultivars. The correlation study revealed that T_{max} had significant positive influence and RH-I, RH-II and RF has significant negative influence at button phase (P_3). Under changing rainfall situations sowing of *Kharif* sunflower crop found beneficial in second fortnight of July *i.e.* 16th July to 29th July (MW 30-31(in medium deep soil of scarcity zone of Maharashtra.

PA-15

Effects of different salt concentrations on *Salvadora persica* L. (meswak): A facultative halophyte

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Salinization of soil has been a major issue in arid regions for plant productivity. *Salvadora persica* L. (meswak) is particularly well adapted to arid and semi-arid regions and has wide adaptability from non-saline to highly saline soils, deserts to heavy soils, and dry regions to waterlogged and marshy areas. An additional quality of this species is the ability of its seeds to germinate in saline water of about 15 dS m^{-1} contrary to many species which constantly require fresh water for their germination. In the present study, seedlings of *S. persica* were imposed to different levels of salt concentration (8.6, 12.8, 17.2 and 19.92 dS m^{-1}) for 30 days and monitored for their morphological, physiological and biochemical responses. A significant decrease was observed in plant height and diameter at high salinity. Leaf photosynthesis rate, transpiration rate and water use efficiency reduced at high concentrations of salt whereas the intercellular CO_2 remained unchanged. The leaf proline and sugar content increased as compared to control revealing that *S. persica* is a potential species for arid lands able to survive under high salt stress and that these plants under stress conditions experience modifications in morphological, physiological and biochemical characters in order to survive.

PA-16

Molecular characterization and identification of informative markers for Fusarium wilt resistance in chickpea

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Chickpea is an ancient and third most important food legume crop after bean and pea, grown over 45 countries across five continents. Despite of increase in area and production, the productivity has been less than one ton per ha mainly due to adverse effects of biotic and abiotic stresses. The emergence of Fusarium wilt (FW) as a devastating root disease of chickpea in central and southern India has been leading to 100% yield losses under favourable conditions. The MABC program was initiated with the cross between PKV Kabuli 4 (Moderately susceptible, recurrent parent) and WR-315 (Resistant, donor parent) to develop Fusarium wilt resistance to race 1 (*foc*-1) during *Rabi* 20018-19. Total 67 different molecular markers were used for the parental polymorphism survey and seven markers found polymorphic namely, TA 194, TS 82, TA 59, TA 110, showed 100% polymorphism and TR 19, STMS 02, TA 03 showed 75% polymorphism. From the hybridization program 75 F_0 seeds obtain among these 45 hybrids were confirmed through using polymorphic markers (TA 14, TA 194, and TR 19). Further, the confirmed hybrids were used for the execution of the first round of backcrossing and 18 BC1F1 plants were grown at this point foreground and recurrent parent genome recovery was carried out. For identification of Fusarium wilt QTLs in the F_2 population, 60 F_2 individuals from a single cross were used simultaneously for genotyping and phenotyping. Using morphological and molecular data linkage map was constructed and one major QTL "qfwch-02" were identified. Which covered a total map length of 93.60 cM, the average map distance between any pair of markers was 16.1 cM and major QTL "qfwCh-02" was identified on linkage group 2 for Fusarium wilt resistance against race-1 at map position 31.4 cM in F_2 progenies of PKV Kabuli 4 X WR-315. This QTL explained 10.91% phenotypic variance with LOD score 3.3 flanked by left marker TA 110 and right marker TR 19.

PA-17

Performance of advanced chickpea genotypes to cold stress at reproductive stage

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Temperature is a crucial environmental element for chickpea blooming and its productivity. The present research evaluated performance of thirteen advanced lines to reproductive cold stress based on pollen viability and yield attributes. The advanced lines exhibited differential thermotolerance to cold stress. Pollen viability varied significantly from 62.9-89.6% among the genotypes. In comparison to check cultivars (GPF-2, PBG-5 and PBG-7), only one advanced line GL29183 had significantly higher viability and pollen load. This feature of GL29183 promotes its pollination success under cold stress in early flowering chickpea. Pooled analysis of yield attributes also reflected better performance of GL29183 than other tested entries (GL27059, GL28202). Highest yield/plant was reported in cultivar PBG-5 which was significantly higher than GL29183.

PA-18

An investigation on relatively new agricultural practice- 'Microgreen cultivation' by using phytochemical analytical techniques

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Microgreens are vegetable greens harvested just after the cotyledon leaves have emerged; or they are the young plantlets harvested approximately after completing their growth of one week. Microgreens are getting attention recently because of their easiness in management and nutritional qualities as well. Leguminous seeds and their vegetable greens are important in the traditional diet of large populations in many parts of the world, because pulse grains are high in proteins, carbohydrates and dietary fibers and are rich source of other nutritional components. Apart from the seeds and pods, microgreens of legumes were also believed to have a rich nutritional profile. Hence the present study is to evaluate the significant changes in the phytochemical composition of microgreens produced from three pairs of legumes under different categories such as wild, traditional and cultivated legumes. The selected species are *Centrosema pubescens, Calopogonium mucunoides, Vigna vexillata, Vigna dalzelliana, Cajanus cajan*and*Sesbania grandiflora.* The specimens were subjected to dry weight determination, qualitative as well as quantitative biochemical analysis. Moisture, fiber, pectin, total carbohydrate, total starch, reducing sugar, soluble sugar, total protein, free amino acid content, total antioxidant activity and some anti-nutritional components were also estimated quantitatively. Dietary fiber content and antioxidant composition were found higher in Microgreens. Studies depicts that anti-oxidant components have the potential to lower the risk of several disease. So that both enzymatic as well as non-enzymatic antioxidants were also analysed for all the specimens. All the interesting results obtained from this study were explained, analysed and interpreted in detail.

PA-19

Analysis of physiological and genetic variation for yield and yield component traits in new plant type lines of rice

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The present investigation aimed at to evaluate new plant type selection (NPTs) to study the assessment of genetic variability for quantitative and physiological traits in new plant type lines of rice. The trial was laid out in randomized block design having three replications with 14 genotypes at the Instructional Farm, Orissa University of Agriculture and Technology, Bhubaneswar during *kharif* 2018-2019. Different yield attributing traits, physiological parameters and biochemical traits were examined to study the availability and extent of genetic variability, nature and magnitude of character association, path analysis, and multiple criteria for selection to sort out the most useful and promising genotypes for their possible use in future breeding program. The analysis of variance showed significant variation among the test genotypes for all the traits studied. The magnitude of genetic variance was moderate to high for majority of traits. Moderate to high degree of heritability estimates were observed for all the traits except for flag leaf angle, fertility% and specific leaf weight. The characters like flag leaf area, fertile grain no., different growth parameters, carbohydrate content, superoxide dismutase content, catalase content, glutathione peroxidase content and grain yield per plant exhibited high genotypic coefficient of variation coupled with high heritability and high genetic advance. The promising cultures identified on the basis of *perse* performance were PA6444, Pratikshya, R 1501-HR-NPT-1, CR 3936-11-1-1-1-1, Hiranmayee and Swarna. The high yield performance of these cultures was responsible for the superior expression of various traits and no definite trend of relationship has been established.

PA-20

Molecular approaches to enhance crop yield by radiation use efficiency

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Conventional approaches to increase the yield of agricultural crops will lag behind to fulfill the demands of growing population. With the advancement of technologies there are many molecular approaches available which can improve crop yield efficiency. Radiation use efficiency is one of the trait which has a huge impact on yield and there are many possible targets to improve the yield of the crop. Radiation use efficiency is the interception of light per unit biomass produced by the plant *i.e.* efficiency of the plant to convert the solar radiation into biomass. The value of RUE in different crop species varies from 1-5 g MJ^{-1}. Its value is recorded high in C_4 crops than C_3 crop. Photosynthesis is the basis of increasing the RUE. There are many targets which can improve the photosynthesis and hence RUE. Like, overexpression of some enzymes involved in the photosynthetic process *i.e.* seduheptulose 1-7 bisphosphate, reduction of photorespiration through introducing GOC pathway through *Agrobacterium* transformation. Conversion of C_4 like pathway into C_3 by changing enzyme activity through introduction of genes coding the enzymes of C_4 pathway. Some anatomical traits can also be modified by molecular approaches. Carbon concentration mechanism can be introduced through using bacterial carboxysome into plants, which increases the efficiency to concentrate the CO_2. Rubisco is the key enzyme of calvin cycle which can be modified to improve the photosynthesis and further the radiation use efficiency.

PA-21

Identification of castor parental lines with drought tolerance

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Castor is an important oilseed crop of India. It is generally grown in poor and marginal soils without irrigation, resulting in yield reduction. Evaluation of genotypes under stress is useful in breeding programs because it allows a direct estimate of drought tolerance or susceptibility of individual genotypes. Hence, an experiment was conducted at Narkhoda farm of ICAR-IIOR to evaluate 59 parental lines for drought tolerance during late *rabi*, 2018 by imposing drought stress from 45 DAS till harvest. Crop growth viz; plant height, node number, stem girth and branch production reduced after 70 days in stress. Effective spike length (ESL), capsule number, spike weight and seed weight of primary and secondary spikes also reduced with drought stress. Drought intensity was very high (intensity index is 0.612) which resulted in an average seed yield reduction of 58% with drought stress. Among the studied genotypes, 16 parental lines with 31-51 g/plant seed yield in stress with <1.0 drought susceptibility index (DSI) were selected which include: DCS-9, DCS-104, DCS-105, DCS-106, DCS-110, DCS-119, DPC-9, DPC-16, DPC-18, DPC-23, DPC-28, ICS-121, ICS-127, ICS-133, ICS-134 and ICS-322.

PA-22

Effect of PEG induced moisture stress on germination traits of *Brassica juncea* (L.) Czern & Coss advanced inbred lines

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Reduced water potential is a common consequence of both drought and salinity. Seed germination and related traits are critical in the life cycle and are often subjected to high mortality rates. The present *in vitro* study was conducted to screen advanced eighty-two inbred lines of *Brassica juncea* for drought, creating stress with six PEG 6000 concentrations of osmotic potentials 0 as control, -0.2, -0.4, -0.6, -0.8, -1.0, -1.2 MPa at seedling stage. Twenty seeds were disinfected with 0.1% mercuric chloride solution for one minute, then washed three times with distilled water and grown in petri plate double-lined with filter paper on the top and bottom and placed in a growth chamber at 25 ± 1°C and RH 85%. Significant variations existed among the inbred lines, stress levels and their interactions for all the studied traits. Osmotic potential of-0.6Mpa restricted the germination but eight inbred lines exhibited ≥ 50% germination even at-0.8Mpa. Mean length of root and shoot was 9.3 and 3.8 cm in control and 0.5cm and 0.1cm at-1.2Mpa. A declining trend in the weights per10 seedlings existed which varied from 1.1 to 152.7 mg in root and 4.7 to 314.5 mg in shoot fresh weight and subsequently in dry matter of root (0.3 to 19.1 mg) and shoot (0.5 to 3.8 mg). Vigour index I and II were maximum in S65 and S90 while lowest in S59 and S41 at all the osmotic potentials. Conclusively, S65 and S90 were rated tolerant to moisture stress under laboratory conditions and simultaneously when evaluated for two years in the field trials.

PA-23

Selection for root traits under non-stress holds good even for stress conditions in sunflower

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Among different traits that contribute to drought tolerance, the importance of root traits in drought avoidance is unequivocally proved. Attempts to study under target environment are cumbersome as lot of effort is required to manage drought. Therefore, to study whether a good root type remains the same in stress condition also or not, eight inbreds of sunflower were grown in poly bags containing 80 kg soil per bag @ 2 plants per bag with 5 replications. Measured quantity of water was applied for both non-stress and stress. Until seedling establishment (i.e., 22 days after germination), all the bags received same quantity of water (8 liters) and from then onwards stress treatment received only 25% of water given to non-stress. By the time of harvesting at 72 DAS, non-stress bags received 58.0 and stress bags 20.5 liters of water per polybag. All the root traits viz., root length (0.85*), root volume (0.81*), root weight (0.81*), and leaf number (0.87*), TDM (0.89*) and WUE (0.89*) showed strong significant correlation between non-stress and stress. This clearly establishes that a good root type remains good root even under stress condition and vice versa and therefore selection for root traits in non-stress condition holds good for stress situation as well.

PA-24

Screening and developing of nitrogen use efficiency genotypes in rice

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A field experiment entitled "Screening and developing of nitrogen use efficiency genotypes in rice was conducted during both *kharif* and *rabi* seasons in 2011-12 and 2012-13 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The experiment was laid out in a split plot design with two nitrogen levels 60 and 120 kg N ha^{-1} as main treatments and twenty six rice genotypes as sub treatments and the experiment was replicated thrice. Based on the yield performance and nitrogen use efficiency, six rice genotypes viz., MTU-1001, WGL-2395, MTU-1010, Pothana, Bhadrakali and JGL-1798were selected from *Kharif* 2011and the crosses were utilized to produce F_1 generation in *Rabi* 2011-12. The F_1 of *Rabi* 2011-12 were selfed to produce F_2 generations in *Kharif* 2012 and back crossed with parents to produce BC generations. Evaluation of parents, F_1, $F_2$and BC generations was done in *Rabi* 2012-13. In the present investigation among the nitrogen treatments application of 120 kg N ha^{-1} recorded significantly higher values for morpho-physiological parameters such as number of tillers $hill^{-1}$, SCMR values, photosynthetic rate and also resulted in maximum number of panicles $hill^{-1}$, number of filled grains $hill^{-1}$, filled grain percentage, 1000 grain weight and grain yield. Spikelet sterility and number of unfilled grains $hill^{-1}$ were minimum in this treatment. The nitrogen content in the component parts of the plant such as leaf, stem and grain also was positively influenced by the nitrogen levels. Nitrogen content recorded was maximum at vegetative stage and declined towards harvest indicating the remobilization of nitrogen to grains at harvest. Among the genotypes, MTU-1001 recorded the maximum grain yield of 5021 kg ha^{-1}even under application of 60 kg N ha^{-1}. This indicated higher nitrogen use efficiency. Maximum yield can be attributed to maximum SCMR values, more photosynthetic rate, more tillers and panicles, more number of grains $hill^{-1}$, maximum filled grain percentage and minimum spikelet sterility.

PA-25

Thermotolerant lines of sunflower with temperature induction response technique

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Heat stress is a menace to current and future crop production. There is a need to develop heat tolerant varieties and hybrids to sustain yields. In this study, a screening protocol was followed based on the principle of "acquired tolerance" in which exposure of seedlings to a sub lethal level of temperature stress from 35°C for 1h, 40°C for 2h and 45°C for 1h (induction treatment) is used to induce tolerance before subjecting to subsequent lethal level of 49°C for 2h. 42 inbred lines and five hybrids were screened for thermotolerance. Significant variation was observed in shoot length, root length, total seedling length, seedling dry weight, survival percentage and seed vigour among the 47 lines of sunflower. Survival percentage ranged from 40 to 86.7% in induction and from 0 to 66.7% in lethal respectively. Among the entries tested, in addition to the five hybrids KBSH 44(56.7%), CO_2 (53.3%), CSFH 12205(53.3%), DRSH 1(50%), RSFH 130(50%) and six lines CMS 135B (66.7%), CMS 144B(63.3%), DSF2B(56.7%), CMS 107B(56.7%), CMS 127B(56.7%) and AKSF 63B(46.7%) showed better mean survival percentage after lethal treatment against a mean survival of 30.8%. Results suggested that TIR technique can be used to screen germplasm lines to identify thermotolerance.

PA-26

Phule chetak- A new high yielding green gram Variety for Maharashtra

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Green gram is one of the important pulse crop requires low inputs. The productivity of kharif green gram is very low. The present improved varieties have lower yield potential and disease susceptibility. There is need to develop high yielding variety combined with early to mid late synchronize maturity, better quality and resistance/tolerance to major pests and diseases. The green gram *var.* Phule Chetak is developed by pedigree selection method from a cross between SML-668 X Naval at Oilseeds Research Station, MPKV, Jalgaon. It was tested for several locations and environments for its stability performance. The variety Phule Chetak and existing released varieties were evaluated for their yield performance under field conditions. The results indicated a significant improvement in yield level under field conditions. The new variety Phule Chetak reported average yield of 1003 kg/ha which is 26.96%, 36.46%, 29.42%, 21.72%, 17.58% and 13.21 percent higher than the check varieties Vaibhav, BPMR-145, AKM-8802, BM-2002-1, BM-2003-2 and Utkarsha respectively. It is bold seeded having early maturity, moderately resistance to major diseases like powdery mildew, mungbean yellow mosaic virus under field conditions. Considering consistent performance, the mung bean genotype PM-707-5 has been released for cultivation in the *kharif* season for Maharashtra under the name of Phule Chetak in Joint Agresco during 29-30 October, 2020 held at Dr PDKV, Akola and State Seed Sub Committee Meeting held online on 2nd September, 2021.

PA-27

Genotypic variation in physiology, yield, nutrient uptake and their efficiency of wheat varieties grown in vertisols of India

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Agricultural crop production per unit area has to be increased to bridge the gap between supply and demand of food grain. Nitrogen (N) and Phosphorus (P) are two major indispensable macro-nutrient elements for crop production in modern agriculture with significant environmental and production costs. The current status of nutrient use efficiency (NUE) in different cropping systems is low for these nutrients for example, 30-50% for Nitrogen (N) and 15-20% for Phosphorus (P). Increasing NUE in wheat crop would reduce fertilizer inputs and would in turn reduce associated environmental concern. Hence, evaluation and use of wheat cultivars with higher NUE can contribute to higher crop growth with optimal inputs without compromising grain yield. To address these, a field experiment was carried out to assess genotypic variation in Nitrogen and Phosphorus uptake and their efficiency in wheat in vertisols of India in the *rabi* season (2020-2021) at of ICAR-Indian institute of soil science Bhopal (India). The experiment was carried out under four levels of nutrients (0% NPK, 100% NPK, 50% N + 100% PK and 100% NK + 50% P) with 120 genotypes. Agro-morphological, physiological and yield parameters including nutrient uptake, apparent nutrient recovery, agronomic and physiological efficiencies were assessed. The selected genotypes exhibited varying degree of response w.r.to leaf area, plant biomass, yield, chlorophyll content, nitrate reductase enzyme activity, photosynthetic rate and nutrient use efficiencies. The genotypes identified with higher nutrient use efficient traits can be utilized in breeding programs to better exploit the constrained ecosystem with reduced impact on environment

PA-28

Identification of novel salt inducible promoter from *Pandanus odorifer* (Forssk.) Kuntze through next generation sequencing approach

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Salinity stress is one of the major environmental factors that drastically affect crop productivity all over the world. At a biochemical level, stress results in the production and accumulation of the osmoprotectants which serves as a mechanism of survival. The halophyte *Pandanus odorifer* (Forssk.) Kuntze belongs to family Pandanaceae. It grows in the wild, mainly along the seashore throughout the tropical and subtropical Pacific Ocean. The populations of *P. odorifer* at the coastal site were found to be highly fertile bearing flowers and fruits suggesting that the species is considerably salt tolerant. In our laboratory, it has been worked out that in the seedlings of *P. odorifer* treated with 1 M NaCl, the asparagine synthetase (ASN) gene was found to be up regulated and the accumulation of the osmolyte asparagine confers salt tolerance to the species. When the seedlings of *P. odorifer* were treated with various concentrations of salt (100 mM, 250 mM, 500 mM, 750 mM, 1M), ASN gene expression was observed only beyond the 500 mM concentration. This suggested that the ASN gene expression is salt inducible and this might be due to promoter. Hence we intrigued to characterize the promoter of ASN in this species. For this, the *de novo* draft genome sequence of *P. odorifer* was obtained and assembly of the promoter was done using SRAs sembler. In the present study, we have identified a novel salt inducible promoter responsible for the expression of the asparagine synthetase gene at a high concentration of salt. Its further characterization is underway.

PA-29

Exploring the natural variation of photosynthesis and photo assimilate partitioning in rice

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Photosynthesis and photo assimilate partitioning are two interconnected physiological processes determining overall plant performance, yield and biomass. The leaf is the prime site for carbon fixation, therefore, different developmental, photochemical, and biochemical traits of the leaf will affect photosynthesis. Photo assimilate partitioning, in the form of sucrose, depends on the source and sink strength, phloem loading and unloading, and the activity of sucrose transporters. In this present study, wild rice species, such as *O. australiensis*, *O. rufipogon,* and *O. latifolia*, showed higher net leaf photosynthesis rate (P_N) compared to cultivated rice *O. sativa* cv. IR 64 and *O. sativa* cv. Nipponabare. Higher photosynthesis in the wild rice species was found to be associated with different leaf developmental traits, specifically mesophyll cell size and lobbing, and vein dimensions. Furthermore, these wild rice species also had efficient phochemical and biochemical features. These wild rice relatives accumulated high NSCs in leaves which is consistent with higher photosynthesis. Using a ^{14}C leveled sucrose loading experiment, quantification of sucrose in phloem sap and expression analysis of *SWEET* genes encoding sucrose transporters suggested efficient phloem loading in the leaves of wild species. However, sucrose transport to the grains of the wild species was not adequate, likely due to abnormal vascular bundles as well as reduced expression of some key *SWEET*s and *SUT*s at the panicle base. Interestingly, a large portion of sucrose in the wild relatives of rice stem was converted to structural carbohydrate such as cellulose and hemicellulose likely due to higher cleavage activity of OsSUS and higher expression of cellulose synthase. Therefore, low starch accumulation in wild relatives of rice seem to be partially responsible for its poor yield. We are continuing to explore the underlying mechanisms which will hopefully support combining efficient photosynthesis and photo assimilate partitioning towards higher crop yield and biomass.

PA-30

Effect of variety, spacing and fertilizer dose on yield and yield contributing characters in black gram

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Black gram is a good source of protein, phosphoric acid and calcium. Being a drought resistant crop, it is suitable for dry land farming and predominantly used as an inter crop. Urdbean is short duration and photo, thermo insensitive, considered as excellent for crop intensification and diversification. A field experiment was conducted at Oilseeds Research Station, MPKV, Jalgaon to study the effect of variety, spacing and fertilizer dose on yield and yield contributing characters of black gram. The field trial was laid out in FRBD with three replications having three factors each with two levels during *kharif* 2020. Two varieties *viz.*, PU-609-43 & TPU-4 were tested with two spacing *viz.*, 30 x 10 cm, 45 x 10 cm and two fertilizer doses *viz*., 100% RDF, 125% RDF. The data were statistically analyzed using ANOVA. The results revealed that the genotype PU-609-43 gave significantly higher grain yield, haulm yield, GMR, NMR, 100 grain weight, grain weight per plant, no. of grains per pod, no. of pods per plant and B:C ratio than the variety TPU-4. The spacing 30 x 10 cm showed better yield performance and 125% RDF recorded higher yield levels but was non significant.

PA-31

Assessment of physicochemical characteristics of saline and non-saline soils

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In India, 6.73 million ha area is having salt affected soils and in Maharashtra, total land area covered by salt affected soils is 6,06,759 ha. In Sangli district, about 2,477 hectare of land is under saline soils and major part of cultivated land is about to turn to be saline. Hence an attempt has been made to assess the physicochemical characteristics of saline and non-saline soil. Saline soil samples were collected from Sangli district and non-saline soil samples from agricultural fields of Kolhapur district. pH of saline soil was in acidic range (5.94 to 6.48) and of non-saline soil was in alkaline range (7.45 to 7.68). Highest rise in Electrical conductivity and chloride content was observed in saline soil (8.06, 8.33, 8.26, 8.43 and 9.13 mMho/cm and 2.261, 2.262, 2.608, 2.247, 2.283 mg/ml) as compared to non-saline soil (0.24, 0.29 and 0.32 mMho/cm and 0.136, 0.131, 0.130, 0.132 and 0.133 mg/ml). Water holding capacity (95.81, 93.15, 94.67, 97.46 and 90.08%), organic carbon (1.10, 1.14, 1.09, 1.06%) and organic matter (1.9, 1.96, 1.83%) were increased in non-saline soil. Reduction in the same was seen in saline soil. Moisture content (5.76, 5.73, 6.33, 6.36, 5.96%) and total dissolved solids (0.196, 0.363, 0.326, 0.370, 0.343%) were increased slightly in saline soil than non-saline soil. Not much difference was observed in the values of bulk density in both the soils. Results revealed that fertility of saline soil may be affected due to rise in salt content.

PA-32

Effect of drying methods and moisture levels on storability of soybean [*Glycine max* (L.) Merril]

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In a study conducted during 2019-20**,** freshly harvested soybean seeds of cultivar DSb-21 were analyzed for drying methods *viz*., zeolite beads, silica gel and mechanical drying to reduce the seeds to different moisture levels *viz*., 9%, 7% and 5% during storage for six months in 700 gauge polythene bags with the control (10%) in cloth bag. Zeolite beads have taken 72, 144 and 336 h time to reduce the seed to 8.9%, 7.1% and 5.2% MC, respectively. Silica gel has taken 72, 96 and 144 h to reduce the seed to 8.9%, 7.1% and 5.3% MC, respectively. Mechanical drying has taken 1 h 30 min, 48 h and 72 h to reduce the seeds to 9.1%, 7.3% and 5.1% MC, respectively. Zeolite beads and silica gel have maintained highest germination (75.22% and 74.78%, respectively) in seeds dried to 7% MC compared to control and lowest in mechanical drying (66.44%). Mechanical damage was recorded lowest in seeds dried by zeolite beads and silica gel at 7% MC (4% and 4.67%, respectively) as compared to control (12%). After six months of storage, highest enzyme activity was observed in seeds dried by zeolite beads and silica gel at 7% MC *i.e.*, SOD (8.82 and 8.73 Units/min/g, respectively), catalase (80.47 and 79.07 µmoles H_2O_2 decomposed/min/g, respectively). Mean peroxidase activity was not clearly differentiated the effect of drying methods and moisture levels. Release of volatile aldehydes was lowest in seeds dried by silica gel and zeolite beads at 7% MC (1.21 and 1.30 µg formaldehyde/g, respectively) as compared to mechanical drying at 5% MC and control (4.80 and 4.45 µg formaldehyde/g, respectively). Hence, seeds can be stored in polythene bags of 700 gauges with zeolite beads and silica gel for six months after drying to 7% MC without drastic reduction in seed quality.

PA-33

Screening of rice genotypes for tolerance to low light stress

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Rice is the staple food for billions of people around the globe. Apart from biotic stresses which affects the yield and quality, abiotic stresses has become a major threat in recent times due to change in climatic scenario. Rice is mainly grown as a rainy season crop and is frequently exposed to poor light intensity at various growth stages. Light intensity determines grain yield and quality. Continuous cloudy days or rainfall during critical stages of growth, such as panicle differentiation or grain-filling stages often cause yield loss coupled with poor grain quality. As low light conditions can damage rice production dramatically, an experiment was conducted to identify low light tolerant genotypes. Eighteen rice genotypes were evaluated for tolerance to low-light stress in *kharif* season in Godavari zone where there is prevalence of low light conditions. Low light stress treatment resulted in increase in the number of days to 50% flowering as well as the days to maturity with respect to control. There was a reduction in plant height, total dry matter at floweringand yield attributes such as grain number/m^2, total dry matter at maturity, 1000 grain weight and grain yield under low light stress. Based on the grain yield under low light stress conditions, IET 27584 (5300 kg h^{-1}) and IET 27581 (4950 kg h^{-1}) could be selected as low light tolerant genotypes as they the yield in these two genotypes was higher when compared to all the other genotypes.

PA-34

Effect of exogenous application of plant growth regulators on seed germination of *Myristica magnifica* Bedd

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Myristica magnifica Bedd. Is an endangered tree species of family Myristicaceae with distribution in the unique wet land ecosystem in the Western Ghats called Myristica swamp (IUCN, 2020). The endangeredness of this species is attributed to overexploitation as medicinal plant, habitat destruction and recalcitrant nature of its seed. The present study was intended to study the effect of exogenous application of Plant Growth Regulators (PGRs) on seed germination of *M. magnifica.* In the present study seeds were immersed in the different concentrations of PGRs and distilled water as the control treatment for 24 hrs. and kept in a seed germinator (KEMI SEED GERMINATOR KSG-2) without light (30 ± 2°C, 80% RH). The seeds soaked in IBA, GA_3 and Panchagavya showed maximum germinabilty at concentration of 20 ppm, 200 ppm, and 8% respectively. The Mean Germination Value (MGV) was also highest in these concentration. Soaking with ABA has shown delayed and poor rate of germination. Hence, pre soaking of seeds with IBA/GA3/ Panchagavya at concentration of20 ppm, 200 ppm, and 8% respectively could be suggested as an effective method for improving the germinability and MGV of *Myristica magnifica* Bedd seeds. All experiments were statistically analyzed by one way ANOVA and the values are expressed as mean ± standard error [LSD ($P < 0.05$)].

PA-35

Plant growth promoting rhizobacteria- An eco-friendly strategy for alleviating drought stress and growth promotion in plants

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Rhizobacteria are a group of bacteria that are found in close association with the rhizosphere with the ability to colonize the plant roots and help in plant growth promotion. These bacteria are helpful in alleviating abiotic stresses and can also act as biocontrol agents against pathogens. The various mechanisms used by Plant Growth Promoting Rhizobacteria (PGPR) for growth promotion and stress control in plants are phosphate solubilization, production of phytohormone, siderophore, exopolysaccharide and 1-Aminocyclopropane-1-carboxylate (ACC) deaminase. In the present study, an attempt was made to isolate the rhizobacteria from the rhizosphere of millets and rice and screen them for the drought tolerance and plant growth promoting traits. A total of 30 rhizobacterial strains were isolated from the rhizosphere samples of millets and rice collected from different zones of Tamil Nadu. The isolation of rhizobacteria was done by using serial dilution method and the isolated strains were screened for drought tolerance using Polyethylene glycol 6000. The drought tolerant strains obtained were further characterized for plant growth promoting traits. The best strains obtained after screening can be applied either as seed coating or root dipping to promote the growth and reduce the stress level in plants. This approach can replace the use of chemical fertilizers thereby restoring the soil fertility.

PA-36

Physiological and molecular changes in response to single and dual nutrient deficiencies in wheat

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The lack of macro- and micronutrients limits the crop production capacity of many soils around the world. One of the most critical plant nutrients for plant growth and development is nitrogen(N). While, Iron (Fe) is required for the biosynthesis of the porphyrin ring of the chlorophyll molecule in plants, as well as for the structural integrity of LHC subunits and photosynthetic reaction centres. Phosphorus (P) is a vital component of adenosine triphosphate (ATP), the "energy unit" of plants, while Potassium (K) is associated with the movement of water, nutrients, and carbohydrates in plant tissue. To get the best economic yield, we need to know how plants react to different nutrient deficits. A study is attempted to assess the plant response to single and dual nutrient deficiencies in the current investigation. In hydroponic settings, seven combinations of nutrient deficit (-N,-Fe,-P,-K,-N-Fe,-N-P,-N-K) were examined in bread wheat. After 30 days of transplanting, the data was obtained at the seedling stage. In K and N deficiency, total chlorophyll concentration was dramatically lowered. In N, K, and N/K dual deficit, root length, volume, and root surface area all increased. In P, N, and N/P dual deficit, the expression of presumptive TaCBL1 increased. Deficiencies in N, Fe, and N/Fe dual deficiency elevated the expression of presumptive TaCBL2. Other TaCBLs' expression exhibited a range of reactions in response to single and dual nutritional deficiency. The nutrient analysis of di-acid digested root and shoot samples revealed a decreased quantity of K^+ in shoots in N/Fe dual deficit compared to control, -K, and-N-K. Root N buildup was lowest in the-N-Fe situation.

PA-37

Induced thermo tolerance response to high temperature stress effect on wheat physiology and productivity by exogenous application of salicylic acid thiourea

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The global warming induced by climate change gradually reduces crop productivity by affecting plant growth and development. Wheat grown under late sown condition is exposed to very low temperature up to booting stage. However, the later stage faces a higher temperature that inhibits grain development, resulting reduction in grain yield. Plant growth regulator application has played an important role in mitigating the heat stress effect in different crops. Therefore, an experiment was conducted for two years, 2018-19 and 2019-20, to explore the possibility of applying some bioregulators *viz*., salicylic acid at 800 & 400 ppm, Thiourea @ 800 & 400 ppm in improving growth, phenology, physiology, seed set, and seed quality attributes and to assess their high-temperature mitigation potential. Reduction in seed yield due to high-temperature stress conditions was observed to be 38%. The seed yield was reduced due to a decrease in chlorophyll content index, grain filling duration, LAI, and LAD, leading to seed yield and quality loss. SA @ 800 ppm mitigates stress effect by retaining higher Leaf Area Index, no. of seed per ear, number of spikelets per ear, ear length 1000 seed weight, seed yield per plant, biological yield, and harvest index. Thiourea @ 800 ppm is the second most superior in maintaining higher seed yield (g/plant), harvest index, no. of tillers per plant, plant height, and first in terms of high seed set percentage. Hence from the present study, it can be concluded that bioregulators SA @ 800 ppm sustained higher seed yield due to superior performance in growth and physiological parameters, thereby inducing thermotolerance under high-temperature stress conditions in wheat.

PA-38

Salicylic acid a potent phytohormone: A study towards plant physiology, biochemistry and signal transduction under abiotic stress

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Salicylic acid (SA) is the potent phenolic signaling molecule and multifaceted plant growth regulator which participate in wide range of growth, metabolic, cellular and defense responses. Exogenous SA application induces germination, growth, flowering, photosynthesis, respiration and antioxidant machinery. SA act as the potent tool in diminishing several abiotic stresses such as salinity, drought, heavy metal, heat, cold and ultraviolet radiation stress by improving physio-biochemical and metabolic processes in plants. SA plays a key role in reducing reactive oxygen species (ROS) and lipid peroxidation by promoting enzymatic antioxidant and non-enzymatic antioxidant machinery, and increasing osmolyte content. SA signaling modulates protein structure, functions and oxidative post-translational modifications. SA up-regulates several physio-biochemical processes, genes and proteins in heathy and stresses plants. Furthermore, it interacts with phytohormones to maintain plant responses. Thus, SA serves as cheap, biodegradable phenolic compound in maintain sustainable agriculture practices and increasing plant productivity.

PA-39

Variability in leaf water traits and membrane stability in *Brassica juncea* (L) Czern and Coss in temperature gradient tunnel

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High temperature is a prominent abiotic stress, restricting the normal growth and development of plant, especially under the changing climatic scenario that predict a rise of 1.1°C in average temperature over last five decades. Harvesting of rice and cotton as well as mixed cropping with wheat often delays sowing of mustard which exposes the crop to heat stress during the reproductive phase leading to yield losses. Keeping this in view, fourteen advanced mustard genotypes, were evaluated in randomized block design with two treatments i) control/ open field and ii) in a temperature gradient tunnel (TGT). Leaf water traits and membrane stability at flowering are most vulnerable to heat stress. Temperature was higher by 3-4°C in TGT than the ambient temperature in open field which led to depreciation of LRWC by 4.4%, LWR by 6.7% whereas RSD increased by 26.3% and WSD by 16.3%. Similarly, elevated temperature decreased the membrane stability with a concomitant increase in membrane injury. In comparison to control, membrane stability declined by 5.9% and membrane injury enhanced by 19.8% in TGT. There was strong negative correlation of seed yield with LRWC (r=-0.655*) and association was positive with RSD (r=0.638*) and WSD(r=0.655*) under TGT. Strong relationship existed between seed yield and LRWC (R^2=0.4289), RSD (R^2=0.4068) and WSD (R^2=0.4289) whereas the relationship was weakened for membrane stability and injury under TGT over control. Genotype JA24 was promising with minimal reduction of LRWC, LWR and membrane stability and minimal increase in RSD, WSD and membrane injury under elevated temperature in tunnel.

PA-40

Biochemical responses of rice to silicon application under well-watered and water-deficit conditions

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Silicon (Si) has been demonstrated to improve both abiotic and biotic stress resistance in a variety of crop species, particularly monocot grasses in the Poaceae family such as rice. Drought stress impairs plant water metabolism, limiting nutrient intake, restricting transpiration rate, blocking growth, interfering with physiological and biochemical processes, and lowering yield and quality. Si is considered as a beneficial element for healthy growth and development of plants including rice which is a typical Si accumulator (> 10% of its dry weight) crop. In this study, a field experiment was conducted during 2020 at the Norman E Borologue Crop Research center of G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). The experiment was arranged as split-plot design with four treatments: control (T1), Si fertilization (T2), Si fertilization + Drought stress (T3), and Drought stress (T4) and replicated thrice. The application of silicon solubilizers was given at the time of maximum tillering and 50% flowering stage. All rice genotypes showed a positive correlation with silicon solublizers application, which increased chlorophyll a, chlorophyll b, total chlorophyll and carbohydrate contents. The goal of this study was to see if silicon solublizers have an impacton biochemical responses in rice genotypes.

PA-41

Morpho-physiological evaluation of farmer's varieties of rice

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Farmer's varieties are traditionally cultivated, developed and conserved by farmers in their fields that are a wild relative or landrace of any variety about which farmers possess common knowledge. Farmer's varieties have the high potential to tolerate heat, drought and biotic stress and bring diversity in climate resilience gene pool. Therefore, the present work has attempted to characterize the farmer's varieties for morpho-physiological traits, yield, and yield attributes for utilization in future rice breeding programs to develop high-yielding rice varieties. Out of 30 farmer's varieties, Navari, Uraiboota, Garud luchai exhibited maximum grain yield due to higher physiological efficiency viz. higher total dry matter accumulation, LAI, LAD, and chlorophyll content index. Principles component analysis result revealed that the PC1 accounted for the highest variability (42.46%) was mostly associated with physiological growth analytical parameters like days to physiological maturity, days to harvestable maturity, leaf area index, leaf area duration, chlorophyll content index, and yield attributes viz., number of grain per panicle, test weight, biological yield harvest index and grain yield. Correlation studies results revealed that grain yield exhibited a significant positive correlation with rapid phenological development, growth analytical traits viz., average total dry matter production, leaf area index, leaf area duration, chlorophyll content index, yield, and yield attributes viz., biological yield and harvest index. PCA revealed that three farmer's varieties viz., Garud luchai, Uraiboota, Nanhaluchai, Karhani confine with desirable physiological, yield and yield attributing traits and present in more than one PC with highest PC score, these lines might be utilized in future rice hybridization breeding programme for the development of promising rice cultivar.

PA-42

γ-Aminobutyric acid (GABA) mediates abiotc stress tolerance in plants using morpho-physiological and biochemical responses in plants

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γ-Aminobutyric acid (GABA) is the non- proteinogenic amino acid bearing 4-carbon, present in all living organism. In mammals, it serves as potent inhibitory neurotransmitter and signaling molecule. In plants also it serves as important signaling molecule during signal transduction for maintain vital plant processes. GABA plays a crucial role in seed germination, growth and development, photosynthesis and respiration. It has key role in mediating cell communication, maintaing pH, citric acid cycle bypass and plant carbon and nitrogen metabolism. GABA plays central role in mitigating several environmental stress (salinity, drought, heavy metal and temperature) by improving plants physio-biochemical traits. GABA serves as potent osmoprotectant, signaling molecule and anti-oxidant which helps in diminishing toxic effect of reactive oxygen species (ROS) during stress. GABA in low concentration improves plants physiological and biochemical responses under stress and non-stress environment. It also plays key role in inducing yield and productivity. Thus, GABA is important metabolite or signaling molecule that has versatile role in plants.

PA-43

Role of coleoptile length in emergence from deep sowings in wheat

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In arid or semi-arid regions, deep sowing allows growers to make use of soil moisture, but the short coleoptiles of semi dwarf wheats or other varieties reduce emergence when sowing at depth. This study was aimed to evaluate the variation in coleoptile length in diverse set of wheat genotypes at optimum growth temperature under control conditions. Further, the germplasm was evaluated in field under deep sown conditions for emergence and other morphological and yield attributes. The genotypes having smaller coleoptile would take more days to reach up the surface when seeds were placed at depth due to high soil strength that developed above the seedling and resulted in delayed emergence and hence, reduced crop stand. Genotypes with longer coleoptiles improved the plant's ability to emerge from greater depths in lesser time. 37.5% of the genotypes which took lesser days for emergence (10, 7.3 days) under deep sowing, possessed long coleoptile length (6.37cm, 4.10cm) respectively. A perfect negative linear relationship existed between coleoptile length and days taken to emergence (r=-0.22) in deep sowing while in normal sowing, there was weak correlation between these two variables (r= 0.15). Morphological attributes under deep sowing such as plant height (75.62cm) and length of first internode (6.74cm) were found to be at par with normal sowing (82.25cm and 6.23cm respectively). Also, 1000-grain weight and grain yield for all cultivars under deep sowing (51.42g, 249.57g) commensurate with normal sowing (53.39g, 255.21g) and differ significantly at P<0.01%.

PA-44

Functional conservation between arabidopsis and physcomitrella cytosine DNA/tRNA Methyltransferase 2 with respect to its role in abiotic stress

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The moss *Physcomitrium patens* is known to tolerate high concentrations of NaCl and mannitol in the growth medium. We have previously shown that *P. patens* DNA methyltransferase 2 accumulates in response to salt and osmotic stress in a temporal manner showing maximum expression during stress recovery period. It plays a pivotal role in stress tolerance by affecting stability of $tRNA^{Asp}$ under stress conditions. The protein shares more than 50% identity with Arabidopsis DNMT2 in the catalytic motif region. To study the conservation between *PpDNMT2* and *AtDNMT2* at functional level, the *PpDNMT2* loss-of-function lines generated previously in the lab were transformed with full length *PpDNMT2* and *AtDNMT2*, respectively and the ability of complemented lines to recover from salt stress was monitored. It was observed that *PpDNMT2* expression in *ppdnmt2* is able to make the plants stress tolerant similar to wild type plants. But, expression of *AtDNMT2* in *ppdnmt2* was unable to completely restore the salt tolerance potential suggesting *AtDNMT2* weakly complements loss of *PpDNMT2* in *ppdnmt2*. Further, comparing the transcriptome of wild type and *ppdnmt2* on 600mM mannitol stress, several genes belonging to starch and sucrose metabolism, intracellular copper ion transport, ethylene-activated signaling pathway, glycogen biosynthetic process, small GTPase mediated signal transduction, response to water deprivation, cell wall organization, polysaccharide biosynthetic process, plasma membrane, cell wall, microtubule associated complex, vacuolar membrane, transferase activity and biosynthesis of secondary metabolites are downregulated while those for thiamine metabolism, photoprotection, cellular response to high light intensity, regulation of chlorophyll biosynthetic process, oxidation-reduction process and cellular response to heat get upregulated.

PA-45

Role of ethylene in plants during abiotic stress

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Stress as an external factor that exerts a disadvantageous influence on the plant. Under both natural and agricultural conditions, plants are exposed to unfavorable environments that result in some degree of stress. Water deficit, chilling and freezing, heat stress and heat shock, salinity, oxygen deficiency, and air pollution are major stress factors restricting plant growth. Plants are commonly exposed to large number of different environmental stresses including extremes of pH and temperature, flooding, drought, high salt, both organic and inorganic contaminants, and a variety of pathogenic organisms. As a consequence of these environmental stresses, plants typically synthesize increased levels of the phytohormone ethylene. The increase in ethylene under stress is of adaptive significance as it helps plants to cope up stress by reducing water loss through increased senescence of fruits/leaves and reduced growth. The magnitude of ethylene increase under stress depends upon growth stage, stress intensity, and stress duration and higher stress levels tend to reduce ethylene concentration. Importantly, the effects of plant hormones on abiotic stress path-way is intimately linked through secondary signals such as Ca^{2+} and ROS. ET regulate various developmental and physiological processes (e.g., root development, anthocyanin accumulation) that may be associated with abiotic stress tolerance. Inherent ethylene production is necessary for the establishment of salt acclimation, and ethylene signaling is indispensable for plant self-adjustment in rapid response to salinity stress and better adaptation to the stress condition.

PA-46

Effect of selected synthetic plant volatiles on green lacewing (*Chrysoperla zastrowi sillemi*) under Y-tube olfactometer

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The behavioural response of *Chrysoperla zastrowi sillemi* (Esben-Petersen) female adults were evaluated with the aim of identifying the compounds responsible for attractiveness under laboratory condition. For this study,8 selected synthetic plant volatiles were tested for their responsive behaviour for green lawing using Y-tube olfactometer. The outcomes of the investigation entail that, all tested plant volatiles were elicited positive response from green lacewing. Among which maximum number of insects were attracted to methyl salicylate (χ^2= 14.22, df = 1, p= 0.0001), caryophyllene (χ^2= 12.80, df = 1, p= 0.0003) and phenylacetaldehyde (χ^2= 11.84, df = 1, p = 0.0005) against control. Other volatiles *viz*., cis-3-hexane-1-ol (χ^2= 10.89, df = 1, p = 0.0009), methyl jasmonate (χ^2= 8.89, df = 1, p = 0.002) and D-limonene (χ^2= 7.20, df = 1, p = 0.007) were also attracted significant number of lacewing adults and stood on equal with the above volatiles. Geraniol (χ^2= 5.40 df = 1, p = 0.02) and farnesol (χ^2= 4.57, df = 1, p = 0.033) were found significant at p = 0.05 for their attractiveness towards Chrysopa population. Understanding the relationship between structure and function of the olfactory system in predatory insects provides the basis for new semiochemical tools to enhance the efficacy of biological control in sustainable agriculture and provides new insights into olfaction in predatory insects.

PA-47

Plant Growth Promoting Rhizobacteria- An eco-friendly strategy for alleviating drought stress and growth promotion in plants

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Rhizobacteria are a group of bacteria that are found in close association with the rhizosphere with the ability to colonize the plant roots and help in plant growth promotion. These bacteria are helpful in alleviating abiotic stresses and can also act as biocontrol agents against pathogens. The various mechanisms used by Plant Growth Promoting Rhizobacteria (PGPR) for growth promotion and stress control in plants are phosphate solubilization, production of phytohormone, siderophore, exopolysaccharide and 1-Aminocyclopropane-1-carboxylate (ACC) deaminase. In the present study, an attempt was made to isolate the rhizobacteria from the rhizosphere of millets and rice and screen them for the drought tolerance and plant growth promoting traits. A total of 30 rhizobacterial strains were isolated from the rhizosphere samples of millets and rice collected from different zones of Tamil Nadu. The isolation of rhizobacteria was done by using serial dilution method and the isolated strains were screened for drought tolerance using Polyethylene glycol 6000. The drought tolerant strains obtained were further characterized for plant growth promoting traits. The best strains obtained after screening can be applied either as seed coating or root dipping to promote the growth and reduce the stress level in plants. This approach can replace the use of chemical fertilizers thereby restoring the soil fertility.

PA-48

Impact of water deficit (Drought) stress in sugar beet

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Water deficit (drought) stress is a major environmental factor limiting the production of crops. A pot experiment was conducted using tropical sugar beet under different regimes of drought stress of 5, 10, 15 and 20 days with day temperature of 36.3°C–39.7°C, to evaluate its tolerance performances. After imposing stress T1, T2, T3, T4 treatments are re-watered regularly till harvest. Significant reduction observed in plant fresh and dry weight, leaf area, LAI, shoot: root ratio and RWC over control. Water deficit also resulted decrease in CSI, chlorophyll a, chlorophyll b, and total chlorophyll in leaves of sugar beet. In response to drought, plants have performed osmotic adjustment, therefore minimizing harmful effect of water stress. Proline acted as osmoprotectant and induced tolerance, gradually increased when stress duration is increased from 5 days (2.024 $\mu g.g^{-1}$) to 20days stress (7.398 $\mu g.g^{-1}$). Total soluble carbohydrate contents are increased against control, where starch accumulation increased up to 15days stress but significantly reduced at 20 days of water withholding, showing its mobilization towards root growth and metabolism, showing the higher value of adaptability. The reduction in growth performance somehow recovered after re-watering the stressed plants which is observed at harvest, in their tuber yield values from moderate to severe stress treated plants i.e. T2(25.817$t.ha^{-1}$) & T4 (13.918$t.ha^{-1}$), conditions in comparison to non-stressed plants. At moderate stress, sugar beet plants are showing tolerance and adaptation by triggering accumulation in roots. Hence it may be concluded that sugar beet crop is relatively tolerant to drought, but is very sensitive during growing stage.

PA-49

Role of coleoptile length in emergence from deep sowings in wheat

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In arid or semi-arid regions, deep sowing allows growers to make use of soil moisture, but the short coleoptiles of semi dwarf wheats or other varieties reduce emergence when sowing at depth. This study was aimed to evaluate the variation in coleoptile length in diverse set of wheat genotypes at optimum growth temperature under control conditions. Further, the germplasm was evaluated in field under deep sown conditions for emergence and other morphological and yield attributes. The genotypes having smaller coleoptile would take more days to reach up the surface when seeds were placed at depth due to high soil strength that developed above the seedling and resulted in delayed emergence and hence, reduced crop stand. Genotypes with longer coleoptiles improved the plant's ability to emerge from greater depths in lesser time. 37.5% of the genotypes which took lesser days for emergence (10, 7.3 days) under deep sowing, possessed long coleoptile length (6.37cm, 4.10cm) respectively. A perfect negative linear relationship existed between coleoptile length and days taken to emergence (r=-0.22) in deep sowing while in normal sowing, there was weak correlation between these two variables (r= 0.15). Morphological attributes under deep sowing such as plant height (75.62cm) and length of first internode (6.74cm) were found to be at par with normal sowing (82.25cm and 6.23cm respectively). Also, 1000-grain weight and grain yield for all cultivars under deep sowing (51.42g, 249.57g) commensurate with normal sowing (53.39g, 255.21g) and differ significantly at P<0.01%.

PA-50

Effect of combined presence of NaCl and anthracene on antioxidant enzymatic activities of *Cicer arietinum* L.

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Due to rapid industrialization and ever increasing anthropogenic activities, numerous persistent organic pollutants (POPs) are released into the environment. One class of such pollutants are Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are mutagenic, carcinogenic, immunosuppressant, genotoxic in nature, hence becoming pollutants of great concern. Anything released into the environment ultimately finds their way into the soil, adsorbing onto the soil particles and eventually entering into the plants. Being ubiquitous in nature, PAHs are present in saline soils also. Salinity is one of most significant abiotic stress affecting plant yield and development to a great extent. Combined presence of PAH and Salt may have synergistic or antagonistic affects in plants. The present research aims to study the combined effect of Anthracene (PAH) and NaCl on antioxidant enzyme activities of two chickpea genotypes viz. GPF2 and PDG4. The experiment was conducted in growth pouches for 21 days. Different concentrations of NaCl and Anthracene was given to the plant alone as well as in combinations and various antioxidant enzyme activities viz. Catalase, Peroxidase, Superoxide Desmutase, Ascorbate Peroxidase, Glutathione Reductase, Glutathione S-transferase and ɣ-ECS were estimated spectrophotometrically. Results indicated that antioxidant enzyme activity was higher in chickpea genotype PDG4 as compared to GPF2 indicating that PDG4 was sensitive to the combined presence of NaCl and Anthracene while the chickpea genotype GPF2 was tolerant.

PA-51

Growth and antioxidant system under moisture in chickpea

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The investigation was undertaken to evaluate morpho-physiological parameters, level of osmolytes and activities of anti-oxidative enzymes by withholding irrigation at pre- and post-flowering growth stages in field. A significant decrease amongst all the genotypes for physiological parameters *viz*., photosynthetic rate, transpiration rate, stomatal conductance, chlorophyll index and RLWC under moisture stress at pre- and post-anthesis stages under field condition over unstressed control was observed. The tolerance of ICC 4958, Vijay and Phule G 0752 seems to be the result of equilibrium between many physiological parameters *viz*., stomatal conductance, photosynthetic and transpiration rate and RLWC ensuring plant growth under stress. The high proline accumulating genotypes, ICC 4958, Vijay and Digvijay also exhibited the higher accumulation of glycine betaine under PEG 6000 induced osmotic stress. A similar trend of osmotic accumulation observed even at pre- and post-flowering crop growth stages under field condition. The lowest decline in relative leaf water content was observed in tolerant types than susceptible types under stress condition. The activities of antioxidative enzymes such as superoxide dismutase, catalase and ascorbate peroxidase were significantly higher in the leaves of tolerant than susceptible genotypes. The genotypes ICC 4958, Vijay, Digvijay and Phule G 0752 recorded higher antioxidative enzyme activities as compared to other genotypes under field condition. Among the tested genotypes, Vijay, ICC 4958, Digvijay and Phule G 0752 maintained higher growth, yield and yield traits showing their tolerance to water stress, while Phule G-0305-3, ICCV 11117, Phule G-405-44-2 were adversely affected both for growth traits and yield as well.

PA-52

Role of coleoptile length in emergence from deep sowings in wheat

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In arid or semi-arid regions, deep sowing allows growers to make use of soil moisture, but the short coleoptiles of semi dwarf wheats or other varieties reduce emergence when sowing at depth. This study was aimed to evaluate the variation in coleoptile length in diverse set of wheat genotypes at optimum growth temperature under control conditions. Further, the germplasm was evaluated in field under deep sown conditions for emergence and other morphological and yield attributes. The genotypes having smaller coleoptile would take more days to reach up the surface when seeds were placed at depth due to high soil strength that developed above the seedling and resulted in delayed emergence and hence, reduced crop stand. Genotypes with longer coleoptiles improved the plant's ability to emerge from greater depths in lesser time. 37.5% of the genotypes which took lesser days for emergence (10, 7.3 days) under deep sowing, possessed long coleoptile length (6.37cm, 4.10cm) respectively. A perfect negative linear relationship existed between coleoptile length and days taken to emergence (r=-0.22) in deep sowing while in normal sowing, there was weak correlation between these two variables (r= 0.15). Morphological attributes under deep sowing such as plant height (75.62cm) and length of first internode (6.74cm) were found to be at par with normal sowing (82.25cm and 6.23cm respectively). Also, 1000-grain weight and grain yield for all cultivars under deep sowing (51.42g, 249.57g) commensurate with normal sowing (53.39g, 255.21g) and differ significantly at P<0.01%.

PA-53

Evaluation of drought tolerance at seedling stage in chilli

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Drought tolerance of twenty three genotypes of chilli belonged to *Capsicum annuum, C. frutescens*, and *C. chinense* species was evaluated at the time of seedling emergence. Evaluated genotypes comprised of landraces, released varieties and F_1 hybrids. Drought was induced artificially using 12 per cent PEG-6000 solution and genotypes were evaluated for root length, shoot length, seedling length and tolerance index. Root length ranged from 0.500 to 6.050cm with a mean of 2.582 in normal condition. In drought, root length range narrowed from 0 to 3.70cm with a mean of 0.530. Genotypes viz., S14, Arka Lohit, S15, Vellayani Samrudhi and SC7 had high root length in drought stress. These genotypes could be used as root stocks in drought condition. Shoot length ranged from 0.375 to 5.325cm with a mean of 1.721 in normal condition. In drought, shoot length range reduced from 0 to 3.050cm with a mean of 0.417. In drought condition, genotypes viz., S14, SC 7, S15, Vellayani Samrudhi and Keerthi had high shoot length. Seedling length ranged from 0.930 to 9.330cm with a mean of 4.303 in normal condition, where as it ranged from 0 to 6.75cm with a mean of 0.947in drought. Genotypes viz., S14, SC 7, S15, Arka Lohit and Vellayani Samrudhi generated high seedling length in drought. Genotypes viz., S14, Keerthi, Arka Meghna, Arka Lohit, SC7, S15, Arka Haritha and S19 expressed high tolerance index. S14 and Keerthi had tolerance index of >1 indicating their suitability towards water stress environment. Arka Meghna, Arka Lohit, SC7, S15, Arka Haritha and S19 had tolerance index from 0.381 to 0.552 indicating their similar growth pattern in normal as well as in water-stress environment. Genotypes with better performance in drought at seedling stage could be utilized for further evaluation studies at field level.

PA-54

Quercetin a plant derived flavonoid in plant physiology and development

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Flavonoids are a very unique class of hydroxylated phenolic compounds having an aromatic ring structure. Quercetin is a special subclass of these flavonoid. It is a bioactive natural compound built upon the flavon structure nC6 (ring A)-C3(ring C)–C6(ring B). Quercetin have the potential to regulate several plant physiological processes, such as seed germination, pollen growth, antioxidant machinery, and photosynthesis, as well as it induces proper plant growth and development. Moreover, the quercetin is a powerful antioxidant; hence it potently provides plant tolerance against several biotic and abiotic stresses. This flavonoid has a major role in increasing several physiological and biochemical processes under stress and non-stress environments. Additionally, it also play crucial role in mitigating biotic and abiotic stresses (e.g., salt, heavy metal, and UV stresses). This compound also plays an important role in plant development via interfering with Auxin and ABA signaling mechanism.

PA-55

Influence of leaf thickness and stomatal frequency on water use efficiency in rice

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Rice is the staple crop for the human population. Uneven rainfall and frequent droughts due to climate change bring the necessity to adopt aerobic cultivation. Water use efficiency (WUE) is one of the important physiological traits that needs to be improved. WUE is a complex trait controlled by both photosynthesis and transpiration. Furthermore leaf thickness and stomatal density are critical for these traits. To evaluate the influence of leaf thickness and stomatal density on WUE, an experiment was conducted in summer 2021 at UASB. Plants were maintained at two water regimes at the phenomics facility at our centre i.e., well-watered (100%FC) and water-limited (60%FC) conditions. Leaf thickness was measured in terms of specific leaf weight (SLW) and stomatal frequency was determined using the imprint method. Parameters such as leaf area, cumulative water transpired (CWT) and biomass were measured. The constituent physiological traits of WUE viz., net assimilation rate (NAR), mean transpiration rate (MTR) and WUE were computed. The relationship between leaf area and WUE was strong (R^2=0.6). Some lines differed significantly for WUE at a given leaf area. NAR was key determinant of WUE under both control (R^2=0.5) and stress (R^2=0.4) conditions. Under water-limited conditions, leaf thickness played a major role in determining WUE, whereas under well-watered conditions stomatal frequency was found to be critical. The reduction in mesophyll conductance in thicker leaves might be compensated by having many stomata.

PA-56

In vitro screening protocol for variability in root traits among the panel of rice germplasm lines

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One of the major threats torice productivity, under changing climatic conditions and depleting water resources, is drought stress. Though aerobic cultivation helps to save water, it comes at the cost of yield. Efforts are being made to identify traits to improve the productivity under water limitation. Under drought, improving root traits for efficient water mining as well as higher water use efficiency to maintain productivity are a few viable options. To improve root traits there is a need to screen for variability in length, weight, thickness and other anatomical characters. Studying seedlings in small containers *in vitro* may not provide conclusive information regarding root characters such as length, area and architecture at the initially growth phases of rice. Therefore, we designed a method to grow seedlings in larger containers in “gellan gum” media. This system also provides an option to assess root growth response to water stress through the use of polyethylene glycol (PEG) or any other osmotic substances. Images of roots recorded frequently provides an option to assess root growth rates in large number of accessions. A suitable software has been developed to estimate many other root architecture traits. Lines with better root growth at early stages will be able to establish quickly and can produce more biomass even when drought occurs at a later stage. Further, a field experiment with the same lines should provide the complete information regarding root growth.

PA-57

Enigmatic root traits as a half-hidden avenue to drought tolerance

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Leaf production of Mulberry, the only source of food for Silkworm (*Bombyx mori*) seems to constrain silk production in India. Among various stresses, drought is the major constraint effecting mulberry foliage production and its quality. In recent years, scientists have become eloquent in their knowledge of how above-ground plant parts adapt to drought. But, the quest of what happens below-ground, is yet to be unveiled completely. The root system is regarded as the "half concealed path" of plant growth and development as it is the prime trait to access water and nutrients. Furthermore, roots may operate as water-deficit sensors, sending signals to above-ground shoots. Therefore, studying variation in root traits to capture variability will be useful in improving foliage production adapted to abiotic stress conditions. In the present study, root traits, as actuated under irrigated conditions in root structure. Relationship between morpho-physiological parameters like root biomass, total dry matter (TDM) and total leaf area were measured. The result suggests that both leaf area and root biomass contribute to total biomass. The wide genetic diversity was depicted among mulberry accessions for root traits, SCMR, stomatal frequency, SLA and leaf area. The root traits might predict the plant's elastic feedback response under drought conditions. This study forms the phenotypic basis for discovery genes/QTL for important root architectural traits. These genes and markers can be effectively deployed to improve mulberry leaf production through molecular breeding. Enhanced leaf production even under rainfed condition would significantly impact silk production in India.

PA-58

Mitigation strategies for abiotic stress in crop plants to combat the effect of climate change

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Climate change is a serious threat to agriculture reducing the crop yields and productivity which will in turn affect the food security and balanced environment. The effect of climate change imposes abiotic plant stress like drought, elevated CO_2, extremely low and high temperature stress, waterlogging, rainfall and sunshine intensity. A significant rise in the temperature and shift in precipitation due to climate change over time will result in reduced rainfall, wind speed and snow cover which leads to a reduced length of growing season of the crop, affect the quality of the produce, disturbs the plant metabolism and photosynthesis, occurrence of plant nutrient deficiency or toxicity symptoms, reduced soil quality resulting in salinity and alkalinity and production of gaseous pollutants such as ozone, sulphur dioxide etc. The development of new plant species and crop varieties through genetic engineering and molecular marker-assisted breeding techniques, which can adopt to the adverse climatic conditions is the major interest for the scientists to combat the effect of climate change. The simple agronomic practices such as adjusted sowing dates, organic and inorganic nutrient management and efficient irrigation supply and application of phytohormones, signalling and trace elements and osmoprotectants can reduce the effect of stress on crop plants. The introduction of plant-growth-promoting rhizobacteria (PGPR) which are associated with plant roots also mitigate the impact of abiotic stresses on plants. Use of precision tools such as nano-sensors and other sensing devices provide information regarding the optimal time for crop sowing and harvesting and facilitate the timely application of various agrochemicals.

PA-59

Influence of nocturnal on water use efficiency (WUE) of rice

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Global climate change, especially in view of severe changes in precipitation pattern, is posing a great threat for the agricultural sector, mainly for semi aquatic crops like rice. Therefore reducing water requirement of rice has paramount significance. This approach is all the more important to harness the water saving advantage of aerobic cultivation. But significant yield reduction is often noticed when rice is cultivated under "aerobic" condition. Decreasing water requirement without decreasing yield potential is an extremely important strategy which can be achieved by improving WUE. Understanding the influence of unproductive water loss which occurs during night time is therefore most crucial. Based on extensive phenotyping at the drought stimulator platform, four contrasting genotypes differing in total transpiration were selected to understand the influence of nocturnal transpiration on WUE. Interestingly, two genotypes showed high WUE despite high night transpiration. Diurnal and nocturnal gas exchange measurement were made at hourly interval revealed that genotypes that show a predawn raise in transpiration recorded higher WUE and had higher growth rates. In contrast, genotypes with lower nocturnal transpiration though had higher WUE were not associated with better growth rates. This study forms a basis to examine the benefits of nocturnal transpiration on carbon gain.

PA-60

Phenology and crop-weather relationship of chickpea under changing weather scenarios in the northern dry zone of Karnataka

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A field experiment was conducted to study the phenology and crop-weather relationship of chickpea in the Northern Dry Zone of Karnataka during *Rabi* 2020-21 at RARS, Vijayapura, Karnataka. The experiment was laid in a split-plot design consisted of four sowing dates *viz*., 1st fortnight of October, 2nd fortnight of October, 1st fortnight of November and 2nd fortnight of November in main plots and three genotypes *viz*., JG-11, BGD-111-1 and JG-14 in subplots. The result indicated that sowing early in the 1st fortnight of October took more days to attain phenophases and observed better growth and yield attributes than delayed sowings. The accumulated growing degree days (GDD, 1388 ^{o}C day) and helio-thermal units (HTU, 10313^{o}C day hrs) were higher in early sown crops and decreases with delay sowing resulted in lower yield. The total dry matter and its distribution, biochemical parameters (SPAD and RWC), growth parameters (leaf area, leaf area index) recorded significantly under 1st fortnight of October. The GDD showed a positive linear response with total dry matter production (r=0.93) and seed yield (r=0.77). In conclusion, the genotype JG-11 and BGD-111-1 performed better under the normal sown condition during the 1st and 2nd fortnight of October to achieve higher productivity and profitability, while the genotype JG-14 was thermo-tolerant and most suitable for delayed sowing condition (2nd fortnight of November).

PA-61

Mitochondrial antioxidative response to osmotic stress in chickpea

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Chickpea is generally grown on residual soil moisture in winter that affects various metabolic processes of the plant. Drought stress alone causes 40-50 per cent reduction in yield globally. The plant mitochondria are involved in some metabolic processes implicated in cell adaptation to abiotic stresses. The seeds of chickpea genotypes *viz*., Vijay (drought tolerant); JG-11 and JG-24 (drought susceptible) were grown in pots containing sand under light. After 9 days seedlings growth, plants were divided into two groups, control and (-0.8 Mpa) osmotic stress treatments. The osmotic stress was created by irrigating pots with PEG-6000 solution. The osmotic potential of stressed group was decreased at the rate of-0.2 Mpa at 2 day interval from 9th day to 15th day progressively to achieve-0.8 Mpa osmotic potential. Mitochondrial fraction of 15 days old seedlings of control and osmotically stressed chickpea genotypes were analysed for antioxidative activity and isozyme patterns. Mitochondrial antioxidative enzyme activity was significantly increased in all the three chickpea varieties under osmotic stress condition. Vijay recorded maximum increase in SOD and CAT activity followed by JG-11. JG-11 recorded maximum increase in APX activity of 37.59 per cent. Two SOD isozymes (Mn-SOD and Cu/Zn-SOD) are detected in mitochondrial fraction of all three varieties under both control and osmotic stress condition. Four APX isozymes of mitochondrial fraction were detected in all varieties under osmotic stress condition, from which only three isozymes were observed under control condition. Thus, mitochondrial located antioxidative enzymes alleviate moisture stress in chickpea.

PA-62

Variations in morphological and grain characteristics of rice exposed to heat stress under irrigated conditions

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Climate change has drastically affected the global rice crop and overall food security in the world. Combined effects of elevated temperature and carbon dioxide have posed a risk for future rice production. The present work investigates the effect of heat stress on rice variety Swarnabh grown under irrigated conditions (locally known as *Boro*). A pot experiment was conducted with rice plants grown inside transparent chambers. The plants were exposed to different levels of heat treatment during tillering (21 to 49 DAT), panicle initiation (56 to 63 DAT), flowering (63 to 77 DAT) and grain filling (84 DAT) stages. There was a control (T1) in ambient temperature with no chamber or heat treatment. The high temperature treatments given in the other chambers were T2 = ambient temperature + 1°C; T3 = ambient temperature + 2°C; T4 = ambient temperature + 3°C; T5 = ambient temperature + 4°C. Morphological characteristics like plant height, leaf number and tiller number were recorded weekly. Panicle length, number of fertile tillers per pot and percentage of filled grains per panicle were recorded at harvest. Statistical analysis of the data with SPSS revealed that there were significant differences in all the studied variables among the treatments except for panicle length. Although plant height and leaf number was found to be lower in control, it recorded a greater number of tillers compared to the heat stressed plants. Significantly greater number of fertile tillers, filled grain percentage and grain yield was recorded in control compared to the heat stressed plants.

PA-63

Evaluation of rice germplasm for anaerobic germination

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Anaerobic germination is an important trait for direct seeded rice (DSR). Asrice is the only cereal exhibiting some degree of tolerance to anaerobic conditions during germination (AG) by way of coleoptile emergence and partial growth. The main reason for low germination under anaerobic condition is poor crop stand in DSR. So the present investigation was conducted to find out the effect of anaerobic condition in different rice cultivars. The experiment was laid out in complete randomized design in artificially constructed submergence tanks at central soil salinity research institute, Karnal during kharif season 2020. Out of 40 genotypes, 15 genotypes were not germinated and remaining genotypes were selected to study the trait based on parameters namely germination percentage, seedling length and vigor index. The pre result on this research revealed that genotype CSR 2748-271 is superior with respect to germination percentage, seedling length and vigor index. This genotype could be used as a parent to introduce anaerobic germination tolerance in to improved cultivars to utilize under direct seeded conditions.

PA-64

Candidate gene expression profiling in contrasting groundnut genotypes differing in moisture stress adaptation

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Drought or water deficit stress is one of the main environmental stresses and a major constraint to the productivity of many crops affecting various physiological and biochemical processes. 70% of Groundnut is largely cultivated as a rain-fed crop and hence the crop is exposed to intermittent moisture stress resulting in reduced productivity and crop loss. Therefore, there is a need to tolerate drought stress by maintaining superior water relations maintain water relations such as better water mining by water use efficiency (WUE) and water conservation traits to sustain the growth under moisture stress conditions. The present study compared the differences in physiological parameters: relative water content (RWC), canopy temperature, cell membrane leakage, photosynthesis, transpiration, stomatal conductance and water use efficiency at different water regimes (100% FC (control), 50% FC and 25% FC). Biochemical attributes; viz. chlorophyll, protein and proline content were also recorded at varied water regimes. Tolerant genotypes exhibited significantly higher RWC and lower cell membrane leakage at the end of stress induction period than the sensitive genotypes. The gas exchange traits viz., photosynthetic rate, stomatal conductance and transpiration rate also recorded high in tolerant genotypes under stress conditions. The differential expression pattern of seven candidate drought responsive genes were analysed in moisture stress tolerant (Kadiri-9 and TCGS-1694) and sensitive (Kadiri-6 and JL-24) groundnut genotypes. Quantitative reverse transcription PCR analysis revealed stress responsive nature of the selected genes. The relative expression pattern of the seven selected drought responsive genes were normalized against Elf-1. Among the seven genes, *HSP 17.9* showed the highest transcript accumulation in all the genotypes under drought stress condition and the relative expression of the gene was higher (10.7 folds) in the tolerant genotypes compared to the susceptible types followed by *HSP 60*, *PRP 2* and *LEA 5* genes. The differential expression of these important drought responsive genes in tolerant genotype of groundnut indicates its further usefulness in developing varieties with improved drought stress tolerance.

PA-65

Canopy temperature depression as an effective physiological trait for drought screening in common bean

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Water stress is a major production constraint in common beans. Current strategies of high throughput phenotyping are hindered by poor or inconsistent correlations and multiple mechanisms involved. Among the huge list of above-ground traits that can be used to screen genotypes for water stress tolerance, canopy temperature depression has emerged as a potential surrogate given its easy to record, fast data collection, substantial natural variation in crops, its correlation with root's ability to acquire water from the soil as well as its correlation with yield. Based on the experimental findings two types of ideotype models based on CTD have been proposed as isohydric ("water-saving") and anisohydric ("water spending"). The isohydrics have an advantage in harsher environments, whereas the anisohydrics perform better under moderate/mild drought situations. Water savers have a shallow root system with intermediate root growth and thin roots. They are early and have high water use efficiency, reduced transpiration, and limited leaf area and canopy biomass development, and superior photosynthate remobilization to pod and grain. Contrary to this, water spenders have a vigorous and deep rooting system with rapid root growth and a thicker root system. Such genotypes are early and have highly effective water use, moderate transpiration, and fast leaf area and canopy biomass development, moderate sink strength, and superior photosynthate remobilization to pod and grain formation. This paper discusses the potential role of CTD as an effective surrogate for high throughput water stress screening in common bean under field and greenhouse conditions.

PA-66

Variability in stomatal traits captured in rice accessions using high through-put phenomics

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The major factor affecting productivity in agriculture is climate change. The reduced allocation of water for agriculture adds to this drawback. Most of the capillary water is lost by transpiration process and stomata are the key driving force of transpiration. The variability existing in the stomatal characters within the species enable the plants for adapting to new environments. In this study, 150 rice accessions with similar phenology for flowering were screened for variations in stomatal characters such as stomatal frequency and stomatal size during the *kharif* 2020 in the phenomics facility. The stomatal frequency varied from 30.96 to 65.38 per 0.33 mm^2 microscopic area, while the range of stomatal size was between 483.54 µm to 1525.71 µm. Although, the variability in stomatal frequency was high, most genotypes with highest cumulative water transpired (CWT) had stomatal frequencies of 40-50 stomata per mm^2microscopic area. For the same range of stomatal frequency, there was considerable differences in water use efficiency (WUE) because of the variation in the stomatal size. Similarly, most genotypes with highest biomass were also found to have a stomatal frequency of 40-50. This implies that stomatal frequency along with the stomatal size plays an important role in regulating WUE of rice accessions.

PA-67

Physiological indices, phenological characteristics and evaluation of chickpea genotypes response to different sowing dates

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To manage sowing date based on optimal compatibility to the environmental condition a split plot experiment with three replications was carried out in the Northern Dry Zone of Karnataka during *rabi* 2020-21. Four sowing dates (1st fortnight of October, 2nd fortnight of October, 1st fortnight of November and 2nd fortnight of November) in main plots and three genotypes (JG-11, BGD-111-1 and JG-14) in subplots were studied. According to analysis of variance results, grain yield, yield components and biological yield were significantly affected by sowing date, genotypes and interaction effect. The first sowing date (1st fortnight of October) had maximum grain yield (1913 kg ha^{-1}) and after it other sowing dates showed decrease in amount (7.2, 15.2 and 20.96% respectively). First sowing date was superior in physiological index as compared to the other sowing dates. JG-11 genotype, due to the fact that it had a higher leaf area index (1.52), total dry matter (18 g $plant^{-1}$) and maximum grain yield, was seen to be the most adaptable genotype. The result indicated that sowing early in the 1st fortnight of October took more days to attain phenophases and observed better growth and yield attributes than delayed sowings. Finally according to the results of the present work, sowing of the chickpea genotype JG-11 and BGD-111-1 performed better under the normal sown condition during the 1st and 2nd fortnight of October, while the genotype JG-14 was thermo-tolerant and most suitable for delayed sowing condition (2nd fortnight of November).

PA-68

Chitosan: a versatile biomolecule for abiotic stress management in crops

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Agriculture production and productivity are vulnerable due to abiotic stresses. These stresses adversely affect the plant growth, development and crop yield all over the world. Only 9% of the world's agriculture area is conductive for crop production whereas 91% is under stresses which occur in combinations. While losses to an extent of more than 50% of agricultural production occur due to abiotic stresses .In recent years, advances in physiology, molecular biology and genetics have greatly improved our understanding of crops response to these stresses and the basis of varietal differences in tolerance whereas, currently the most of people relay on the applications which are practically effective, cheaper and environmentally safe. Chitosan is a natural biopolymer modified from chitins which act as a potential biostimulant and elicitor in agriculture. It is non-toxic, biodegradable and biocompatible which favors potentially broad application. It enhances the physiological response and mitigates the adverse effect of abiotic stresses through stress transduction pathway via secondary messing. Chitosan treatment stimulates photosynthetic rate, stomatal closure through ABA synthesis; enhances antioxidant enzymes via nitric oxide and hydrogen peroxide signaling pathways, and induces production of organic acids, sugars, amino acids and other metabolites which are required for the osmotic adjustment, stress signaling, and energy metabolism under stresses. It is also known to form complexes with heavy metals and used as tool for phytoremediation and bioremediation of soil. Besides, this is used as antitranspirant compound through foliar application in many plants thus reducing water use and ensures protection from other negative effects. Based on such beneficial properties, chitosan is utilized in sustainable agricultural practices owing to changing climates forcrop improvement programs.

PA-69

Screening of wheat varieties for drought tolerance based on morpho-physiological and biochemical traits

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Drought stress is the most commonly occurring event among all the abiotic stresses and has a discernible effect on physiological, morphological, and biochemical processes of the wheat that occur at any growth stages. Drought is a menacing factor for wheat productivity in important wheat growing zones of India. Physio-biochemical characterizations were done in seven NWPZ timely sown wheat varieties and two checks at seedling stage. The experiment was done in pots in completely randomized design with three replications for each genotype under controlled condition. Genotypes were grown for twenty-one days under controlled lab conditions. Watering was stopped 30 days after germination for 1 week to simulate drought condition. CCI, CFL, RWC, root and shoot weight were significantly reduced under drought stress, whereas proline content, OP and MSI were increased in drought-treated plants. There was significant increase in the activities of CAT, POX, MDA and APX under stress conditions. In this study a tolerance matrix was prepared based on the stress responses of genotypes for each trait and final tolerance score was given to each genotype. Based on relative variations in tolerance score, genotypes DBW88, PBW343 and NI5439 were identified as tolerant, HD3086, WB2 and WL711 as susceptible. DPW621-50 and HD2967 as moderately susceptible and DPW621-50, DBW17 and HD2687 as moderately tolerant to drought stress. Hence, this study information is useful in wise selection of genotypes for sowing in NWPZ based on weather forecast of the location for creating varietal mosaic in context of climate change under drought stress.

PA-70

Physiological responses of wheat associate with heat tolerance

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This study was performed to explore heat stress tolerance indices that can judge terminal heat tolerance genotypes from nine wheat genotypes viz; AKAW 5023, AKAW 4927, PBN 4905, PBN 4751-02, NIAW 3523, NIAW 2891, AKAW 4210-6 (C), NIAW 34 (C), NIAW 1994 (C) at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MH) during rabi 2016-17 and 2017-2018 growing season. The trial was setup in RBD design with 3 replications. Yield and Physiological traits were recorded and correlated with yield. Genotype NIAW 2891 noted significantly more germination%, CTD (4.30^{o}C), minimum membrane thermo-stability index (48.86%) at 75 DAS (grain filling stage), exhibited more RGR (0.0074 g g^{-1} day^{-1}), NAR (0.0500 g dm^{2} day^{-1}), early 50% flowering (58.16 days), days to maturity (91.83 days) and more grain yield ha^{-1} (35.65 q/ha) than other genotypes followed by genotype NIAW 3523 (33.83 q/ha) during both the year of sowing and noted as heat tolerance genotypes and best check AKAW 4210-6. Correlation analysis showed that yield under stress environment had positive significant correlate with days to 50% flowering and physiological maturity however, canopy temperature and membrane thermo-stability index had negative significant correlation with yield. Hence, due emphasis should be given to these attributes for genetic improvement in wheat under heat stress condition.

PA-71

Dissecting the sub components of water use efficiency by combining phenotypic and haplotype diversity through GWAS in Rice

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Changing climate being a major cause for the depletion in water resources is becoming a global threat for the cultivation of crops. Rice, the most important staple cereal in India, is an extremely water intensive crop consuming more than 50% of all the fresh water used in agriculture for irrigation. Therefore, it's important to go for the cultivars with high Water Use Efficiency without compensating the yield. Physiologically WUE is the ratio of biomass to water transpired. Stomatal conductance (g_s) that controls diffusion of CO_2 and water vapour, determines both carbon assimilation and transpiration. In genotypes where stomatal factors regulate WUE, a yield loss is normally encountered. Whereas, if the differences are caused predominantly due to chloroplast carbon assimilatory capacity or increased photosynthetic rate, selection for high WUE would also associate with improved crop growth rates. With this background, a set of 150 accessions from 3 k panel were selected based on the similar phenology and allelic variations present in 35 major genes controlling subcomponents of WUE. These 150 accessions were extensively phenotyped using Mini lysimeter based phenomics platform under control (100% Field capacity) and Stress condition (60% field capacity). The results revealed, some of the genotypes selected for High Water Use efficiency were due to high Net Assimilation Rate (NAR) indicating that Photosynthetic capacity of these genotypes were higher at any given g_s. This study forms a basis to identify some of the donor lines for high WUE without compensating the yield under water limited conditions.

PA-72

Effect of different soil types on biochemical constituents, yield and quality of lemongrass

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The variations in biochemical contents, yield parameters and essential oil characteristics in two varieties of lemongrass (CIM-Shikhar and CIM-Krishna) under different soils were studied. Along with soil calcareousness other soil characteristics like cation exchange capacity, sodium absorption ratio of different soils impacted lemongrass varieties and they differed significantly in their herb and oil yield, proline content, lipid peroxidation, nitrate reductase activity and major and minor constituents of essential oil. The herb and oil yield of lemongrass significantly decreased with an increase in soil calcareousness from 8.00% to 15.20% however, the extent of decrease in yield was lower for the variety CIM-Shikhar than CIM-Krishna. The total citral content in the essential oil was highest for the variety CIM-Krishna (85.12%) grown in clay loam soil and lowest in CIM-Shikhar variety (68.15%) grown in sandy loam soil. The free proline content and lipid peroxidation status of both lemongrass varieties grown in sandy loam and clay loam soil was significantly higher as compared to other two soil types, whereas nitrate reductase activity decreased in varieties grown in sandy loam and clay loam soil.

PA-73

Salicylic acid mitigates salt stress by regulating level of antioxidant enzymes in chickpea

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The investigation was carried out with chickpea genotype HC-3 grown under different levels of salinity (0 and 4 dSm^{-1}) in the screen house of Department of Botany and Plant Physiology, CCS HAU, Hisar, Haryana during *rabi* season of November, 2018-19. Salicylic acid (SA) of different concentrations (0, 25, 50, 75 and 100 ppm) was applied to chickpea plants grown under non-saline and saline conditions. Sampling was done at 7 days after spray. Salt stress inhibited growth and biomass yield of chickpea plants. Reactive oxygen species (ROS) are produced in both unstressed and stressed cells. Antioxidant defense system in plants was composed of a number of enzymes and antioxidant substances. The activities of antioxidant enzymes such as SOD (from 1.59 to 4.86 unit mg^{-1} protein min^{-1}), CAT (from 0.58 to 4.36 unit mg^{-1} protein min^{-1}) and POD (from 2.687 to 5.033 unit mg^{-1} protein min^{-1}) increased at 4dSm^{-1} with respect to their control in chickpea plants. On the other hand, exogenous application of salicylic acid of different concentrations to salinized plants enhanced the activities of examined antioxidant enzymes such as SOD (from 4.86 to 7.61unit mg^{-1} protein min^{-1}), CAT (from 4.36 to 7.03 unit mg^{-1} protein min^{-1}) and POD (from 5.033 to 7.030 unit mg^{-1}protein min^{-1}) and enhancement was more with 100 ppm at 4dSm^{-1}. Thus, our study demonstrates that exogenous supply of salicylic acid (i.e. of 100 ppm) is effective in mitigating salt stress in chickpea plants by enhancing the biosynthesis of antioxidant enzymes.

PA-74

Assessing the effects of cold stress on chickpea

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Chickpea is the 2nd most important legume crop after common bean and an economically beneficial protein-rich food legume. It is a cool season crop and its reproductive phase coincides with low temperature (<10°C) that causes flower drop and unfilled pods leading to poor yield. Therefore, in the present study, we have evaluated four chickpea genotypes (ICC 16348, ICC 16349, GPF-2 and PBG-1) having contrasting sensitivity towards cold stress (average day temperature: 17.6°C; average night temperature: 4.9°C) at their reproductive phase. Two genotypes (ICC16348 and ICC16349) showed flowering and pod set, while other two cold sensitive genotypes (GPF-2 and PBG-1) failed to do so during the stress conditions indicating the former to be cold tolerant. Apart from this, cold stress led to some vegetative aberrations besides damage to the reproductive stage. On the whole, pollen development at young microspore stage appeared to be severely affected in sensitive genotypes as compared to the tolerant genotypes. Pollen viability and stigma receptivity were reduced in sensitive genotypes as compared to tolerant genotypes; *in vivo* pollen germination and pollen tube growth were more inhibited in sensitive than tolerant genotypes. Fluorescent studies showed no pollen load on stigma and inhibited pollen germination on its surface in cold sensitive plants. Mostly, the pollen tubes were impaired in their growth and did not reach the ovules leading to failure in fertilization. Biochemical parameters associated with carbohydrate metabolism were also evaluated in these contrasting genotypes and it was analyzed that activity of sucrose synthase and starch content in cold tolerant genotypes was more than that of cold sensitive genotypes. On the other hand, the content of reducing sugars was more in cold sensitive genotypes as compared to cold tolerant genotypes.

PA-75

Assessment of mungbean genotypes for heat tolerance

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High temperature stress is one of the major limiting factors for the plant growth and development. It has various negative impacts on almost each stage of plant growth starting from seed germination to pod setting. These impacts eventually lead to drastic reduction in yield and productivity of agricultural crops. Mungbean is an important summer-season short duration food-legume that consumed world-widely for its higher nutritional values. The optimum temperature for growth and development of mungbean is 28-30°C; increase in temperature beyond these limits especially during reproductive phase, significantly confine its yield performance. Therefore, a study was conducted to investigate the impacts of heat stress (>40/28°C) during reproductive growth on mungbean genotypes and to explore mechanisms related with thermotolerance. For this purpose, forty one mungbean lines were screened by growing them under outdoor environment conditions at two sowing times (1) in march, the normal sowing time (temperature during reproductive stages <40/28°C) (2) in April, the late sowing time (heat stress; temperature during reproductive stage >40/28°C. Under late sown conditions, plants showed various symptoms of leaf rolling, scorching, reduced leaf area, chlorosis, necrosis, membrane damage and chlorophyll damage compared to normal sown plants. Also, accelerated phenology and significant reduction in biomass, total pods/plant and total seed weight/plant were recorded. In the present study, few promising heat tolerant genotypes were identified (EC693357, EC693358, EC693369, Harsha and ML1299) that would not only serve as effective donor for breeding programs but also provide insight toward heat stress induced effects on cellular metabolism and their mitigation mechanisms.

PA-76

Variation in anaerobic enzymes and formation of aerenchyma in roots of waterlogged sesame genotypes

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Sesame, the queen of oilseeds often falls prey to unpredictable rains. Root hypoxia created by waterlogging results in shift in aerobic respiration to anaerobic fermentation. Lactate dehydrogenase, Alcohol dehydrogenase and Pyruvate dehydrogenase are the important enzymes in anaerobic respiration. In this study 8 sesame genotypes were screened for tolerance to waterlogging at vegetative stage by imposing 72 hr waterlogged condition. Lactate dehydrogenase (LDH), Alcohol dehydrogenase (ADH) and Pyruvate decarboxylase activity (PDC) were estimated from roots at the end of waterlogging period. The most tolerant and susceptible genotypes were examined for the presence of aerenchyma in root which is an important mopho-physiological adaptation for waterlogging. The results revealed that 4 genotypes recorded less than 45% survival percentage (CO 1, Thilatara, AT231, TMV4), whereas other 4 genotypes recorded more than 70% survival (*Sesamum malabaricum*, Ayali, Thilarani, SVPR 1). In the genotypes CO 1, Thilatara and AT231, LDH enzyme activity was increased whereas in Ayali, Thilarani, *S. malabaricum* and SVPR 1 increase was noted in the activity of ADH and PDC. This indicate that lactic acid fermentation is predominant in susceptible genotypes whereas alcoholic fermentation is predominant in tolerant genotypes. Root anatomical study in the sesame genotypes *S. malabaricum* (Tolerant) and CO1 (Susceptible) revealed the presence of aerenchyma in the tolerant genotype. The tolerant genotypes can be further utilized in breeding programmes.

PA-77

Conventional and indigenous phenotyping tools to assess drought responses of chickpea genotypes

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Changing climate is one of the major causes of recurrent occurrence of abiotic stresses such as drought that adversely affects sustainable production of food grains including pulses. Chickpea is an important pulse crop of semi-arid region, which is highly prone to drought. Hence drought tolerant varieties that carry drought tolerant traits are highly essential. Screening diverse genotypes for such traits is crucial for identifying promising ones that can serve as parent lines for developing drought tolerant cultivars. By keeping this as main objective, an experiment was conducted at farm of ICAR-NIASM, Malegaon, in year 2020-2021. In this experiment, 32 chickpea genotypes with standard check variety – Digvijay, were screened for drought. Drought stress was imposed 60 DAS by withholding irrigation. Growth as well as physiological responses of chickpea genotypes to drought was monitored periodically by employing various screening tools such as infra-red thermography, NDVI and chlorophyll fluorescence imaging system. In addition, indigenous field phenomics tool was employed to monitor ground cover and leaf senescence pattern. Results revealed that genotypes – GNG 1958, JG-16, BGM 408 maintained their canopy cooler than check variety under soil moisture stress. Genotypes like Pusa Green 112, BGM 408, GNG 1958 and Digvijay maintained their canopy greenness even under stressful conditions

PA-78

Melatonin alleviates drought stress in finger millet by improving membrane stability and plant water status

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Drought stress is considered as the most devastating abiotic stress that impairs the stability of cell membranes and plant water status, hence, photosynthesis and other metabolic processes are severely affected which lead to drastic reduction in yield in food crops. Finger millet is an important food crop after cereals and it is grown extensively in the rainfed areas because of its adaptive characters. But, the yield potential observed to be low than the actual potential due to drought that occurs during critical stages of the crop. Alleviation of effect of drought through plant growth regulating compounds is one of the options to sustain the yield of finger millet growing extensively under drought prone areas. Melatonin is one such compound, acts as an antioxidant and promotes the tolerance of plant against abiotic stresses. To assess the efficacy of melatonin in ameliorating the consequences of drought in finger millet, an experiment was laid out with four treatments *viz.,* irrigated control, drought control, drought with melatonin treatment and drought with 0.2 ppm brassinosteroids, each with three replications under pot culture condition. Separate set of plants were maintained for imposing vegetative (35-40 DAS) and reproductive stage (55-65 DAS) drought by withholding of water for a period of 10 days. The melatonin @ 60 μM was given as foliar spray at 3 days after the imposition of drought, when the plant water status (RWC) reduced to below 90%. Melatonin treatment had significantly influenced the traits related to the cell membrane stability like MDA, electrolyte leakage and activities of catalase, superoxide dismutase, ascorbate peroxidase. Also, melatonin application helps to maintain high plant water status under drought condition by regulating the stomatal conductance, enhancing the osmotic potential, osmotic adjustment and relative water content and thereby photosynthetic activity.

PA-79

Identification of drought tolerance in maize genotypes based on phenological, physiological, biochemical and yield traits

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Drought is one of the major abiotic stress that severely influences productivity of maize crop, especially when it occurs during the reproductive phase. A field experiment was conducted with four maize (*Zea mays* L.) genotypes under controlled (well water, WW) and drought stress (water deficit, WD) imposed at the initiation of tasselling stage. The impact of WD stress on phenological, physio-biochemical and yield parameters was quantified to compute drought tolerance indices. The results revealed that among the four maize genotypes, drought stress significantly increased Anthesis Silking Interval (ASI) of M-24 by 4.6 days and significant decreased Anet (50.3%), gs (69.2%), Tr (58.5%). While the genotypes M-22, DTL-4-1 and Harsha showed better tolerance to drought stress as compared to M-24 as WD stress triggered significantly higher accumulation of proline and lower malondialdehyde (MDA) content and increased activity of SOD in these genotypes might have enabled them to maintain better cell membrane stability (CMS) revealing that these genotypes possess inherent genetic makeup to overcome the stress impacts and imparting stress tolerance. These genotypes were also identified as drought-tolerant genotypes with low yield fluctuations based on drought tolerance indices namely geometric mean productivity (GMP), mean productivity (MP) and stress tolerance index (STI). These identified maize genotypes are better suitable to cultivate in drought prone areas and identified traits are useful in crop improvement programs to develop drought tolerant cultivars.

PA-80

Effect of imidacloprid and cyantraniliprole pesticides on soil enzyme activities in grapes rhizospheric soil

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Extensive use of pesticides in the grape ecosystem may alter the dynamics of microorganisms and can change the biochemical properties of soil. Changes in enzymatic activity within the bacterial population shows that pesticide application significantly affected distribution of bacteria. Objective of the present study was to assess the effect of imidacloprid and cyantraniliprole pesticides on soil enzymatic activity in the grape rhizospheric soil. Organic soil from the grape rhizosphere was fortified with 1, 10, 50 mg/kg dose of pesticides along with control were imposed under controlled conditions. Pesticide residues in fortified soil at different time intervals were analyzed by LC-MS/MS. Also the enzymatic activity of acid and alkaline phosphatases, ureases and dehydrogenases was assessed using a spectrophotometer. LC-MS/MS analysis showed that residues of the pesticides dissipated non-linear persisting up to 60 days in the soil. In case of enzymes, dehydrogenase activity was significantly increased up to 20 days in imidacloprid compared to control with highest in 50 mg/kg treated soil; whereas cyantraniliprole showed negative affect. Acid phosphatase showed significantly higher activity in 1 mg/kg treated soil and was negatively affected in higher cyantraniliprole treated soil; in imidacloprid, negative effect was observed in all treatments up to 30 days. Alkaline phosphatase showed a negative effect for up to 20 days in imidacloprid and was positively correlated in the long run at higher dose. A negative correlation was observed for alkaline phosphatase at higher dose for cyantraniliprole. There was no significant effect on urease activity in imidacloprid treated soil; however, a negative effect was observed up to 30 days in case of cyantraniliprole.

PA-81

Residual effect of boron and salinity on growth and biochemical parameters of green gram

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Abiotic stress like salinity deteriorates plants process. Once salinity or boron toxicity develops in field, their effects persist to subsequent crops. The salinity prone areas are generally associated with micronutrient toxicity/deficiency, but there level critically regulate plant growth and development and nutrient use-efficiency. Boron is such an element of this category, in sodic and saline sodic soils, toxicity of boron is a common feature. Green gram is a common pulse crop grown in India during *kharif*. In this study, different doses of B and NaCl were applied during *rabi* to wheat crop in pots. After harvest of wheat, during subsequent *kharif* green gram was sown in these pots. When different levels of B and NaCl applied to wheat during *rabi* had significant residual effects on morphophysiological and biochemical parameters of green gram grown in the subsequent *kharif* season. On the basis of present investigation it is known that different levels of or boron (B) or Sodium chloride (NaCl) stress, when applied individually or in combination, significantly affects the plant growth and development. It is, therefore, suggested that in soil which are moderately saline or boron is present in higher amounts in soil or applied for maximizing wheat production during *rabi*, in the subsequent *kharif* season green gram cultivation may be avoided, as it may reduce its production and productivity.

PA-82

Effect of polyethylene glycol on pigeon pea genotypes for drought tolerance at early seedling stage

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Pigeonpea is an important pulse crop widely consumed in India. Water stress at early growth stage effects the morphological and physiological functions in Pigeon pea seedlings. Five Pigeon pea genotypes were evaluated for the genetic potentiality to drought tolerance at seedling stage. The genotypes were subjected to three osmotic stress level (0.5, 1 and 2 per cent PEG 6000) and control (distilled water) for early screening. The results indicated that the germination percentage decreases as the PEG concentration increases in the same manner average root length and average shoot length decreases among the genotypes listed. At higher concentration of PEG germination percentage ranged from 40-90 under controlled condition. Among the genotypes RGKA-1 has shown highest germination percentage (95%) and lowest germination percentage (40%) was observed in genotype Asha at 2 per cent PEG 6000. RGKA-1 has shown highest average shoot length of 9cm followed by BDN-711 (4.1cm) and Asha shown lowest average shoot length (3.4cm) at 2 percent concentration. RGKA-1 has shown highest average root length (12.3cm) followed by Asha(6.3cm) and BDN-711 shown lowest average root length (6.1cm) at 2 percent concentration. Genotype RGKA-1 at 1% PEG recorded the germination percent (95%), average shoot length (7.7 cm) and average root length (12.8 cm) indicating higher genetic potential ability to perform better under higher osmotic stress compared to other genotypes. The experiment concluded that genotype RGKA-1 found more superior in morpho-physiological traits compared to other genotypes and can be used in further breeding programme for drought tolerance.

PA-83

Morpho-physiological aspects of chickpea genotypes under salt stress

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Salinity is one of the major abiotic stress limiting growth and productivity of agriculturally important crops like chickpea in many areas of the world. Chickpeais one of the important leguminous crops, which is sensitive to salinity. The experiment was designed to study the effect of salinity on morpho-physiological parameters of chickpea genotypes (GNG 1581, C 235, HC 5, HC7 and CSG 8962). The Chickpea genotypes were grown in plastic pots filled with 10 kg of yellow dune sand. After 15 days of sowing, the plants were irrigated with saline water of 0, 6 dSm^{-1} and 9dSm^{-1} prepared by mixing the salts viz. NaCl, $MgCl_2$, $MgSO_4$, and $CaCl_2$ in appropriate ratio. The morphological and physiological changes were recorded at vegetative state (50 DAS) and days of 50% flowering. It was observed that under salinity stress, number of branches/plants, plant height, plant fresh and dry weight decreased gradually in all genotypes with increase in salinity levels from 0 to 9 dSm^{-1} coupled with the decline in total chlorophyll content, relative water content (RWC) and electrical conductivity (EC). Out of four genotypes tested, genotypes C235 and GNG 1581 proved to be sensitive towards salinity whereas CSG 8962, HC 5 and HC 7 were comparatively tolerant to high level of salinity stress.

PA-84

Response of plant growth regulator AVG and ethrel on physiochemical attributes in wheat for stay-green traits under high-temperature stress

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Post-anthesis high-temperature stress is a major concern for wheat in India. Stay Green (SG) is a beneficial trait with a delayed senescence rate and acts as a key indicator for plant adaptation. To study the mechanism of heat tolerance, three wheat genotypes, BWL 5391, WH 1124, and HTW 64 selected from field studied from the 2018-19 crop season were grown in the net house during rabi 2019-20. Genotypes were analyzed for the effect of ethrel (ethylene source) and AVG (ethylene inhibitor) on various physio-biochemical attributes for the stay-green trait. Biochemical and physiological studies such as Proline, MDA, Free Radical Scavenging Activity, SCMR (SPAD chlorophyll meter reading), canopy temperature, plant height, and grain yield per plant were recorded under late and very late sown environment. Foliar application of AVG (2 ppm) and Ethrel (10 ppm) was given at heading stage. Proline, Free radical scavenging activity, SCMR, and grain yield were found significantly higher in BWL 5391, which is a slow senescing and stay green genotype, indicating the protecting role in heat tolerance. Foliar application of Aminoethoxy vinyl glycine (AVG) has shown increased proline, free radical scavenging activity and grain yield whereas MDA content decreased in all three genotypes under both environments. Foliar application of ethrel has shown a decrease in proline, free radical scavenging activity and yield in all genotypes. This suggests that by extending the duration of active photosynthesis as observed by retaining chlorophyll content based on SCMR at the reproductive stage in wheat, an increase in yield can be attained improving the physio-biochemical status of the plant under high-temperature stress.

PB-85

Induction of systemic acquired resistance in rice by fruit extracts of *Azadirachta indica* Juss. against sheath blight disease

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Sheath blight of rice caused by *Rhizoctonia solani* is a common and destructive disease leading to serious economic yield losses all over the world. Induced resistance by elicitors is considered to be an eco-friendly strategy to stimulate plant defence against pathogen attack. In this study, we elucidated the effect of fruit extracts of neem [both 50% aqueous leaf extract (ALE) and 50% ethanolic leaf extract (ELE)] on induced resistance in rice plants against *Rhizoctonia solani* inciting Sheath blight and evaluated the possible defence mechanisms involved. Plant samples were pre-treated with neem fruit extracts followed by challenge inoculation after 48 hours of spray. The data on disease severity, no. of lesion per plant, lesion length and relative lesion height were recorded. Fresh samples were collected at 12 hour interval starting at 0 hour of pathogen inoculation till 168 hours post inoculation for quantification of enzymatic activity and biochemical defence mechanism. Spraying of crude fruit extracts led to a significant reduction in disease incidence and disease severity on the leaves in addition to a significant decline in the lesion length and lesion count. Our findings suggested that the elevated H_2O_2, CAT, POD, PPO, PAL and TAL activities, lignin, endogenous SA contents which could potentiate the resistance in rice against sheath blight. The results showed that after the treatment, the enzyme activities of all the defence-related enzymes increased to a certain level even without pathogenic infection in comparison with non-treated plants. Consistent with the occurrence of induced resistance, the pronounced increase in total soluble proteins, chitinase and beta 1,3-glucanase activities were observed. The ELE of neem showed better induction effect than ALE.

PB-86

Impact of elevated temperature and elevated CO_2 on the biochemical composition of maize and in turn its effect on the demography of maize fall armyworm

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In recent years, overall agriculture has been influenced by climate change *viz.,* increased temperature and CO_2concentration, which in turn have effects on insect-plant interactions. Experiments were undertaken to study the life history of fall armyworm *Spodoptera frugiperda* in maize at elevated temperature and elevated CO_2 concentrations under Open Top Chamber (OTC) and Soil Plant Atmosphere Research (SPAR) system, respectively. Five levels of temperature (32°C, 33°C, 34°C, 35°C and 36°C) and carbon dioxide (430 ppm, 460 ppm, 490 ppm, 520 ppm and 550 ppm) were maintained. Biochemical analysis of maize leaves revealed that with increase in temperature and CO_2 concentrations, there was increase in carbohydrate, protein, proline, phenol, tannin and carbon content but reduction in C: N ratio, vitamin C and chlorophyll content. But nitrogen content diluted with increased CO_2 concentrations. The age specific survivorship of fall armyworm decreased with the progress of age at elevated temperature and CO_2 concentrations. The increased fertility and population outburst were recorded upto 34°C and 490 ppm. The rise in temperature and CO_2 concentrations above the ambient environmental condition directs to variation in demography of insects through biochemical changes in the host plant maize.

PB-87

Salicylic acid and Selenium a coordinative player in mitigation of high temperature induced-photosynthetic inhibition, oxidative stress, yield and fruit quality of tomato

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The increasing threat of climate change has had deleterious effects on crop yields, and the increased temperature is expected which triggers global food shortage in near future. Salicylic acid (SA) and selenium (Se) plays a key role in regulating plant growth and development. So the present study was designed to study the ameliorative role of SA and Se in tomato under low temperature stress conditions. At 20-days after sowing seedlings of tomato var. S-22 (high temperature-sensitive) and PKM-1 (high temperature tolerant) were transplanted in earthen pots, and at 20 days after transplantation (DAT), plants were exposed to varying levels of high temperatures (35/28 or 40/35 °C or 25/18 °C) for 24 h in a growth chamber. At 30 DAT plants were treated with 10-5 M of SA via foliar spray and 10 µM of Se applied via soil and after 40 DAT plants were assessed for several physio-biochemical and stress attributes, while fruit quality attributes were assessed at 160 DAT. High-temperature stress reduced the photosynthetic potential, chlorophyll content and induce an adverse effect on root morphology, stomatal behavior, chloroplast organization, decreased viability, fruit quality, and yield attributes in both varieties of tomato. Besides this high temperature increased the proline and SA content, lipid peroxidation, electrolyte leakage, and reactive oxygen species (ROS) level. However, application of SA and Se under serene and stress conditions significantly enhanced the photosynthetic potential, antioxidant activities, chlorophyll, proline and SA content, but decreased the electrolyte leakage, ROS content, and lipid peroxidation.

PB-88

Phenological development of chickpea in scarce rainfall zone of Andhra Pradesh

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The phenological development of chickpea (*Cicer arietinum* L) was studied in Regional Agricultural Research Station, Nandyal using sowing dates 1st fortnight of October (D1), November (D2) and December (D3) during 2018-19 and 2019-20. Phenology data showed that among the genotypes, days taken to attain different phenological stages and total duration were differed significantly by changing the date of sowing. The crop duration to attain physiological maturity ranges from 87.3 to 101.0 days. Among the dates of sowing, 1st fortnight of October (D1) sowing recorded more number of days for maturity, followed by November (D2) sowing and lowest in December (D3) sowing. The variation in number of days to attain maturity can be due to the effect of GDD, HTU and PTU during the crop growth period. At 50% flowering to first pod phenophase, 1st FN of November (D2) sowing recorded significantly higher GDD (312.5 °C day), HTU (2312.5 °C day) and PTU (3537.7°C day) compared to D1 and D3 sowings and have influenced higher flower to pod ratio. Similarly higher GDD was recorded in 1st FN of November (D2) sowing compared to D1 and D3 sowing during first pod to physiological maturity and have influenced heat use efficiency in terms of pod filling ability. Ensuring relatively large sink (pods) quantity could also contribute to improved yield under increasing ability of heat energy utilization during critical phenophases of crop growth.

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PB-89

Potentiality of *Trichoderma* isolates as biocontrol agent against *Pythium myriotylum,* cause soft rot disease in ginger

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Ginger (*Zingiber officinale Rosc.*) is an economically important crop grown for its aromatic rhizomes, widely used as spice and also for herbal medicines. The productivity of this spice crop is being hampered by various diseases and pests. Among the serious diseases, fungal soft rot is considered as a major problem which negatively affect on productivity of the crop. The soft rot is being reported from almost all the states of India, wherever this crop is grown commercially. Various species of *Pythium* found to be reported as causative agent of the disease, and the most important and common species identified as *Pythium myriotylum*. The uses of agrochemicals are needed to be used in fields for better and reasonable yield from crops. Since the produce obtained from ginger plants being consumed directly as spice and medicine, the use of inorganic agrochemicals in the fields should be discouraged due to their hazardous impacts on the environment and consumer. The use of inorganic and hazardous pesticides being found decreased under modern agriculture and biological control is found as an alternative for the same. In the present study, various isolates of *Trichoderma* tested against the notorious soft rot pathogen, *Pythium myriotylum*, under laboratory conditions for their interactive effects as parasitism, antibiosis and hyphal interactions. From the preliminary investigations, it was revealed that, five *Trichoderma* isolates, under 3 species, such as *T. asperllum* (T1&T5), *T. virens* (T2& T3), *T. ressei* (T4) showed significant effect as growth suppressor, against the pathogen *Pythium myriotylum.*

PB-90

Functional characterization of *CYP81B140* and *CYP81B141* enables to understand their involvement in the plumbagin biosynthetic pathway from *Plumbago zeylanica* L.

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Plumbago zeylanica L. (plumbaginaceae) is a medicinal plant traditionally used in various treatments like skin disorders, neuroprotective agent, hepatoprotective, cardiotonic etc. Its potent anti-cancerous property endows its importance in the drug development. Previous study from our lab on leaf and root transcriptome identified the candidate genes involved in the plumbagin (5-hydroxy-2-methyl-1,4-naphthoquinone) biosynthesis. The cytochrome P450 superfamily genes involved in catalysis of various reactions such asoxidation, hydroxylation, epioxidation etc from various secondary metabolite biosynthetic pathways. Docking analysis of *CYP81B140* and *CYP81B141* suggests that 3-methyl-1-8-napthalenediol and isoshinalone act as intermediates for plumbagin biosynthesis. The 3-methyl-1-8-napthalenediol undergoes oxidation at C1 position and hydroxylation at C4 position to form isoshinanolone furthermore isoshinanolone undergoes oxidation at C4 position to form plumbagin. The *CYP81B140* and *CYP81B141*might have role in the above steps of plumbagin biosynthesis. Artificial amiRNA mediated transient silencing and co-silencing experiment was carried to understand function of both CYPs. Individual silencing of *CYP81B140*showed that down regulation of *CYP81B140* but up regulation of *CYP81B141* and vice versa with little reduction in plumbagin accumulation. However, co-silencing experiment showed down regulation of both the genes with the 50% reduction in plumbagin accumulation and 40% increase in 3-methyl-1,8-naphthalene-diol and isoshinanolone content. This experiment demonstrates the functional redundancy of both the CYPs.

PB-91

Sources of nitrogen allay cadmium phytotoxicity in Indian mustard by modulating N-metabolism and antioxidant response

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The potential of four soil-applied sources of nitrogen [N; 100 mg N kg^{-1} soil (100N) and 200 mg N kg^{-1} soil (200N)] in the form of potassium nitrate, urea, ammonium nitrateand calcium nitrate in the reversal of 200 cadmium (Cd, 200 mg Cd kg^{-1} soil) induced oxidative damage and photosynthetic and growth inhibition of Indian mustard (*Brassica juncea* L. cv. Giriraj) were studied. Based on observed growth and photosynthetic response,200N level was considered as more effective than 100N. N applied to soil mitigated negative impacts of Cd200 on N-assimilation, cell viability and photosynthetic functions with a lower electrolyte leakage, lipid peroxidation, and the contents of reactive oxygen species (ROS: hydrogen peroxide, H_2O_2; superoxide anion, $O_2^{\bullet-}$). Generally, the mustard plants supplied with various N sources exhibited a higher activity of antioxidant enzymes (superoxide dismutase, ascorbate peroxidase), increased contents of ascorbate (AsA), reduced glutathione (GSH) and their regenerating enzymes (dehydroascorbate reductase and GSH reductase), as well as rise in enzymes of N-metabolism, biosynthesis of non-protein thiol (NPT) and phytochelatins (PCs). Compared to the other N-sources tested herein, ammonium nitrate more prominently protected *B. juncea* cv. Giriraj against Cd-impacts by restraining Cd-accumulation and its root-to-shoot translocation; reducing membrane damage and cellular ROS, accumulating osmolytes like proline and improving Cd-chelation (NPTs and PCs), thereby strengthening the defence machinery against Cd. The study provides insights into the mechanisms of how ammonium nitrate favors plant growth and development, as well as design an effective agronomic strategy for the management of N supply also in Cd-contaminated agricultural soils.

PB-92

The alleviation of sodium chloride toxicity by the application of gibberellic acid in Indian mustard

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Salt stress, particularly sodium chloride (NaCl) stress in the soil, is a common environmental threat to agriculture. It adversely affects the plant physio-biochemical processes that eventually reduce plant growth, development and productivity. To cope with such adverse conditions, an exogenous application of plant growth regulators could play an important role. Gibberellic acid (GA_3) is one of them and regulates various plant responses to abiotic stress. A randomized pot experiment was performed to investigate whether the foliar application of GA_3 could alleviate NaCl toxicity in Indian mustard (*Brassica juncea* L. cv. Pusa Agrani). Four levels of NaCl (0, 50, 100 and 150 mM) were applied to the soil at 20 days after sowing (DAS). Foliar application of 5 µM GA_3 was performed at 50 and 70 DAS. Plants receiving NaCl treatment were sprayed with deionized water separately for comparison (control). The data revealed that increasing levels of NaCl decreased plant biomass, leaf chlorophyll and net photosynthetic rate, while increased hydrogen peroxide, superoxide anions and malondialdehyde contents in a dose-dependent manner. The application of GA_3 improved plant resistance to NaCl by increasing plant biomass and photosynthetic efficiency. The foliar spray of GA_3 also reduced NaCl mediated osmotic and oxidative stress injuries by improving leaf proline, glycine betaine and relative water content and activities of catalase, peroxidase and superoxide dismutase. It may be concluded that the exogenous application of GA_3 ameliorates the adverse effects of NaCl stress to a great extent.

PB-93

Improvement in growth, photosynthesis and enzyme activities of *Brassica juncea* L. by the foliar application of sulphur

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A factorial randomized pot experiment was conducted to evaluate the effect of leaf applied sulphur (S) on growth, photosynthesis and enzyme activities of three cultivars of Indian mustard (*Brassica juncea* L.). Five level of leaf applied S (potassium sulphate) viz. 0, 40, 80, 120 and 160 ppm constituted one variant and three cultivars (Chuutki, Nath Sona and Rohini), the other. Seeds of cultivars were sown in pots each filled with four-kilogram mixture of sandy loamy soil and farmyard manure in the ratio of 4:1. The levels of S were sprayed twice, first at 50 and second at 70 days after sowing (DAS). There were four replicates for each treatment. The parameters were studied at 90 DAS. Data revealed that increasing levels of S up to 120 ppm improved all parameters studied. The highest level of spray (160 ppm S) was either toxic or less effective than 120 ppm S. Cultivar Nath Sona followed by Rohini and Chuutki performed best. Of interaction, 120 ppm S × Nath Sona proved best. This interaction increased shoot length by 17.61%, area per leaf by 37.94%, fresh weight by 60.99%, dry weight by 67.35%, chlorophyll SPAD value by 26.92%, net photosynthetic rate by 55.62%, nitrate reductase and carbonic anhydrase activities by 12.91 and 46.97% and mineral nutrient (N, P and K) contents by 25.82, 20.26 and 34.27% respectively compared with 0 ppm S × Chuutki which gave the least value. It may be concluded that two sprays of 120 ppm S proved influential particularly for nath sona cultivar.

PB-94

Physiological investigations on growth and productivity of soybean under various seed rates and sowing methods.

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Soybean is called as wonder crop because of its essentiality in industrial sector due to good quality protein (35-40%) and oil (20%). Soybean is highly sensitive to soil moisture stress which creates unfavourable conditions for growth and reduces porosity, soil aeration, reduced root growth, unavailability of hormones to root and enhanced abiotic stress affecting the physiology of a plant adversely which reflects on the productivity. Our hypothesis is that by reducing the seed rate, seed yield and quality is enhanced due to better penetration of light and least damage of seeds due to disease infestation. For testing our hypothesis an experiment was conducted during the *kharif* season 2019 with Factorial Randomized Block Experimental Design by taking two factors of variation as treatment *i.e.,* three levels of seed rate (70 kg ha^{-1}, 60 kg ha^{-1}, 50 kg ha^{-1}), two levels of sowing method (Ridge & Furrow and Flat Bed method) in variety JS 20-98 with three replications. The study conducted reveals that the lower seed rate of 60 kg ha^{-1} is superior (15.85%) in terms of seed yield (g $plant^{-1}$). With respect to seed sowing method ridges and furrows sowing method is superior in terms of seed yield g $plant^{-1}$ (9.79%) , seed yield kg ha^{-1} (4.47%). The minimal increment of 2.05 %, 2.53% on days to flower initiation, days to 50% flowering was observed in 50 kg ha^{-1}. This might be due to lower plant density and better availability of light and radiation to the canopy in lower seed rates. For seed quality attributes, 60 kg ha^{-1} was found to be superior in enhancement of germination percentage (1.88%), seedling length (2.36%) over control (70 kg ha^{-1}). Ridges and furrows sowing method exhibited superiority for seed quality attributes in terms of enhancement in germination percentage (4.56%), seedling length (2.20%), vigour index I (1.46%), and vigour index II (3.0%).

PB-95

Expression dynamics indicate the role of Jasmonic acid biosynthesis pathway in regulating macronutrient (N, P and K^+) deficiency tolerance in rice

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Deficiencies of macronutrients (N, P and K^+) and consequent excessive use of fertilizers have dramatically reduced soil fertility. It calls for development of nutrient use efficient plants. Plants combat nutrient deficiencies by altering their root system architecture (RSA) to enhance the acquisition of nutrients from the soil. Amongst various phytohormones, Jasmonic acid (JA) is known to regulate plant root growth and modulate RSA. Therefore, to understand the role of JA in macronutrient deficiency in rice, expression pattern of JA biosynthesis genes was analyzed under N, P and K^+ deficiencies. Several members belonging to different families of JA biosynthesis genes (*PLA1, LOX, AOS, AOC, OPR, ACX* and *JAR1*) showed differential expression exclusively in one nutrient deficiency or in multiple nutrient deficiencies. Expression analysis during developmental stages showed that several genes expressed significantly in vegetative tissues, particularly in root. In addition, JA biosynthesis genes were found to have significant expression under the treatment of different phytohormones, including Auxin, cytokinin, gibberellic acid (GA), abscisic acid (ABA), JA and abiotic stresses, such as drought, salinity and cold. Analysis of promoters of these genes revealed various *cis*-regulatory elements associated with hormone response, plant development and abiotic stresses. These findings suggest that JA biosynthesis pathway by regulating the level of JA might control the RSA thus, it may help rice plant in combating macronutrient deficiency.

PB-96

Genome wide association study for grain micronutrient content and its regulation by nitrogen in rice

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The two biggest challenge of current crop research is dealing with micronutrient malnutrition, environmental and economic damage caused due to excessive use nitrogenous fertilizers. Billions of people is dependent on rice for their food but unfortunately rice grains contains very less micronutrients. Nitrogen status of crops has been proven to play a key role in mineral nutrient uptake, distribution, and accumulation in edible parts of plants, but use of large amount of nitrogenous fertilizer poses a severe threat to environment and also affects the production cost. Thus this study was planned to select rice genotypes accumulating high micronutrients in grain even under nitrogen deficit condition and decipher the QTLs associated with grain micronutrient accumulation of Cu, Fe, Mn, Mo and Zn under nitrogen sufficient and deficient condition by performing genome wide association study. The study was planned with 150 rice genotypes raised in greenhouse under two nitrogen levels. A significant decrease in micronutrient content of grain (brown rice) under nitrogen stress was observed, except for manganese. We identified potential contrast donors for micronutrient content in grain under control and stress conditions. The genotypes 384190 and BAM4797 were found to accumulate high zinc and iron under control condition while under nitrogen stress condition Safri-17 was accumulating high Zn and Fe. By genome wide association study we identified 51 QTLs (40 novel and 11 previously reported) for micronutrient content under control and 39 QTLs (29 novel and 13 previously reported) under nitrogen stress condition, further annotation of which will help to find putative candidate genes explaining mechanisms under grain micronutrient accumulation.

PB-97

Physiological alterations by application of silicon in *Vigna radiata* (L.) grown under salinity stress

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Salinity is the most dominant stress among various abiotic stresses, poses productivity challenges to worldwide agriculture system. Mungbean [*Vigna radiata* (L.) Wilczek] is an important leguminous crop with multiple benefits i.e, improving soil fertility, expansion of cereal based agro-ecologies, but mungbean is severely affected by the soil salinity which affects its critical growth stages. We investigated the effects of different levels and mode of application of silicon (Si) and salinity on some physiological traits in relation to yield of mungbean crop grown under screen house conditions. Treatments were comprised of two Si levels of foliar application (50, 100 mg/l; in the form of Sodium meta-silicate, $Na_2SiO_3.nH_2O$), and single level of silicon in soil as 50 mg/kg of soil with two levels of salinity (4 and 6 dSm^{-1}) were maintained in the pots. The experiment was arranged as a completely randomized design, with four replications. Increasing salinity level resulted in a significant decrease in plant height, relative water content (RWC), and chlorophyll fluorescence (F_V/F_M), whereas showed a marked increase in electrolyte leakage. These changes in physiological traits resulted in decreased seed yield due to decreased pod length and 100 seeds weight. Application of silicon either in soil or foliar mode enhanced the plant water status and membrane stability which resulted in the increase of yield and its attributes under salinity stress.

PB-98

Biochemical evaluation of *rabi* sorghum genotypes for shoot fly resistance

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Sorghum is grown in 86 countries covering about 42 million ha with an annual production of 7.4 million tonnes. India's contribution in sorghum is 24% in area and 16% in production of the world. In India, it is cultivated in an area of 11.5 m ha with a production of 11.08 m.t and a productivity of 950 kg/ ha. In the dry land agriculture, the yield and quality of sorghum produced is affected by a wide array of biotic and abiotic constraints. Around 150 insect pests attack sorghum of which sorghum shoot fly, *Atherigona soccata* is a serious pest that reduces sorghum production in the semi-arid tropics. The sorghum shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae), is economically an important pest of grain, forage and sweet sorghum in Asia, Mediterranean Europe and Africa. Due to shoot fly damage, a loss of 80–90% of grain, and 68% of fodder yield was recorded in India. The experiment was conducted at All India Co- ordinated Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar during the year2019-20. The experimental material consisted of 11 sorghum genotypes *viz;* RSV 1628, RSV 1023, RSV 1910, RSV 2371, RSV 1945, RSV 1838, RSV 2025, RSV 1918, RSV 1988, RSV 2391, RSV 1941, three varieties *viz.,* Phule Vasudha, Phule Revati, M-35-1, three shoot fly resistant checks *viz.,* RSV 1188, IS 18551, RSE 3 and a susceptible check *i.e*. DJ 6514Sorghum genotypes with high amount of total sugars were susceptible to shoot fly, while silica and polyphenol contents imparted resistance to shoot fly in resistant sorghum genotypes. Low levels of reducing sugars and total sugars seemed to enhance the degree of resistance to sorghum shoot fly. From the enzyme activity studies, it was observed that peroxidase and polyphenol oxidase activity in the affected resistant and susceptible genotypes were higher when compared with healthy plants respectively. Resistant genotype exhibited higher level of peroxidase and polyphenol oxidase activity as compared to susceptible genotype. The genotype RSV 1941, RSV 1945, RSV 2391, RSV 1988 exhibited higher chlorophyll content and soluble protein.

PB-99

Occurrence of *Pythium* species, causing soft rot infection in ginger, in Kozhikode district, Kerala, India

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Soft rot due to different species of *Pythium*is an important disease drastically affecting the cultivation of ginger all over the world. The present work was mainly aimed for conducting a detailed survey on the intensity of soft rot disease in ginger in different agro-ecological niches of Kozhikode district of Kerala, and also to isolate and identify *Pythium* associated with diseased samples. Seventy seven randomly selected ginger fields were surveyed for soft rot disease, out of which, thirty one fields found infected (percent of infected fields = 40.25%). Infected samples collected from these fields were brought into the laboratory for the isolation and identification of the pathogen, and also to prove their pathogenicity. Twelve *Pythium* isolates recovered from the samples, which could cause disease symptoms with a minimum of 30% disease severity, were identified based on morphology and further confirmed by molecular approach. Among them, *Pythium myriotylum* was the predominant pathogen followed by *P. delicense* and *P. splendens.*

PB-100

Impact of Salinity, moisture deficit, and combined stresses on the physiological response of chickpea (*Cicer arietinum*)

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Chickpea (*Cicer arietinum*) is an annual pulse crop with high economic and nutritional value and is grown during the rabi season in semi-arid tropical regions. Chickpea productivity has fallen in India and around the world due to a variety of environmental factors. Chickpea, like many other legumes, is very vulnerable to salinity and drought stress. CSG8962, a salinity-tolerant chickpea genotype, was grown hydroponically for two weeks before being subjected to various treatments: Control (C), salinity stress (S, 120mM NaCl), moisture deficit (MD), and dual stress (DS, Moisture deficit +120mM NaCl salinity). Leaf area, fresh biomass, dry biomass, root characteristics, photosynthetic pigment content, total soluble protein, and catalase enzyme activity were measured. Under DS, MD, and S, leaf area reduced by 55 %, 53 %, and 51.3 %, respectively. Total chlorophyll concentration dropped by 60% in DS, 50% in S, and 49.89% in MD. In DS, chlorophyll and carotenoid content decreased significantly, followed by MD and S, respectively. Moisture deficit treatment had the greatest drop in total root length, root surface area, and root volume, whereas DS had the smallest decrease. In MD, conversely, lateral root growth has increased by 4.27 percent, while lateral root growth decreased in S and DS. MD treatment resulted in a 62% rise in catalase activity in the roots and a 37% decrease in catalase activity in the shoots. The genotype under consideration (salinity tolerant) had better survival in salinity and moderate survival in drought stress. The stress effects on DS were substantial, as seen by the severe reduction in leaf area, biomass, chlorophyll content, root growth, and catalase enzyme activity. The close relationship between visual phenotypic analysis and recorded physiological measures indicated that the above-mentioned parameters were suitable for large-scale physiological screening of chickpea genotypes. In the future, further focus and extensive research of the physiological and molecular alterations in response to dual osmotic stress will be required.

PB-101

Water uptake, TE and canopy temperature variation in safflower genotypes under progressive soil moisture depletion

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Higher transpiration efficiency (TE) has been proposed as a mechanism to increase crop yields in dry environments where water availability usually limits yield. Safflower, an important oilseed which thrives under residual moisture in semi-arid conditions. Though, safflower is a drought adopted crop, a significant reduction in soil moisture levels impairs crop growth and productivity. A study was conducted to comprehend the variations in leaf hydraulics emphasizing on water uptake, transpiration efficiency and canopy temperatures under progressive soil drying condition. Significant variation was observed for normalised transpiration rate (NTR) under fraction of transpirable soil water (FTSW) at genotypic level. Genotypes ISF 764, GMU 2347 recorded minimum threshold values (0.37) for NTR, whereas GMU 3438 recorded highest (0.83). Higher transpiration efficiency of GMU 2347 indicates the genotype's ability to synthesize higher biomass under FTSW. Canopy temperature and SCMR are two traits that are highly associated with TE which was well established among the genotypes. Minimum canopy temperature depression (CTD) (-15.4 ^{O}C) was recorded in A1, followed by ISF 764 revealing their efficient soil moisture utilization. Understanding the minimum FTSW threshold at which NTR drops, CTD, SCMR and TE further be employed for safflower improvement. Our results suggested that genotypes A1, ISF 764 and GMU-2347 exhibited a late descend by maintaining transpiration under progressive soil water depletion; whereas genotypes 68-2 and CO-1 showed transpiration drop at early stages.

PB-102

Identification of terminal heat tolerant in wheat by physio-biochemical indices

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An experiment was conducted with six wheat genotypes Halna, PBW343, Raj 3765, K9006, NW4035 and HD2967 for evaluation of terminal heat tolerance during rabi season 2019-20. The wheat varieties exposed to heat stress by delayed sowing of 60 days from normal date of sowing so that reproductive stage of wheat could experienced severe heat stress. The wheat genotypes were evaluated on the basis of membrane stability index (MSI), chlorophyll stability index (CSI), canopy temperature depression (CTD) and grain protein profiling. The protein profiling of wheat grains showed altered banding pattern over control at grain filling stage. The wheat genotypes Halna, Raj 3765 and NW4035 showed high MSI, CSI and CTD over PBW 343, K9006 and HD2967 under terminal heat stress condition. The altered protein banding pattern Halna, Raj 3765 and NW4035 were noted while these bands in PBW 343, K9006 and HD2967 disappeared under heat stress condition. Halna, Raj 3765 and NW4035 also showed less reduction in yield and yield components comparatively over other genotypes due to membrane stability, stay green duration and high canopy temperature depression over other genotypes. Thus MSI, CST, CTD and protein profiling at terminal heat stress can be used as physiological indices for evaluating heat tolerant in wheat.

PB-103

Morpho-anatomical characterization of five major genera of Loranthacea

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Hemiparasitic plants of family Loranthaceae are major tree parasites. Apart from being a troublesome parasite they also serve as a linchpin reservoir supporting an extensive ecosystem. *Dendrophthoe falcata*, *Helicanthus elastica*, *Macrosolen capitellatus* are major hemiparasites infecting perennial crops of the plains of Kerala. *Helixanthera wallichiana* and *Taxillus tomentosus* are two important hemiparasites infecting the fruit and timber trees of the high ranges of Kerala. Hemiparasites possess a physiological structure called haustoria through which they abstract water and minerals from the host. Morpho-anatomical characters of representative species of the five selected genera *viz*., *D. falcata*, *H. elastica*, *M. capitellatus, H. wallichiana* and *T. tomentosus* were studied. Samples of these were collected from various locations from the plains and high ranges of Thrissur, Kerala. In all the selected species, leaves were oppositely arranged, *D. falcata* and *H. elastica* had oblong shaped leaves, leaves of *M. capitellatus* was lanceolate in shape, and *H. wallichiana* and *T. tomentosus* had narrow ovate shaped leaves. Fruit was berry in all the genera. Haustorial portions of the collected samples were treated and prepared to permanent slides. Anatomical sections of the haustoria of these genera revealed that there exists a transition zone between the host-parasite interphase region. This was observed as undifferentiated parenchymatous cells which aid in translocation of molecules. Presence of xylem elements were observed at the haustorial region. Results from further radio assay using ^{32}P indicated that there was bidirectional movement of nutrients from host to parasite and parasite to host through this interphase.

PB-104

Evaluation of different inoculation methods of siderophore producing *Bacillus* species for managing bacterial blight caused by *Xanthomonas oryzae* in rice plants

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Xanthomonas oryzae responsible for causing bacterial blight disease in rice plant causing tremendous damage to *Oryza sativa L.* The results showed 15 isolates out of 90 siderophore producing strains were positive for antagonistic activity against *X. oryzae*. The isolates CWTS5 and CWTS10 showed maximum inhibitory effect which were identified as *Bacillus tequilensis* and *B. wiedmannii* based on 16S rDNA sequencing. The quantification of siderophore production ranged from 89.02% to 92.54%, and indole-3-acetic acid 62.55 to 70.55 µg/ml by CWTS5 and CWTS10, respectively. The isolates also produced ACC deaminase in adequate amount and solubilized phosphate. The crude extract of siderophore from the isolates using methanol and ethyl acetate also showed inhibition of *X. oryzae* ranged from 10-12 mm byCWTS5 and CWTS10. Further, the crude siderophore extracts were subjected to FTIR (Fourier transform infrared) spectroscopy and LCMS (Liquid chromatography-mass spectrometry). The FTIR results showed a peak at different wavelengths, indicating the presence of functional groups of siderophores. LCMS analysis of positive and negative electrospray ionization revealed the presence of antimicrobial compounds in the siderophore extract. The *in vivo* application of bacteria and siderophore extracts showed that the disease incidence and disease severity index in terms of percentage was less in the soak method>inoculation method > spray method. Furthermore, the isolates also enhanced the plant growth of rice even in the presence of *X. oryzae*. This is the first report of *B. tequilensis* and *B. wiedmannii* effect on *X. oryzae*. Further field experiments are needed before being formulated as a biocontrol agent to manage bacterial blight caused by *X. oryzae.*

PB-105

Effect of seed coating and foliar spray of nano-fertilizers on productivity and seed quality attributes in wheat

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Deficiencies of macro-nutrients like zinc, sulphur, and phosphorous limit crop plants' growth and productivity and several metabolic activities. To cope with this problem in meeting the productivity targets of wheat, Nanotechnology (NT) is being visualized as a rapidly evolving field that can mitigate the problem of nutrient deficiencies. We hypothesize that Nano-seed coating will enhance field emergence and physiological efficiency leading to improvement in plant growth performance and yield. A research experiment was conducted in *Rabi* season 2020-21 at experimental farm of AICRP-National Seed Project-Seed Technology Research and Laboratory of Seed Technology Research Unit, College of Agriculture, JNKVV, Jabalpur. In order to test our hypothesis, ten various combination of seed coating and foliar spray of Nano-formulations of Zinc, Iron and Phosphorous were applied. From where, treatment T_5 (75% RDF (100% N/K with 75% P) + seed coating of nano P (phosphorus) @125 ml ha^{-1} (100%seed coating) in which there is a replacement of 25% of the recommended dose of phosphorous with seed coating @125 ml ha^{-1} stands superior in expression of maximum grain yield (40.72 q ha^{-1}), biological yield (64.91 g $plant^{-1}$) and Harvest Index (31.72%) over treatment T_2 (Check with an application of 100% of the recommended dose of NPK) (36.02 q ha^{-1}) with an application of 100% of P from conventional fertilizer. Treatment T_5 also stands superior in seed quality traits attributed to maximum field emergence (64.04%), germination percentage (96.2%), seedling length (28.13 cm), seedling dry weight (0.32 g), seed vigor index I (2707.8) and seed vigor index II (30.49).

PB-106

Physiological insights of drought tolerance with melatonin in rice

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Drought stress being a major constraint to rice production, particularly in water-limited environments has recorded a global crop yield loss of 18 million tonnes. Foliar application of plant growth regulators (PGRs) and nutrients is being employed increasingly as a management option in the recent years. Such a new compound to be explored for stress mitigation is melatonin. The role of melatonin in the mitigation of drought stress in rice is not much explored. Hence, the physiological and biochemical responses of melatonin sprayed plants under drought were investigated with rice variety CO 54. From the preliminary laboratory study, it was observed that among the different melatonin concentrations (0, 50, 100, 150, 200, 250µM), 200µM noted the highest germination per cent followed by melatonin @ 250 µM under polyethylene glycol (PEG) induced drought condition. Hence, these two concentrations were selected and given as foliar spray to the plants subjected to drought stress (with holding of water) in pot culture experiment. The observations of physiological parameters showed that, the foliar application of 200µM at panicle initiation and anthesis stages conferred drought tolerance by maintaining improvedgas exchange parameters. Also, stressed rice plants sprayed with 200µM melatonin recorded the highest values for drought tolerance indices such as relative water content, osmotic potential and osmotic adjustment during panicle initiation and anthesis stages. Plants subjected to foliar spray of melatonin had more fertile spikelets per panicle with comparable yield under drought stress. Hence, melatonin could be used an effective management technology for obtaining higher yield in rice.

PB-107

Nutrient analysis of soil samples from different villages of Gandhinagar, Gujarat

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Nutrient management is dependent on the collection and analysis of soil and plant samples for nutrient assessment. This study leads us to the conclusion of nutrient's quality present in soil of Gandhinagar district. The analysis of nutrient is done in order to measure the pH level, organic carbon, nitrogen, phosphorous and potassium that is present in the soil and it provides all the necessary information in order to set nutrient application. The results depends on quality of soil samples. The soil samples collected from different villages of Gandhinagar. The value of pH was observed from 6 to 7 EC and organic carbon in the range from 0.48 to 0.56 %. The availability of nitrogen was ranges from 152 to 248 kg/ha. The availability of phosphorous was ranges from 11 to 18 kg/ha and potassium content ranges from 231 to 318 kg/ha. In order to study the effect of phosphate fertilizer, phosphorous and application of nitrogen ti increase percentage yield of crops. This information will helps farmers to solve the problems related to soil nutrients, amount of which fertilizers to be used to increase the yield of crops.

PB-108

Biochemical changes in sugarcane germplasm clones in response to drought and waterlogging stress

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Ten sugarcane germplasm clones were evaluated for their responses to drought and waterlogging stress at formative phase. The experiment was completely randomised with two factors: genotype (G) and treatment (T). Plants were raised in plastic pots filled with 5 kg of potting mixture, withtwo single-budded setts in each pot, and nine pots for individual treatment (G×T). Pots in control were maintained at field capacity, while drought was imposed at formative phase by withholding irrigation for 15 days. Waterlogging was imposed by saturating the pots for 30 days. SPAD chlorophyll index reduced significantly under stress, with wide variation among the tested genotypes. Averaged over treatment, highest SPAD index was recorded in IK 76-166 (43.26), and Awela Green Sport (38.21), while Djantoer-1 (29.42) and Pansahi (24.56) had the least values. Nitrate reductase activity (NR) reduced significantly under drought (15%) and waterlogging (30%) as compared to control. Oshima, IND 85-490 and Djantoer-1 recorded higher activity of NR under stress, on par with that of control. Likewise, total soluble protein was higher inOshima, IND 85-490 and Djantoer-1 with minimum reduction under stress over control. Superoxide dismutase (SOD) activity reduced by 11% and 17% under drought and waterlogging, respectively; Djantoer-1 and Oshima recorded slightly higher SOD activity under stress. Peroxidase (POX) activity reduced significantly due to drought (36%) and waterlogging (42%), while catalase (CAT) activity reduced by about 27% under both stresses. Under drought, highest POX activity was observed in IK 76-99 (3.78), while Awela Green Sport recorded highest POX activity (2.31) under waterlogging. CAT activity was highest in IND 85-490 under drought (2.43) and waterlogging (2.44), whereas Pansahi showed about 20% higher CAT activity under stress over control. IND 85-490, PutliKhajee and IK 76-166 under drought and Djantoer-1, IND 85-490, PutliKhajee and IK 76-99 under waterlogging stress were recorded higher single cane weight under stress as well as control. Assessing the variability among the available germplasm for biochemical changes under stress is essential in order to identify traits and mechanisms imparting abiotic stress tolerance, for further use in conventional as well as molecular breeding programmes.

PB-109

Effect of different levels of soil applied copper on *Brassica juncea*: In terms of the morpho-physiological, photochemical, antioxidant response and phytoremediation ability at different growth stages

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Copper (Cu) is an essential micronutrient important for various metabolic processes in plants. upto certain threshold levels, it improves the plant growth and development, However its excess levels due to various anthropogenic activities, disturb and inhibits the normal growth in plants. The present study was designed to assess the impact of different Cu concentrations (30, 60, and 90 $mgkg^{-1}$) on *Brassica juncea* cv. Varuna plants. The experiment was conducted in a randomized block design, and various physio-biochemical, microscopic, histochemical parameters and phytoremidation potential were assessed at 30, 45, and 60 days after sowing. As evident from the results, Cu inhibits the overall growth of plants and the response was in a concentration dependent manner. The decline in growth may be correlated with the reduction in photosynthesis and related parameters, downregulation of nitrate reductase and carbonic anhydrase activity, as well as reduction in carbohydrate levels and nutrient status in treated plants. Moreover, Excess Cu levels, induced the oxidative stress by generating different reactive oxygen species and uplifting malondialdehyde content in plants, which directly upregulates the enzymatic antioxidants (catalase, superoxide-dismutase, and peroxidase) as well as non-enzymatic antioxidants (glutathione, proline). The maximum toxicity was reported in plants cultivated on Cu 90 mg kg^{-1} of soil. From the above findings, we conclude that the application of Cu reduced the growth, photosynthetic parameters, and biochemical parameters in *Brassica juncea* in all the concentrations.

PB-110

Effects of abscisic acid and nitric oxide on antioxidant system and osmotic adjustment to alleviate salinity inhibited photosynthetic potential in *Brassica juncea* L.

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The present study assessed the effect of abscisic acid and sodium nitroprusside (nitric oxide donor) in minimization of salinity impact on growth, photosynthetic efficiency, Rubisco activity, nitrogen and sulfur assimilation, oxidative stress (H_2O_2), lipid peroxidation measured as thiobarbituric acid reactive substances, (TBARS), osmolytes (Proline and Glycine betaine) content, and the activity of antioxidant enzymes (superoxide dismutase, SOD glutathione reductase, GR; ascorbate peroxidase, APX) in cultivar RH0-749 of *Brassica juncea* L. Plants were treated with 0, 100 mM NaCl, 25 µM ABA, 100 µM SNP, 25 µM ABA+100 µM SNP, 25 µM ABA +100 mM NaCl, 100 µM SNP + 100 mM NaCl, 25 µM ABA +100 µM SNP + 100 mM NaCl, 25 µM ABA +100 mM NaCl + 100 µM cPTIO and 100 µM SNP + 100 mM NaCl + 50 µM Flu. NaCl stress caused significant elevations in H_2O_2 and TBARS, and differentially modulated proline and glycine betaine content, the activity of antioxidant enzymes, and impaired growth and photosynthetic functions. The results showed that ABA/SNP treatment alone or in combination markedly alleviated the negative effects of salt stress. Further under salt stress, ABA in combination with cPTIO differentially abolished these protective effects of ABA. However, treatment with SNP in combination with Flu did not affect the SNP-induced protective effect against salt stress.

PB-111

Effect of sulphur in mitigating arsenic induced oxidative stress involved enhanced sulphur assimilation and antioxidant reponse

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Arsenic (As) pollution of the arable lands has become a serious concern across the globe for its potential to reduce global crop production by hampering plant growth and development. Among many stress-relieving substances, sulfur (S) is widely used macronutrient that is essential for plant growth and development in both physiological and stressed conditions. The current study was performed to evaluate the toxic effects of As (0, 100, and 200 µM As Kg^{-1} soil) on physiological and biochemical alterations in five *Brassica napus* cultivars (Neelam, Teri-Uttam Jawahar, Him Sarson, GSC-101, NUDB 26-11). The As toxicity inhibited the growth and photosynthetic indices of *B. napus* cultivars and this depletion being more evident in cultivar NUDB 26-11. *Brassica napus* cultivar Neelam was selected as the most tolerant cultivar among five cultivars (namely Neelam (Gobhi sarson), Teri Uttam Jawahar, Him sarson, GSC-101, NUDB26-11) formulated on noticeable reductions in growth and photosynthesis in plants exposed to 100 and 200 mg As kg^{-1} soil. Further to counter the As-induced impacts on *B. napus* cultivar, S in the form of elemental S in two doses i.e. (100 mg S kg^{-1} soil and 200 mg S kg^{-1} soil was supplied. Application of S particularly 200 mg S kg^{-1} to the soil alleviated the negative impacts and toxicity of As on growth and photosynthetic matrices of plants. Elemental S also exacerbated the antioxidant potential of plant, and with a lower lipid peroxidation, electrolyte leakage, and contents of reactive oxygen species (ROS: hydrogen peroxide, H_2O_2, and superoxide anion, $O_2^{\bullet-}$) in As affected plants. In general, 200 S more perceptibly increased the activities of antioxidant enzymes (ascorbate peroxidase, catalase and superoxide dismutase), non-enzymatic antioxidants like glutathione and ascorbate; and metal-chelators such as non-protein thiols and phytochelatins. Further, application of S to *B. napus* cultivar affected from As-induced toxic effects considerably intensified the endogenous hydrogen sulfide (H_2S) content and its regenerating enzymes L-cysteine desulfhydrase (LCD) and D-cysteine desulfhydrase (DCD)that further strengthened the defence capability plants to withstand As-stress. Our results suggest that H_2S is involved in S-induced defence operations of the *B. napus* plants. The current finding shows that elemental S might be used to promote the growth and development of *B. napus* plants cultivated in agricultural soil polluted with As.

PB-112

Qualitative screening of rice lines/germplasm/genotypes for endospermic iron content

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An experiment was conducted with 26 rice germplasm /lines/ genotypes for screening of high iron contain in grain. The Perl Prussian blue method was adopted for qualitative teat for iron contain in rice endosperm. The six rice lines were found high deep blue color in rice endosperm showing high iron content relative to other lines. These materials were further tested by triple acid test for further confirmations about endospermic iron contain and the same results were found on qualitative basis. These results need to further confirmation for exact quantitative test by more study in rice lines.

PB-113

Storability of black gram seeds as influenced by various packaging materials and storage conditions

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The experiment was conducted to know the influence of various packaging materials and storage conditions on the seed quality of black gram. The seeds of black gram were packed in cloth, gunny, high density polythene (HDPE), vacuum packed bag, and these packed materials were stored under ambient and cold storage (5 -7 ºC temperature with 60 ± 2 % relative humidity) for the period of 18 months. As the storage period progressed, there was bruchid infestation after 8 months of storage under the ambient condition in cloth, gunny, and HDPE bags only, while no infestation was seen to black gram seeds even after 18 months of the storage period in vacuum packed bags under both conditions. Due to bruchids infestation germination was reduced to below 20 per cent. Further, under cold condition, seeds stored in cloth, gunny, and HDPE bags were not maintained minimum germination as described by the Central Seed Certification Board (CSCB) at the end of the storage period. So, the vacuum packaging technology can be effectively used to extend the storage period of black gram without any aid of storage chemicals i.e., in a chemical-free environment. Hence, along with maintaining seed health for a longer time, a threat to the environment can be completely averted.

PB-114

Prediction of seed yield by using pod images in greengram

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Trait based crop breeding program requires phenotyping of large number of genotypes to facilitate identification of relevant gene with greater power of prediction. Yield and yield components are critical traits for improvement productivity crops including legumes such as Greengram. However, manual phenotyping is laborious, costly, time-consuming and error prone. Therefore, an attempt was made to develop and test high throughput phenotyping of pods and seeds of Greengram by imaging system that can be affordable and reliable. Imaging system was designed with cost effective materials like Polystyrene (Thermocol), background luminescent light source, and smartphone with high resolution camera. This system was used to acquire images of more than 300 pods and about 1500 seeds without any background noise. Images were analyzed by using Image J open source software. There was significant association between the manually measured pod length and the digital pod length as revealed by R^2 value of 0.99. Correlation analysis revealed that digital pod parameters extracted from images could explain the variation in the number of seeds per pod and also the manually measured seed weight per pod. Digital seed parameters i.e. perimeter, width and height were strongly correlated with number of seeds per pod ($R^2 > 0.93$); and seed weight per pod ($R^2 > 0.9$); Further, area, perimeter and length of the pods were closely related with digital seed parameters ($R^2 > 0.8$), seeds per pod ($R^2>0.7$) and seed weight per pod ($R^2 > 0.82$). Results from this experiment could establish strong relation between pod geometry and seed yield. This experiment proves the potential utility of highly economic and non-invasive protocol developed for high throughput phenotyping of at least 2000 pods of Greengram within 4-5 hours.

PB-115

Rhematic Area: Nano-fertilizers -An emerging technology for sustainable agriculture

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There will be higher pressure on global agricultural system to provide food security for growing world population with environmental security in the coming years. The chemical fertilizers lead to loss of nutrients from agricultural field via leaching and gaseous emission that create environmental pollution and climate change. Advanced nano-engineering is used to boost sustainable crop production while reducing chemical fertilization's negative impacts on the environment. Nano-fertilizer technology is a recent innovation substituting conventional method of fertilizer. A nano-fertilizer refer to a product in a nanometre scale that deliver nutrients to crops. Nano-fertilizers are important tools in agriculture to improve crop growth, yield and quality parameters with increase nutrient use efficiency, reduce wastage of fertilization and cost of cultivation. Nano-fertilizers leads to higher productivity and the nutritional quality of field crop via enhanced nutrient use efficiency (NUE) and decrease nutrient losses Nano-fertilizers can release their nutrients at slow and steady pace, either when applied alone or in a combination with synthetic or organic fertilizers. They can release their nutrients in 40-50 days, while synthetic fertilizers do the same in 4-5 days. Nano-fertilizers provide more provide more surface area for different metabolic reactions in the plant which increase rate of photosynthesis and produce more dry matter and yield. Nano-fertilizers increase availability of nutrients to the growing plant which increase chlorophyll formation, photosynthesis rate, dry matter production and result improve overall growth of the plant. Nano-fertilizers can increase the tolerance of plants against biotic and abiotic stresses.

PB-116

Effect of low light stress on amylose content of rice grain determines its market value

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Light has a significant role in the growth and development of plants. Even though the natural growth cycle is present in each plant, the vegetative and reproductive stages of growth are directly governed by light because of its crucial role in photosynthesis and photomorphogenesis. Reduced irradiation is the continuous fate of the Kharif season rice crops in India and South Asia due to overcast cloud throughout the growing period. Reduction of light intensity during the life cycle of rice plays a vital role in low productivity and reduction of grain quality. As rice is considered as the staple food for several countries including India and a good quality grain is always preferred by people, therefore increasing the production of good quality grain is always the aim of scientists. In this context, research was conducted in the year 2019-20 to know the effect of low light stress on grain amylose content, which determines the grain quality and ultimately the market value of rice. A set of nine late duration rice varieties along with 2 checks were taken with three light treatments (NL, 75%L, 50%L) in field condition and after harvest the grain amylose content was biochemically analyzed. The result revealed that the rate of reduction of amylose content was more in 50% light stress than that of 75% light stress. Variety A-42 in 50% light condition showed the highest rate of reduction of amylose content (21.87%) and A-1 Showed a lower rate of reduction in amylose content (3.64%). Reduction of amylose content affects the Head rice recovery, broken rice during milling and cooking properties of rice, which ultimately decides the market value of rice.

PB-117

Utilizing mitochondrial orf147 from *Cajanus cajanifolius* for development of inducible hybrid system in chickpea and identification of corresponding restoration factors

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In Gynodioecious plants, the male sterility trait is believed to have been transferred matrilineally. The genetic elements are therefore believed to reside in the cytoplasm along with other autosomal genes which help in the restoration of fertility. The expression of cytoplasmic male sterile (CMS) genes can be suppressed by the products of restorer genes. Male sterility systems are essential for developing hybrids. Due to drastic climatic changes, such as, unpredictable rainfall, long dry spells; special efforts are being taken to increase the vigour and yield of food legumes. Superior traits can be incorporated with the help of hybrids. Several mitochondrial genes have been characterised in pigeonpea, one the most widely consumed rain fed legume in South Asia and ESA. Pigeonpea has a natural out-crossing occurrence and its CMS have been exploited to create hybrids. The potential of *orf147* to induce male sterility has been established in model species *Arabidopsis thaliana* and *Nicotianatabacum*. The resulting transgenic progenies demonstrated partial to complete male sterility, with phenotype co-segregating with the transgene. Male sterile transgenic plants in both tested model species showed aberrant floral development and reduced lignin content in the anthers. The potential of using pigeonpea orf147, for inducing male sterility in other closely related crops such as chickpea which are self-pollinated and rarely produce hybrids has been performed using Agrobacterium-mediated transformation and the subsequent genotypic and phenotypic analysis has been done upto T_2 generation. Additionally, the identification and characterization of corresponding restoration factors is underway in pigeonpea. For this purpose, various PPR genes were identified from the pigeonpea PPR gene database. The nuclear encoded PPR proteins carry N-terminal mitochondrial or chloroplast targeting sequence which contribute to the post-transcriptional modification by virtue of their RNA binding activity. The interaction of orf147 and Rfs is being validated using EMSA (Electrophoretic mobility shift assay). To further validate the Rf-Orf interaction, yeast three hybrid (Y3H) is being employed to validate RNA-protein interaction.

PB-118

Pre sowing studies to enhance seed germination in *Gloriosa superba* L.

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Gloriosa superba L., family colchicaceae, is a medicinally important horticultural crop. It is mainly propagated by tubers (i.e. vegetative propagation) and also by seeds (i.e. sexual propagation). However, vegetative propagation is preferred since seeds exhibit unreliable, delayed and most importantly low rate of germination capability. The germinations problem still is unaddressed leading to over collection of tubers from the wild. We employed various pre-sowing treatments individually and in combination to enhance germination capacity to overcome its dormancy. Treatment of GA_3 250ppm for 60 min of soaking yielded higher percentage in germination both in *in vivo* and *in vitro* conditions. The growth performance parameters like shoot length, tuber length and vigour index was observed higher in GA_3 150ppm for 60 min of soaking. This very simple and inexpensive pre sowing approach can be suggested as nursery practice to produce plenty number of plants in a less duration. The implementation of this germination protocol will also reduce reliance on wild tubers collected as planting material eventually minimizing habitat loss of this demanding species.

PB-119

PIMT and HSF; the combating role against seed aging

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Seeds occupy a very crucial stage in the plant life cycle as seeds transmit genetic material from parents to the next generations and also ensure plant survival during unfavourable environmental conditions. Orthodox seeds, in particular, can survive for a prolonged period; however, get deteriorate over time during aging or storage. These processes are often associated with damage of nucleic acids, proteins, and lipids during storage. To restrict the protein damages, seeds employ several protective proteins including Protein Repairing Enzymes (PRE) PROTEIN L-ISOASPERTYL METHYLTRANSFERASE (PIMT, EC 2.1.1.77), seed-specific Heat Shock Factors (HSFs), and Heat Shock Proteins (HSPs), in which PIMT through robust repairing mechanisms, and HSF, directly or indirectly through chaperons, protect the proteins from damages, and thereby participate in maintaining seed vigor and longevity. Even these pathways were shown to work independently; interplay and link between these pathways in preserving seed vigor and longevity are largely unexplored. While analyzing the detailed molecular riddles of PIMT in seed, interestingly, through Co-Immunoprecipitation (Co-IP) followed by MS/MS identifications, we found HSF as one of the molecular partners in aged rice seeds. We speculated that HSFs may accumulate isoAsp during seed maturation which can be repaired by PIMTs. We observed that OsHSF accumulates isoAsp significantly more upon heat treatments/aging when ectopically expressed alone without OsPIMTs in *Nicotiana* plants; however, isoAsp accumulation was reduced when OsPIMT is ectopically co-expressed. In this study we show the interaction of PIMT and HSF and possible role in seed vigor and longevity.

PB-120

Genetic potentiality of *rabi* sorghum for drought tolerance under osmotic stress

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Sorghum (*Sorghum bicolor* L. Monech) is one of the five major cereals in the world. It is exceptionally tolerant to adverse conditions, in particular, water limiting environments. A current investigation was to study the influence of drought stress using Polyethylene glycol (PEG) 6000 in five *rabi* sorghum genotypes at early growth stage. The screening of drought tolerance was carried at department of Genetics and Plant Breeding, College of agriculture, Vijayapura during 2021. Three osmotic stress levels *via* control (distilled water), 1, 1.5 and 2 per cent PEG 6000 solution were used. Results indicated that germination percent decreases with increase in PEG concentration. Among the genotypes listed SVD-1433 recorded significantly higher germination per cent (90%), average root length (7.12 cm) and shoot length (5.88 cm) under 2 per cent PEG compared to M 35-1. The check variety M 35-1 recorded germination percentage of 80 at 2 per cent PEG. The least gemination percentage was recorded in genotype RSV 2397 (75%) under 2 percent PEG. The germination percentage of all the genotypes ranged between 75 to 85 under controlled conditions. The average root and shoot length decreased with increase in PEG concentration in all the five genotypes. However, genotype AKSV-401R (6.68 cm) was found on-par with check variety M 35-1 (6.96 cm) for average root length. The experiment concludes that genotype SVD-1433 found more superior in morpho-physiological traits compared to other genotypes and can be used in further breeding programmes for drought tolerance.

PB-121

Quick screening of wheat genotypes for stay green trait

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Stay-green is an ability of plants to maintain leaf greenness and photosynthesis for a longer period after anthesis, and thereby contributing photo assimilates for an extended time towards grain development. Dark-induced senescence has been a frequent subject of academic studies due to its rapid progression. Therefore, a Lab experiment was conducted in order to screen swiftly a set of 32 wheat genotypes for stay green trait under dark stress condition. For this study, detached flag leaves were taken and their cut ends were merged in distilled water inside the glass test tubes and the whole set up was kept under dark stress conditions and records were made on photosynthetic pigments (chl_a, chl_b, total chl, and total carotenoids) and SPAD values continuously for 8 days at an interval of 2 days. Significant genotypic variations were observed in SPAD values, chl_a, chl_b, total chl and total carotenoids and their degradation rates in wheat genotypes at 0, 2, 4, 6, & 8 days intervals under dark stress condition. Subsequently, Bi-plot analysis was done between overall degradation rate of SPAD value and different photosynthetic pigments. Thus, two genotypes Chirya 3 and HD 3086 had below average degradation rates of SPAD values and different photosynthetic pigments and emerged out to be best based on slowest senescence rate and proved to be stay green.

PB-122

Genetic variation in leaf senescence indices and yield relations in *kharif* chickpea under water-limited environment

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Characterization of stress-inductive plant functional traits and exploring their genetic diversity is crucial for future crop improvement. Manifestation of some of the traits such as leaf senescence due to environmental stress as well as plant developmental process would have considerable significance. The study aimed to evaluate the genotypic variations in leaf senescence trait(s) in *kharif* chickpea. A diverse panel of 72 chickpea genotypes was selected for the study and categorized in two major groups based on their observed maturity duration under the water-deficit stress condition. Crop phenological and senescence parameters like days to senescence initiation (DSI), leaf senescence duration (SD), days to 50% flowering (DF), reproductive period (RP), and days to maturity (DM) were recorded for each genotype and their associations with grain yield were determined. The trait DSI was used to determine the earliness or delay in onset of senescence and SD was used to characterize the pace of senescence. Leaf senescence dynamics were visually scored (0-10 scale) in each genotype at two-day interval. Results showed that in late-sown water-deficit condition, chickpea grain yield was adversely affected by the duration of leaf senescence (SD) irrespective of the maturity group though it was more conspicuous in long-duration genotypes. Further, significant positive correlations between grain yield and [DSI/DM] were observed for both early and late-matured genotypes ($p < 0.01$). Multivariate regression analysis demonstrated that the senescence period and growing degree days during the senescence period (GDD_{SP}) have a strong negative influence on grain yield in both the early and late matured genotypes facing terminal-drought stress. Hence, the delayed and fast senescence at the end of the crop cycle may serve as selection traits for genetic improvement of drought tolerance in chickpea. The study further suggests that relative estimation of senescence parameters such as [SD/RP] and [DSI/DM] could serve as useful indicators for precise characterization of senescence traits in *kharif* chickpea.

PB-123

Factors regulating starch digestibility, resistant starch and glycemic index of staple crops

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The starchy crops which normally form the staple diet of people are rich in carbohydrates. People leading a sedentary lifestyle and consuming high amounts of carbohydrate-rich food normally invite obesity and type-II diabetes. Upon digestion of starchy food, postprandial blood glucose level rises rapidly and sharply, which reflects a high glycaemic index (GI) value. Various factors affect starch digestibility and the GI of a food or its products. The internal factors such as amylose, lipid, protein, phytic acid, dietary fibre and resistant starch (RS) have been correlated with lower GI value. The external factors which affect GI and starch digestibility include cooking, processing, retrogradation, soaking and germination. Various food matrices are also responsible for alteration in the GI value. Moreover, changes in the environmental conditions including abiotic and biotic stresses are also responsible for the change in starch structure and composition which ultimately affects GI of starchy crops. The GI and starch digestibility of foods are affected by intrinsic and extrinsic factors which affect strategies for management of sugar level to ensure better human health. High amylose, RS, lipid and protein in the food were found to reduce starch hydrolysis. Further, retrogradation, various cooking methods and modification of starch by physical and chemical means resulted in lower GI and increased RS considerably. Analysis and management of post prandial blood glucose level while eating starchy crops would help to understand the risk of diabetes and other lifestyle-related diseases.

PB-124

Orthosilicic acid aftermath over *Brassica juncea*

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Brassica juncea (L.) Czern and Coss (Indian mustard, Rai), being a major oilseed crop, have various medicinal properties. There are various bio stimulants effecting crop parameters and enhances crop yield. OSA (Orthosilicic acid), as a silicon (Si) source, have role in the growth and developmental aspects of this crop. The effect of OSA over Indian mustard varieties (RH 725 and RH 0749) was examined on concentration basis and yield depending on various physiological, biochemical and yield parameters was observed. Foliar application of four different OSA concentrations (0ppm, 20ppm, 30ppm, 40ppm) were done at both vegetative and flowering stage in both varieties. Sampling was done after three days of each spray for growth and developmental parameters analysis including leaf gas exchange traits, biochemical parameters (considering activity of Superoxide dismutase, Catalase, Ascorbate peroxidase and Peroxidase) with non-enzymatic antioxidant defense. Metabolites (Ascorbate and Glutathione content) and yield and its attributes at harvest stage. Results highlights an increased yield after the application of OSA concentration by enhancing physiological parameters as Relative water content (%), Chlorophyll fluorescence (f_v/f_m), Total chlorophyll content (SPAD), Chlorophyll stability index (%), Canopy temperature depression (ºC) after 20ppm OSA application. Also, biochemical attributes are influenced as Relative stress injury (RSI), Hydrogen peroxide content, and Malondialdehyde content show declined values. Antioxidant defence enzymes shows variability in results in accordance to varied concentration and variety. Yield and its attributes showed significant increase, the increased in yield was found to be 15% in RH 725 and 18% in RH 0749after 20 ppm OSA applications.

PC-125

Effect of elevated carbon dioxide on thermotolerance level of wheat under heat stress

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Crops are crucial gift given by nature for human kind. It requires a favorable climate i.e. optimum temperature, water, nutrients, etc. for their proper growth and development. Unfortunately, due to anthropogenic activities, the global climate has been changing continuously that affect the normal activities of most of the plants. Wheat, being widely grown staple food grain crop, is highly sensitive to heat stress. Elevation of $CO_2$and temperature adversely affects the quantity and quality of the grains. However, some cultivars have inherent tolerance mechanism i.e. expression of SAGs and enzymes to overcome these threats. We also studied the effect of eCO_2 (700±5 ppm) and temperature (38±3°C) on different biochemical parameters linked with HS-tolerance. Four diverse wheat genotypes - HD2329, HD2967, HI1500 and GW322 grown under eCO_2, HS, and combined treatment of both were analyzed. We observed increase in the activities of antioxidant enzymes during pollination and grain-filling stages, SOD showed maximum activity in wheat *cv*. HD2967 in response to eCO_2+HS during grain-filling stage. Similar pattern of activity was observed in case of catalase and guaiacol peroxidase. Similarly, total antioxidant potential was observed maximum in wheat *cvs*. HD2967 followed by HI1500, whereas minimum was observed in case of HD2329. Elevated CO_2 and HS were observed to enhance the accumulation of ROS (H_2O_2) in all the wheat genotypes. We observed decrease in the activity of nitrate reductase (NR) in response to eCO_2+HS, though NR in HI1500 showed very high activity (0.975 U/mg proteins) in response to combined treatments. To conclude, there is a need for in-depth study of effect of eCO_2 on different metabolic processes and alteration in source to sink ratio under HS. The information generated will help to fight the menace of climate change in best possible manner without compromising with the grain-quality and yield.

PC-126

Assessing the responses of crop plants to elevated temperature and CO_2- Issues and concerns

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The predicted increased atmospheric temperature, changed rainfall pattern and enhanced CO_2 concentration are the challenges to sustain the agricultural productivity in the future. To assess the response of different crops to these variations many research programmes are initiated all over the world with different confined as well as field facilities. We initiated field experiments at ICAR-CRIDA with OTCs, FATE and CTGC facilities to evaluate major rainfed crops to elevated CO_2 (550ppm, eCO_2), elevated temperature (+3°C above ambient, eT) and their combination. The results indicated that the influence of eCO_2 differed with C3 and C4 crop plants for physiological parameters like Anet, gs, Tr and WUE as well as biomass and yield with higher response of C3 crop plants. However, it is interesting to record that even C4 crop plant like maize registered improved performance when they were exposed to moisture deficit stress. The increased temperature negatively impacted the growth of all the crops and the presence of eCO_2 ameliorated the ill effects of eT. The degree of reduction of different parameters with eT and responsiveness to eCO_2 was observed to be not only specific to crop but also depend on the genotype. The other variables such as season, nutrient and moisture status also influenced the crop response to these conditions. Hence it is suggested that when quantifying the response of any crop to these climate change parameters, one need to take sufficient care about other influencing variables.

PC-127

Carbon sequestration and carbon dynamics in agriculture and forest ecosystem: with reference to climate change

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Climate change is one of the most important global environmental challenges in the history of mankind caused primarily by increasing concentration of greenhouse gases (GHGs) carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Agricultural fields are major anthropogenic source of CH_4 and N_2O and a sink for CO_2. On the other hand forests are considered as major terrestrial reservoirs of CO_2 due to its inherent capacity of storing carbon for a long period of time. Scientific studies for understanding of the processes involved with the production and emission of CH_4 and N_2O and carbon storage ability of soil are of utmost importance in the field of global climate change research. Series of field experiments were conducted over the years at Tezpur University campus to understand the dynamics involved with emission of greenhouse gases (CH_4 and N_2O) and soil carbon sequestration. Soil C storage of 0.51 Mg C ha^{-1}, 0.31 Mg C ha^{-1} and 0.32 Mg C ha^{-1} were recorded in the plough layer of soil of irrigated, rainfed upland and rainfed low land rice ecosystems respectively. Thus rice ecosystem can be considered as good sink of C in the soil. Study on net CO_2 flux in a semi evergreen forest Kaziranga National Park (KNP) by eddy covariance method reveals the forest's ability to act as moderate sink of carbon on annual basis. The month of June is found to be the most favorable for day time carbon uptake by the forest. Variation in leaf area index of KNP is the most important and significant driver of seasonal and monthly variation of CO_2 flux.

PC-128

Elevated CO_2 favors ginger under soft rot (*Pythium aphanidermatum*) disease

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The effect of changing climate on plants particularly increasing levels of atmospheric CO_2 necessitates the development of climate change-ready crop varieties. It is also equally important to predict the disease susceptibility of crop plants under future climate conditions. In this context, the high economic and medicinal spice Ginger was selected for the study. Since, it is highly susceptible for *Pythium* species and accounts for the complete crop annihilation succumbing ginger to soft rot. The present study was conducted to assess the impact of elevated CO_2 on tolerance to soft rot in three ginger varieties Aswathy, Athira and Maran. The ginger varieties (105 Days old) were shifted to Open Top Chambers enriched with 500 ppm of CO_2 and were challenged with *Pythium aphanidermatum.* Results illustrate that large area of cell death was observed under ambient CO_2, whereas the per cent disease index (PDI) was reduced by 12.49% under elevated CO_2. Further, the retention of total chlorophyll, photosynthetic rate and Phenylalanine ammonia-lyase (20.91 Units mg^{-1} total protein) activity as well as accumulation of phenols (32.40 mg g-1 DW) were higher at elevated CO_2. The reduction in the fresh weight of rhizome upon pathogen inoculation was higher (21.37%) under ambient CO_2 when compared to elevated CO_2 (16.74%). All these physiological remodelling of Ginger plants accounted for better tolerance against *P. aphanidermatum* with enhanced production of anti-oxidants. Allocation of photosynthates to defence-related metabolites played a crucial role for slowing down the disease progress under CO_2 enrichment.

PC-129

A novel physiological approach for heat tolerance in chickpea

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Pulses have been described as a "poor man's meat and affluent man's vegetable" in India. Chickpea (*Cicer arietinum L.*) is the third most significant food legume crop grown during rabi season under receding soil moisture. Chickpeas is known to flourish in drought-prone conditions, but it seems to be sensitive to heat stress exceptionally during reproductive development, resulting in considerable yield loss. The performance of chickpeas under heat stress is more variable. It is crucial to develop screening tools to identify thermotolerant chickpea genotypes because of the increase in average global temperatures. In this view, a lab experiment was conducted to standardize the temperature induction response (TIR) protocol for chickpea seeds and seedlings. Temperatures were standardized as sub lethal *i.e.,* challenging temperatures as 32ºC to 50ºC (for 5 hours & 30 min) for seed, 32ºC to 40ºC (for 4 hours) for seedlings and lethal temperatures as 58°C (for 3 hours) for seed, 50°C (3 hours) for seedlings. This technique can be used as a potential tool to identify and select temperature tolerant lines at the seed and seedling stage from a large population. A set of diverse chickpea germplasm comprising of 6 genotypes were screened for intrinsic tolerance using the standardized Thermo Induced Response (TIR) protocol. Among the genotypes JG-14, JG-11 and A-1 showed highest thermo tolerance in terms of higher survival of seeds (germination percentage) and seedlings with less per cent reduction in root and shoot growth. The genotypes with intrinsic heat tolerance can be explored for the development of varieties suitable for late sown conditions in Karnataka where chickpea is prone to terminal heat stress.

PC-130

Callus induction and shoot regeneration of *Valeriana wallichii* DC. through *in vitro* and *in vivo* grown plant

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Valeriana wallichii DC. syn. *V. jatamansi*; family: Valerianaceae one among the important medicinal plant species, in this study on *Valeriana wallichii*, effect of different PGRs on different explants of naturally grown and *in vitro* grown plants was evaluated. Leaves andNodes (runner node) of naturally grown and *in vitro* grown plants were used as explant types for the study. Effect of 2, 4-D, NAA and BAP on different explants was evaluated. Response was recorded after 30 days of inoculation. Callus obtained from different explants of *in vitro* grown plants was transferred to media containing 5-20 µm BAP. It was observed that only callus obtained from nodal explants was able to regenerate shoots form it while callus obtained from leaves showed no response. Shoot multiplication was recorded only in media containing 20µm BAP where average 20 shoots per callus clump was recorded. It was observed that in almost all explant types callusing was induced. the magnitude of which varied with concentration of PGRs and the explant type. Callus regenerated from nodes induce multiple shooting in the media containing high concentration of BAP.

PC-131

Assessment of climate change impact on crop water requirement: A regional case study in the semi-arid province of Western Maharashtra, India

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The hydrological cycle has been massively impacted by climate change and human activities. Thus it is of the highest concern to examine the effect of climate change on water management to understand possible future shifts in water supply and water-related crises. Fortunately, there arises a high degree of ambiguity in determining the effect of climate change on water requirements. In current article, the Statistical Down Scaling (SDSM) model is applied to simulate potential impact of climate on crop water requirement (CWR) by downscaling ET_0 in Western Maharashtra, India for the future period's *viz.,* 2030s, 2050s, and 2080s. Four crops (cotton, soybean, onion, and sugarcane) were selected during the analysis. The Penman-Monteith equation is used to calculate reference crop evapotranspiration (ET_0), which further in conjunction with the crop coefficient (K_c) equation estimates reference crop evapotranspiration (ET_c). The predictor variables are extracted from the NCEP reanalysis dataset for the period 1961-2000 and the HadCM3 under H3A2 and H3B2 scenarios for the period of 1961 – 2099. The results indicated by SDSM profound good applicability in downscaling. The projected ET_0 indicated an increase in mean annual ET_0 as compared to the present condition during the 2030s, 2050s, and 2080s. The ET_0 would increase for all months (in summer, winter, and pre-monsoon seasons) and decrease from June to September (monsoon season). The estimated future CWR show variation in the range for cotton (-0.97 to 2.48%), soybean (-2.09 to 1.63 %), onion (0.49 to 4.62 %), and sugarcane (0.05 to 2.86 %).

PC-132

Moisture stress impact on morphological, physiological, biochemical and biomass changes in groundnut genotypes

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Moisture stress is one of the most important abiotic stress limit the plant growth and development. The present study was aimed to understand the morphological, physiological, biochemical and biomass parameters in four groundnut genotypes under Well Water (WW) and Water Deficit Stress (WDS) imposed at vegetative stage. The results showed that significant genotypic variability is there among the groundnut genotypes for the parameters studied. WDS significantly increased the root length in K-9 (79.8%), K-6 (43.7%) and Dharani (15.5%). The genotypes K-9 and Dharani also maintained higher chlorophyll content under both WW and WDS conditions. While higher accumulation of total soluble sugars and starch were recorded with K-9 and Dharani under WD stress, as a result lower reduction of RWC and MDA content was observed as compared with K-6 and Narayani. The WDS condition impacted biomass partitioning significantly in all the groundnut genotypes. The reduction in leaf biomass with WDS was higher as compared with stem biomass in all groundnut genotypes however improved root biomass of K-9 and Dharani was recorded. Among the groundnut genotypes, K-9 and Dharani recorded increased root length and root biomass as well as higher accumulation of compatible solutes in response to water deficit stress, indicating the inherent moisture stress tolerance characteristics in these genotypes.

PC-133

Differential response of blackgram genotypes to moisture deficit stress at flowering stage

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A field experiment was conducted to evaluate the morpho-physiological, biomass and yield response of four blackgram genotypes (IPU-06-02, PLU-826, PSRJ-95016, IPU-94-1) to moisture deficit stress at flowering stage during *kharif* 2021 in replicated trial. One set of plots were irrigated to maintain stress free treatment and other set was maintained purely rainfed. The crop experienced dry spell of 16 days during flowering stage. Among the four genotypes, moisture deficit significantly reduced the plant height, number of branches, leaf number, leaf area and leaf biomass in IPU-06-02, while the lowest reduction was registered by PSRJ-95016. The RWC decreased in plants experienced moisture deficit stress and highest reduction (15.4%) was observed with IPU-06-02, while the lowest reduction (9.8%) with PSRJ-95016 as compared with irrigated controls. This response of PSRJ-95016 was supported by its higher accumulation of proline which might have facilitated to maintain better plant water status and maintain membrane stability even under drought condition. At harvest, the yield and yield contributing parameters were recorded. Among the four genotypes, highest number of pods, seeds and seed yield were recorded with PLU-826 under both irrigated and stress conditions, however stress impacted these parameters, whereas lowest impact of stress was recorded with PSRJ-95016 which possessed lower yield potential. The high yielding PLU-826 also possessed better root parameters such as root length, volume and biomass as compared with other genotypes. The stress impacted biomass and yield parameters and from the data it can be concluded that the genotypic variability in mitigating the stress impact is present.

PC-134

Heat stress tolerance mechanism and breeding strategies for crop improvement in major cereal crops

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Abiotic stresses are the major area of concern for plant breeder as they cause massive yield losses. Among all the stresses, global food security and nutritional security are at greater risk due to escalating adverse effect of heat stress. It induces physical damage, biochemical changes and physiological disruption and thus, increases the yield gap between potential yield and the actual yield production in crop plants. Therefore, a better understanding of plant responses to these stresses has pragmatic implication for remedies and management. The conventional means like recurrent selection and back cross breeding method or new generation breeding methods like CRISPER-Cas9, Trangenics and Molecular assisted back cross breeding can be use for crop improvement. However, conventional efforts, aimed at improving plant heat stress tolerance, have limited success and are time consuming. Moreover, wild species and landraces of various crops have unknown heat tolerant genes that should be identified and incorporated to high yielding modern cultivars. The functional genomic approaches such as GWAS, SSH and Micro array technology can be employed which catalysis the discovery of noval genes associated with heat stress tolerance. These identified genes can be validated using TILLING, VIGS and TALENS. The plant breeding strategies and new biotechnological tools including genome editing techniques can use these validated genes to enhance heat stress tolerance in crop plants. The integrated approach of plant breeding with biotechnology will accelerate the development of heat tolerance genotype.

PC-135

Impact of elevated temperature and its interaction with elevated CO_2 on transpiration efficiency of blackgram and greengram genotypes

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Two blackgram genotypes -T-9, LBG-752 and two greengram genotypes -LGG-460, WGG-42) were assessed for biomass, yield, water transpired and transpiration efficiency at elevated temperature of 3.0 ± 0.5°C above ambient canopy temperature(eT) and its interaction with elevated CO_2 of 550±50 ppm (eT+eCO_2) under Free Air Temperature Elevation (FATE) facility. Whole plant level TE was determined gravimetrically from seedling to maturity. The study revealed that eT significantly decreased biomass and seed yield in both the genotypes of black gram and green gram whereas eT+eCO_2 condition reduced the ill effects of eT. The water transpired was higher at eT and eT+eCO_2 compared to the ambient. Decrease in biomass and increase in water transpired at eT lead to decrease in TE under eT compared to ambient. TE in all genotypes is highest at ambient followed by eT+eCO_2 indicating that eCO_2 ameliorated the ill effects of eT.

PC-136

Nutrient management influenced residue and soil carbon mineralization under different soil moisture regimes in Vertisols of India

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Crop residue, a key organic carbon input, has the potential for soil carbon sequestration. However, previous studies have shown an inconsistent effect of residue return on the magnitude of residue and soil carbon mineralization. We used a laboratory-based soil incubation to test the response of soil carbon mineralization to crop residue type, soil moisture, and how nutrient management modulates these responses. In this study, we incorporated crop residues with different qualities (wheat, rice, soybean, and maize) at two soil moisture {80% field capacity (FC) and 60% FC} and under seven nutrient levels: N0P0K0 (no nutrients), N0PK, N100PK, N150PK, N100PK+manure @ 5 Mg ha^{-1}, N100PK + biochar @ 5 Mg ha^{-1}, N150PK+ biochar @ 5 Mg ha^{-1}. The results demonstrated significant ($p<0.01$) differences in the magnitude of CO_2 emissions among treatments. The interactive effects of residue, moisture, and nutrient management significantly influenced SOC mineralization. Residue addition triggered the mineralization of SOC to CO_2, which was significantly greater at higher (80% FC) than lower moisture content (60% FC). Across nutrient and soil moisture, CO_2 release was higher by 2.3 (wheat), 2.0 (rice), 1.9 (soybean), and 2.4 (maize) times in residue returned soils compared with control soil. The order of CO_2 release was control < soybean ≈ rice < maize ≈ wheat. The results indicate that the nutrient addition increased the loss of SOC and CO_2 release to the atmosphere in control soil. Apparent residue C mineralization was significantly influenced by residue type, nutrient management, soil moisture, and residue × nutrient × moisture interaction ($P < 0.01$). The total residue C mineralized annually was the highest in wheat (39-86%) and maize (40-94%), followed by rice (32-74%) and soybean (17-58%) residue at 80% FC. Regardless of soil moisture, the residue C mineralization decreased by 9% (N0PK), 36% (N100PK), 4% (N150PK), 19% (N100PK + Manure), 10% (N100PK + Biochar) and 30% (N150PK + biochar) over N0P0K0 treatment.

PC-137

Melia dubia based agroforestry systems to cope up with climate change

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Agroforestry offers new approaches that can boost production while simultaneously helping to mitigate climate change through increased carbon sequestration and strengthening the system's ability to deal with the detrimental consequences of changing climate conditions. Environmentalists require tree species that can grow into a complete tree in a short period of time, *Melia dubia*can mature into a full-fledged tree within 4-5 years. As global temperatures and pollution continue to rise, this species can be raised in the fields in order to tackle climate issues at a faster pace. The majority of crops are stressed by high temperatures, however growing annual cropsbeneath trees provides them with a cooler climate. Wheat crop grown with *Melia dubia* trees revealed to have (-5.58 ^{0}C) Canopy temperature depression (CTD) however, (-5.27 ^{0}C) CTD was recorded in non-shaded conditions. Present study revealed DBH (diameter over breast height), tree height, and canopy spread of *Melia dubia* were found higher in agroforestry system as compared to pure stand of *Meliadubia* (lacking agricultural crop). Mean DBH of trees having wheat as intercrop was recorded with 56.6 cm, however trees without any intercrops were recorded with mean DBH of 55.6 cm at the end of season. Trees with intercrops showed more canopy spread (6.9 m) and tree height (16.3 m) as compared to pure stand (6.6 m) and (16.2 m) of *Melia dubia* trees. Results suggests *Melia dubia* based agroforestry system can be used as a potential tool to cope up climate change.

PC-138

Photochemical efficiency is negatively correlated with the Δ9-tetrahydrocannabinol content in *Cannabis sativa* L.

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Cannabis sativa L. is an important plant, which is a source of durable fibers, nutritious seeds, and medicinally important phytocannabinoids including Δ9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Light has shown to be a key modulator of biomass and cannabinoid yield suggesting responsive photochemical machinery. The present study was envisaged to understand the effect of the increasing levels of metabolic THC on the photochemical efficiency in *Cannabis*. The chlorophyll *a* fluorescence kinetics, photosynthetic pigments and immunodetection of the photosynthetic machinery was analyzed on seven accessions from different environments, in conjunction with the cannabinoid content. All the accessions were clearly divided into three groups based on their relative content of CBD and THC. Group I with (CBD/THC > 1) had a clear advantage in terms of the damage to the D1, RbCL and Lhc1 protein holo-complex. Performance indicators of photochemistry based on the OJIP kinetics suggested a stoichiometrically negative correlation with the THC content. Zeaxanthin-dependent quenching is primarily responsible for lower NPQ in Group III with high THC content (THC > 6%). The THC treatment on *Arabidopsis thaliana* also suggested dose-dependent decrease in the photochemical efficiency suggesting the exclusivity of THC in causing the response. This resulted in the damage of photosynthetic machinery and the generation of free radicals, thereby compromising the yield. The study also opens a new screening method for *Cannabis*, based on cannabinoid content

PC-139

Physio-biochemical responses of contrasting genotypes of mungbean under combined drought and heat stress

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The physio-biochemical basis of drought and heat stress tolerance in mungbean (*Vigna radiata* (L.) R. Wilczek) was studied in a field experiment with four contrasting genotypes i.e. tolerant (IPM410-3 & IPM1103-1) and sensitive genotypes (IPM1603-3 & IPM1604-1) under hot arid region of Rajasthan. The experiment was conducted in summer season with different stress treatments viz., i) control (timely sown, fully irrigated), ii) drought stress (timely sown, withholding one irrigation at 35DAS), iii) heat stress (late sown, fully irrigated) and iii) combined heat and drought stress (late sown, withholding one irrigation at 35DAS). Stress conditions affected the performance and growth of all the genotypes with more negative effects on sensitive genotypes with respect to physiological traits. Analysis of variance showed significant differences among the genotypes on relative water content (RWC), membrane stability index (MSI), chlorophyll content, leaf area, canopy temperature, biomass and yield traits (number of pods plant-1, number of seeds pod-1, total seed yield plant-1) due to drought and heat stress. The reduction in MSI, RWC, leaf area, biomass and yield traits were higher in sensitive accessions under all stressed conditions as compared to tolerant ones. It was concluded that the genotype IPM410-3 was found superior under the all stress conditions. The tolerance of heat and drought stress in the said genotype would pave the way in developing stress tolerant cultivar for the hot arid region, where environmental stresses are the part of crop production.

PC-140

Is strigolactone hormone secretion by rice plants is essential for improving mycorrhizal fungal association?

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Arbuscularmycorrhizal fungi (AMF) and its role in sustainable rice production has been well recognized, but there is very little information about their application and utility in aerobic and flooded rice cultivation. Recent findings indicated in many crops that the AMF association can be improved by altering the hormonal secretion particularly strigolactones (SLs) in plant system, but there is no much information available in rice. SLs and their derivatives have recently been recognized as a important plant hormone which is involved directly or indirectly with enormous capability in the regulation of cytoskeleton-mediated developmental events, orchestrating root-shoot architecture, stimulating root hairs, hypocotyls, influencing the microbes towards the root, stress management, protection from pathogens attack through inducing resistance, nutrient uptake, and yield enhancement. SLs also play major role in stomatal conductance, photosynthesis and transpiration in rice plants. The release of SLs from roots into the rhizosphere under nutrient-deprived conditions is the first response for the symbiotic association between rice and AMF which boosts its capacity to uptake minerals, sugars and water. The external application of the synthetic SLs analog*(rac*-GR24) regulates shoot and root development through activating the *MORE AXILLARY GROWTH2* (*MAX2*) gene, and also enhances AMF symbiotic association in rice. In the present study, the role and functions of SLs hormone secretion by rice plants and its influence on enhancing plant growth through AMF associations are discussed.

PD-141

Molecular characterization of putative RNA binding proteins and their target RNAs in sweet potato

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Sweet potato *(Ipomoea batatas)* is the third most important tuber or storage root crop after potato and cassava. Sweet potato is nutritionally rich, has diverse applications in medicine and industry; however, the molecular mechanism of storage root development is unknown. The functions of RNA-binding proteins (RBPs) and their target RNAs are well studied in potato tuber development. Potato RBPs like polypyrimidine tract-binding proteins (StPTB1and-6) bind to mRNAs of homeobox transcription factors, such as StBEL5 (BEL1-LIKE protein) and POTH1 (POTATO HOMEOBOX1) to form a ribonucleoprotein complex and facilitate their movement from leaf to stolon to activate tuber growth. Previously, it has been suggested that the pathway regulated by mobile RNAs and PTBs could be conserved between potato and several storage root crops. Through bioinformatic analysis, different orthologues of PTBs (5), BEL5 (3) and POTH1 (4) were identified in sweet potato. To understand their tissue-specific expression patterns and physiological roles, we are using various approaches like gene expression, promoter characterization, overexpression and gene knock-out. In one-month old sweet potato plants, selective orthologues of PTBs and BELs showed differential expression in shoot-tip, leaf, petiole, stem and node. The expression pattern of these orthologues in tissues like leaf, fibrous root and different stages of storage roots (three-month-old plants) is currently underway. To validate the interaction between IbPTBs and mobile RNAs, we aim to conduct electrophoretic mobility shift assay. So far, I have generated the overexpression and promoter::GUS fusion constructs, and efforts are ongoing to generate their stable transgenic lines of sweet potato.

PD-142

Influence of different packaging materials and storage conditions on quality of moth bean seeds

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Investigations were carried out to study the influence of different packaging materials and storage conditions on the seed quality of moth bean. Seeds were packed in cloth, gunny, high density polythene (HDPE), and vacuum packed bag without any aid of chemicals, and packed materials were stored under ambient and cold storage (5 -7 ºC temperature with 60 ± 2% relative humidity) for the period of 18 months. After 4 months of storage, moth bean seeds were infested with bruchids to the tune of 80% in all the packaging materials except vacuum packed bag under ambient condition whereas, no bruchids infestation were seen in cold storage even after 18 months of storage. Seeds packed in cloth, gunny, and HDPE bags were failed to maintain minimum germination as described by the Central Seed Certification Board (CSCB) under cold condition and there was a minimum reduction in the quality of seeds packed in vacuum packed bags under both conditions at the end of storage period. So, the vacuum packaging technology can be effectively used for the safe storage of moth bean seeds.

PD-143

CRISPR/Cas9 mediated genome editing of MS1 gene in wheat

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The crop production needs to be increased by 60–100% above current level to meet the food demand of rapidly increasing population. Hence, there is an urgent need to utilize new techniques to improve crop yield. The hybrids are widely developed in many crops, but it has been a challenge to develop viable hybrid system in wheat because of its complex genome and recalcitrant nature for tissue regeneration. ICAR-IIWBR being the nodal institute for wheat research in India has initiated genome editing research in wheat. An experiment was designed using CRISPR/Cas9 mediated knockout/mutation approach in Indian wheat genotype (DBW187) for MS1 gene. The targeted Ms1 gene is specifically expressed in microsporocytes and is essential for micro gametogenesis, encodes a glycosylphosphatidylinositol-anchored lipid transfer protein and necessary for pollen exine development. The sgRNA was designed using Wheat CRISPR targeting first exon of the MS1 gene and for all the three copies of the genome. The modified plasmid pDirect_25 was used for cloning of the designed sgRNA and then into *E.coli*. The transformation of sgRNA-Cas9 vector into wheat system was done with *Agrobacterium* mediated transformation using EHA105. The calli induced embryos and *Agrobacterium* were co-cultivated and further co-cultured into the regeneration, shooting/rooting medium to get the complete plantlets. The T_0 generation plantlets exhibited required phenotypic characters like very less/no anthers and reduced seed set in spikes as compared to control plant. Further molecular and phenotypic characterization in T_1 generation are under progress. Hybrid development in wheat provides an opportunity to capture the heterosis yield gain in less time period.

PD-144

Physiological characterisation of Eucalyptus clones for gas exchange and water use efficiency associated traits

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Dwindling freshwater resources, shrinking cultivable lands, erratic climate pattern and increasing demand for wood from wood-based industrial sector necessitates the development of clones with desirable physiological trait including high water use efficiency (WUE). Eucalyptus ought to be one such genus in the area of tropics as a dominant source of raw material for its manifold use in industrial wood sector. Although eucalyptus could satisfy the demands of the industrial sector within a short period of time, WUE and continual supply of quality genetic resources always has been a major concern. Despite many studies aimed to reduce the level of water usage and evapotranspiration through different silvicultural practices and techniques, there is a growing need to characterize and improve the water use efficiency especially in Eucalyptus. WUE appears to be important trait in establishing drought tolerance, as it represents amount of biomass produced per unit of water transpired. In order to obtain the baseline information for the selection of clones for arid and semiarid regions, gas exchange and physiological traits related to WUE were studied in eucalyptus under well water condition. Among the fifteen clones, a significant amount of variation was observed for their physiological and associated WUE traits, where the clone EU UG 10 exhibited a higher net photosynthetic rate (An) coupled with WUE, followed by the clone ET 46. As a result, clones identified for higher WUE will produce higher amount of biomass per unit of water transpired even under water-limited conditions. Furthermore, this study demonstrated the variability for physiological traits associated with water use efficiency which could be used in the tree improvement program for developing drought tolerant Eucalyptus clones.

PD-145

NGS based comparative expression profiling from the *de novo* transcriptome short read assembly of male and female plants of seabuckthorn

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Seabuckthorn (*Hippophae salicifolia)* is a multipurpose dioecious wonder plant known for its huge medicinal, nutritional, and therapeutic properties and usage. Earlier studies have reported a number of molecular marker-based approaches to develop different gender-specific markers for the identification of gender in sea buckthorn originating from different regions of the Indian Himalayas, but study at the transcriptome level has not been undertaken for the other less popular species, namely *Hippophae salicifolia*. The sea buckthorn male and female plant saplings were collected from Munsyari, Uttarakhand, India. Total RNA was isolated from the leaf tissues of two samples of each of male and female plants. Purified cDNAs containing sequencing adaptors were sequenced using Illumina NovaSeq Paired end. The short reads obtained were further processed for assembly, annotation and analysis using Trinityrnaseq-2.6.6 assembly tool. The sea buckthorn transcriptome data revealed approximately 3.2 million raw short reads. High-quality reads were assembled using Trinity (v. rnaseq 2.2.6) tool. Finally, *de novo* short read assembly yielded 50,259 transcripts (>100bp), representing about 3.5GB of sea buckthorn transcriptome. DESeq was performed using the R package to understand the differential gene expression by using the negative binomial distribution. The assembled transcripts were also screened for the presence of transcription factors and SSRs. GO, COGs and KEGG pathway analyses were also performed to assign GO terms to DEGs and ascertain their biological functions. The present study of complete transcriptome profiling provide a valuable resource for gene discovery, and other functional genomics studies aiming for the selection of candidate genes for the development of sex-specific markers.

PD-146

Glutathione homeostasis: An overall defence against arsenic stress in plants

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Arsenic (As) toxicity has become a global concern due to its increasing contamination in water, soil and crops in many regions of the world. To reduce this impact of arsenic compounds, efficient strategies are required. It has been observed that Glutathione has promising effect in reducing as load in the upper part of the plant parts, this effect can be exploited in both the ways, crops as well as Phyto remediating plants. Glutathione (GSH) is a tripeptide, consisting of glutamate (Glu), cysteine (Cys) and glycine (Gly) to form γ-Glu-Cys-Gly. Glutathione plays various important functions in plants via its thiolic residue of Cys, that leads execution of redox reactions and enable it to as key regulator of redox homeostasis. In its stress compensating role, it detoxifies photosynthetically generated hydrogen peroxide through asorbate-glutathione cycle. GSH get polymerized to form pyochelin's, (γ-Glu-Cys)2-11-Gly, that has capability to chelate heavy metals and then transport them into the vacuole, where they are metabolically inactive, which is the main pathway of heavy metal detoxification. Glutathione synthesis and degradation in plants is very similar as in animals. Glutathione is also the main long-distance transport form of reduced sulphur translocated from mature leaves to the roots and to other parts of the plant. Besides this translocation function, it is also a storage form of reduced sulphur in plant cells. Considering these important role in cellular homeostasis and capacity to cope up with stress, GSH is found very potential in normal as well as stress condition.

PD-147

Response of betel vine to organic and inorganic nutrient supplements

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The economic part of the betel vine is green, tender and fresh leaves. So, the nutrients, particularly nitrogen requirement of the crop is very high. Most of the betel vine growers supplement this high amount of nitrogen requirement through oil cakes and balanced nutrition as well. Application of chemical fertilizer is hardly practiced in betel vine cultivation. Present investigation was carried out to study the response of betel vine to organic and inorganic nutrient supplements. Two betel vine cultivars namely, Simurali Bhabna and Ghanagatte were selected for the experiment. The experiment was laid out as randomized block design consisting of eight treatments replicated thrice. Treatment combinations included Control (T1); recommended dose of FYM (T2); FYM + Protein hydrolysate @ 100 ppm (T3); FYM + Urea @100ppm+ KH_2PO_4 @100 ppm (T4); FYM + urea @50 ppm + KH_2PO_4@ 50 ppm(T5); FYM +Protein hydrolysate @100 ppm + Paclobutrazol @ 100 ppm (T6); FYM + Urea @ 100 ppm+ KH_2PO_4@ 100 ppm + Paclobutrazol @ 100 ppm (T7); FYM + urea @ 50 ppm + KH_2PO_4@ 50 ppm + Paclobutrazol @ 100 ppm(T8).Findings of the present investigation revealed that foliar application of organic and inorganic fertilizers enhanced growth and yield of the betel vine crop in comparison to control with the traditional nutrient management only. All the growth and yield related traits were observed to be highest in T4 treatment. Paclobutrazol did neither favourably partitioned the assimilate towards the production of yield nor induced reproductive development of the vines but it induces profuse nodal root formation.

PD-148

Farmer's opinion on causes of climate change

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Present study mainly focused on Farmer's opinion on climate change and reasons for causing on climate change. The study was conducted in two Agro ecological zones of Andhra Pradesh. i.e., Krishna Godavari & scarce rainfall zone. A total sample of 320 farmers were taken for the study. To analyze the opinions of farmers on climate change. 10 statements were prepared on what farmers perceived that climate is changing and 7 statements on causes on climate change related to population and another 10 statements on climate change related to agriculture were prepared in interview schedule. Garrett ranking technique was used to rank the statements. The results revealed that non receipt of monsoon at right time was ranked first in farmers perceived climate changing, the next rank was given to shift in seasons. Long wet spell in crop season and unusual frost are least ranked by the farmers in perceived climate changing. Increased population and increased vehicles are 1st and 2nd rank respectively given by farmers in climate change related to population. To many buildings/less green cover statement was least ranked in climate change related to population. Finally use of chemicals and fertilizers and increased practice of mono cropping were main reasons for climate change related to agriculture as given by farmers. Overgrazing by livestock and lack of tank/lake management are least ranked by farmers in climate change related to agriculture.

PD-149

Identification of salt tolerance in wheat genotypes at seedling stage using hydroponic technique

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Wheat being the moderately tolerant crop faces many challenges in the arid and semi-arid regions under irrigated agriculture. The relative salt tolerance of wheat crop is 7.0 dS/m and its yield decrease is 25% at 9.0 dSm^{-1}, but this reduction varies from cultivar to cultivar, phenological stages, and the duration of plant exposure to the stress. Wheat crop comprises six growth stages i.e. CRI/seedling, tillering, jointing, booting, heading, and maturity. Out of these, CRI (crown root initiation) stage is considered as most sensitive stage. Therefore, the present work was to evaluate 25 wheat genotypes for seedling stage tolerance at 150 mM NaCl using hydroponic technique. After seeing the visible toxicity symptoms on the leaves, root growth suppression was used as criteria to characterize salinity tolerance. It was noted from the results that under saline water of 150 mM NaCl, all the studied 25 wheat genotypes showed more than 35% reduction in root length except KRL 2001, KRL 2014, KRL 2021, HD 2967, HD 3271, PBW 771 and DBW 222 which showed less than 25 per cent reduction in root length along with used checks (Kh-65, KRL 3-4, KRL 99 and C-306). Although these were preliminary observations, but based on the performance of these genotypes, KRL 2001, KRL 2014, KRL 2021, HD 2967, HD 3271, PBW 771 and DBW 222 exhibited better growth responses as compared to other genotypes and were characterized as tolerant wheat genotypes at seedling stage.

PD-150

Silicon nutrition improves the yield and yield traits of rice genotypes under salt stress

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Rice (*Oryza sativa* L.) is main staple cereal crop, feeding and providing daily calories for ever increasing population around the world, and it is highly sensitive to salt stress at both early seedling stage and reproductive stage. In our study, pot culture experiment was conducted with six rice genotypes namely ADT 53, ASD 16, CO 51, TRY 3, IR 64, and Pokkali at whole plant level. we imposed the salt treatment 125mM NaCl at boot leaf stage of the crop up to flowering and the salinity stress effect was ameliorated by the foliar application of 0.6% silicon nutrition along with 125mM NaCl stress (125mM NaCl+ 0.6% silicon nutrition) at heading stage. The 125mM NaCl stress significantly reduced the yield and yield components like number of productive tillers per hill, panicle length and weight, number of grains per panicle, spikelet fertility, 1000 grain weight and grain yield per plant but the negative effect of 125mM NaCl stress on yield and yield components was slightly ameliorated by foliar application of 0.6% silicon along with 125mM NaCl stress. From our findings we conclude that the silicon nutrition improves the yield of rice genotypes under salt stress and thereby it imparts tolerance to rice plant against salt stress.

PD-151

Expression analysis of genes involved in N and P uptake and transport in wheat

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Nitrogen (N) and phosphorous (P) are the macronutrients essential for protein synthesis, chlorophyll and nucleic acid synthesis that ultimately support the plant growth and reproduction. These macronutrients are not available to the plants in adequate amount as P is in low abundance and highly immobile in soil whereas N applied in the form of fertilizers lost through surface run off, leaching and denitrification. Therefore, plants have evolved some physiological and molecular mechanisms to adapt the N and P limiting conditions as reported in *Arabidopsis*, rice and wheat. In our study we grown the wheat genotype DBW16 (with low NUE) and WH147 (with high NUE) hydroponically in N (2mM) and HD2967 (with low PUE) and WH1100 (with high PUE) in P (0.2mM) for 15 days and then N and P stress was imposed by transferring half of the plants to N (200µm) and P (20 µm) deficient medium. After 48 hrs samples of roots and shoots were collected for RNA isolation. Relative expression of gene involved in N and P uptake and transport such as *NPF* (NITRATE TRANSPORTER 1/PEPTIDE TRANSPORTER*)*, *NRT* (Nitrate reductase), *NLP* (NIN like protein), *IPS* (Induced by Phosphate Starvation 1) and *PHT1.7(*Phosphate transporter*)* were investigated in both efficient and deficient wheat genotypes. Among these *NLP* showed significant upregulation under N starvation condition in N efficient genotype (WH147) whereas *IPS* and *PHT1.7* showed significant upregulation under P starvation condition in P efficient genotype.

PD-152

Phenotyping of seed traits in mungbean minicore accessions using digital image analysis

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Phenotyping plays a key role starting form identification of sources for the trait, to selection and advancement of lines, and evaluation of cultivars prior to release. Grain weight and number per pod are the routine post-harvest parameters used by crop scientists for assessing performance of genotypes while other features of grains are often ignored due to constraints in phenotyping. Recent image analysis techniques offer opportunities to bridge this gap. Such techniques need to be optimized for high throughput assessment of individual seed which is practically difficult to do manually for large number of samples. Hence, experiments were conducted to optimize image based protocols for phenotyping seed morphological features in addition to grain number and grain weight. Seeds of 296 accessions of mungbean obtained from the World Vegetable Center, Taiwan were used for image analysis. For image acquisition, light illuminated setup was used to capture the images of 12192 seeds. Images were analysed by using ImageJ, an open-source software. Different seed parameters *viz*. Roundness, Feret Y, Feret angle, Feret X, Circularity, Solidity, Raw integrated density, Aspect ratio, Integrated density, Perimeter, Width, Height, and Feret diameter. These data could differentiate the origin of the seeds as the originating countries could be classified into different clusters. Among the seed parameters, roundness, solidity, feret angle and circularity showed high genotypic variation. Experiments are in progress to establish the relevance of these parameters to grain yield performance under harsh conditions. The present experiment could demonstrate that digital images can facilitate breeders attempt to phenotype large number of seeds in rapid and robust manner. Additionally, results from this experiment could reveal that seeds originating from the cluster of countries like USA, Australia, and Philippines were different from those originated from the Afghanistan, Nigeria, Taiwan and Thailand. Seeds originated from Brazil, France, Kenya, Iran, Iraq, India, Mexico, Netherland, S. Korea, Turkey were grouped in separate cluster. Thus, the image based protocol developed by us offer potential to provide better insights into the genotypic variation as well as origin of seeds, which needs to be further validated by assessing core collections.

PD-153

Genetic variability for translocation efficiency and grain filling traits in rice under high temperature stress

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The grain filling of rice is gets weakened by heat stress due to reduced spike photosynthesis at heat stress. An alternate source of carbon is stored stem reserves for grain filling. Rate of stem DM, TE (translocation efficiency) and CR (contribution rate), grain yield were monitored under control and high temperatures in the growth chamber. Cultivar N22 always sustained higher GFR (grain filling rate), TE and CR percentage as well as grain yield than CO51. Hypothesis of TE was evaluated under field condition since it acts as an important source of carbon for supporting grain filling rate under heat stress. Low sterility genotypes had a higher GFR and TE percentage at the onset of grain filling, greater depletion of stem DM and longer duration of grain filling. On the other hand, high sterility genotypes were more heat-susceptible in terms of higher spikelet sterility, higher panicle temperatures and lower GFR and reduced TE percentage at elevated temperature. This suggests that detailed physiological studies under controlled environment conditions compared to the field. Therefore, the superior capacity of low sterility genotypes including N22 for grain filling from mobilized stem reserves is a constitutive trait which supports grain filling under heat stress in rice.

PD-154

Contribution of pre- and post-anthesis photosynthates to pearl millet grains in a rain fed condition

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The presence of assimilate during the flowering and grain filling stage is subsequently remobilized to the development of grains which may act as a buffer against water scarcity during the flowering and grain filling stage in pearl millet. To determine the contribution of pre-and post-anthesis assimilates to grain yield under rain-fed condition, six pearl millet hybrids MPMH 17, MPMH 21, RHB 177, ABH 1200, Pusa composite - 443, and Pusa composite - 612 were grown at the farm of PC Unit, ICAR-AICRP pearl millet, Mandor, Jodhpur, India, over two growing seasons (*kharif* 2019 and 2020). Data were taken at two stages, i.e. before and after anthesis. Under the rain-fed condition, the maximum pre-anthesis assimilates were translocated to the stem and the minimum concentration to the panicle. In contrast, post-anthesis assimilates maximum in the panicle and minimum concentration in the leaf during both seasons. This study revealed that pre-anthesis assimilates contributed to 15-20 per cent while post-anthesis assimilates contributed to 45-65 per cent in grains development in pearl millet, it was maximum found in MPMH 17 and MHMH 21. Selection of such hybrids that have a higher percentage of post-anthesis would produce a higher grain yield. The finding would help select better suiting hybrids of pearl millet under rain fed conditions.

PD-155

Sugar accumulation and photosynthetic attributes of sugarcane genotypes grown under subtropical India

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Diverse varieties of sugarcane viz., CoLk 11206, CoLk 09204, Co 0238, Co 05011, CoLk 9709, CoLk 8001, CoLk 8102, CoPk 05191, CoLk 94184, BO 91, CoJ 64, CoPant 97222 were grown under field condition for evaluation of sugar accumulation, carbon fixation and other attributes related to gaseous exchange. All the parameters were recorded at 180 days after planting. Activities of various sucrose metabolising enzymes (Sucrose Synthase, Sucrose Phosphate Synthase and Invertases) were also recorded and significant variations observed during grand growth (GG) phase which marks the maximum sugar accumulation phase in sugarcane. Maximum photosynthesis rate was recorded in BO 91 which was at par with CoLk 8102 while transpiration rate was maximum and at par in CoLK 9709 and CoLk 8001. A measurement of relative leaf water contents revealed variety Co5011 to have highest water retention during GG phase. Other yield characteristics like number of millable cane (NMC), single cane weight, cane length, diameter and number of internodes were also recorded along with juice content in stalk. Sucrose content was found to be in the range of 11.04 to 14.23% and was highly correlated with the variation in activities of sugar metabolising enzymes. Differential response of sugarcane genotypes towards different physiological traits associated with sugar accumulation and photosynthetic traits indicate that variations for such traits is already existing in sugarcane genotypes which may be studied in detail for better understanding of sugar accumulation pattern in low sugar lines versus high sugar lines

PD-156

Physiology of flowering behavior in Jute (*Corchorus* sp.) and effect of foliar application of urea on flowering time

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The flowering behaviour of popular jute varieties were studied under field conditions. *Capsularis* varieties of jute follow a normal curve of flowering during the flowering period. The cumulative number of open flowers per five days was counted in case of *capsularis* varieties. The flowering period varies from 25 to35 days in case of capsularis varieties. The *olitorious* variety does not follow any specific pattern of flowering. The duration of flowering also varies among varieties from 21 to 31 days. To investigate the ability of foliar application of nitrogen in delaying flowering in jute, six commercial jute varieties have been tested. Four *olitorius* variety namely JRO-524, JRO-204, NJ-7010 and S-19 and two capsularis variety namely JRC-212 and JRC-517 were taken for this study. All varieties were early sown. We had applied 2% urea (w/v) at 25 days after sowing (DAS) and 40 DAS. It has been observed that application of nitrogen as urea does not have any significant effect on onset of flowering in these six commercial varieties. Flowering in 90% of the population has been considered as the onset in both the years. Thus we conclude that foliar application of nitrogen does not have the ability to delay flowering in jute.

PD-157

Impact of sowing time on growth and yield of black gram

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Black gram (*Vigna mungo* L.) is one of the important pulse crops grown in India by contributing about 10% to the total pulse production. In India, it can be cultivated in summer and kharif season and is grown mainly as arainfed crop. India, produces about 1.5 to 1.9 million tonnes of black gram annually from about 3.5 million hectares of area with an average productivity of 555 kg/ha. Field experiments were conducted at Centre for Environment Science and Climate Resilient Agriculture, Indian Agricultural Research Institute situated at New Delhi ($28^0$35'N and $77^0$12'E, 228.16 m above mean sea level), India to evaluate the effect of sowing time on growth and yield of black gram. Field experiment on black gram was conducted during the kharif season of year 2018. Crop was sown in four dates at every 15 days interval starting from the first sowing on 16-07-2018, second sowing on 30-07-2018, third sowing on 15-08-2018 and fourth sowing on 30-08-2018 in Randomized Block Design (RBD) with 3 replications. The parameters studied were the Leaf Area Index (LAI), Normalized Difference Vegetation Index (NDVI), seed yield and Harvest Index (HI). The maximum LAI and NDVI observed were 3.25 and 0.84 in second sowing followed by the crop sown in first (2.95, 0.78), third (2.80, 0.77) and fourth (2.70, 0.69) date of sowing. Black gram grain yield has also shown the same trend as maximum grain yield of 1237kg/ha was obtained in the second date of sowing followed by 1171 kg/ha, 1090kg/ha and 979 kg/ha grain yield in the first, third and fourth date of sowing, respectively. The maximum harvest index was in the crop of first sowing (0.24) followed by third (0.22) second (0.18) and fourth sowing (0.14). Results indicated that the date of sowing had significant impact on growth yield of black gram in Delhi region. Delayed sowing has resulted in reduced the LAI (10 to 17%), NDVI (7.2 to 17.8%) and grain yield (up to 20%) as compare of second date of sowing (July last week) which is found to be better sowing time (among four sowing times tested) for black gram in Delhi region.

PD-158

Phenomics for crop improvement

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The whole-genome sequencing has been made possible of many crops which necessitates for big-data and high-throughput technologies in crop functional genomics studies. But large-volume of phenotypic data has become major limiting step in crop breeding and functional genomics. So, reliable, automatic and high-throughput phenotypic technologies are required for quick and significant genetic gain in breeding programs. This led to emergence of new field called 'phenomics.' Over the years, many automatic and high-throughput phenotyping platforms have come up for screening different crop species like *Arabidopsis,* rice, maize *etc.* Particularly, *Arabidopsis thaliana* used as a model plant due to life cycle, small genome also its closeness with Brassicaceae family. Various breeding studies likewise of forward genetics, reverse genetics, and quantitative genetics relies on automated and large-scale phenotyping under controlled environmental conditions. Various platforms like PHENOPSIS was dedicated for *Arabidopsis* responses to water deficit later on extended as PHENOPSIS DB. On the same line GROWSCREEN was developed to measure the dynamics of seedling growth acclimation (total leaf area, relative growth rate, and root area) under altered light conditions.

PD-159

Determination of heat susceptibility indices for some quantitative traits in bread wheat

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The present investigation entitled “Determination of heat susceptibility indices for some quantitative traits in bread wheat” was undertaken to understand the impact of higher temperature on yield attributing characters and to select higher heat stress tolerant genotype for future breeding programme. To fulfill the requirement of this objective, the experiment was conducted at Post graduate Institute, MPKV, Rahuri in two environments i.e. normal (15th Nov.) and late sown (15th Dec.) condition with 23 diverse genotypes. In the present study, the HSI value of parents and crosses for different quantitative characters was calculated and genotypes were classified in to four different categories i.e. highly heat tolerant (HSI < 0.50), heat tolerant (HSI: 0.51-0.75), moderately heat tolerant (HSI: 0.76 – 1.00) and heat susceptible (HSI > 1.00). The overall ranking of heat susceptibility index indicated that among the genotypes NIAW 1994, NIAW 2304, NIAW 2275 and NIAW 2348 were found to be desirable for most of the characters as they attained HSI value less than 1.

PD-160

Determination of heat susceptibility indices for some quantitative traits in bread wheat

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PE-161

Applications of CRISPR/Cas9 technology for gene editing in rice

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Clustered Regularly Interspaced Short Palindromic Repeats/CRISPR-associated protein 9 system (CRISPR/Cas9) has emerged as the method of choice for site-directed mutagenesis in plant genes. This system consists of a guide RNA that contains sequence complementary to the target gene and a Cas9 protein which is an endonuclease that makes double stranded cut at the site marked by gRNA. The applications of CRISPR/Cas9 using single and multiple gRNAs have been successfully utilized in targeting different plants to alter agronomic traits including tolerance to biotic and abiotic stresses. Here, we have adopted different strategies to create loss of function mutants and precise editing of genes involved in rice tolerance to phosphate deficiency response. Our results demonstrate a high rate (up 80%) of targeted mutagenesis in a rice galactolipid synthesizing gene, *OsMGD3.* In another approach, we used a multiplexing CRISPR/Cas9 strategy to re-architect promoter of a phosphate transporter gene *OsPHO1*. The promoter of *OsPHO1* has two W boxes which are putative binding sites for the WRKY transcriptional factors that acts as negative regulator for its expression. In this system, we intended to use the multiple gRNAs cloned in a single Polycistronic-tRNA-gRNA (PTG) gene to remove those W-boxes present in the promoter of *OsPHO1*. Although efficiency was low, gene-edited plants displayed a W-box less promoter and consequently, enhanced expression of *OsPHO1*.Together, these findings demonstrate applications of CRISPR/Cas9 technology in efficient gene-editing in rice for crop improvement using single or multiple gRNAs.

PE-162

Physiological analysis of the effect of altitudinal gradients on *Abies spectabilis* on the Tungnath, Western Himalaya

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High-altitudinal gradients can have a detrimental impact on plant dispersion as well as restrict plant development and reproduction. In compared to lowland plants, most high-altitude plant species are isolated and have a limited number of niche habitats. Because of their narrow altitudinal distribution ranges, endemic species are most commonly endangered at high altitudes. The habitats of High-altitude are largely affected by climate restrictions, and most plants thrive only near their climatic boundaries. However, less is known how forest growth responds to climatic change along elevation. Information about the seasonal changes in plant enzyme activity along altitudinal gradients is key for understanding the responses of plant biochemical processes to ongoing climate change. Therefore, experiment was conducted for the four seasons in *Abies spectabilis* (D. Don) Mirb., which were obtained from an alpine region of the Tungnath, western Himalayas. To evaluate the effect of altitude on the physiological characteristics of *Abies spectabilis* (D. Don) Mirb., we measured the lipid peroxidation, chlorophyll quantification, proline, and the activities of superoxide dismutase (SOD), peroxidase (POD) in leaves from below and above the treeline in Tungnath, which is the part of Western Himalaya. The leaves were collected for the four times (March, May, July, September) and the average vertical distance between two adjacent collection sites was approximately 100 meters. This study provided some supporting evidence for the negative effects of altitudinal gradients on *Abies spectabilis* (D. Don) Mirb. growth on the Tungnath. The accumulation of secondary metabolites (SMs) has been shown to play an important role in tolerance to various environmental biotic and abiotic stresses.

PE-163

Foliar application with plant-derived smoke-water and karrikinolide boosts the essential-oil yield, active constituents and leaf physiological parameters of *Mentha arvensis* L.

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Plant-derived smoke-water (PDSW) plays a significant role in seed germination, seedling growth and other physiological attributes. Karrikinolide (KAR1), extracted from plant-derived smoke-water, enhances the growth and physiological attributes in various plant species. To ascertain the effect of PDSW and KAR1, a net-house experiment was conducted on *Mentha arvensis* L., which is a perennial plant, carrying medicinal, aromatic, antiseptic and anaesthetic properties. Various concentrations of PDSW (1:125v/v, 1:250 v/v, 1:500 v/v and 1:1000 v/v), KAR1 (10^{-6} M, 10^{-7} M, 10^{-8} M and 10^{-9} M) were applied as foliar sprays, using double distilled water as control treatment. PDSW treatment 1:500 v/v and KAR1 treatment 10^{-8} M increased the length of shoot and root of the plant. Leaf physiological-parameters, viz. chlorophyll fluorescence, PSII activity and total chlorophyll content were also increased as a result of application of these treatments (1:500 v/v of PDSW and 10^{-8}M of KAR1). In addition, these treatment also significantly increased the essential oil yield and active constituents of *Mentha arvensis* compared to the control treatment. Results indicated that PDSW, being a cheap source of karrikins, might be successfully used to augment the production of mint essential oil and its quality.

PE-164

Responses of plant growth and functioning to changes in water supply in a changing climate

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Several environmental factors adversely affect plant growth and development and final yield performance of a crop. Environmental variation as a result of human activities, such as continuing increases in concentrations of ozone in the atmosphere, will also impact significantly on plant water relations and interact with the other important climatic variation. As rainfall patterns become more unpredictable as climate changes, plants will be subjected to increasing fluctuations in soil moisture availability. Clearly that reductions in plant growth can be brought about by only very small reductions in water and nutrient availability. Excessive precipitation resulting in inundation of soil will reduce the partial pressure of oxygen around the roots of plants, which usually reduces their hydraulic conductivity, thereby reducing water uptake. Therefore, rather counter-intuitively, plant water deficits can result, even when there is plenty of water available in the soil. Such changes in plant water status will reduce plant growth, as will any additional flood-induced chemical perturbations, including modifications in hormone content of the soil and the plants and the accumulation of toxic metabolites. Under drought the plant hormone ethylene can be involved in both the suppression of root growth during soil drying and the suppression of leaf growth via long-distance chemical signalling, again emphasizing a key role for this hormone in the regulation of plant production in water scarce environments.

PE-165

Exogenously-sourced ethylene expresses *psbA* and *psbB*, coordinately modulates photosynthetic activity, carbohydrate metabolism, and antioxidant activity for high temperature stress tolerance in rice

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The effects of exogenously-sourced ethylene (as 200 µL L^{-1} ethephon) on photosynthesis, carbohydrate metabolism, and high temperature stress tolerance in two rice (*Oryza sativa* L.) cultivars, Taipei-309 and Rasi, exposed to a temperature of 40°C for 6 h per day over 15 days, then allowed to recover at 28°C, was studied. Heat-stressed plants showed increased oxidative stress, with higher levels of H_2O_2 and TBARS (thiobarbituric acid reactive substances), as well as significant declines in sucrose and starch contents and carbohydrate metabolism enzyme levels, leading to reduced photosynthesis. In the tested rice cultivars, exogenous ethephon improved both photosynthesis and carbohydrate metabolism and reduced oxidative stress by enhancing the enzymatic antioxidant defense system and lowering H_2O_2 and TBARS levels; both cultivars exhibited improved growth and yield, particularly Taipei-309. The genes *psbA* and *psbB*, which encode core proteins of photosystem II, were highly up-regulated in ethephon-treated heat-stressed plants, indicating that ethylene positively impacted photosynthesis under high temperature stress. Foliar application of ethephon, on the other hand, effectively down-regulated high temperature stress-induced elevated ethylene biosynthesis gene expression. Overall, ethephon application under high temperature stress optimized ethylene levels to regulate carbohydrate metabolism and the antioxidant enzymatic system, reducing the adverse effects. These findings suggest that ethylene regulates photosynthesis via carbohydrate metabolism and the antioxidant system, thereby influencing high temperature stress tolerance in rice.

PE-166

Biopriming of rice (cv.CO5) for enhancement of seed germination and seedling vigour

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An experiment was conducted under laboratory conditions in rice (cv. CO5) to find out the effect of biopriming on seed germination and seedling vigour at Agricultural College and Research Institute (TNAU), Madurai during 2018. The seeds were soaked with *Trichoderma viride* (40%, 60% and 80%), *Pseudomonas flurosecens* (40%, 60% and 80%), Azosprillium, (10%, 15% and 25%) and phospho bacteria (10%, 15% and 20%) in different durations viz., 6, 12, 18 and 24 hours. In addition to the above treatment, the seeds were also treated with water (hydro primising) in 6, 12, 18 and 24 hours duration. The untreated seeds (nonprime) were also maintained as control. The observations on seed germination, speed of germination DMP and shoot length, root length, total chlorophyll content, total free amino acids, amylase activity, starch content and vigour index were assessed and the data were statistically analyzed. The results revealed that the seeds soaked with *Trichoderma viridie* for 12 hours registered higher seed germination percentage, enhanced amylase activity, higher starch content, free amino acid content, reducing sugars than the non primed seeds (control). The seedling of the above treatment also recorded higher vigour index, total chlorophyll content and total dry matter production

PE-167

Arabidopsis exhibits differential immune response by alteringproline metabolism during defense against host and nonhost pathogen infection

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A host-pathogen surpasses the plant defense machinery and successfully infects the plant to serve its needs. In contrast, a nonhost pathogen is restricted by activated plant immune responses. In this study, we deciphered the differential responses of Arabidopsis against the host-pathogen (*Pseudomonas syringae* pv. *maculicola, Psm*) and the nonhost pathogen (*P. syringae* pv. *tabaci, Psta*) infection. The *Psta* multiplication was restricted in Arabidopsis plant coinciding with the absence of any disease symptoms which was also associated with the increase in defense associated, *pathogenesis related gene1* (*PR1*) expression and callose deposition. Host-pathogen infection, on the other hand, caused chlorotic symptoms with much less activation of the defense marker genes compared to the nonhost infection. Proline content was decreased in plants infected with *Psm* but not in case of *Psta* infection. Proline is a crucial plant metabolite, and its pathway is suggested to be involved in plant defense responses. However, the role of proline pathway under a susceptible or resistance response has not yet been unravelled. The expression profile of proline metabolism genes in a time course post-infection revealed drastic differences after *Psm* and *Psta* pathogen infection. The elevated expression of proline catabolic genes, *AtProDH* and *AtP5CDH*were noted under *Psm* infection. In contrast, plants infected with *Psta* showed upregulation of *AtProDH* but a decline in*AtP5CDH* transcripts along with an upregulation of the biosynthesis genes i.e. *AtP5CS* and *AtP5CR*.Our study shows that proline metabolism is tightly regulated under host and nonhost pathogen infection and impacts susceptibility and resistance of the plants, respectively.

PE-168

Absorption pattern of chromium in *Strobilanthes alternata* (Burm. F.) E. moylan ex J.R.I. wood cultivated in hoagland medium artificially contaminated with this metal

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Strobilanthes alternata is well known medicinal plant for its wound healing property. This plant is found to be highly sensitive to chromium. In the present study, rooted cuttings were exposed to potassium dichromate in Hoagland nutrient medium. Immediate response of the plant towards this metal is observed in morphology and anatomy. Presence of stained bodies in stem and root of treated plants indicates the presence of chromium in the plant body. Occurrence of stained particle deposits and their distribution are found to be a mechanism for sequestration of chromium in *S. alternata*. Impact of chromium on plant growth and development and the influence of Cr and/or deterioration of medicinal properties of *S. alternata* are discussed.

PE-169

Impact of aluminium, chromium, copper and mercury in morphology of *Artemisia nilagirica* (Clarke) Pamp.

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Toxic effect of heavy metals such asAl, Cr, Cu and Hg was studied in *Artemisia nilagirica* (Clarke) Pamp. This shrub is an important medicinal plant. Rooted propagules of plant were grown in Hoagland nutrient medium contaminated with known concentrations of Aluminium chloride, Pottassium dichromate, Copper sulphate and Mercuric nitrate. Due to the treatment of these metals morphology of *Artemisia nilagirica* remarkably changed. It shows significant impact in plant morphology in terms of stem length, root length, tolerance index and leaf area as compared to control plant. Such altered morphology indicates that these heavy metals should adversely affects the healthy growth of *Artemisia nilagirica*. This may retar medicinal value of the plant.

PE-170

Physiological basis of growth and yield of low land rice cultivars grown under low light environment

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Rice is the world's main food crop. It secures millions of people's livelihoods globally, notably in Asia's poorest regions. Abiotic stress such as salt, drought, hot and cold temperatures, and light intensity all affect rice yield. Low light stress is one of the most persistent abiotic stresses impacting rice yield in India, mainly in Eastern and North Eastern states, where it has a considerable impact on agricultural productivity. Low light conditions impair rice production, affecting not only duration but also physiological and agronomic aspects. Considering the growing threat, many attempts have been made to unravel the molecular, biochemical, and physiological mechanisms of low light stress. The entire experiment was placed at the National Rice Research Institute in Cuttack, Odisha, during the 2016 and 2017 *kharif* seasons. The experiment used a Randomized Block Design and included hundred rice genotypes. Ten genotypes were chosen for *kharif* 2018 and 2019 (used as seed material for detailed investigation). Three replications of the experiment were conducted during the *Kharif* season under Normal Light, 75 percent light intensity (25% light cut off), and 50% light intensity (50% light cut off). The treatment of low light was imposed by installing agro-shade nets of varying light intensities matted to the hardwood frame. At 30 days after treatment, Swarnaprabha and IR-8 were used as tolerant and susceptible checks, respectively. The number of tillers m^{-2}, panicle m^{-2}, specific leaf area (SLA), specific leaf weight (SLW), root length, root weight, shoot length, shoot weight, yield attributing parameters Attributing characteristics for yield were recorded during flowering and harvesting stages. On the other hand, biochemical parameters (total chlorophyll, total soluble sugar, Superoxide Dismutane, Catalase) were recorded. Panindra, PS-3, and Swarnaprabha outperformed other rice genotypes in low light circumstances. Panindra outperformed all other kinds in terms of grain yield, thousand grain weight, and Harvest Index. We analysed the expression of genes involved in photosynthesis and starch production, i.e. the Source-Sink idea. Under low light stress, selected genes in Panindra, PS-3, and Swarnaprabha showed non-significant down regulation, whereas HKR-126 and IR-8 showed considerable down regulation. They show that light influenced photosynthetic and starch biosynthesis genes. The results suggest that the selected tolerant genotypes (Panindra, PS-3, and Swarnaprabha) could be used as model plants for low light tolerance in crop plants.

PE-171

Desiccation tolerance of Photosystem II in Wild species of Eggplant

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The magnitude of abiotic stresses is being exacerbated due to the global climate change. Among them, water stress is of major concern. The reduction of soil moisture content leads to leaf desiccation that affects the physiological functions and processes in the plant system. The Photo System-II (PS II), which is an important component of photosynthesis process in the plant, is highly sensitive to the water stress. This can be more conspicuous in vegetable crops that require more water particularly in semi-arid and high temperature environments. Among vegetable, eggplant is major crop grown across the country throughout the year and hence often exposed to soil moisture stress. Therefore, there is need of moisture stress tolerant cultivars and genetic source for improving water use efficiency in eggplants. Wild species of eggplant naturally grow in very harsh conditions and hence can be the potential source for tolerance to water stress. In the present experiment we screened the different wild species of eggplant including commercial cultivated species for the leaf desiccation tolerance. The leaves of five different species were allowed to desiccate upto 54 hours for comparison with respective controls without desiccation. PS-II efficiency of leaves and leaf water content in desiccated and non-desiccated treatments were monitored at regular time interval. The results clearly revealed that among the different species, *Solanum macrocarpum* had the significantly less reduction in PS-II efficiency in response to desiccation. Hence, it clearly revealed that *Solanum macrocarpum* can be the potential donor species for imparting water stress tolerance traits in cultivated species.

PE-172

Mulberry *MaLTIP* gene undergoes alternative splicing in response to drought stress

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Perennial tree systems like mulberry are routinely exposed to variable environmental variations. Plant-environment interaction governs phenotypic behaviour, and abiotic stresses like drought affect growth and development by altering the expression of trait-specific genes that are regulated mainly at transcriptional, post-transcriptional, and translational levels. One of the post-transcriptional regulatory mechanisms is alternative splicing (AS), which plays a key role in developmental processes, contributing to mRNA and protein diversity. In this study, we are reporting AS events in drought-responsive genes in mulberry experiencing drought stress. From the drought-specific transcriptome data generated in our previous study, we analyzed AS event in a novel downstream drought-responsive gene called *MaLTIP* (low temperature-induced protein). Northern expression analysis indicated the stress-responsive nature of the gene. To analyze the AS in mulberry, plants were established in pots under rain-out shelter, and drought stress was imposed by gravimetric approach. The stress effect was assessed by recording different physiological and biochemical parameters after 14 days of drought imposition and leaf tissue was collected for the analysis of AS events. Expression analysis of LTIP by RT (Reverse transcription)-PCR indicated the presence of transcript variants and the variant of size 1500bp was specific to drought treatment (40% soil field capacity). The identity of the splice variant was confirmed by sequencing. This is the first report on the presence of splice variant in LTIP and its biological relevance need to be examined. The determination of mode of alternative splicing event and its corresponding variant's biological significance would add on to the knowledge of the stress tolerance mechanism in mulberry.

PE-173

Mechanisms of salinity tolerance

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The physiological and molecular mechanisms of tolerance to osmotic and ionic components of salinity stress are reviewed at the cellular, organ, and whole-plant level. Plant growth responds to salinity in two phases: a rapid, osmotic phase that inhibits growth of young leaves, and a slower, ionic phase that accelerates senescence of mature leaves. Plant adaptations to salinity are of three distinct types: osmotic stress tolerance, Na^+ or Cl^- exclusion, and the tolerance of tissue to accumulated Na^+ or Cl^-. Our understanding of the role of the *HKT* gene family in Na^+ exclusion from leaves is increasing, as is the understanding of the molecular bases for many other transport processes at the cellular level. However, we have a limited molecular understanding of the overall control of Na^+ accumulation and of osmotic stress tolerance at the whole-plant level. Molecular genetics and functional genomics provide a new opportunity to synthesize molecular and physiological knowledge to improve the salinity tolerance of plants relevant to food production and environmental sustainability.

PE-174

Decline of saffron production due to change in climatic conditions in Kashmir valley

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Kashmir is the second largest producer of saffron in the world after Iran and is only state in the country where saffron is being cultivated. Saffron (crocus-sativus) originating from the Arabic word 'zafaran' meaning yellow, is a fascinating spice steeped in rich history. This "golden spice" is known as 'kumkum' and 'kesar' in Sanskrit and koung in Kashmiri language. Saffron is grown on uplands terms in the local language as "karewas" located at an altitude of 1585 to 1677m above mean sea level, under temperate climatic conditions. The vivid crimson and stigma called threads, are collected and dried for use mainly as a seasoning and colouring agent in food. Saffron has long been the world's most costly spice by weight. Saffron's taste and iodoform like or hay like fragnance result from the phytochemicals picrocrocin and safranal. It also contains a carotenoid pigment, crocin, which imparts a rich golden-yellow hue to dishes. Saffron known the world over as the "golden condiment" because of its extreme high cash value and low volume and this great commercial activity and is known as 'golden zest' in Indian agriculture. Saffron is used for asthma, cough, whooping cough (pertussis). It is also used for sleep problems (insomnia), cancer," hardening of the arteries", intestinal gas, depression, fright, shock, spitting up blood, pain, heart burn and dry skin. It is also used to induce sweating. Some people apply saffron directly to the scalp for baldness. In foods, it is used as a spice, yellow food colouring and as a flavouring agent. In manufacturing, saffron extracts are used as fragnance in perfumes and as a dye for cloth. Recent scientific findings have been encouraging, uniformly showing that saffron and its derivatives can affect carcinogenesis in a variety of in vivo and in vitro models particularly crocin and crocetin have anticancer activity in breast, lung, pancreatic cancer. This colourful spice has many non-volatile active components, the most important of them is a crocin, a carotenoid compound, which gives pistils their characteristic golden yellow colour. The active components in saffron have many therapeutic applications in many traditional medicines as antiseptic, antidepressant, anti-oxidant, digestive and anti-convulsant it is rich in many vital vitamins including vitamin A, folic acid, riboflavin, vitamin-c that is essential for optimum health.

PE-175

Correlation funnel: next-generation exploratory association analysis

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A correlation coefficient is a simple exploratory analysis widely used in the life sciences. They form the building blocks of virtually all multivariate data analysis. Correlation coefficient analysis discovers the relationship, degree and direction of relatedness between the two numeric variables. Although it is quite simple and intuitive, its assumptions of linear relationship and absence of heteroscedasticity between variables, observation within variables must be independent, continuous, large, normally distributed and free from outliers. A person's correlation coefficient matrix is most frequently used and due to its assumptions, their estimate is arbitrary and does not represent the realistic association in the biological system. In present investigation, forty homozygous mungbean genotypes and their observation recorded for seed yield and its eleven yields attributing traits were used as variables. A novel method of association analysis was undertaken using a correlation funnel based on binary correlation analysis. Seed yield per plant considered as the target variable; while the remaining variables as the response variable. Seed yield per plant had higher threshold values for harvest index, days to maturity, days to 50percent flowering and pod length; while lower threshold values for test weight, number of branches per plant, number of seeds per pod, plant height, and number of pods per plant. To achieve, desirable target for higher seed yield per plant, threshold values of response variables: Test weight up to 3.03grams, harvest index above 34.54percent, number of branches up to 3, days to maturity greater than 68days, number of seeds per plant up to 6.5, pod length up to 9.93cm, plant height up to 35.66cm, days to 50percent flowering greater than 33.25 days and number of pods per plant up to 18.59. From this study, it is clear that correlation funnel analysis provides more realistic estimates along with threshold values for the response variable. Threshold values showing positive correlation are represented on the right of the correlation funnel. It takes into consideration both linear and non-linear relationships between variables and can work with both quantitative and qualitative variables, present in biological and physiological systems. Thus, the correlation funnel is a better choice than the correlation matrix.

PE-176

Evaluation of sunnhemp genotypes for green manuring

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Fourteen sunnhemp genotypes were evaluated for morphological traits and it's nutritional status during kharif-2021. The actual growth period for green manuring purpose was ranged between 65.00 and 68.00 days. The effective growth periods were 35.81 and 40.54, 38.44 and 41.74, 21.38 and 22.71 for plant height, number of branches per pant and number of leaves per plant, respectively. The genotypes, JRJ-610, SIN 28, SIN-37, SIN-44 and SUIN-053 were found better for green biomass production along with addition characters, viz. Plant height, number of branches or number of leaves. The genotypes, JRJ-610 and SIN-25 for nitrogen content, SIN-37, JRJ-610 and SIN-21 for phosphorus content and SIN-25 and JRJ-610 for potassium content were found promising for respective characters. The genotypes, SIN-25 and SIN-45 added maximum amount of nitrogen content, whereas, JRJ-610 and SIN-37 added maximum phosphorus and potassium content in soil. On the basis of overall performance, The genotype JRJ-610 attained maximum green manuring characters.

PE-177

Identification of dual-specificity kinase specific threonine phosphorylation sites imparting dual-affinity to nitrate transporter (*NRT1.1*) in various monocots and dicots

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The switching of affinity in *AtNRT1.1* gene providing 'dual-affinity' function due to phosphorylation of Threonine (Thr) residue at position 101in Arabidopsis is well characterized. We conducted a comprehensive study including monocots (*Oryza sativa indica, O. sativa japonica*, *Triticum aestivum*, *Brachypodium distachyon*, *Zea mays*, *Hordeum vulgare,* and *Sorghum bicolor*) and dicots (*Arabidopsis thaliana* and *Glycine max*) to identify the position that might provide dual-affinity to *NRT1.1*. The coding DNA sequence of *AtNRT1.1* was used as a reference. The homologous sequences having maximum percent similarity (>60%), high query coverage, and all the motifs and domains as in *AtNRT1.1* were chosen for further analysis. The*AtNRT1.1*possessed five exons and four introns whereas the number of exons and introns ranged from twoto fiverespectively in other selected plant species.The NRT1.1 protein contained 12 transmembrane helices except in *T. aestivum*on A genome. The identified dual-specificity kinase specific phosphorylation sites (p-sites) of The residues were found to be deleterious (PROVEAN score between 3.85 to 4.05) and were present either inside the cytoplasm or on the transmembrane helix. However, no phosphorylation sites were found in NRT1.1 of *T. aestivum* and *H. vulgare.* Thirty-five putative chemical substrate binding pockets were identified in the proteins of selected monocots and dicots, out of which 18 were highly conserved. Based on these analyses it is suggested that the deleterious dual-specificity kinase specific Thrphosphorylation sites may serve as a potential target to alter *NRT1.1* to act asdual-affinity nitrate transporter that might enhance nitrate uptake.

PE-178

Development of ihpRNA Vector against BBrMV replicase and movement protein gene

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Banana, worlds most important fruit crop and source of staple meal for millions of people. Banana production and cultivation is hampered by various biotic and abiotic factors; the *Banana Bract Mosaic Virus* (BBrMV) is one of them. As of now no resistance source has been reported for this disease. So, the objective of the present study was to develop intron hairpin RNA (ihpRNA) vectors for BBrMV targeting replicase (Rep) and movement protein (Mvp) genes. Partial Rep and Mvp genes were amplified using PCR from infected plants. Amplified products were sequenced and analysed using BLASTn, Restriction mapping and Dicer substrate siRNA prediction tool. Based on the in silico analysis, 357bp sequence for Rep, 224 bp for Mvp and 647bp for combination of Mvp-Rep genes together were amplified using respective sets of primers anchored with restriction sites (*Kpn*I and *Spe*I restriction sites for sense and *Asc*I and *Pac*I sites for antisense strand). Amplified products were cloned into a pJET cloning vector. Later cloned fragments were released from the pJET vector with respective restriction enzymes to generate the fragments with sticky ends. Generated fragments were ligated into the pSTARLING vector along the sides of *cre* intron for the formation of hairpin structure. Presence of the insert was confirmed with restriction digestion. For *Agrobacterium* mediated transformation, ihpRNA cassettes were removed from pSTARLING by digesting with *Not*I enzyme. Then ligated at *Not*I site within the *lacZ* gene of pART27. Transformed white coloured colonies were confirmed for the incorporation of ihpRNA cassette using PCR. The binary vector with the insert was moved to *Agrobacterium tumefaciens* and ihpRNA inserts were confirmed by PCR and restriction analysis.

PE-179

Growth improvement through drought mitigation in cowpea grown under residual moisture conditions

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A field experiment on physiological approaches for drought mitigation in cowpea (*Vigna unguiculata* L.) was conducted during *rabi*2019, at MARS, UAS, Raichur. The experiment was laid out in randomized complete block design with three replications and thirteen treatments. Foliar spray was taken at 50 % flowering stage. Basal dosage of fertilizer 25:50 kg N: P_2O_5 ha^{-1} was applied to all plots. Among the treatments, foliar spray of pulse magic and chickpea magic @ 8 g l^{-1} had the profound effect in improving the growth attributes *viz*., plant height, leaf area index, leaf area duration, crop growth rate, specific leaf weight and net assimilation rate.

PE-180

Effect of salinity stress on morphological, biochemical traits and its correlation with yield of grain Amaranth

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Salinity is a major abiotic stress, altering growth, physiological, biochemical and molecular attributes of plants. Grain amaranth, belongs to the family *Amaranthaceae* and genus *Amaranthus* is an important C_4 crop cultivated in tropical region of world. In the present investigation pot experiment was laid out in factorial completely randomized design, with 10 genotypes in three replications under different level of salinity viz., control, 5 dS m^{-1} and 10 dS m^{-1} conditions, to study the effect of salinity on growth, biochemical traits and its association with yield. It was recorded that SUVARNA have higher plant height at 5 dS m^{-1} than all the genotypes while at 10 dS m^{-1} GA-5 maintained the maximum height. Leave area $plant^{-1}$ was maximum recorded in genotype GA-4 at 5 dS while GA-1 at 10 dS.GA-5 maintained the maximum value for shoot and root biomass at 5 dS m^{-1} and 10 dS m^{-1}.GA-5 maximum membrane stability, relative water content, leaf potassium content and minimum leave Na^+ content under salinity stress. Chlorophyll content was maximum recorded in genotypes SUVARNA under all the treatments, while leave carotenoid content was maximum in genotype EC-198122 at 5 dS while SUVARNA have maximum value at 10 dS. The maximum yield was recorded in GA-3 and EC-198127 which is at par with GA-1 and NIC-22553 at 5 dSm^{-1} while at 10 dSm^{-1} the maximum yield was recorded in EC-198127 which is at par with NIC-22553. The salt tolerance index was recorded maximum in EC-198127 at 5 dS and 10 dS. Yield of grain amaranth was positively correlated with plant height, leaf number, leaf area, shoot dry weight, root dry weight, total chlorophyll, total carotenoid and leaf potassium content. These traits may be utilised as markers for development of salt tolerant cultivar of grain amaranth.

PE-181

Jelly seed formation in mango, possible causes and its management

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Physiological disorders associated with mango caused enormous losses by reducing the quality of the fruits thereby affecting their consumer acceptability. The problem of pulp tissue softening (jelly seed) disorder is very high in Dashahari mango, hence need major attention. Jelly-seed is a breakdown of mesocarp in the area surrounding the seed (stone). The affected portion develops off-flavour and may become dis-coloured in later stages. Due to Jelly seed problem, the Dashehari mango growers are facing problems in terms of poor market price, consumer acceptability and which also hampered its export potential. This problem in mango, attracted many researcher in recent years in order to investigate the incidence level its possible causes, but the exact cause of problem is still not clearly understood. The maximum incidence of JS was noticed in the fruits that harvested after second week of June or after. Further, the incidence was higher in tree ripened fruits as compared to artificially ripened fruits. Till date no clear cut mechanism of JS formation was established by researcher, although various theories have been proposed. In recent year researchers from IIHR reported that JS formation in 'Amrapali' mango arose at the start of germination-associated events in the seed of developing fruit. At molecular level, ERF21 and ERF39 plays important role during mango ripening and jelly seed formation. ACS10 and ACS12 are involved in development and ripening. 6 different TIFY transcription factors genes/transcripts (MiTIFY3B, MiTIFY4B, MiTIFY5A, MiTIFY6B, MiTIFY9, MiTIFY10A) in the fruit transcriptome data of mango jelly seed tissue was observed. Further, various chemical treatment have been proposed by researchers, in order to mitigate the problem. Among these solutions, Calcium application got maximum attention because Ca^{+} ion play important role in membrane stability *via* link between Ca and phosphate group of phospho-lipid and carboxyl group of protein on the surface of membrane, and cell integrity. During fruit senescence, the soluble calcium in the fruit decreases and the fruit cell wall degrades, resulting in physiological disorder metabolism of the fruit and consequently fruit decay and deterioration.

PE-182

Study about the physical properties of Henna crop in Pali (sojat) District, Rajasthan, India

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Henna, (*Lowsonia Inermis* L), is one of the rainfed plantation crop commercially in Rajasthan on 32,084 ha for its leaves, which are important source of a natural dye. The present study has assessed the physical properties of henna crop. The various physical parameters of henna crops such as Length, diameter of steam and canopy of crop, were studied in Pali district, (R.J.). there is two varieties of henna were available in Pali District (R.J.). It was found that henna plant length: 2000 to 2500 mm, diameter: 20 to 30 mm. The parameters depend on their variety, soil and climatic condition.

PE-183

Pre-harvest application of ethrel and potassium schoenite on yield, quality, biochemical changes and shelf life in crimson seedless grapes

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The field study was carried out at ICAR-National Research center for grapes during the year 2020-2021, to know the effect of potassium schoenite and ethrel on yield, quality, biochemical changes and post harvest losses of Crimson Seedless grape. The experiment comprised of five treatments laid out in randomized block design and replicated thrice. The foliar application of potassium schoenite (2.50 g/L and 5.00 g/L) and ethrel (300 and 600 ppm) was carried out at veraison stage. Results obtained from this study revealed that the yield and quality parameters were highest in treatment potassium schoenite @ 5.00 g/L. whereas, biochemical parameters recorded highest in treatment ethrel @ 600 ppm. Anthocynin content increased with application of ethrel @ 600 ppm it enhance the colour of berry results in better quality of grapes. Potassium schoenite (5 g/L) and ethrel (600 ppm) applied at the time of varaison stage reduces the physiological loss in weight ultimatly it increased the shelf life of Crimson Seedless grape. From this investigation, it is concluded that potassium schoenite (5 g/L) found best for improvement of yield parameters. Whereas, ethrel found best for increasing anthocynine content in berry it enhance the colour of grape berry.

PE-184

Effect of chlorimuron herbicides on physiology of growth and quality of soybean

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Soybean (*Glycine max*), also called golden bean or soja bean, annual legume of pea family (Fabaceae) and its edible seed. The soybean is economically the most important bean in the world, providing vegetable protein for millions of people and intergradient for hundreds of chemical products. A field experiment was conducted during kharif season 2018 at Research Farm, Department of Agronomy, JNKVV, Jabalpur (M.P) to study the effect of chlorimuron herbicides on physiology of quality of soybean (*Glycine max* L.). The research was laid out in randomized block design with 03 replications and 07 treatments viz; T1 (Chlorimuron @4 g ha^{-1}), T2 (Chlorimuron @ 6 g ha^{-1}), T3 (Chlorimuron @ 9 g ha^{-1}), T4 (Chlorimuron @12 g ha^{-1}), T5 (Chlorimuron + Quizalofop @ 9+50 g ha^{-1}), T6 (Hand weeding 20 and 40 DAS) and T7 (Weedy check). The present research highlighted that the treatment T6 (Hand weeding 20 DAS and 40 DAS) were found more effective in controlling weeds improving quality of soybean seed viz. Protein (40.16%), fat (21.64%), total carbohydrate (21.17%), crude fiber (8.23%), ash (5.36%) in soybean seeds recorded maximum in case of hand weeding (20 and 40 DAS) treatment followed by combined application of Chlorimuron+ Quizalofop 9+50 g ha^{-1} protein (39.24%), fat (20.36%), total carbohydrate (20.54%), crude fiber (8.09%), ash (5.12%) respectively. Yield and yield components viz., plant height, number branches $plant^{-1}$, total number of nodes $plant^{-1}$, number of effective nodes $plant^{-1}$, number of seeds pod^{-1}, pods length, pods width, pods girth, seed index, seed yield and biological yield were significantly superior under hand weeding treatment, followed by application of Chlorimuron + Quizalofop (9+50 g ha^{-1}) as post emergence while minimum recorded in control (weedy check). Key words: soybean, herbicide, hand weeding, etc.

PF-185

Physiological and metabolic dynamism in *Oryza sativa* (var. Varsha) subjected to Zn toxicity

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The excessive use of fertilizers and fungicides in arable lands creates a negative impact on the growth of different crop plants. *Oryza sativa*is one of the important staple food crops with metal tolerance potential. To analyze the excess zinc (Zn) induced modulation in the physiology and metabolism of *O. sativa* (var. Varsha), 45 d old plants were exposed to 1.95 g Zn Kg^{-1} soil. Zinc toxicity significantly reduced total chlorophyll content, carotenoid content, and $F_V/F_M$of*O. sativa.* Moreover, Zn restricted the stomatal opening that causes a reduction in the gaseous exchange. The circular-shaped special structures seen as an opening on the leaf surface of plants exposed to Zn stress possibly was a means for the emission of volatile compounds synthesized because of excess Zn ion in the cells, which can lead to the reduced rate of photosynthesis. The oxidative stress elicited by the elevated Zn content was mitigated with the overproduction of antioxidant metabolites such as phenolics, amino acids and soluble sugars. The pattern of Zn uptake and transport had a significant change, the lower translocation factor (TF) value in the plants subjected to Zn toxicity indicates the potential of the plant to reduce the translocation of Zn ions to the metabolically active shoot regions. This study found different Zn tolerant mechanisms in *O. sativa* (var. Varsha) that aid the plant to withstand high concentrations of heavy metal in arable lands and further studies in these aspects should help to develop new metal tolerant varieties.

PF-186

Arbuscular mycorrhizal fungal species improved Cd tolerance in pigeonpea by modulating sulphur metabolism along with related defense enzymes

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Pigeonpea is an agriculturally important food legume crop and ranked 6th in importance globally. India is one of the largest producers of pigeonpea with 4.55 mha area under cultivation and 3.31 MMT annual productivity. However, presence of heavy metals (HMs) in agricultural soil, especially cadmium (Cd), pose a serious constraint to its productivity. In recent years, relative role of arbuscular mycorrhizal fungi (AMF) in alleviating stress induced damages have gained importance. The present study was designed to compare effectiveness of four AMF species [*Rhizoglomus intraradices* (Ri), *Funneliformis mosseae* (Fm), *Clarodieoglomus claroideum* (Cc), *C. etunicatum* (Ce)] in imparting Cd (0, 25, 50 mg Kg^{-1}) tolerance to pigeonpea plants. Cadmium accretion resulted in reduced plant growth, with more negative impact on roots when compared to shoot. Moreover, substantial production of reactive oxygen species (ROS) was recorded in tissue and concentration dependent manner. All the four AMF species improved plant growth, reduced metal uptake and lowered oxidative burden with maximum benefits provided by Ri, when compared with other three species. These effects could be related with their relative mycorrhizal colonization (MC) as well as glomalin releasing ability in soil. Higher efficacy of Ri could also be related to its maximum potential to attain nutrients from the soil and strengthened sulphur metabolism along with related defense enzymes. Thus, the study suggested that the selection of suitable host-AMF combinations can be used as an important tool in imparting Cd tolerance to the pigeonpea plants.

PF-187

Effectiveness of silicon and arbuscular mycorrhizae in enhancing growth and yield of arsenic stressed *Cajanus cajan* (L.) Millsp. by modulating starch metabolism

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Arsenic (As) pollution of soil reduces the growth and reproductive potential of plants. Silicon (Si) and arbuscular mycorrhizal (AM) fungi play significant roles in alleviating adverse effects of as stress. However, studies are scant regarding alleviative effects of Si in pigeonpea (*Cajanus cajan* L. Millsp.) because legumes are considered low Si-accumulators. Present study investigated the individual as well as synergistic potential of Si with two AM species (M1-*Claroideoglomus etunicatum* and M2-*Rhizoglomus intraradices*) in improving growth and yield of pigeonpea genotype (Pusa 2001) grown in arsenate-AsV and arsenite-AsIII challenged soils. Both As species hampered the establishment of AM symbiosis, thus, reducing nutrient uptake, growth and yield, with AsIII more toxic than AsV. Exogenously applied Si and AM species decreased metal bioavailability in soil, increased nutrient acquisition, plant biomass and chlorophylls, with maximum benefits provided by M2 inoculation, closely followed by Si and relatively lower by M1. These amendments boosted the activities of starch hydrolytic enzymes (α-, β-amylase, starch phosphorylase), along-with simultaneous increase in TSS concentrations. This enhanced sugar accumulation directly led to improved reproductive attributes, more efficiently by M2 and Si than M1. Additionally, combined applications of Si and AM, especially +Si+M2, complemented each other where AM enhanced Si uptake, while Si increased root colonization, suggesting their mutual and beneficial roles in ameliorating metal(loid) toxicity and achieving sustainability in pigeonpea production under as stress.

PF-188

Influence of light emitting diode (LED) on growth and bioactive metabolites of Indian Marshweed

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Limnophila indica (L.) Druce (Family: Plantaginaceae) known as Indian Marshweed. It is also used as a carminative and antiseptic. In the present investigation, plants were exposed to white (W), red (R), blue (B) and different combinations of R and B (2BR and 2RB) light emitting diode (LED). After 21 days of light treatment, growth and bioactive metabolites were examined. Plants grown under 2BR light had the longest shoot length (7.3±0.9 cm) and maximum leaves per plant (15.7±0.9) were observed in plants grown under 2BR and W light. In addition, highest number of roots per plant (12.0±1.5) and biomass in terms of shoot and root dry weight (0.170±0.1 and 0.25±0.1g, respectively) were recorded from seedlings exposed white (W) light. 2BR treatment significantly altered photopigments wherein highest chlorophyll a, chlorophyll b and total carotenoids were reported. Other phytochemicals like TPC (35.5±1.0 mg TAE/g extract), TFC (27.93±2.7 mg CE/g extract) and TTC (300.76±9.8 mg CE/g extract) were found maximum in R and 2RB treatment. Furthermore, in AOX, DPPH (158.74±0.58 mg AAE/g PM), FRAP (75.68±0.92 Mg Fe(II)/g PM), PMA (65.87±1.85 mg AAE/g PM) and MCA (79.37±9.8 mg EDTA/g PM) activities were noted promising under the influence of blue light alone, while ABTS activity found maximum in white light (3.78±0.01 mg TE/g PM). Solvent methanol found to be best for antioxidants extraction (DPPH, FRAP, PMA and MCA). Based on the study, we found that LEDs are noted as a significant element for influencing plant development and secondary metabolites production.

PF-189

Optimization of phenolics from the fruits of *Diplocyclos palmatus* (L.) C. Jeffrey

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Diplocyclos palmatus (L.) C. Jeffrey (Family: Cucurbitaceae) is commonly called 'Shivlingi'. It contains diverse group of compounds that are used to treat several health-related problems. Phenolics are the essential part of human diet and are of considerable interest due to their antioxidant properties and potential beneficial health effects. Important bioactivities like antioxidant, anti-carcinogenic, antimicrobial, anti-mutagenic, and anti-inflammatory activities were reported by phenolics. In present investigation, extraction factors like extraction time (30-300 s), solvent concentration (20-100%), SS ratio (1:10-1:60 g/mL) and sample particle size (150-850 µm) were optimized for maximizing the recovery of phenolics by microwave extraction method. Results showed that highest yield phenolics (14.36 mg TAE/g DW) was obtained at 180 s extraction time. Similarly, among different concentrations of ethanol tested, maximum yield (23.71 mg TAE/g DW) was recorded when pure solvent was used. SS ratio at 1:20 g/mL found to be the excellent condition for the highest recovery of phenolics (19.65mg TAE/g DW). Particle size at 450 µm found more influential for the extraction of phenolics (29.09mg TAE/g DW). Among all the treatments, particle size found to be the most crucial factor for extraction of phenolics when microwave assisted extraction was used. Further interactive effect of these independent factors on phenolics yield is in progress.

PF-190

Investigating the trade-off between nitrogen and carbon assimilations in rice germplasm differing in yield and grain protein content

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Malnutrition is a serious concern for Socio-Economic development in India. Rice is the most consumed cereal and is the biggest source of dietary protein in India. Rice grains contain 73-76% of carbohydrates and 6-8 % of protein, which is quite less compared to other cereals. However, protein from rice is more digestible and absorbed compared to other plant sources. Improving protein content in rice grains is therefore, the most suitable solution to mitigate malnutrition in India. The major bottleneck in efforts to improve grain protein content is a strong trade-off with biomass accumulation that leads to reduced yields. To circumvent this situation detailed understanding of physiological mechanisms is needed. Proteins are synthesised using nitrogen absorbed from soil. NO_3^- and NO_2^- are reduced to NH_4^+ by taking electrons from Photo-chemical reactions and this NH_4^+ is used in production of various amino acids. The High Grain Protein types showed a significantly lower yields, as supported by others. We measured Photosynthetic rate, Quantum efficiency, Light saturation and Nitrite reductase activity in genotypes varying for grain protein content. Genotypes with higher protein content had significantly higher Photosynthetic rate, Quantum efficiency, Light saturation and Nitrite reductase activity compared to genotypes with low protein content. High protein genotypes had higher $\delta^{15}N$ (‰) and $\Delta^{13}C$ compared to low protein genotypes. Screening germplasm for quantum efficiency is expected to result in identifying specific genotypes to overcome the trade-off.

PF-191

Harnessing photosynthetic traits for enhancing productivity in wheat

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Wheat yield must increase by 1.6% each year to ensure food security for rapidly expanding global population, which is expected to reach 9.6 billion people by 2050. Recently, the yield improvement through harvest index and ideotype selection of crop is reaching plateau. Hence, there is an urgent need to find some of the unexplored traits for yield improvement and one such trait is photosynthesis. The present efficiency of the photosynthesis in plants is 6%, which is below its maximum potential. In the present study, wheat varieties released over different decades were validated for the variation in photosynthetic rate and observed no significant variation which clearly indicates photosynthetic traits are still not much explored in wheat improvement programmes. Hence, an intense study was undertaken in diverse wheat genotypes for exploring physiological, biochemical, molecular and anatomical traits associated with photosynthesis. Large variations were observed in each of these traits and promising genotypes were identified. Strategic crosses were made to stack the traits and obtained potential entries with higher yield in stable generation. Optimal stomatal characters were designated for improving stomatal conductance. Identified contrast lines for photosynthetic traits in a mutant population and molecular studies were done for finding genes and SNP's for improving photosynthesis. Thus, these kind of intense studies in unexplored traits will give a pave for complementing wheat breeding programme and ensures future food security.

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Estimation of biochemical components and fatty acid profiling in grape seeds and their modulation in different grape rootstock for nutraceutical merit

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Grape seeds are rich source of phenols, flavanoids and fatty acids which attracts interests of scientific and research communities. To explore the influence of varying rootstocks on phenols, flavonoids and fatty acids composition of grape seeds, an experiment was conducted with Cabernet Sauvignon grafted on seven different rootstocks (110R, 140Ru, 1103P, SO4, 101.14 MGT, Fercal and Gravesac). The study revealed that among the different rootstocks, the concentration of total phenols and total flavonoids were higher in Fercal rootstock (30.53% and 23.41%, respectively) and antioxidant activities- cupraic activity was higher in Gravesac rootstock (30.71%) and DPPH activity was higher in 1103P rootstock (53.15%). Further, fatty acids were identified and quantified by gas chromatography equipped with a flame ionization detector. The identification of fatty acids was further confirmed by using gas chromatography with mass selective detector. The results revealed that the palmitate (16C) and methyl eicosatrienoate (omega-6) fatty acids were significantly higher in grape seed of Cabernet Sauvignon grafted on 101.14 MGT rootstock, whereas linoleate (omega-3) fatty acid was found significantly higher in Fercal grafted vines. Secondary metabolites and fatty acids play a paramount role in promoting several health benefits. Therefore, results of present study suggest optimal rootstock-scion combination in the preparation of need based concentration of phenols and flavonoids, omega-3 and omega-6 fatty acids derived from grape seeds in the supplementary nutraceutical merit products for maintaining human health.

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Effect of seed soaking treatments on seed quality, yield and yield attributing parameters of rabi sunflower

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The experiment was carried out both in laboratory as well as in field to study the effect of seed soaking treatments on sunflower during Rabi 2018-19 and 2019-20 in black cotton soils at Regional Agricultural Research Station, Nandyal. The experiment was conducted in Randomized Block Design with sunflower hybrid NDSH-1012 and seeds were soaked with different treatments for two to twelve hours i.e., T1-Control(no soaking),T_2-Hydration for in 1:2.5 (seed: water) ratio for 2 hr,T_3- Hydration with PEG-6000 (200 g/1000 ml) solutionfor 2 hr,T_4-Hydration with 2 per cent $CaCl_2$ for 2 hr,T_5- Hydration in 0.5 per cent KH_2PO_4 for 2 hr,T_6- Hydration in 1 per cent KNO_3 for 2 hr and T_7- Hydration in 50 ppm GA3 for 12 hours and dry .Under laboratory conditions significant differences germination (98.0%),root length (12.8 cm), total seedling length (23.4 cm), seedling Vigor Index-I (2287.5) and seedling Vigor Index-II (39.8)were recorded when seeds soaked with PEG-6000 (200 g/1000 ml) solution for 2 hr. In field experiment the study revealed that the seed soaking treatments recorded nonsignificant differences among yield attributes and seed yield of sunflower.

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In vitro bioaccessibility of biguanide related compounds and polyphenolics from yellow, red and purple fleshed potatoes

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The present study compared the difference in bioaccessibility of biguanide related compounds (BRCs, antidiabetic compounds) and polyphenolics from colored potatoes. Eight varieties/crosses viz. Kufri Neelkanth (flesh/peel color; Yellow/Purple), Kufri Pukhraj (Yellow/Yellow), Kufri Bahar (White/White), MSP/16-272 (Yellow/Yellow), MSP/15-60 (Yellow-Red/Red), MSP/17-89 (Red/Red), MSP/16-300 (Purple/Dark Purple) and MSP/16-375 (Purple/Dark Purple) were analyzed in raw and boiled form. *In-vitro* gastro-intestinal digestion was carried out in boiled potatoes. The results revealed that red potatoes exhibit higher bioaccessibility (14%) of BRCs compared to light yellow potatoes and bioaccessibility was the maximum in MS/15-60 (3.84 mg/g FW). This is the first report that revealed potatoes to be a good source of BRCs due to their high bioaccessibility. Polyphenolics' bioaccessibility ranged from 66 (MSP/16-272) to 156mg/100g fresh weight (MSP/16-375), and bioaccessibility was 1.1 folds higher in red and almost 2 folds higher in purple potatoes. Chlorogenic acid bioaccessibility ranged from 56 (MSP/16-272) to 573µg/g FW (MSP/15-60), neochlorogenic acid bioaccessibility ranged from 7 (Kufri Pukhraj, MSP/16-272) to 72µg/g FW (MSP/17-89) and cryptochlorogenic acid bioaccessibility ranged from 6 to 77µg/g FW. The bioaccessibility of chlorogenic acid, neochlorogenic and cryptochlorogenic acid was 5.1, 5.7, 4.6; and 4.6, 3.7 and 6.9 folds higher, respectively, in boiled red and purple potatoes compared to light yellow potatoes. The anthocyanin bioaccessibility ranged from 3 (Kufri Pukhraj) to 116mg/100g FW (MSP/16-300). Total anthocyanins were 3.2 and 16.2 folds more bioaccessible from red and purple boiled potatoes, respectively. Due to high bioaccessibility of polyphenolics, anthocyanins and BRCs, purple and red potatoes are more beneficial for human health.

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Exogenous melatonin alleviate salt stress by modulating the physiological and biochemical activities in cassava

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Cassava (*Manihot esculenta* Crantz) is a major tuber crop that is widely cultivated for its starch content. Cassava is moderately sensitive to salt stress especially at the time of the early vegetative stage. The occurrence of salt stress during the vegetative stage significantly affects the physiological and biochemical functions of the cassava plant which leads to poor plant growth and tuber yield. Recently, a new plant growth regulator called melatonin can be used as an anti-stress compound to improve the salt tolerance capacity of the plants. The present study was carried out to know the mechanism of exogenous melatonin alleviates salt stress by modulating the physiological and biochemical activities in cassava variety Sree Athulya with nine treatments under 120mM NaCl salt stress condition. Treatments were given as both sett treatment and foliar application of 100 ppm melatonin at 30 DAP and 60 DAP of the crop growth. Control (salt stress + no melatonin) and absolute control (no stress and no melatonin) were also maintained for comparison purpose. The salt stress of 120 mM NaCl was imposed from day one to 120 days. The results revealed that the application of melatonin at 100 ppm as sett treatment plus foliar spray twice at 30 DAP and 60 DAP mitigates the salt stress through the effective osmotic adjustment, anti-oxidant activity, and salt sequestration. The tuber yield and starch quality were also found to be more in melatonin-treated plants even under salt-stressed conditions.

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Exogenous ascorbic acid helps jute seedlings to maintain the redox state under drought

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Early drought reduces seedling vigour in jute thereby reducing crop yield. In this study, response of jute seedlings under drought stress was evaluated under drought with exogenous ascorbic acid. 30 days old jute seedlings of JRO-204 were subjected to drought (SMC=8%). Additional sets of plants were sprayed with 10 mM ascorbic acid. Plants under drought showed reduced leaf water status, membrane stability, chlorophyll content, fresh and dry biomass, plant height and increased proline content, reactive oxygen species content and root length. Both enzymatic and non-enzymatic antioxidant fraction were modulated under drought. Flavonoid content increased under drought which decreased with exogenous ascorbic acid application. In contrast, the endogenous ascorbic acid which decreased under moisture deficit further increased upon exogenous ascorbic acid application thereby increasing its antioxidant potential under drought. In addition, antioxidant enzymes like ascorbate peroxidase and peroxidase showed higher activity to quench the ROS. It may be thus inferred that exogenous ascorbic acid application on jute plant under stress regulates its antioxidant mechanism thereby balancing the redox status of plants to withstand drought conditions.

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Physiological basis of germination behaviors of different soybean variety under seed treatments

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Seed germination have become a serious problem in areas where soybean cultivate intensively. Although numerous of studies have been done to assess its impacts on seed quality and crop yields, the understanding of different seed treatments to enhance germination and other physiological parameter, its effects on plant growth is still limited. In this study, a pot experiment conducted to study the differential responses of genotypes for seed priming and to study the biochemical and physiological changes due to seed priming and relate this changes to the germination behavior of soybean seeds. Keeping this objectives in view, the present investigation will conduct during *Kharif* seasons (June 2021-Oct. 2021) at Botany Section, Ramakrishna Bajaj College of Agriculture, Wardha, Maharashtra. A pot experiment was laid out in a factorial randomized block design with three replications. Seed priming of three different chemical make before sowing, in the treatments from T_1 to T_3. In this study seed treatments given to soybean seed are T_0 – untreated control, T_1 – 0.1% potassium nitrate, T_2 – GA 50 mg/l, and T_3 - silver nitrate 2mg/l before sowing. Observations recorded on seed germination test revealed the variety and seed treatments showing significant difference. Also highest germination percentage noted in V_3S_3 (69.33%) and V_6S_3 (69.33%) followed by V_7S_3 and lowest in V_3S_1(31.67%). Meanwhile seedling emergence listed maximum in V_6S_3 followed by V_5S_3 on days after sowing. Data recorded on chlorophyll content, plant height and number of pod also showed significant difference in interactions, variety and among treatments over control.

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An affordable tool to phenotype coastal-salinity induced leaf-senescence in rice seedling

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To sustain the rice productivity in coastal saline lands, it is crucial to enhance salinity tolerance by introgressing relevant traits. Leaf senescence is one of the traits that reveal salt tolerance in plants in response to osmotic and ionic stresses. Efficient and high-throughput screening techniques and advanced image-based phenotyping have been demonstrated to screen salinity tolerance traits in a wide range of germplasm in a reliable, quantitative, efficient and non-destructive way. However, existing phenotyping tools are costly and requires high technical knowledge. Hence attempts were made to develop and employ an imaging structure by using inexpensive cardboard material and high resolution phone camera with artificial light source. Two popular coastal rice cultivars were grown in disposable cups filled with coastal saline soil. After 21 days, seedlings were imposed with three different salt treatments (control, 6 EC and 9 EC). The imaging structure was used to capture responses to different salt treatments at 0,24 and 48 hours after salt treatment. All images were analysed by using software that could extract RGB pixels from images. R/RGB, G/RGB and B/RGB pixel counts could differentiate the responses of plants growth with or without salt stress. The results revealed significant differences in responses between the cultivars and also across the levels of salt. The results validate utility of economic and easily affordable image acquisition system and RGB based image analysis protocol as a valuable tool for quantitative and non-destructive measurement of leaf senescence in response to coastal salinity.

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Response of foliar feeding of bioregulator and micro nutrient on soil health and yield attributes of mustard

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An experiment was carried out at Soil Science and Agricultural Chemistry Research farm, Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Rabi season 2020-21 is located at 25^0 24' 42" N latitude and 81^0 50' 56" E longitudes at 98 m altitude above the mean sea level, trial was laid out in 3×3 factorial randomized block design with three replications, consisting of nine treatments. Treatment T_9 (@ 100% RDF+$ZnSO_4$ @ 10 kg ha^{-1}+NC @ 500g ha^{-1}) was found to be best. The pH, EC, OC, available Nitrogen (kg ha^{-1}), Phosphorus (kg ha^{-1}) @ Potassium (kg ha^{-1}), Sulphur (ppm) and Zinc (ppm) which were as 7.44, 0.27, 069, 325.82,30.67,205.06 and 1.51 respectively. The soil physical properties as the texture (Sandy loam), bulk density (Mg m^{-3}), particle density (Mg m^{-3}) and Pore space (%) were found to be significant. Soil Health can be maintained with integrated management practices.

PF-200

Application of phenomics to differentiate response of sugarcane genotypes to depleting soil moisture and bio stimulants

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The occurrence and magnitude of abiotic stresses are increasing due to global climate change. Among the various abiotic stresses, the drought, featured by depleting soil moisture, is major limiting factor for productivity of crops including sugarcane. In addition, it is necessary to minimise water consumption in sugarcane, the major driver of rural economy of the nation. This can be achieved through both the genetic improvement and the resource management approaches. In this context, bio stimulants are gaining importance due to their potential to alleviate soil moisture stress in plants. Hence, experiments were planned to employ high throughput phenomics protocols to assess the threshold of soil moisture tolerance of sugarcane during soil moisture depletion in three genotypes of sugarcane viz., Co 86032, CoM0265, VSI 08005. Images acquired through high resolution (visible range), thermal (IR) and Near InfraRed (NIR) imaging systems at National Plant Phenomics Facility at ICAR-NIASM were analysed to assess stress responses of shoots. Image parameters that could differentiate the treatment effects were selected to determine the threshold of stress tolerance and to identify promising bio stimulants. The phenomics protocol could help in identifying the most resilient genotype and bio stimulant non-invasively. Chitosan and silixol, used as bio stimulants, could help in enhancing threshold level of tolerance by retaining high tissue water content and absolute green area in plant. This study suggested that the green leaf area, brown leaf area, dry leaf area and yellow leaf area out of more than forty image parameters assessed, could reveal the threshold of stress tolerance of different genotypes of sugarcane and also the efficacy of bio stimulants in alleviating moisture stress at initial growth stages.

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Variation in photosynthetic efficiency in response to salinity in rice genotypes targeted for konkan coast

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Rice grown in coast is highly prone to salinity. High salt in plant cell damages the membrane system and thylakoids in chloroplasts and hence affect photosynthetic performance. This can be quantified by assessing Photosystem-II (PS-II) efficiency. However, this technique has not been employed so far to assess salinity tolerance in rice genotypes adapted to salinity in Konkan Coast. Hence, PS-II efficiency in response to salinity, as a potential trait, was considered for optimising screening protocol that can accelerate breeding varieties for salt-affected areas. Experiments were conducted with 20 rice genotypes collected from various known sources of coastal area including checks as well-known salt tolerant and salt sensitive varieties. Plants were exposed to medium (MSS) and high (HSS) salt stress with electrical conductivity 6 and 9 dS/m respectively with control (C) (Coastal saline soil with no additional salts) 21 days after emergence. The PS-II efficiency (Fv/Fm) and leaf chlorophyll content were measured at 6, 24 and 36 hours after imposing salt stress. There was a large variation in salinity tolerance among the rice germplasms as revealed by both Fv/Fm and chlorophyll content. Among 20 rice genotypes SR 3-9, Ratnagiri 5, Panvel 61, Panvel 3, Damodar, Kala rata and Karjat 3 retained high Fv/Fm in medium salt stress condition while Panvel 2, Panvel 3, Pancel 61, CSR 36, CST 7-1 and Damodar retained high Fv/Fm in high salt stress condition as compared to popular cultivars such as FL478 and Karjat 4. This work reveals the potential of PS-II efficiency as a trait for differentiating the responses of rice genotypes to coastal salinity. This can help identify relevant genes essential to develop salt-tolerant varieties.

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Gas chromatography-mass spectrometry (GC-MS)-based identification of metabolomic discriminators in seabuckthorn berries originating from different regions of Uttarakhand, India

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Seabuckthorn (*Hippophae*; Elaeagnaceae) has acquired an important status as a source of nutraceuticals, cosmaceuticals, and plant-based medicines. Substantial research is available on metabolome profiling of *H. rhamnoides*, however, *H. salicifolia*, another important species, remains largely unexplored for metabolome diversity. Hence, a comprehensive GC-MS-based metabolome analysis was conducted by analyzing the differential solvent derivatized extracts of *H. salicifolia* berries originating from three regions of Uttarakhand, namely Badrinath, Gangotri, and Yamunotri. A total of 305 metabolites were annotated, of which 15 crucial metabolites were reported for the first time. The quantified peak intensity was matched with the standard compounds present in different libraries of the National Institute of Standards and Technology, including NIST14, NIST14s, and Wiley8. Multivariate analysis was performed following principal component analysis (PCA), partial least-squares discriminant analysis (PLS-DA), and orthogonal partial least-squares discriminant analysis (OPLS-DA). The PLS-DA and OPLS-DA plots provided the most prominent model to discriminate seabuckthorn berry samples from different regions. PLS-DA loading and associated variable importance plots (VIP) revealed 15 highly expressed metabolites, including four from Badrinath, three from Gangotri, and eight from the Yamunotri region. The findings of the present study provide valuable information for the identification of the sources of metabolites related to the quality of various food products, nutraceuticals, pharmaceuticals, and cosmeceuticals.

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Genetic improvement of foxtail millet (*Setaria italica* L.) for climate smart agriculture: Landraces for mapping population development, linkage map construction and QTL identification

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Traditional food crops are those which are predominant food source in local areas. Popularization of the Green Revolution, is the cause for the gradual diminish with respect to their area under cultivation, irrespective of the superior nutritional value and stress tolerance ability. Foxtail millet (*Setaria italica* L. 2x = 2n = 18, with a small genome of about ~515 MB) is a staple crop grown in arid and semi-arid regions of India. Landraces are the farmer varieties, known to adapt to the local harsh environmental conditions with high nutritional value. Based on the comprehensive studies in our lab, we have identified significant differences with respect to drought stress tolerance and seed micronutrient content along with high genetic polymorphism among land races compared to elite / released varieties. Particularly this is prominent at loci associated with abiotic stress response and heading date. Based on the integrative data, different combinations of biparental crosses were made, true F_1's were selected, advanced to F_7 generation and RIL mapping population(s) were developed. The potential utility of these genetic resources were evaluated in the filed for various yield and yield related traits and their association with grain yield was derived. Further, the molecular genetic diversity assessment studies were initiated for the selected parental lines and the mapping population using high throughput illumina HiSeq2500 Next Generation Sequencing (NGS) technology based ddRAD sequencing. The potential utility of these genetic (landraces), genomic (NGS whole genome based SNP's) in parental lines and segregating mapping population of foxtail millet will be presented.

PF-204

Commercial-scale *in vitro* propagation of *Siraitia grosvenorii* clones for utilization as natural sweetener

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Past decade has witnessed a steep rise in the utilization of dried fruits of *Siraitia grosvenorii* (monk fruit) in various dietary supplements, due to global rise in diabetic disorders. The compounds responsible for its non-caloric natural sweet taste are mogrosides- a group of cucurbitane type of triterpene glycosides. Mogrosides have zero calories, fat, carbohydrates and sodium, and because of these important aspects, its global market is expected to rise USD 379.4 million by 2026. Despite its high international demand, monk fruit is not cultivated outside China due to poor seed germination, high viral infection, and lack of distinguishing features between male and female plants during vegetative stage. Therefore, to meet the increased demand of monk fruit, *en massein vitro* propagation protocol is the need of the hour. In current study, a well-established, commercial scale micropropagation protocol was developed for both male and female plants using nodal explants for either direct shoot multiplication, or callus induction and regeneration using various combinations of PGRs. The rooted plantlets were hardened and planted under shade net house with 100% survival rate. The *in vitro* developed plants showed active growth as a climber under shade net conditions. Plants established under field conditions have similar morphological characteristics and photosynthetic yield as that of mother plants. Well-developed napiform roots also developed under field conditions, after completion of one growing season.

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Morpho-physiological and biochemical analysis of foxtail millet landraces along with released cultivars under induced drought stress at vegetative and reproductive stages

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Foxtail millet (*Setaria italica* L. 2x = 2n = 18) is a staple crop grown in arid and semi-arid regions of India. Though it is known as hardy plant, it still experience water deficit during its life cycle. Drought is the most common abiotic stress, affecting the crop severely at various growth stages, cause substantial yield loss. Landraces are the farmer varieties, known to adapt to the local harsh environmental conditions with high nutritional value. To the best of our knowledge, very few studies are reported on screening of foxtail millet landraces for their ability to cope up with drought compared to release cultivars. In this context, a set of 20 genetically fixed foxtail millet landraces along with four released cultivars were subjected to drought stress at vegetative and reproductive stages. The mean of morpho-physiological traits and biochemical assays showed significant variations to induced drought stress during vegetative and reproductive stage compared to the irrigated counterparts. Correlation, Principle component and cluster analysis revealed that physiological traits are more sensitive to induced drought stress than morphological and biochemical traits. The total genotypes were grouped into 3 groups based on their ability to tolerate drought stress conditions. In this present his comprehensive screening, most of the landraces outperform released cultivars under induced drought conditions. These landraces intended for further evaluation for varietal approval and also will be utilized in foxtail millet breeding program for its improvement.

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Profiling of seed protein quality and antioxidant properties in chickpea and pigeon pea genotypes

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Legumes are known as 'Poor man's meat' because of their high protein content and are considered as staple food for those who cannot afford animal proteins or are vegetarian by choice and thus have the potential for improving nutritional status of the people and combating the Protein Energy Malnutrition (PEM). Chickpea (*Cicer arietinum* L.) and pigeonpea (*Cajanus cajan* L.) are the two most important food legumes in India both in terms of production & consumption. Considering these points, a study was conducted to determine the protein, quality in selected genotypes of important food legumes of India, chickpea (*Cicer arietinum* L.) and pigeonpea (*Cajanus cajan* L.). Among chickpea genotypes, *Desi* types showed highest protein digestibility of 86% (Pusa 256) with PDCAAS values of > 0.5 as compared to *Kabuli* types, while protein digestibility of pigeonpea genotypes are ranged between 39.00% to 82.84%. The amino acid profile of pigeonpea and chickpea showed that they can contribute 45%–100% DV for a 60 kg adult (based on per capita consumption of pulses) of various essential amino acids except methionine. Thus, our results clearly showed that, the amount of essential amino acid content can be met with 100% DV with the daily intake of 100 g dhal/whole seeds of chickpea and pigeonpea except for methionine. The generated information will thus help in identifying promising chickpea and pigeonpea genotypes with high nutritional quality and aid in future breeding programmes.

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Deciphering the regulation of sulfate uptake and expression of sulfate transporter genes for the enhancement of methionine content in *Cicerairetinum*

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Increasing sulfate assimilation and utilization efficiency is a valuable approach to augment the concentration of sulfur-containing amino acids in legume seeds. Sensing of sulfate by high affinity sulfate transporters helps in capturing greater reserves of sulfur. Sulfur fertilization favorably affects protein quality largely with the availability of potential genotypes having high sulfate uptake capacity. Chickpea being largely produced in India among all pulses holds an important source of protein in human diets. Like other grain legumes, its protein quality is sub-optimal, being limited by the levels of the essential sulfur amino acids like methionine. Therefore, it is apparent to study the role sulfur nutrition to ensure rapid and precise modulation of sulfur metabolism. A study was carried out to optimize the hydroponic protocol for chickpea with sulfur deficiency (0mM SO_4^{2-}) and sufficiency (0.5 to 1mM SO_4^{2-}) based on phenotypic screening and root physiological parameters analysis. The root physiological parameters such as root length, root volume and root surface area of 0.5mM SO_4^{2-} supplemented plants are 716 cm, 1.03 cm^3 and 96.06cm^2 respectively, while 1mM SO_4^{2-} supplemented plants has showed the same parameters as 627 cm, 0.89cm^3 and 83.75 cm^2 respectively. Thus sulfate sufficiency conditions for chickpea seedlings can be attained with 0.5mM SO_4^{2-}. Further, sulfur deficient symptoms have been observed in plant supplemented with 0mM SO_4^{2-} like pale chloratic leaves and reduced root. Here on, 0.5mM SO_4^{2-} concentration will be used as sulfur sufficient condition to the sulfur transportation / assimilation efficiency in chickpea genotypes by expression analysis of *SULTR(s)* and sulfate anion quantification.

PF-208

Effect of salinity stress on morphological, biochemical traits and its correlation with yield of grain Amaranth

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Salinity is a major abiotic stress, altering growth, physiological, biochemical and molecular attributes of plants. Grain amaranth, belongs to the family *Amaranthaceae* and genus *Amaranthus* is an important C_4 crop cultivated in tropical region of world. In the present investigation pot experiment was laid out infactorial completely randomized design, with 10 genotypes in three replications under different level of salinity viz., control, 5 dS m^{-1} and 10 dS m^{-1} conditions, to study the effect of salinity on growth, biochemical traits and its association with yield. It was recorded that SUVARNA have higher plant height at 5 dS m^{-1}than all the genotypes while at 10 dS m^{-1}GA-5 maintained the maximum height. Leave area $plant^{-1}$ was maximum recorded in genotype GA-4 at 5 dS while GA-1 at 10 dS.GA-5 maintained the maximum value for shoot and root biomass at 5 dS m^{-1} and 10 dS m^{-1}.GA-5 maximum membrane stability, relative water content, leaf potassium content and minimum leave Na^+ content under salinity stress. Chlorophyll content was maximum recorded in genotypes SUVARNA under all the treatments, while leave carotenoid content was maximum in genotype EC-198122 at 5 dS while SUVARNA have maximum value at 10 dS. The maximum yield was recorded in GA-3 and EC-198127 which is at par with GA-1 and NIC-22553 at 5 dSm^{-1}while at 10 $dSm^{-1}$the maximum yield was recorded in EC-198127 which is at par with NIC-22553. The salt tolerance index was recorded maximum in EC-198127 at 5 dS and 10 dS. Yield of grain amaranth was positively correlated with plant height, leaf number, leaf area, shoot dry weight, root dry weight, total chlorophyll, total carotenoid and leaf potassium content.

PF-209

Crop simulation model as a tool for crop improvement

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Impact and Damages due to adverse weather strongly depend on crop type, crop stage and management. So, requires crop weather modelling approach to capture the interactions between the crop, its environment and the occurrence of the meteorological event. The hypothesis is that extreme and adverse weather events can be quantified and subsequently incorporated in current crop models. A study was carried out during *kharif* 2019 at Agriculture Research Institute, PJTSAU, Rajendranagar, Hyderabad, Telangana state with an object to evaluate the tomato performance with CROPGRO-Tomato model under different dates of planting and cultivars. The experiment was conducted with dates of planting (02 Jul, 12 Jul, 22 Jul, 02 Aug, 11 Aug, 23 Aug, 03 Sep and 13 Sep) as main plot treatments and cultivars US 440 & TO-3251 (Saaho) as sub-plot treatments. The CROPGRO-Tomato model performed well in simulation of phenology and fruit yield during calibration for US 440 and TO-3251. Calibration results revealed that model perfectly predicted days to anthesis with no difference between simulated and observed data for both cultivars with RMSE of 0 day, further model simulated the days to last picking and fruit yield with RMSE of 0.9 and 0.7 day, 545 kg ha^{-1} and 389 kg ha^{-1} (dry weight), for US 440 and TO-3251 cultivars respectively. Calibrated model was used for further validate the experimental data and found that, simulation of days to anthesis and days to last picking was excellent with NRMSE value of less than 10% for both cultivars, poor with total fruit yield greater than 30% due to over estimation.

PF-210

Comparative evaluation of wheat varieties and assessment of high temperature sensitivity in field grown wheat

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With unpredicted climate changes, especially global warming are severely affecting plant growth and productivity. On the other hand, the world population is increasing exponentially; this will witness severe food shortages in future. Therefore, there is a strong need to develop crop varieties with high productivity and high tolerance to the stressed environment. Protecting crop yield under adverse environmental stresses is probably the greatest challenge being encountered by modern agriculture. This study was conducted to elucidate the potential wheat varieties and assessment of high temperature sensitivity. Seeds of nineteen wheat varieties were obtained from the Punjab Agricultural University, Ludhiana, Punjab. The wheat crop was sown in the 2nd week of November during the growing season of 2017-18, 2018-19, 2019-20, which are considered as normal-sown in the Punjab region. The experiment was performed by randomized block design with three replications in the experimental plots of the Department of Plant sciences, Central University of Punjab, Bathinda, Punjab. During 2018-19 growing season wheat samples were tested for membrane stability and relative leaf water content. Wheat was harvested in the month of April for yield related parameters. Results showed that heat stress dramatically affects membrane stability at different stages of wheat development. Membrane damage was more prominent during the post anthesis stage. Varieties PBW 343 PBW644 and PBW670 showed less ELI and MDA content, hence more membrane stability. RLWC was higher in varieties with less membrane damage. Further, 1,000-grain weight, number of grains per ear, and harvest index of wheat genotypes PBW670 were highest.

PF-211

Responses of yield to elevated co_2 with different levels of nitrogen on maize

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The research was conducted in *rabi* season during 2019-2020 at Central Research Institute for Dryland Agriculture (ICAR-CRIDA), Santoshnagar, Hyderabad to study on "Morphophysiological and yield responses to elevated CO_2 with different levels of nitrogen on maize (*Zea mays* L.). An experiment Two maize genotypes (DHM-117 & 900M GOLD) were raised in 18kgs capacity pots and evaluated under ambient (400ppm) and elevated (550ppm) CO_2 conditions with four nitrogen levels of N0 (No- extra N), N1 (recommended dose of N), N2 (25% extra of recommended dose of N) and N3 (50% extra of recommended dose of N) in open top chamber (OTC) facility was laid out in a randomized block design. Results indicated that the leaf area was significantly increased with elevated CO_2 and N levels in both genotypes. There was significant increase in photosynthetic rate (Anet) due to increased levels of N application and higher photosynthetic rate (Anet) values ware recorded at eCO_2 of both the genotypes at vegetative as well as flowering stages. Among the two genotypes, DHM-117 recorded higher response to eCO_2 than 900M GOLD and improvement in photosynthetic rate (Anet) with eCO_2 was significantly higher at N_2 level. Cob length, grain weight and 100 grain weight increased significantly with increased N levels and with eCO_2 condition in both genotypes.

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Genetic engineering approaches to develop climate resilient rice

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Environmental vagaries adversely affect the growth, development and yield of the crop plants. Thus, selection and development of genotypes able to tolerate various abiotic stresses is the need of the hour. However, under different abiotic stresses, plants show an immense plasticity to remodel them and to modulate defence mechanisms that provide resistance for their survival. Plant tissue culture represents an important technique that provides a basic system to be used forvarious genetic engineering and breeding programs. Keeping this in mind, we used genetic engineering approaches to develop climate resilience rice. We demonstrated that constitutive over expression of myo-inositol-1-phosphate synthase gene (*SaINO1*), ADP ribosylation factor (*SaARF1*) and actin-depolymerizing factor (*SaADF2*) from a halophyte *Spartina alterniflora*, significantly improved tolerance against salinity and drought. Similarly, by over expressing metallothionein (*OsMT1e-P*), cyclophilin (*OsCyp2-P*) and phosphoglycerate kinase gene (*OsPGK2a-P*) genes in tobacco we demonstrated their role bestowing multiple abiotic stress tolerance by scavenging reactive oxygen species and ion homeostasis. Further, qRT-PCR analysis of Meprin and TRAF Homology (MATH) domain containing protein (MDCP) genes in rice under drought and salinity stress identified *OsM4* and *OsMB11* as potential candidates for generating stress resilient crops. Moreover, we have reported that *OsCKX2*, via controlling cytokinin levels, regulates floral primordial activity modulating rice grain yield under control as well as abiotic stress conditions. Recently, established a positive correlation between trehalose overproduction and high-yield under drought, saline, and sodic conditions by raising marker free transgenic rice plants by overexpressing a fusion gene from *E. coli* coding for trehalose-6-phosphate synthase/phosphatise (TPSP) under the control of ABRC promoter.

PG-213

Response of growth regulators on tolerance to abiotic stresses in crops

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Plant growth regulators are synthetic chemical substances that are directly applied to crops to alter some structural processes. Paclobutrazol (PBZ) is a member of the triazole family of plant growth regulators and has been found to protect several crops from various environmental stresses, including drought, chilling and heat radiation. The growth regulating properties of paclobutrazol are mediated by changes in the levels of important plant hormones including the gibberellins, abscisic acid and cytokinin. Paclobutrazol affects the isoprenoid pathway, and alters the levels of plant hormones by inhibiting gibberellin synthesis and increasing cytokinin level. When gibberellins synthesis is inhibited, more precursors in the terpenoid pathway accumulate and that resulted to the production of abscisic acid. Water availability is a limiting factor for growing crop worldwide. Water scarcity impedes plant growth via direct effect on cell division and expansion and perturbs ion balance and induces senescence. Elevated abscisic acid can enhance plant adaptation to various abiotic stresses. Paclobutrazol acts as stress ameliorant by maintaining relative water content, increasing root activity and protects the photosynthetic machinery, chlorophyll content, high yield with minimum usage of water, thus improving water use efficiency and crop yield.

PG-214

Plant growth and development: The backbone of food security

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Growth is an irreversible increase in size by synthesizing macromolecules at the expense of metabolism. Growth is restricted to meristems (primary and secondary). Plant structures are determinate and indeterminate. Indeterminate ones can be killed, but potentially immortal whereas death is the ultimate fate of determinates. Indeterminate becomes determinate when the meristems turn from vegetative to reproductive. Sigmoid slanting S shaped curve obtained when growth rate is plotted against time. It has lag, log, decreasing, and steady phase and represents the integrated sum of the curves for each growing organ. Growth is determined by internal (stress resistance, respiration, assimilate partitioning, enzyme activity) and environmental (climatic, edaphic and biological factors). Limitation of growth factors is explained by Liebig's law of minimum, Blackman's law of limiting factors, and Mitscherlich's law of diminishing returns. Plant development is a combination of growth and differentiation that leads to an accumulation of dry matter. Differentiation is the formation of specialized cells like xylem and phloem and formation of different plant parts like root, stem, leaves, etc. Growth analysis studies yield influencing factors and plant development as net photosynthate accumulation integrated over time. Parameters arrived through growth analysis includes leaf's area, index, ratio, duration, ratio, specific area, specific weight, and net assimilation, relative growth and crop growth rate. Thus, it is obvious that the plant growth and development paves way for the food production.

PG-215

Evaluation of pre-release foxtail millet cultures for yield and its contributing traits under rainfed conditions

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In India Foxtail millet (*Setaria italica, 2n=18*) is cultivated in Andhra Pradesh, Karnataka, Maharashtra and hilly areas of Northern India. The crop is mostly grown under rainfed conditions without irrigation and manuring in light and marginal soils. The crop is ideal in an era of climate change and steadily depleting natural resources. In the recent past, the crop is gaining popularity among the farmers. There is a need to increase the area and production to meet the increased demand of 15 to 20% by 2030. The yield levels in this crop are low. Development of high yielding varieties is essential to get profitable returns from this crop. This necessitates the identification of most adaptable varieties for different zones by testing in multi-location trials. With this view, the present study was carried out to evaluate the newly developed foxtail millet genotypes for grain yield and its contributing traits for identification of high yielding genotypes. Seven foxtail millet cultures including four newly developed pre-release cultures (SiA 3159, SiA 4201, SiA 4203 and SiA 4148) and three checks (Suryanandi, SiA 3085 and SiA 3156) were evaluated at Agricultural research station, Perumallapalle during Kharif 2018. Data on days to 50% flowering, days to maturity, plant height (cm), productive tillers per plant, panicle length (cm), fodder yield (t/ha) and grain yield (q/ha) was recorded. The maturity duration for the tested entries ranged from 71 days (Suryanandi) to 86 days (SiA 3159). Plant height ranged from 103 cm (SiA 4148) to136 cm (SiA 4203). More number of productive tillers was observed in Suryanandi (4.3). Lengthy panicle was observed in SiA 3085 (19.93 cm). Among the tested entries, SiA 3159 (12.68 q/ha) recorded significantly superior grain yields than high yielding check SiA 3156 (10.40 q/ha). In the tested entries, SiA 4203 (5.21 t/ha) recorded high fodder yield followed by SiA 3159 (4.74 t/ha). SiA 3159 recorded high grain and fodder yields were recommended for mini kit testing in Andhra Pradesh state.

PG-216

Melatonin counteracts the negative impact of drought stress in tomato plants

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Melatonin (Mel) is an indolamine bio-active signalling molecule and present in number of higher plants. This molecule governs wide range of biochemical and physiological actions in plants. Particularly, under abiotic stress challenges it acts as a potential antioxidant molecule. Therefore, an experiment was conducted to study the role of melatonin responding (Mel)under different levels of drought stressed tomato plants, imposed by different percentage of field capacity (60, and 30% FC). At 20 days after sowing (DAS), the seeding were dipped in Mel (50 or 100 µM) for four hours prior to transplantation. Drought stress was imposed at 30 DAS and maximum drought stress (30% FC) induced a significant reduction in growth traits, chlorophyll content and rate of photosynthesis at 40 days after transplantation. With enhancing the drought stress level, activities of antioxidant enzymes (superoxide dismutase, peroxidase and catalase) and proline content were increased substantially. However, Mel treatment under drought stress and non-stress condition significantly increased the growth traits and regulates different biochemical and physiological parameters. Moreover, Mel enhanced the activities of antioxidative enzymes and proline content, which were already enhanced by the drought stress. It is concluded that treatment of Mel (through roots) significantly improved the growth traits, photosynthetic efficiency and various biochemical attributes under stress and stress-free conditions by up regulating the antioxidants system of plants and inhibition of overproduction of ROS (reactive oxygen species).

PG-217

Effect of plant growth regulators on growth of ashwagandha

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The research experiment was conducted to study the effect of plant growth regulators on growth of ashwagandha (*Withania somnifera* L.) at State level Biotechnology Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri. The five different genotypes were selected *viz;* Askand, Nagori, RAS-2, RAS-3 and RAS-4 with treatment consist of four combinations of plant growth regulators. Results revealed that minimum of 5 days were required by RAS- 2 for establishment of explants on Murashige and Skoog (MS)+ 2mg/lBAP and 0.4 mg/l kinetin and maximum of 9 days for Askand on MS+ 1mg/lBAP and 0.2 mg/l kinetin. The plant growth regulator concentration of MS + 2 mg/l BAP + 2 mg/l kinetin was required minimum days (3.66 days) for emergence of first shoots in genotype RAS-2 as compared to other genotypes. It is also found that the application of plant growth regulator i.e. MS+3mg/l BAP+1 mg/l IAA was produced highest number of multiple shoots (7.00) in the genotype RAS-2 followed by Nagori (6.67) and RAS-3 (6.33). The maximum number of roots were produced by RAS-2 (40.67) on MS with 1.5 mg/l IBA as compared to RAS-3 (33.33) while minimum was in Askand (12.67) on MS + 1mg/l IBA. The maximum percentage of survival (80 percent) was observed in genotype RAS-2 whereas minimum found in Askand. Hence, genotype RAS-2 was the suitable ones in terms of various concentrations of plant growth regulators in ashwagandha.

PG-218

Characterizing the effect of differential sowing timing on flag leaf cell membrane integrity and antioxidant activity in different wheat varieties

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Wheat is one of the important cool season cereal crops globally. But varied climatic and sowing conditions are great concerns regarding low production/ yield of wheat throughout the world. Elevated temperature due to delayed sowing of wheat shows a heavy threat to grain filling as anthesis and grain filling both are the most sensitive stages for high temperatures. Thus identification and development of suitable wheat varieties under delayed sowing conditions are of the utmost importance. The plants have a natural ability to adapt or tolerate stressed conditions by enhancing their thermo-tolerant traits resulting in no harm/ least reduction in yield. Osmotic adjustments, less lipid peroxidation and development of antioxidant system together protect plants from the harmful effect of elevated air temperature during anthesis and grain filling stage and provides tolerant characteristics to the plant. Identification of such wheat varieties that shows better thermo-tolerant behaviour at the time of anthesis and grain filling under elevated temperatures can be beneficial for breeding programmes and help in generating heat-tolerant advanced lines. To observe the effect of elevated air temperatures on cell membrane stability and antioxidant activity in flag leaves, four wheat varieties (UP2628, HD3086, UP2526, UP2565) were sown in the November (normal) and December (elevated air temperatures) 2018. The results conclude that the proline content functions as osmolyte was increased upto 63.57% (at anthesis) and 75.05% (at grain filling) under elevated temperatures as compared to normal in all wheat varieties. Elevated temperature also increased Malondialdehyde (MDA) content upto 79.66% at anthesis and 38.05% at grain filling in flag leaves of wheat varieties due to heat stress as compared to normal.

PG-219

Mitigation and adaptation strategies to sustain the productivity of tropical tuber crops under climate change

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Human activities mediated climate change is taking a serious toll on agricultural productivity and human nutrition. Tropical tuber crops (TTCs) (other than a potato) namely cassava, sweet potato and elephant foot yam are important food security crops consumed by more than 1-2 billion people across the globe. Even though these crops are referred to as abiotic stress-tolerant crops, adverse climatic conditions, in the form of drought, high-temperature stress and elevated CO_2 (ECO_2) cause notable unfavorable alterations in the physiology, productivity and nutritive values. Given that these crops represent a valuable subsistence and cash crops in many tropical-subtropical countries, it is of utmost importance to assess the effect of climate change on productivity and develop mitigation and adaptation strategies to address these issues. In this connection, we have attempted to develop the high-temperature stress management strategies in elephant foot yam with the foliar application of 0.2% Salicylic acid at fortnight interval during 4-8 months after planting and the application of $CaCl_2$ @ 0.2% at in sweet potato at fortnight interval during 2-3 months after planting (MAP) or whenever high-temperature stress-induced water stress and *vice-versa* occurs. In cassava, foliar spray of 1% KNO_3 at the fortnight interval during 3-4 MAP or whenever water stress occurs, enhanced the photosynthesis rate and tuber yield. Sree Reksha, a cassava mosaic disease (CMD) tolerant variety of cassava was identified as drought-tolerant variety based on the higher photosynthetic efficiency evaluated across three cropping seasons with the 90 days of early-season water stress induced during 3-5 MAP. In a bid to develop the climate-smart varieties of cassava and to assess their efficacy under future projected climatic conditions, the photosynthetic efficiency of cassava was evaluated under 400, 600, 800 and 1000 ppm CO_2 concentration. Linear increment in the photosynthetic rates across ECO_2 makes cassava an ideal ingredient of one of the strategies to alleviate the inevitable negative effects of climate change. We are of the strong opinion that scientific knowledge generated through this study could serve as a basis to understanding the complex phenotypic response of TTCs to abiotic stresses and will complement breeding strategies to present an alternative route toward the development of climate change mitigation and adaptation strategies to sustain the productivity of TTCs.

PG-220

Melatonin: A potential growth regulator for amelioration of abiotic stresses in cereal crops

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The exposure of crop plants to abiotic stresses is a major limitation to cereal productivity for the last two decades. Recently, the multifaceted role of phyto-regulator melatonin has stressed metabolomic research in the field of plant sciences. Chemically, melatonin is N-acetyl-5-methoxytryptamine, which is synthesized from tryptophan and possessed auxin like properties. This multifunctional signaling molecule maintains cellular redox homeostasis by direct scavenging of the active oxygen species during abiotic stresses. The bio-stimulating properties of melatonin such as delay of leaf senescence, prevention of photoinhibition under drought and heat stress are well cited in the literature. The exogenous application of melatonin has been found to maintain photosynthetic efficiency, reduce canopy temperature and improving the antioxidant potential of cereals like rice, wheat, sorghum etc. under abiotic stresses especially heat and drought. Thus, the beneficial effect of melatonin in the mitigation of redox stress during abiotic constraints can be utilized to enhance the cereal grain yields.

PG-221

Impact of foliar application of drought mitigation chemicals on growth and yield of redgram under rainfed ecosystem

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In redgram prolonged dry spells during the critical growth stages especially during flowering to pod development stage (terminal drought) significantly reduce the yield of crop. Management practices act as an important tool for drought mitigation and yield enhancement under moisture stress conditions. In this context, a field experiment was conducted to study the effect of foliar application of drought mitigation chemicals on the growth and yield of redgram under rainfed ecosystem during 2019-20 and 2020-21 at Regional Agricultural Research Station, Lam Guntur. In this experiment nine treatments were imposed in three replications in randomized block design. The 9 treatments are Urea @ 2%, DAP @ 2%, KNO_3 @ 1% (Multi K), Thiourea @ 150 ppm, Potassium Orthophosphate @ 2%, Salicylic acid @ 100 ppm, Triacontanol @ 1 ppm, 19-19-19 @ 1%, and Control with water spray. These drought mitigation chemicals were sprayed on the variety LRG 223 at flowering and pod formation stages. Parameters like Plant height, Leaf Area, SCMR, Dry matter production, Chlorophyll a, b, total chlorophyll, Number of pods per plant, hundred seed weight and yield were recorded. Results revealed that among the chemicals tested, spraying with DAP @ 2% gave rise to significantly higher yields when compared to other treatments and control. Parameters like Plant Height, Number of branches, total chlorophyll content, no. of pods per plant and hundred seed weight were found to be higher when sprayed with DAP@2%. Hence DAP@2% can be used as drought mitigation chemical in red gram for achieving superior yields.

PG-222

Photosynthetic and yield response of mung bean to bioregulatory molecules

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Mung bean, being a leguminous crop is rich in protein (approx. 25%) by virtue of nitrogen fixation. However, its average productivity is 0.5 t/ha which is lower than its yield potential of 2-3 t/ha, due to various intrinsic physiological limitations such as source limitation, low leaf area development, indeterminate growth habit, limited C_3 photosynthesis, slow initial dry matter accumulation, flower and pod shedding, poor pod setting and slow pod development, diversion of metabolic energy to sinks for protein synthesis. The application of bioregulatory molecules is an option to minimize physiological constraints for the enhancement of the yield. Therefore, a trial was conducted to analyse the response of mung bean varieties to bioregulatory molecules. This trial was comprised of foliar treatments of bioregulatory molecules viz. GABA @1mM, Glutamine @ 0.5mM, Ascorbic Acid @ 50µM, Proline @5mM, Salicylic Acid @ 0.5mM, Calcium nitrate @ 7.5mM, Spermidine @ 0.25 mM, Thiourea @10 mM, Arginine @1 mM, Glycine betaine @ 0.5mM, Tryptophan @ 1mM, Trehalose @1.5 mM and water spray as control. These treatments were applied at the flowering initiation stage. On average, in general, the bioregulatory molecules treatments enhanced yield and its components in both mung bean varieties by increasing photosynthesis, stomatal conductance, transpiration, canopy temperature depression, SPAD value, NDVI, level of photosynthetic pigments, fluorescence parameters, membrane stability index, growth parameters and dry matter partitioning towards the economic yield.

PG-223

Genome-wide association studies in bread wheat revealed genes controlling physiological traits governing phosphorus use efficiency

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Availability of phosphorus (P) in soils is a major concern for crop productivity worldwide. As phosphatic fertilizers are a non-renewable resource associated with economic and environmental issues so, the sustainable option is to develop P use efficient crop varieties. We phenotyped 82 diverse wheat (*Triticum aestivum* L.) accessions in soil and hydroponics at low and sufficient P. To identify the genic regions for P efficiency traits, the accessions were genotyped using the 35K-SNP array and genome-wide association study (GWAS) was performed. The high-quality SNPs across the genomes were evenly distributed with polymorphic information content values varying between 0.090 and 0.375. Structure analysis revealed three subpopulations (C1, C2, C3) and the phenotypic responses of these subpopulations were assessed for P efficiency traits. The C2 subpopulation showed the highest genetic variance and heritability values for numerous agronomically important traits as well as strong correlation under both P levels in soil and hydroponics. GWAS revealed 78 marker-trait associations (MTAs) but candidate genes were identified for only 35 MTAs which passed Bonferroni correction and belonged to soil experiment. Out of 35, nine MTAs controlled polygenic trait (two controlling four traits, one controlling three traits, and six controlling two traits). These multi-trait MTAs (each controlling two or more than two correlated traits) could be utilized for improving bread wheat to tolerate low P stress through marker-assisted selection.

PG-224

Impact of strigolactone (GR24) application on growth, photosynthetic, and physiological characteristics of *Artemisia annua* L.

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Phytohormones are known to regulate various plant growth and developmental processes. Among various phytohormones, strigolactones are one of the newly discovered group of plant hormones which have been found to be involved in shoot inhibition, root growth regulation, mediating mycorrhizal association and many other functions in plants under normal as well as stressful conditions. The aim of the present study is to reveal the impact of foliar application different concentrations of exogenous strigolactone (GR24) on *Artemisia annua* L. plants. *A. annua* plants are valuable due to presence of artemisinin, a sesquiterpene lactone synthesized in the glandular trichomes present in the aerial parts of the plant. The artemisinin is used in the formulation of artemisinin-based combination therapies used to treat malaria caused by *Plasmodium falciparum*. It is also effective against a number of other bacteria, viruses and certain cancers as well. The present investigation revealed the positive impact of GR24 on general growth, photosynthesis, and other physiological and biochemical attributes of A. annua plants. There was a significant increase in the activity of certain photosynthesis related enzymes like carbonic anhydrase, nitrate reductase, and RuBisCO. Furthermore, the present study also revealed the positive impact of exogenous GR24 on area and density of glandular trichomes. It also resulted in enhancement of artemisinin content and yield as a result of improved growth. Therefore, the present study shown the positive impact of exogenous GR24 on *A. annua* growth and artemisinin production and needs further analysis to elucidate its mechanism.

PG-225

Seed priming mediated drought tolerance enhancement in soybean (*Glycine max*) using GA_3 and BAP plant growth regulators (PGR) at early growth stages

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Drought is one of the most important abiotic stresses that negatively influence the early growth stages of plant *viz*. seed germination and seedling development. Seed priming is an emerging alternative method to enhance abiotic stress tolerance in crop plants. Plant hormones can be effectively utilized in seed priming treatments to combat abiotic stress tolerance. In present investigation, the seed priming treatments with plant growth regulators (PGR) *viz*.GA_3 (100 ppm) and BAP (4.87mg/liter) are applied to the seeds of soybean cultivars *i.e.* JS-335 and MAUS-71. Then seeds were germinated under control and drought stress (induced by 15% PEG 8000 solution) conditions and grown for seven days after germination along with non-primed seeds. Further germination percentage, osmolytes accumulation (proline and glycine betaine), antioxidant enzymes (superoxide dismutase, ascorbate peroxidase, and catalase) activity, isozymes study of antioxidants enzymes (superoxide dismutase and ascorbate peroxidase), total phenolic contents and reduced glutathione (GSH) were measured under primed and nonprime conditions. The observations revealed that, seed priming with GA_3 and BAP had significantly increased the germination rate (by 20-25%) and drought stress tolerance of germinating soybean seeds by accumulating osmolytes (2-5 folds) and antioxidant enzymes (2 to 2.5 folds) as compared to non-primed seeds. Thus GA_3 and BAP seed priming could be effectively utilized for enhancing drought tolerance and induction of defense responses such as antioxidant defense mechanisms and osmatic adjustment in soybean.

PG-226

Studies on growth and yield in mango ginger as affected by different levels of zinc and boron

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Mango ginger (*Curcuma amada* Roxb.) is an underground rhizomatous crop belonging to family Zingiberaceae. The rhizomes find wide application in pickling industry due to typical raw mango flavor and found growing in Southern states of India like Kerala, Karnataka and Tamilnadu. The studies on agronomical requirements of the crop are scarce. Hence the present investigation was carried out at college of Horticulture, Mudigere during 2018-19. Rhizomes were planted at spacing of 30*30 cm on raised beds. Three levels of micronutrients *i.e.,* boron and zinc (0, 5, 10 kg/ha) each were tried in 9 different combinations. T_1: $ZnSO_4$ 0 kg/ha + Borax 0 kg/ha (Control), T_2: $ZnSO_4$ 0 kg/ha+ Borax 5 kg/ha, T_3: $ZnSO_4$ 0 kg/ha + Borax 10 kg/ha, T_4: $ZnSO_4$ 5 kg/ha + Borax 0 kg/ha, T_5: $ZnSO_4$ 5 kg/ha + Borax 5 kg/ha, T_6: $ZnSO_4$ 5 kg/ha+ Borax 10 kg/ha, T_7: $ZnSO_4$ 10 kg/ha + Borax 0 kg/ha, T_8: $ZnSO_4$ 10 kg/ha + Borax 5 kg/ha, T_9: $ZnSO_4$ 10 kg/ha + Borax 10 kg/ha. Nutrients were applied as soil application at the time of sowing. Blanket dose of N: P: K at 180:150:300 kg/ha was common for all the treatments. Different growth and yield parameters were recorded at regular intervals. The results revealed that growth parameters *viz*. plant height (73.97 cm) and number of leaves (7.00) were found maximumin T9($ZnSO_4$ 10kg /ha+ Borax 10kg /ha) whereas, leaf area (133.27 dm^2) and LAI (1.48) were recorded maximum in plants supplied with $ZnSO_4$ (5 kg / ha) + Borax (10 kg / ha) (T_6). Significantly higher Chlorophyll content (63.44SPADunits) was noted in T_9. Yield parameters like number of primary fingers (6.13), number of secondary fingers (18.13), rhizome length (17.54 cm), rhizome width (16.82 cm), fresh weight of the rhizome (279.33 g), dry weight of rhizome are found to be highest in treatment T_9 (combined application of zinc and boron at the rate of 10 kg per hectare each). Rhizomes yield per bed (11.4 kg) as well as calculated yield per hectare (32.12 t) were found to be maximum in T_9 (combined application of zinc and boron at the rate of 10 kg each) followed by T_6 (combined application of zinc and boron at 5 kg and 10 kg/ha respectively).

PG-227

Relative effectiveness of arbuscular mycorrhizaand polyamines in modulating ROS generation and ascorbate-glutathione (AsA-GSH) cycle in *Cajanus cajan* under nickel stress

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Nickel (Ni) is an essential, naturally occurring micronutrient required for plant growth and metabolic functions. However, it becomes toxic, when present in excess in the soil. In the recent years, use of polyamines (PAs) and arbuscular mycorrhiza (AM - *Rhizoglomus intraradices*) have gained importance and play key roles in alleviating heavy metal (HM) toxicity in plants. Therefore, the current study was designed to evaluate relative impacts of three PAs (Put, Spd, and Spm) and *R. intraradices* in reducing Ni uptake, ROS generation, and modulating antioxidant defense machinery in two differentially tolerant pigeonpea genotypes. Roots of Ni stressed plants accumulated significant Ni concentrations, more in roots than leaves that led to proportionate decline in their dry weights and enhanced ROS generation. Although, three PAs and AM inoculations improved plant growth by reducing oxidative burden. AM was more effective in upregulating the antioxidant defense as well as enzymes of AsA-GSH cycle when compared with three PAs. Among the PAs - Put was most effective in alleviating Ni stress and its combined application with AM strengthened antioxidant enzymes activities more strongly than +Spd+AM and +Spm+AM.

PG-228

Growth, yield and quality of ginger in soilless culture under protected structure as influenced by growth retardant and nutrient levels

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Zingiber officinale habitually referred to as ginger is a monocotyledon perennial spice of the family Zingiberaceae that is used worldwide for its aromatic and pungent rhizomes. Ginger is fertility exhausting crop and being propagated through rhizomes, it is naturally susceptible to several devastating soil borne plant pathogens when grown as a field crop. Thus adoption of soilless culture system could be the most preferable alternative. Controlling plant size is one of the most important aspects of greenhouse crop production especially where underground part is of economic concern. Hence use of synthetic growth regulators can be beneficial. Thus experiment was carried out at College of Horticulture Mudigere during 2020-2021. The experiment was laid out in Completely Randomized Block Design (Factorial). The plants were grown in soilless media comprising cocopeat and sand (75:25) inside naturally ventilated polyhouse. The experiment comprised of two factors namely nutrients (N) at four levels (N_1: 100% of RDF + 100% Secondary nutrients + Micronutrients, N_2: 140% of RDF + 140% Secondary nutrients + Micronutrients, N_3: 180% of RDF + 180% Secondary nutrients + Micronutrients, N_4: 220% of RDF + 220% Secondary nutrients + Micronutrients) and growth retardant (Chlorocholine chloride) at three levels (G_1: CCC @ 500 ppm, G_2: CCC @ 1000 ppm, G_3: Control). There were totally 12 treatment combinations. Significant differences were recorded for growth, yield and quality traits. The treatment combination N_3G_2 recorded leaf area (14274.10 cm^2), number of leaves per clump (350.87), number of tillers (15.73), length of rhizome (24.00 cm), width of rhizome (11.37 cm), primary fingers (9.70), secondary fingers (11.60) fresh weight of rhizomes (826.67 g/ clump) and dry weight of rhizomes (220.87g / clump). Essential oil content (1.40%), oleoresin content (10.20%) and crude fibre content (4.70%) were also found highest in the same treatment combination.

PG-229

Paclobutrazol dissipation and its influence on soil microbial community in mango orchard ecosystem

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Paclobutrazol [(2RS, 3RS)-1-(4-chlorophenyl)-4, 4-dimethyl-2-(1H-1, 2, 4-trizol-1-yl)-pentan-3-ol] is a plant growth regulator largely utilized to increase the mango production through the control of alternate bearing habit. It is usually applied in to the soil, where it may remain active for long periods. Indiscriminate use of paclobutrazol has become a major threat to soil health of mango orchard ecosystem. Based on this background the effect of paclobutrazol on soil microbial community, Dehydrogenase, Fluorescein diacetate activities along with its dissipation rate was assessed at regular intervals in treated soil of mango cv Dashehari and compared to control. The paclobutrazol in soils of mango orchard, affected negatively the soil microbial community particularly at higher concentration. The average value for total bacterial was increased with day after paclobutrazol application and maximum value (134.67**–**144.33 cfu/ml) was recorded at 320 days at lower concentration (2-8 g a.i.) but the same was gradually reduced at higher (10g a.i.) concentration. However, marginal difference in fungal population was recorded in treated soil as compared to untreated. The lower dose (2-8 g a.i./tree) of paclobutrazol only influenced positively (>0.5 TTC µg/g FW) to dehydrogenase activity. However, no set pattern of FDA under the paclobutrazol treatment was observed. Maximum level of paclobutrazol residue and maximum inhibition of microbes at higher dose may be related to the negative effect of paclobutrazol on soil biota. This could also suggest that in the lower dose, paclobutrazol does not cause any deleterious effect of soil health in terms of soil microflora.

PG-230

Efficacy of salicylic acid as elicitor to modulating the physio-biochemical attributes of vegetatively propagated

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Salicylic acid (SA) one of the most important plant phenolic, alters a number of metabolic pathways including photosynthesis and secondary metabolites in plants. Due to its hormone-like activity, SA has been employed in different plant species to explore its role for sec metabolite production along with modulated various physio-biochemical processes. *Bacopa monniera* commonly known as brahmi, an important medicinal herb from Scrophulariaceae family is the source of dammarane-type triterpenoid saponins Bacosides, the main active chemical constituent for pharmaceutical utilization however, the lack of high bacoside cultivars has limited pharmaceutical utilization. Optimization of suitable concentrations of salicylic acid has been accomplished for the improving the physio-biochemical attributes. The foliar application of SA with different concentration (25, 50, 75, 100, 125, 150 mg/L^{-1}) was done to elucidate the chl a, chl b, total chlorophyll content, carotenoid and total phenol content including malondialdehyde (MDA). In a pot experiment above parameters were analyzed after 7 days of foliar sprays with in 30 days interval from transplanting. The obtained results indicated that SA Foliar application able to enhance total chlorophyll content along with chl a at 150 mg conc. of SA, while 50 mg conc. effective to improved the chl b and carotenoid content. Although externally applied SA enhanced MDA content in all SA conc. as compared to control. But high phenol content increased at SA (75 mg) conc. as compared to control which emphasized the SA action in secondary metabolism also. Hence, it is concluded that the optimum level of SA significantly affected the physio-biochemical attributes of *Bacopamonniera*.

PG-231

Summer stratification: A productive approach for revival of hybrid seedlings in low chill peach

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Currently, in the face of a changing climate, the breeding of low chill peach fruit is becoming increasingly laborious and time-consuming. One of such aspect is the success percentage of germination of low chill peach hybrid seed. The development period of most low peach cultivars is short, which leads to embryo abortion and is one of the primary factors limiting the germination of low chill hybrid progenies. In these cases, fruit ripening takes place before the embryo could complete its morphological and physiological development. This results in the embryo not being able to absorb critical metabolites and PGRs required to complete its development. Then after, it will get abort and perish if not rescued. But in light of the higher expense and the poor recovery of hybrid seedlings in *in vitro* embryo rescue, the effects of summer stratification and germination under controlled conditions were investigated. Summer stratification and seed germination under controlled conditions were accomplished by harvesting fully matured fruits and storing them at 5°C for up to two days until the seed was extracted. The seeds were stratified in media, containing cocopeat +perlite (2:1) and were stored at 4±2°C for stratification till 25-30% radicle emergence is seen in the seeds. The stratification period of the hybrid seed varied from 47 days in Saharanpur Prabhat × Florda Red to 50 days in Saharanpur Prabhat × Early Grand to 43 days in Saharanpur Prabhat × Pratap and to 52 days in Sharbati × Florda Red. Maximum germination (84.5%) was recorded in the cross Sharbati × Florda Red, which differ significantly from Saharanpur Prabhat × Early Grand (70.64%). It was followed by seed germination (67.36%) in Saharanpur Prabhat × Florda Red and by Saharanpur Prabhat × Pratap (65.59%).

PG-232

Discerning the interactome under osmotic stress in the moss *Physcomitrella patens*

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DNA methyltransferase 2 (*DNMT2*) is annotated as tRNA (cytosine38-C5)-methyltransferase that unlike the other proteins of the methyltransferase family methylates cytosines (C5) located in both DNA, mRNA and specific tRNAs such as $tRNA^{Asp}$, $tRNA^{Val}$ and $tRNA^{Gly}$. *DNMT2* has a conserved role in stress management across plant and animals. In the moss *Physcomitrella patens* this methyltransferase plays a vital role in imparting tolerance to plants when exposed to salt and osmotic stress by modulating stability of $tRNA^{Asp}$. It directly interacts with other tRNA methyltransferases (Trms) and the stability of TRMs is affected in the *PpDNMT2* loss-of-function plants suggesting the presence of a functional network. In order to characterize PpDNMT2 interactome under osmotic stress we pulled out proteins existing in complex with PpDNMT2 after exposing protonemata to 600mM mannitol by immunoprecipitation using PpDNMT2-specific antibody followed by Peptide Mass Fingerprinting. A number of stress-responsive proteins such as Catalase, Heat shock proteins, superoxide dismutase, glyceraldehyde-3-phosphate dehydrogenase were identified. Glyceraldehyde-3-phosphate dehydrogenase was found to be directly interacting with PpDNMT2 in the yeast nuclei. Based on its interacting partners we propose that PpDNMT2 may play a crucial role in maintaining tRNA stability by forming a functional network with other tRNA modifying enzymes and the antioxidant enzymes.

PG-233

Acanthamoeba sp. enhance the nutrient uptake and change the metabolomic profile of *Oryza sativa* L. in presence of PGPB

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Plant growth promoting rhizobacteria play a significant role in improving plant growth and health via direct and/or indirect effect. But the functioning of these microbes strongly influenced by their interaction with protist present in the rhizosphere. Protist play a vital role and considerable efforts have been made in the past to reveal the importance and impact of this interaction on plant growth. So, in present study, the common soil habituating protist i.e., *Acanthamoeba* sp. have been isolated and identified through 18S rDNA technique from rice rhizosphere and the feeding trials were performed with previously identified PGPB species such as *Enterobacter cloacae*, *Pseudomonas fluorescens* and *Bacillus cereus*. The controlled laboratory experiment as well as pot culture study at green house were performed to analyze the interactive effect on physiological parameters and nutrient uptake by rice (*Oryza sativa* L.) plants. A real-time PCR method was utilized to explore the fold change of Indole-3-acetic acid concentration in rice plants. The present results revealed that the *Acanthamoeba* sp. and PGPB significantly enhanced the rice plant biomass and nutrient uptake. However, the largest impact was observed in case of simultaneously inoculated (*Acanthamoeba* sp. and *Enterobacter cloacae)* plants. The results of significant change in the expression of IAA-gene were in accordance with observed ramified root architecture of rice seedlings in presence of *E. cloacae* and *Acanthamoeba* sp. Beyond that, the results of induction of plant biochemical response through GC-MS analysis revealed the dynamic changes in the metabolomic profile of treated and untreated plant. Overall, the results suggest that inoculation of protist and PGPB may be the key solution for sustainable agriculture.

PG-234

Magnesium, zinc contents and deficiency symptom in chilli leaves

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Chilli (*Capsicum* spp.) is an important solanaceous vegetable which finds its use in food, pharmaceutics and industry. Present study was conducted on six chilli accessions belonged to *C. annuum* and *C. frutescens* species. Selected accessions were raised in uniform environment without inorganic fertilizer application. Accessions were characterized for ten morphological descriptors viz., colour of leaf, shape of leaf, pigmentation on node, position of pedicel at anthesis, colour of corolla, pigmentation on calyx, margin of calyx, presence of annular constriction, immature position of fruit and immature colour of fruit. Physiologically active leaves were collected at reproductive stage of the crop and, Magnesium and Zinc contents were estimated through atomic absorption spectroscopy. Magnesium content had significant variation across accessions where as variation in zinc content was not significant. With the limited number of accessions used for the study, there were no significant species specific differences for both mineral contents. Visual symptoms of interveinal chlorosis expressed when leaf Magnesium content is 175ppm or less where as the deficiency symptom was absent when the content was 200ppm or more. Appearance of intervienal chlorosis was depending on genotype characteristics also. There was no significant difference in both mineral contents with respect to different states of morphological descriptors suggesting these characters could not be used as indicators of leaf Magnesium and Zinc contents. On the other hand, the present study strongly supports the veracity of morphological unit characters as various descriptors as these characters were not affected by nutrient status of soil or plant tissue.

PG-235

In vitro regeneration of (*Vitis vinifera*) crimson seedless cv. using lateral bud explant

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Grapevine is the most popular grown fruit crop in the world and it is very important to national economies. Micro-propagation technique used widely for production of large number of plantlets in short time and it is well established methodology for *in vitro* regeneration of grapevine (*Vitis vinifera*). The aim of this work was to study the *in vitro* regeneration of Crimson Seedless using lateral bud explant. Lateral bud were cultured on MS medium supplemented with different concentration of BAP. Furthermore, shoot multiplication of initiated explants were cultured on different medium containing *viz*. T1 (MS medium with 0.5 mg/l BAP and 0.1 mg/l IBA), T2 (MS medium with 20% Coconut water and 0.1 mg/l IBA), T3 (MS medium with 0.5mg/l BAP and 20% coconut water) were used. The highest shoot multiplication and growth was observed in the 0.5 mg BAP with 20% coconut water supplemented in the medium.

PG-236

Soil inoculation of bio-stimulants improves physiological traits, mineral nutrient content and yield in compact cotton

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Cotton is the most important cash crop and has significant role in improving the agricultural economy of the country. Bio-stimulants can be an interesting alternative for sustainable agriculture as they have the potential to increase the nutrient uptake, improve the growth, physiological efficiency, seed yield and quality of different crops. The effects of different bio-stimulants were studied in newly released compact cotton variety, CO 17. The experiment was executed in a randomized block design with six replicates and seven treatments. The impact of soil application of bio-stimulants was assessed by evaluating the physiological characters, plant nutrient content and yield of cotton crop. Plant growth, physiological and yield traits were found influenced by different products developed using bio-stimulants such as *Enterobacter hormaechei, Glomus intraradices, Bacillus subtilis,* and a consortium of VAM with vitamins and amino acids. Physiological traits such as stomatal gas exchange, chlorophyll index and Normalized Difference Vegetative Index (NDVI) were recorded higher in bio-stimulants treated plants. Plant nutrient content such as nitrogen, phosphorus, potassium and zinc content were significantly improved in bio-stimulants treated plants over control plants. Soil application of *Ralligold* (10 kg ha^{-1}), an exclusive product containing consortium of VAM with vitamins and amino acids ascertained its supremacy by registering higher seed cotton yield (651.73 kg $acre^{-1}$) with an increase of 16.76 per cent over untreated control plants. Thus, the application of bio-stimulants improved the physiological potential and nutrient content of the crop causing better field establishment and higher seed cotton yield.

PG-237

Effect of plant growth substances on fruit set, yield and fruit quality of Pear cv. Punjab Beauty

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Fruit set is a major problem resulting in low fruit yield and reduction in the income of pear growers in sub-tropical regions. Plant growth substances such as boric acid (200 & 300 ppm), CPPU (5 & 10 ppm), NAA (10 & 20 ppm) and P-Ca (150 & 300 ppm) were sprayed at full bloom stage on pear cultivar Punjab Beauty in the sub-tropical region of Punjab, India. All the treatments influenced the fruit set and number of fruits retained from pea stage to harvest stage of fruit growth significantly as compared to the control. Among the treatments, boric acid sprayed at 200 ppm proved to be most effective with maximum fruit set (6.91%), fruit retention (59.93%) and yield (57.83 kg/tree) as compared to control and the other treatments. With regard to fruit quality, CPPU (5 ppm) and NAA (20 ppm) resulted in a significant enhancement of fruit length (8.43 cm) and fruit weight (162.30 g) which was significantly higher than the control. The treatment boric acid (200 ppm) resulted in significantly higher TSS (12.38º Brix) and TSS: acid ratio (53.35) over the control. Hence, application of 200 ppm boric acid resulted in improved fruit set, yield and fruit quality in sub-tropical pear.

PG-238

Hydroponics and aeroponics as proficient techniques for combating and mitigating the aftermath of climatic change on medicinal plants

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Climate change is a topic of paramount concern all around the globe. The compounding effects of climate change are leading to many changes in ecosystem including both flora and fauna prevailing on earth. Climate change is posing serious threats and changes in vegetation on the earth including medicinal and aromatic plants. Medicinal and aromatic plants are of utmost importance to humans due to their vast healing and aromatic properties. The medicinal and aromatic plants are in use since the beginning of life on earth. The livelihood of many people is sustained through the cultivation and trade of MAPs. Specially in this Covid-19 pandemic, the demand for medicinal and aromatic plants have drastically enhanced. So, there is need for the development of new techniques to mitigate the effects of climate change on medicinal plants. Due to climatic change, with its predicted impacts of increased erratic and potentially destructive weather patterns, floods, and droughts, it may become increasingly challenging to grow medicinal plants using traditional methods. Hydroponics and aeroponics offers a way to work around many of those climate change impacts by cultivating medicinal plants. Thus, hydroponics and aeroponics can offer permanent solution for the cultivation of medicinal plants under controlled environmental conditions without the interruption of climatic variables.

PG-239

Effect of different concentrations of iron sulphide nanoparticles on growth and nutritional status of button mushroom

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Iron deficiency is one of the leading risk factors for disability and death worldwide, affecting an estimated 2 billion people. Nutritional iron deficiency arises when physiological requirements cannot be met by consuming monotonous plant-based diets. Targeted iron supplementation, iron fortification of foods, or both, can control iron deficiency in populations. Metal nanoparticles, that are based on the micronutrients can potentially induce and improve the antioxidant response in organisms as well as enhance the level of the particular micro and macronutrients after treatment. Studies show that iron fortification can be an effective strategy against nutritional iron deficiency. The present study was carried out to evaluate different concentrations (0, 10, 25 and 50% in culture media and 0, 25, 50, 75 and 100% in spawned compost) of iron sulphide nanoparticles on growth, nutritional status and iron content of *Agaricus bisporus*. The mycelium growth rate was seen maximal at the concentration of 10% iron sulphide nanoparticles. Growth parameters like pileus diameter and stipe length were found to be maximal at the concentration of 25% iron sulphide nanoparticles. However, stipe diameter was maximal at 100% concentration of treatment. At the lower concentration of nanoparticles improvement in economic yield and carbohydrate content was seen. All the treatments of nanoparticles on *Agaricus bisporus* led to the increased iron content in fruiting bodies. Thus, iron sulphide nanoparticles have potential to improve growth, nutritional status and iron content of *Agaricus bisporus* at specified concentration to offset the problem of iron malnutrition.

PG-240

Crop responses to interaction between plant growth regulators and nutrients

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Growth and development events in plants are controlled by growth regulators. These can be found in the plant naturally or they may be manufactured. As production of the natural material known as plant hormones is not economically feasible and as the determination of the optimum conditions under which they function is difficult. The plant growth regulator is organic substances which in low concentration promotes, inhibits or modify growth and development, whereas growth inhibitor is an organic compound that retards growth generally. Mineral nutrition includes the supply, absorption, utilization of essential nutrients for growth and yield of crop plants. Plants count on a wide variety of metabolic, physiological, and developmental responses to adapt their growth to variations in mineral nutrient availability**.** To react to such variation's plants have evolved complex sensing and signaling mechanisms that allow them to monitor the external and internal concentration of each of these nutrients, both in absolute terms and also relatively to the status of other nutrients. Recent evidence has shown that hormones participate in the control of these regulatory networks. Conversely, mineral nutrient conditions influence hormone biosynthesis, further supporting close interrelation between hormonal stimuli and nutritional homeostasis. Both hormones and nutrients improve the plant growth and development.

PG-241

Effect of boron foliar application on yield and yield related attributes in wheat

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Wheat is the major staple food crop, providing almost half of all calories in the region of North Africa and West and Central Asia. It is known to respond to the application of several macro and micronutrients during its growing stages and results in enhanced output in terms of yield. While the macronutrients NPK have been extensively used for wheat production, micronutrients have been largely overlooked. Among the micronutrients boron is one of the seven essential micronutrients required for the normal growth of most of the cereal, fruit and vegetable crops. B plays an important role in plant life and adequate B fertilization is a must for successful crop production on B deficient soils. Plant species differ in their sensitivity to B deficiency and toxicity. Hence, needful and careful B fertilization is the key for sustainable production of crops in intensive cropping systems in India. Foliar B application is an effective strategy for improving B supply to plants especially when root growth is restricted due to dry soil conditions. Foliar application is done at later stages of crop growth and this method of B application has been found more effective in yield improvement and grain enrichment. To find out the effect of foliar application of boron (0, 0.1, 0.2% borax and 0, 0.06, 0.125% boric acid) in wheat, an experiment was conducted in the year 2020-21 at Crop Research Centre, G. B. Pant University of Agriculture and Technology Pantnagar. From the results the maximum increase in grain yield was observed with two sprays of 0.2% borax at 30 and 60 days after emergence. While maximum straw yield was observed with two sprays of 0.1% borax at 30 and 60 DAE. Maximum concentration of boron in leaf, grain and straw was observed at 0.12% boric acid (two sprays), 0.06% boric acid (one spray at 30 DAE) and 0.2% borax (two sprays) respectively.

PG-242

Evaluating compact cotton CO 17 through foliar application of growth retardants and nutrients to enhance yield and quality

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Cotton, the king of fiber crops is the most important global cash crop and controls economy of many nations. Worldwide sustainability of cotton yield is the major challenges for meeting impending threats under climate change. The aim of breeders to enhance the yield and quality by introducing new varieties is still on the road to overcome the demand for cotton production. With this background, present field experiment was taken up to study the growth, physiology, and yield traits of pre- released TCH 1819 culture by different chemical treatments (2018-2020). Observation on the leaf cross sections, the cells clearly distinguished the alteration and depicted the partitioning efficiency of the culture. Observation on growth, leaf area reduction and gas exchange changes under growth retardant treated plants found to have higher yield by more synchronization. By characterizing the physiological potential through manipulation by growth retardant [Mepiquat chloride (0.015%)] increased the yield by 30%. Thus, this method of studying the pre-released culture deeply helps in identifying the complex traits to be manipulated to enhance yield, quality and helps the farmers to get desirable outcome.

PG-243

Nutritional and molecular characterization using reference gene specific PCR assay of promising soybean genotypes

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Vegetable soybean (*Glycine max* L.) is a food-type soybean harvested when the seeds reach the full pod (R6) stage of the physiological development stage. The present investigation aimed to nutritional and molecular characterization using reference gene specific PCR assay of promising soybean (*Glycine max* L.) to elucidate the information about evaluation and identification of desirable soybean lines at as well as assessing for morphological and nutritional quality traits and aroma at R6 and R8 stage. The study also depicted the information about molecular characterization of promising soybean genotypes. Soybean genotypes were screened at R6 and R8 stages for nutritional quality traits and aroma. All the soybean genotypes shown significant differences in terms of nutritional and morphological characters at both R6 and R8 stage. The observations recorded were days to 50% flowering, days to maturity, plant height, number of pods per pod, 100 beans weight, 100 mature seed weight, bean yield/plant, pod length, pod width. The content of calcium, zinc, copper and manganese was higher at R6 than the R8 stage. Altogether the information generated from this study may be useful to breeders deciding breeding targets for development of vegetable soybean and willing to use genetically diverse genotypes in soybean improvement program. The SNAP marker GmBADH2 G1 revealed fragrance alleles in genotypes AGS 450, AGS 457, AGS 459 at 185 bp on 10% denaturing PAGE (Poly acryl amide Gel Electrophoresis). As expected, the marker clearly separated the two groups of soybean varieties.

PG-244

Effect of degree of deacetylation of chitosan on seed germination in soybean

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Chitosan is organic ecofriendly promising candidates as a seed-priming agent prepared by extraction from shrimp shells by deacetylation of chitin. Thin layer coating based on Chitosan was used for enhancing the germination and quality of soybean seeds. The present study was conducted to evaluate different types of chitosan having (70-90 DD%) level of degree of deacetylation provided by ISF chitin and Marine products LLP, Kerala, India. The *in-vitro* experiment was carried out in a laboratory by soybean seeds were dipped for 1 min in Chitosan concentration 0.1 to 1.6%. After seed treatment seeds were incubated at 25°C for germination. After 48 hours of incubation the seeds were determined for the percentage of germination and the length of the radical. The investigation showed that the all-Chitosan treatment inducing germination percent, the number of leaves, the length of the stem and root of the seedlings. Among the treatments, Chitosan >90 DD at concentration 0.4% Chitosan for germination i.e., 73.33% than other treatments. The present investigation showed that the root and radical length significantly increased with the increasing seed germination percentage, vigor and vegetative growth of soybean seedlings.

PG-245

Exogenous salicylic acids and kinetin modulate reactive oxygen species metabolism and upregulate glyoxalase system to confer waterlogging stress tolerance in soybean

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We conducted this study to investigate the positive effects of foliar applied salicylic acid (SA) and kinetin (KN) in improving waterlogging stress tolerance, by upregulating reactive oxygen species (ROS) metabolism and antioxidant defense including glyoxalase system in soybean (*Glycine max* cv. Sohag) grown under different levels of waterlogging. Waterlogging was imposed on plants at 15 days after sowing at four different durations viz. waterlogging for 0 days (W0), waterlogging for 3 days (W3), waterlogging for 6 days (W6), waterlogging for 9 days (W9) and plants were supplemented with exogenous SA (0.5 mM) and KN (0.1 mM). Waterlogging resulted in the increase of lipid peroxidation (malondialdehyde content), hydrogen peroxide content, electrolyte leakage, proline content and glutathione S-transferase (GST) activity while ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR), glutathione reductase (GR), catalase (CAT), glutathione peroxidase (GPX), peroxidase (POD), glyoxalase I (Gly I) and glyoxalase II (Gly II) activities were decreased. On the contrary, exogenous SA and KN reduced the MDA content, H_2O_2 content, proline content and electrolyte leakage under waterlogging. Further, supplementation of SA and KN enhanced the activity of APX, MDHAR, DHAR, GR, CAT, GST, GPX, POD, Gly I and Gly II under waterlogging stress. In the current study, the results indicate that both exogenous SA and KN effectively improved the ROS metabolism and waterlogging stress tolerance in soybean by enhancing the antioxidant defense and upregulating the glyoxalase system.

PG-246

Effects of zinc excess on growth and productivity of pea

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Throughout the literature zinc has widely been documented as one of the most important micronutrients limiting plant growth of a wide range of plant species. Thus along with the evaluation of uptake of zinc, various stress related markers of toxic zinc concentration is also important in order to understand the effect of zinc excess on plant growth and zinc uptake. Therefore, the present investigation was undertaken to evaluate the effect of varying zinc concentration on growth and productivity of pea plants. In the study zinc concentration ranging from 0-100 mg/L was applied to field grown pea plants and the following parameters were studied including Chlorophyll, Protein, Superoxide dismutase, MDA, Peroxidase and catalase.

PG-247

Response of promising pre release sugarcane clones for salinity tolerance

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Sugarcane (*Sacharun officinarum* L.) is moderately sensitive to salinity. Decrease in yield is being takes place with increasing soil salinity. Salinity inhibits plant growth by ion toxicity, nutritional imbalances, osmotic effect and oxidative stress. Using the salt tolerant crops is one of the most important strategies to solve the problem of salinity. The differential growth performance of genotypes under salinity may be related to their ability to uptake, transport of ions and salt exchange mechanisms. Salt tolerant genotypes compromises either in yield or quality and thus able to perform mechanisms. Keeping this in view a field experiment was conducted during 2012-13 to study the influence of salinity on growth and yield of promising sugarcane clones at Agricultural Research Station, Perumallapalle, ANGRAU, Andhra Pradesh. Four sugarcane clones (2014 T 20, 2014 T 65, 2014 T 71 and 2003 V 46) were evaluated for salinity tolerance under control (normal) and saline conditions. Soil EC @ 6 $dSm^{-1}$was developed with addition of salt water. Data on germination%, nutrient content, K/Na ratio and cane weight were recorded. The germination percent, single cane weight and sucrose percent were significantly affected by treatments. 2014 T 71 showed less percent reduction in germination and CCS under saline conditions. However, 2014 T 65 resulted less reduction in single cane weight and sucrose than other entries in saline pots. K/Na ratio was also higher in 2014 T 65 under saline conditions. From this data it had concluded that 2014 T 65 and 2014 T 71 showed salt tolerance and suitable for saline soils.

PG-248

Evaluation of biotic and a-biotic elicitors' efficacy against alternaria leaf spot of soybean

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Soybean plants are challenged by a variety of biotic stresses lead to a huge economic loss due to low productivity. The biotic and a-biotic elicitors which play role in trigger intracellular plant defence activity were evaluated against leaf spot of soybean *Alternaria alternata* to evaluate environmental friendly alternatives to chemical fungicide in field experiment. The experiment was conducted at three different locations by using of two foliar sprays at flower initiation and at 55 days after sowing. The elicitors Salicylic acid (SA) @ 100 ppm, Benzoic acid @ 100 ppm, Humic acid @ 1%, Jasmonic acid @ 100 ppm were used along with Potassium nitrate (KNO3) @ 1%, bioagents *Trichoderma viride* @ 1%, *Pseudomonas fluorescens* @ 1%, Propiconazole 0.1% as recommended fungicide and water as control. The observation recorded after 45 and 65 days after sowing. At three location all treatments were able to reduce disease index at 45 and 60 DAS as campare to control. Among treatments, propiconazole (0.1%) achieve minimum disease index, it was at par with Jasmonic acid @ 100. Similar trend was found at second spray i.e. 65 DAS and in yield. Least yield was recorded in water spray control (750 kg/ha). Two spray of Jasmonic acid @ 100 ppm at flowring and 60 DAS has been advocated to induce systemic resistance against *Alternaria alternata* leaf spot of soybean.

PG-249

Effect of different types of chitosan on seed germination in wheat

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Chitosan is a non-toxic, biocompatible and biodegradable polysaccharide, acts as a natural plant growth regulator and elicitors. In this study, the effect of different types of chitosan A, B, C, D having different level of degree of deacetylation, molecular weight, viscosity on seed germination and initial vegetative growth of wheat seedling was evaluated. The seeds were disinfected and imbibed for one hour in chitosan A, B, C, D at concentration of 0 to 2%. After seed treatment seeds were incubated at 25°C for germination. After 72 hours of incubation the germination percentage, the length of the radius, and seedling length was determined. The results showed that the all chitosan showed induction of germination rate, a greater number of leaves, the higher length of the stem and roots, the more radical dry mass and leaf area of the seedlings at dose 0.1 to 0.6%. Among the all-Chitosan C showed highest induction than other three chitosan, it also observed that concentration, degree of deacetylation, viscosity and molecular weight parameter impact on the germination rate and vegetative growth of wheat seedlings.

PG-250

Screening of Soybean germplasm for post-anthesis drought resistance

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Climate change-induced drought stress is one of the major constraints that limit soybean productivity due to reduced water absorption and nutritional uptake, increased flower & pod abortion, and shriveled seeds due to poor seed filling. The present study was conducted to identify soybean genotypes tolerant toward post-pod-initiation drought stress. The severe water deficit stress treatment (-55 kPa) was imposed by withholding irrigation for eleven days after pod initiation, and phenotyping for drought tolerance traits was performed. Twenty-nine soybean genotypes were classified into four groups based on relative seed yield per plant and relative DSI of yield. The average relative seed yield per plant was 5.36 g plant^{-1}, while the average DSI for a yield of all the genotypes was 0.96. Out of 29 genotypes, six (DAVIS, JS 97-52, JS 21-73, JS 20-98, SQL-88 and AMS 5 MB-518) exhibited high seed yield and low DSI (Quadrant I), whereas ten genotypes (YOUNG, SQL-31, HARDEE, JS 20-69, JS 21-72, AMS-59, CAT- 703, AGS-38 and CAT-649) showed low seed yield and high drought susceptibility index under drought stress condition (Quadrant III). Based on drought susceptibility index SQL-88, DAVIS and JS 97-52 were found to be highly drought tolerant, while YOUNG, TGX 852-3D, and JS 21-17 were identified as highly drought susceptible soybean genotypes. Drought tolerant soybean genotypes flower and mature three days earlier as compared to drought susceptible genotypes. Growth rate and growth analysis component characterization reveals maximum LAD, CGR, RGR and NAR for high yielding genotypes under well-watered condition. Drought stress at post pod initiation stage leads to a reduction in seed yield (36%), pods per plant (36%), seeds per pod (2%), plant biomass (19.6%), plant height (9%). High-yielding drought-tolerant genotypes retain higher MSI, RWC, chlorophyll, carotenoid content, chlorophyll content index and reflect less lipid peroxidation. The identified drought-tolerant genotypes can be used in molecular breeding/genetic engineering programs to develop drought-tolerant soybean. The contrasting genotypes identified for post-pod-initiation drought tolerance will be used to identify genes and QTLs for drought tolerance through transcriptomic and molecular breeding approaches.

PG-251

Role of *gluconacetobacter diazotrophicus* in sugarcane production

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Nitrogen is a primary constituent of nucleotides, proteins, and chlorophyll in plants. Although the atmosphere contains 78% nitrogen, its diatomic form makes it inaccessible to plants due to the presence of a triple bond. Sugarcane (*Saccharum officinarum*) is an exhaustive crop that can uptake great amount of soil nutrients for its biomass production. Modern plant agriculture heavily relies on industrial nitrogen fertilizers to maintain optimum yields. The use efficiency of N fertilizers in sugarcane applied with recommended dose of N in the range of 250 to 400 kg ha^{-1} is only 20-30% and hence, at every harvest of the crop soil suffers a net loss of 50-100 kg N ha^{-1}. In addition to this, nitrogen fertilizers are expensive, quadrupling in price from 1999 to 2008. The production and use of nitrogen fertilizers also contribute significantly to greenhouse gas emissions. Adding to this, the fact that nitrogen is mobile, reactive which makes it very vulnerable to losses due to denitrification, volatilization and leaching. Due to increased cost, detrimental effects on environment and also negative impact of nitrogen fertilizers on soil health and crop productivity, using of biofertilizers like *Gluconacetobacter diazotrophicus* helps to the agricultural system by adding fixed nitrogen into the soil through the process of biological nitrogen fixation (BNF). *Gluconacetobacter diazotrophicus*, a nitrogen fixing bacterium is found in high number in all parts of monocotyledon sugarcane plants in which the bacterium actively fixes atmospheric nitrogen and provides significant amounts of nitrogen to plants. This bacterium mainly colonizes intercellular spaces within the roots and stems of plants and does not require the formation of the complex root organ like nodule. It's better colonization in sugarcane is probably due to its capability to grow in the presence of high sugar and low pH. It can excrete about half of its fixed nitrogen in a form that plants can use. It also helps in solubilizing the inorganic phosphates from the soil and make available P for the inoculated crop. Production of plant growth hormones is the other beneficial trait associated with *Gluconacetobacter diazotrophicus.* A new role for the plant growth-promoting nitrogen-fixing endophytic bacteria *Gluconacetobacter diazotrophicus* has been identified and characterized while it is involved in the sugarcane-*Xanthomonas albilineans* pathogenic interactions. Living G. *diazotrophicus* possess and/or produce elicitor molecules which activate the sugarcane defence response resulting in the plant resistance to X. *albilineans*, in this particular case controlling the pathogen transmission to emerging agamic shoots. *Gluconacetobacter* inoculation to sugarcane significantly increases the cane girth, chlorophyll content, total nitrogen, cane length and number of millable canes.

PG-252

Response of chitosan on breaking yield barrier in soybean

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The study was conducted to evaluate the effect of different concentration of chitosan (control, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 ppm) during the year 2020-21. Therefore, the present investigation was conducted at Agril. Botany Section Farm, College of Agriculture, Nagpur (MS). The experiment was laid out in RBD design with 11 treatments and three replications in *kharif* Season. The observations of various morph-physiological and yield attributing characters were recorded. Result revealed that, foliar application of 60 ppm chitosan at 25 and 40 days after sowing significantly increased plant height, no. of branches, leaf area, dry matter chlorophyll content and N content in leaves. Seed weight, no. of pods and seed yield was also increased significantly by using 60 ppm chitosan when compared with other treatment and control. Yield per cent increase over control was 38.79%. Therefore, chitosan recommended to farmers for breaking the yield barriers and increase yield in soybean

PG-253

In vitro study effect of different type chitosan on seed germination in onion

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Chitosan is an ecofriendly organic compound that can be used as a seed-priming agent for the enhancement of seed germination in different crops. In this study, we evaluated the four different types of Chitosan having a different level of degree of deacetylation viz > 75 DD, >80 DD, >80 DD, and 90DD provided by ISF chitin and Marine products LLP, Kerala, India. The onion seeds variety Bhima Dark Red was purchased from the Directorate of Onion and Garlic Research. In vitro study was conducted in the 24-Well plate for study effect of Chitosan on germination. The 2% chitosan was dissolved in 0.1 M acetic acid and working concentration 0, 0.1, 0.2, 0.4, 0.8, and 1.6% was diluted with sterile distilled water. Four replications per treatment was kept and 20 seeds per replication (each well) was soaked in the chitosan solution for 60 minutes and a further 24 well plates at 25 ± 3°C in growth chamber 12hr alternate lights. After 72 hours of incubation, the percentage of seed germination and the length of the radical were calculated. The investigation showed that the all-chitosan 0.1 to 0.2% induced germination while the above concentration inhibits the germination with compared water control. Among the four types chitosan <90 DD showed the highest germination and radical length.

PG-254

Soil macronutrient content and productivity of rice crop in 35th year of cropping and fertilization under rice-wheat-sorghum crop rotation

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A study was accomplished in an ongoing field experiment under AICRP on Micro Secondary and Pollutant Elements in Soil and Plants, initiated in Kharif 1985 in light textured highly calcareous soil. The experiment was designed in Randomised Block Design (RBD) with four fertility levels (0 RDF, 50% RDF, 100% RDF and 150% RDF), two cropping system (Rice-Wheat-Sorghum and Rice-Mustard-Moong) and six replications. The RDF for rice and wheat were 120:60:40; for mustard: 60:40:30; for moong : 20:50:30; and for Sorghum: 60:50:30. After 10 cropping cycles owing to severe deficiency of micronutrients particularly zinc, on four replications out of six superimpositions (10 kg/ha Zn, 10 kg/ha Zn +5 t/ha FYM, 10 t/ha FYM and 10 kg/ha Zn + 10 t/ha FYM) were made. The superimposed treatments were applied in alternate years in kharif. The present investigation was carried out in rice-wheat-sorghum rotation in the 35th cropping cycle. The data were analysed using paired t-test do make out a meaningful comparison among superimposed treatments. The analysis revealed that the superimposed treatment (10 kg/ha Zn + 10 t/ha FYM) out performed all other treatments. A significant improvement in available N, P_2O_5, K_2O and S content over control to the tune of 30.0%, 15.6%, 27.9% and 22.9% respectively was found in surface soil. The organic carbon content also improved significantly. Application of 10 kg/ha Zn along with 5 t/ha FYM or 10 t/ha FYM in alternate years was found significantly superior over individual use of either 10 t/ha FYM or 10 kg/ha Zn with regards to grain yield, straw yield and nutrient uptake.

PG-255

Simulation of *kharif* soybean phenology and yield by using DSSAT model (version 4.6) under varied environmental condition in Parbhani district

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Information needs for agricultural decision-making at all levels are increasing rapidly due to increased demands for agricultural products and increased pressures on land, water, and other natural resources. The Decision Support System for Agrotechnology Transfer (DSSAT) was developed to facilitate the application of crop models in a systems approach to agronomic research. In the investigation, at Parabhani (Maharashtra) during the *Kharif* season (2019), CROPGRO (DSSAT) model was use to calibrate genetic coefficients and validate through conducting a field experiment laid out in split a plot design with three replications. Four dates of sowing were assign as the main plot with three varieties as sub-sub plot treatment. Response of soybean yield found significant with the date of sowing and varieties, but sowing date D1 performed well with pod yield under Parbhani's agro-climatic region in comparison to D2, D3, and D4. Variety V2 (MAUS-158) performed satisfactorily as compared to V1 (MAUS-71) and V3 (JS-335) with pod yield under Parbhani's agro-climatic region. Various test criteria's were applied to validate the performance of the model. The simulation performance of pod yield was better. A positive significant association was observe between simulated and observed mean yield. A positive significant association was observe between simulated and observed mean LAI values. In general, model performance in terms of simulation of yield, phenology, and yield attributing characters were satisfactory.

PG-256

Role of different nutrient sources on grain nutritional quality of Pant Basmati I

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Rice (*Oryza sativa* L.) is an important cereal crops for billions of people and assures food security in the rice consuming countries of the world. Farmers must produce more rice of better quality to meet the demands of ever increasing population in coming years. However the average yield and nutritional quality of rice has been stagnant and remained lower than the production potential, which, might be due to imbalanced use of chemical fertilizers. Excessive or inappropriate use of chemical fertilizers (CFs) is a major cause of nutrient imbalance in soil, as well as imbalance in organic constituent like protein, carbohydrate and amylose content of rice. Nutrient supplied exclusively through CFs enhance the yield of rice initially, but the yields and nutritional quality are not sustainable over time. Integrated nutrient management (INM) helps us to achieve efficient use of synthetic fertilizers integrated with organic sources of nutrient. This may help in enhancing the rice nutritional quality. In the present study, six different nutrient sources were used viz. organic I [Farmyard manure (FYM)+ vermicompost (VC)+ green manure (GM)], organic II(50% organic I + innovative tool i.e. beejamrit, ghanjeevamrit, jeevamrit), inorganic I (NPK 120:60:40), inorganic II(RDF + FYM @ 5 tonne/ha) and integrated I (50% organic + 50% inorganic) and integrated II (25%organic + 25% inorganic + 50% innovative tool) were applied to Pant Basmati I to evaluate their efficiency. Result revealed that that the amount of organic constituent of pant basmati I grains were affected by the different nutrient sources. Protein carbohydrate and amylose content was significantly higher in integrated II followed by integrated I nutrient sources.

PG-257

Assessment of soybean genotypes for depleting soil moisture conditions by employing modern phenotyping tools

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Water scarcity is major threat for agricultural productivity as it greatly hampers the crop yield. Soybean is an important oil seed crop of semi-arid region, which is highly vulnerable to drought. Hence to get sustainable yield under such adverse conditions, development of drought tolerant varieties is of prime concern. Such cultivars that carry drought tolerant traits are screened through large number of population of genotypes. Screening diverse genotypes for drought tolerant traits is vital for identifying promising ones that can serve as parent lines for developing drought tolerant cultivars. By keeping this as main objective, an experiment has been conducted at farm of ICAR-NIASM, Malegaon, in year 2020-2021 with 72 genotypes with JS 335 as local check. The experiment was framed with two level of soil moisture stress. Water stress treatment was imposed by withholding irrigation at anthesis. Soil moisture was assessed by gravimetric method regular interval. Growth as well as physiological responses of soybean genotypes in response to soil moisture was monitored periodically by employing various phenotyping tools such as infra-red thermography, chlorophyll fluorescence imaging system and NDVI. These tools facilitates screening of large number of genotypes with maximum precision and accuracy. Results revealed that genotypes such as JS20-29, SL-525, MACS 13, JS 20-74, PK-471 have maintained their physiology even under stressed conditions by showing less canopy temperature and better PS-II efficiency. Ultimately same genotypes have produced higher biomass and seed yield than that of local check variety and other genotypes. From this, it might be concluded that genotypes like JS20-29, SL-525, MACS 13, JS 20-74, PK-471 can be considered as potential source for drought tolerance that can be used in soybean breeding programs for semi-arid region.

PG-258

Effect of plant growth regulators on growth and yield of *Kharif* groundnut cv. GJG-31

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A field experiment was conducted during *kharif* 2018 at Cotton Research Station, College of Agriculture, Junagadh Agricultural University, Junagadh to study the "Effect of plant growth regulators on growth and yield of *kharif* groundnut cv. GJG-31". This investigation was carried out in randomized block design with three replications. The experiment consisting of ten treatments *viz.,* PBZ @ 200 and 250 ppm, TRIA @ 5 and 10 ppm, BR @ 20 and 40 ppm, SA @ 25 and 50 ppm, water spray at 40 & 55 DAS and control. The experiment results revealed that foliar application of TRIA, BR, SA at both concentrations increased the plant height and it was more in SA @ 50 ppm treated plants. Applications of PGRs increase the root length and no. of branches of groundnut. The increase was more with the treatment of SA followed by PBZ treatments. The increase in the higher level of chlorophyll content may be due to delay in degradation of chlorophyll caused by the exogenous application of growth regulators. Significantly highest chlorophyll a, chlorophyll b, total chlorophyll content was recorded under treatment T_8 (SA @ 50 ppm). Significantly highest mean of nitrate reductase enzyme activity was found in plants treated with SA @ 50 ppm. From the above finding, it can be concluded that foliar application of SA @ 50 ppm at 40 and 55 DAS after sowing improved the yield of groundnut under south saurashtra agro-climatic zone.

PG-259

Response of sugarcane midlate varieties to different planting methods and nitrogen doses in Sandy loam soils of Chittoor district of Andhra Pradesh

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Most parts of the southern zone of Andhra Pradesh, where sugarcane is grown are low in soil nitrogen, this coupled with long term mono cropping as a consequences of raising several ratoons year after year and land scarcity justifies continued use of nitrogen fertilizer field. However, nitrogen fertilizer is costly and indiscriminate management such as inappropriate rate, time and placement may lead to poor crop performance and yield; besides, it may result in such losses as nitrate due to leaching, de-nitrification and ammonium volatilization with serious environmental pollution. Nitrogen is the primary nutrient which influences the yield and quality of cane, however planting method also influences the cane yield. Hence present experiment was executed during the year 2020-2021, to study the response of sugarcane mid late varieties to different planting methods and with different doses of nitrogen. The field experiment was conducted at Agricultural Research Station, Perumallapalle. The experiment was laid out in a split-split plot design with three main plots viz., sugarcane mid late varieties 2014 T 39,2014T40 and it was compared to check variety Co 86032, three subplots viz., planting methods viz., normal row planting (90 cm), wide row planting (150 cm) and dual row planting (30 cm/150 cm) Sub sub plot viz., nitrogen doses viz., 100% RDN,125% RDN and 150% RDN, with three replications. The recommended dose of nitrogen is224 kg nitrogen through urea applied as two doses. Half of the nitrogen dose was applied at 45 days after planting, remaining half dose of nitrogen applied at 90 days after planting. Single super phosphate @ 112 kg P_2O_5 and muriate of potash @ K_2O 112 kg/ha was applied at the time of planting. The experiment results revealed that the sugarcane variety 2014 T 40 recorded higher cane yield in normal row and dual row method of planting with 150%RDN (107 t/ha) compared to check variety Co 86032 (90.6 t/ha). Whereas the sugarcane variety 2014T39 recorded higher cane yield (84 t/ha) when planted at wide row method of planting (150 cm) compared to check variety Co 86032 (80.2 t/ha).

PG-260

Foliar applied salicylic acid and ascorbic acid improved salt stress tolerance in *Vigna unguiculata* (L.) Walp. by alleviating ROS production through modulation of antioxidant enzyme activity

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Salinity stress has become a serious global concern resulting a huge loss of crop production worldwide. Therefore, the use of growth regulators and/or antioxidants possesses ecological benefits are known as short-term measures to improve plant growth and yield under saline environment. Therefore, the present investigation focused on the effect of foliar application of salicylic acid (SA) and ascorbic acid (AsA) in enhancing NaCl stress resistance in cowpea. Salt stress lead change in the antioxidant enzyme activity such as superoxide dismutase, catalase, peroxidase, and ascorbate peroxidase with increasing rate of H_2O_2 and lipid peroxidation level (MDA)were recorded at all sampling days (30, 40, and 50 DAS) in cowpea. On the other hand, a significant reduction in the yield and yield traits were recorded in cowpea. Besides, foliar spray of SA (0.25mM/L) and AsA (0.5mM/L) either singly or combined with NaCl results further enhancement in the synthesis of enzymatic antioxidants and thus, preventing the membrane damage led by higher H_2O_2 levels under salt stress. It is, therefore, concluded from this study that foliar treatments of AsA and SA, not only enhanced the salt stress tolerance but also improved the yield attributes of cowpea.

PG-261

Effect of foliar micronutrients on growth and development of sweet corn

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There are plenty amounts of fertilizers that results in high agriculture yield. Foliar spraying of chelated fertilizer helps in reducing the total amounts of fertilizer applied along with achievement of higher fertilizer efficiency. Instead of soil fertilization, foliar fertilizer application is an effective way to increase the contents of trace elements in crops and crop yield, and to improve the soil environment. Foliar fertilizers are effective for improving element utilization efficiency, crop yield and quality. Sweet corn is a mutant type having recessive alleles in homozygous condition, which subsequently enables the endosperm to accumulate twice the sugar content. Foliar spray with iron, zinc and manganese enhance the plant growth and endogenous nutrient level.

PG-262

Effect of moisture stress on photosystem-II sensitivity in excised sugarcane leaves

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Sugarcane is an important cash crop that plays a crucial role in rural economy of India. However, this crop consumes substantial water resources and is a major concern when access to water is a challenge, particularly during drought period. To optimize use of water in sugarcane, it is essential to understand physiological responses of plant to depletion of soil moisture and relevant traits that can indicate the impact of stress. Photosystem-II(PS-II) is one of the most sensitive components of photosynthesis, a key physiological process that drives biomass accumulation in plants. Moisture deficit in leaves reduces rate of photosynthesis by depleting PS-II efficiency, measured by chlorophyll fluorescence which is a rapid and non-destructive method to study photosystem-II activity. In this context, an experiment was conducted to evaluate the impact of leaf desiccation on PS-II sensitivity in leaves of sugarcane cultivar Nayana CO-86032 with 2 treatments i.e. desiccated and non-desiccated, each with five replications. Chlorophyll fluorescence measurements were recorded at 2 hours interval, beginning from initiation of desiccation treatment. Polynomial regression of each parameter over leaf moisture content revealed the efficacy of each of the parameters in differentiating PS-II response. Out of 83 parameters derived from chlorophyll fluorescence quenching, 25 parameters could explain the impact of desiccation on PS-II of sugarcane as revealed by R^2>0.6. The most reliable parameter to explain the desiccation level was QY_max, which is the maximum quantum efficiency of plants. QY_L3 and qL_Lss parameters were found to be highly sensitive to desiccation as compared to other parameters.

PG-263

Comparative transcriptomic analysis highlights mechanisms associated with sugar accumulation in sweet sorghum

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Sorghum bicolor is a C_4 grass, which is a promising biofuel feedstock. Its grain and stem juice can be used to synthesize bioethanol. Sorghum has remarkable potential to thrive on the marginal land with minimum agricultural inputs. Though, there is a huge scope for yield improvement of sorghum with respect to fermentable sugars and biomass, very little is known about the molecular players regulating its growth and development. In this study, we explored the whole genome transcriptomic changes related to sugar accumulation in the stem internodes of three diverse sorghum cultivars along the course of development as well as in response to progressive water limiting conditions. Approximately 3.4 billion high-quality paired-end reads derived from 42 libraries were aligned against *Sorghum bicolor* genome and differentially expressed genes were annotated. The study revealed systematic changes that occur in pathways affecting stem sugar accumulation and adaptation to drought stress response. It specifically highlighted the significant role of carbohydrate transport and sugar metabolism, cellular signalling components and phytohormones. Under the water limiting conditions, pathways associated with osmotic stress response, oxidative stress, phytohormone and carbohydrate metabolism, were differentially regulated. Further, it highlights the contribution of transcription factors towards stem sugar accumulation and drought stress response. Remarkably high proportion of TFs showing gene expression modulation belonged to three TF families namely ERF, MYB and NAC.

PG-264

Macronutrient use efficiency in rice (*Oryza sativa* L.) cv. Hiranmayee under short term stagnant water

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Rice (*Oryza sativa* L.) is a cereal crop that is consumed by half of the world's population. With the worldwide increment in food grain requirement and diminishing arable land, focusing on resource use efficiency to improve agricultural productivity is essential. Rice cultivars have different dynamics of macronutrient accumulation throughout the life cycle. To study macronutrient uptake and removal by lowland rice cultivars a pot experiment was designed and statistically fitted in a completely randomised design with seven treatments as time of water stagnation and was replicated four times in pots. The plants were put under 15cm of water stagnation in the pots at 30 DAS (Days After Sowing) for a period of 0 days (Control), 5 days, 10 days, 15 days, 20 days, 25 days, and 30 days and thereafter the stagnant water was removed and watering was done as and when required. The recommended dose of fertiliser (80:40:40 NPK kg/ha) and no Ca and Mg fertiliser was applied initially in each pot with nitrogen as three split doses. Macronutrient use efficiency of rice cv. hiranmayee was greatly influenced by short term period of water stagnation that reduced the yield and yield components viz. test weight, number of panicles per plant, number of fertile grains per plant. The translocation and accumulation of N, P, K, Ca, Mg and S to different plant parts (root, leaf blade, leaf sheath, panicle before flowering and grain, husk, rachis after flowering) was decreased as the period of water stagnation continues up to 30 days.

PG-265

Wheat roots targeted metabolite profiling under different sowing environment

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High temperature stress decreases bread wheat (*Triticum aestivum* L) productivity which is a stable food and nourishes billion of people. Yield of wheat is expected to decline by 6% for 1 °C rise in temperature thus there is dire need to increase wheat production up to 60% by 2050 to fulfill global demand of burgeoning global population. Metabolomics is the new and effective biotechnological tool which open new vista to identify metabolites which could be used as promising biomarkers for stress tolerance and genetic dissection for metabolic pathways involved in stress response. The objective of this study was to demonstrate genetic variability in altered metabolic levels in the roots of six Indian wheat genotypes (WH147, WH711, WH1021, WH1105 and WH1184 and HD2967) in contrasting sowing environment i.e. timely sown (TS), late sown (LS) and very late sown (VLS) and to identify potential metabolite associated with heat stress through targeted metabolite profiling using a Liquid Chromatography Quadrupole Time of Flight Mass Spectrometry (LC-qTOF- MS).Total 129 metabolites were expressed in all genotypes and three environmental conditions. Out of these 58 found in TS, 36 under LS and 35 under VLS. Most expressed were exclusive to environment, TS (50), LS (28) and VLS (27). Genotypes also showed wide variability WH147 (24), WH711 (22), WH1021 (26), WH1105 (25), WH1184 (12) and HD2967 (20). The results of the study could provide a framework to understand plant mechanism governing heat stress and promising biomarkers for improving high temperature stress tolerance in wheat, genetic dissection for metabolic pathways involved.

PG-266

Antagonistic regulation of bud break in mulberry by the phytohormones ABA and GA

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Mulberry (*Morus spp.*), is a commercially important tree crop, and its foliage is used for rearing silkworm (*Bombyx mori*) for silk production. For commercial cultivation, mulberry is maintained as bush by regular pruning, and canopy growth post-pruning depends on the bud break process. The regulatory mechanism behind the process of bud break in mulberry is very poorly understood and phytohormones play a crucial role in bud dormancy in temperate trees. In this study, we attempted to understand mulberry (*Morus alba* L) bud break stages and the role of hormones in inducing bud break. We classified the bud break process in mulberry into four different stages (Stage 0 to 3) based on dynamic developmental changes in bud morphological features. To critically analyze the internal bud anatomical features at different stages, bud sections were taken and examined under Scanning Electron Microscope (SEM). SEM analysis revealed the presence of large starch granules in buds Stage 0 and starch granules decreased in advanced opening stages (Stage 2 and 3). To understand the role of major hormones in bud break process, we quantified gibberellic acid (GA) and abscisic acid (ABA) by LC-MS/MS and estimated the relative ratios. At Stage 0, the ratio of ABA/GA was the highest (33.9) indicating that ABA controls mulberry bud dormancy. The ratio reduced significantly in Stage 1 (7.51) which coincided with the release of dormancy. As indicated in SEM and also hormone analysis, in mulberry, GA seems to be essential for bud break, and the mechanism is probably similar to the events reported in the seed germination process.

PG-267

Heat stress tolerance in bread wheat

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Climate change may cause hindrance in progress toward a vision of world without hunger. The most remarkable driver of climate change affecting agriculture is the increase of global temperature. Significant influence of increased global temperature on agricultural productivity along with other consequences related to severity of drought. Exposure to higher temperature results in reduced yield and production of cereals. Wheat is a major food crop that is likely to be impacted by climate change. In wheat, every degree Celsius rise from a seasonal mean minimum crop temperature of 15^{o}C has been found to cost yield losses of up to 5%; although this threshold may vary based on other environmental factors, genotypes, and the developmental stage of the plant. In wheat all the growth stages are sensitive to high temperatures, while the reproductive phase is the most sensitive one as it affects both grain setting and grain filling. High temperature can alter physiological, biochemical, and morphological behaviour in bread wheat, which affects its growth and development causing a reduction in pollen viability, duration of grain filling, and starch synthesis in the grains. At flowering, temperature above optimum results in seed sterility, while post-anthesis heat stress (HS) causes a reduction in starch biosynthesis and alters its composition. Wheat crop has evolved appropriate mechanisms such as escape, avoidance, and/or stay green to cope with heat stress. In addition, plants hasten the production of HS-related proteins such as heat shock proteins (HSPs) as their defence approach. An overview of wheat responses and tolerance to heat stress (HS) at physiological, biochemical, and morphological behaviour may help in formulating appropriate breeding strategies for wheat crop improvement.

PG-268

Orthosilicic acid aftermath over *Brassica juncea*

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Brassica juncea (L.) Czern and Coss (Indian mustard, Rai), being a major oilseed crop, have various medicinal properties. There are various biostimulants effecting crop parameters and enhances crop yield. OSA (Orthosilicic acid), as a silicon (Si) source, have role in the growth and developmental aspects of this crop. The effect of OSA over Indian mustard varieties (RH 725 and RH 0749) was examined on concentration basis and yield depending on various physiological, biochemical and yield parameters was observed. Foliar application of four different OSA concentrations (0ppm, 20ppm, 30ppm, 40ppm) were done at both vegetative and flowering stage in both varieties. Sampling was done after three days of each spray for growth and developmental parameters analysis including leaf gas exchange traits, biochemical parameters (considering activity of Superoxide dismutase, Catalase, Ascorbate peroxidase and Peroxidase) with non-enzymatic antioxidant defense. Metabolites (Ascorbate and Glutathione content) and yield and its attributes at harvest stage. Results highlights an increased yield after the application of OSA concentration by enhancing physiological parameters as Relative water content (%), Chlorophyll fluorescence (f_v/f_m), Total chlorophyll content (SPAD), Chlorophyll stability index (%), Canopy temperature depression (ºC) after 20ppm OSA application. Also, biochemical attributes are influenced as Relative stress injury (RSI), Hydrogen peroxide content, and Malondialdehyde content show declined values. Antioxidant defence enzymes shows variability in results in accordance to varied concentration and variety. Yield and its attributes showed significant increase, the increased in yield was found to be 15% in RH 725 and 18% in RH 0749 after 20 ppm OSA applications.

PH-269

Effect of plant growth regulators on fruit quality of papaya Var. 'Pusa Nanha'

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Papaya (*Carica papaya* L.) is an important fruit crop of the tropical and subtropical regions of the world, having nutritional and numerous medicinal properties. The cultivation of low-quality fruits is a frequent occurrence. Papaya fruit is considered a high-value commodity and even minor changes in production, productivity, product quality, or aesthetic appeal will significantly increase or decrease the product value. During the ripening process, major hormonal changes occur, which give a better scope for quality improvement by applying PGRs exogenously. The use of plant growth regulators has become an integral part of modern fruit production to improve the quality and production of fruits. In the present study, seven treatments of different plant growth regulators, viz. ethrel (100, 120 ppm), ABA (10^{-6} M, 10^{-4} M) and MeJA (10^{-5} M, 10^{-3} M) including a control, were applied at 140 DOF to study the effect on fruit quality of papaya var. Pusa Nanha. As regards quality of fruits, application of 120 ppm ethrel improved the peel (*L** 61.00, *a** 12.50 &*b** 38.23) and pulp (*L** 47.70, *a** 25.96. &*b** 33.80) colour, TSS (11.36 ^{0}B), reducing sugars (3.14%), total sugars (7.67%), flavonoids (21.18 mg/100 g), CUPRAC activity (4.77 µmol/g) and lycopene content (3.78 mg/100 g) of fruits, while the total phenols (24.01 mg GAE/100 g), ascorbic acid (81.42 mg/100 g), total carotenoids (4.22 mg/100 g), and β-carotene content (3.74 mg/100 g) were enhanced after the application of the 10^{-5}MeJA. It was also observed that a higher concentration of ABA (10^{-4} M) did not improve better than ethrel and MeJA, although it was found to be slightly superior over the control for most of the parameters.

PH-270

Evaluation of sugarcane clones for quality cane juice used for beverage

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The Consumer purchasing sugarcane juice as beverage for drinking in local markets prefer light green coloured juice rather than dark green or brown coloured juice. In general *Sacharum officinarum* clones are known for the low fibre content with high juice quality which is being highly used for chewing purpose. The juice vendors also prefer sugarcane clones with higher juice quantity with less baggase which results in more juice extraction per cent. The light green coloured juice producing canes were identified in the study during 2020-21 for consumer preference due to its attraction. The sugarcane juice consumer always prefers light coloured juice. Among 15 sugarcane clones tested, sugarcane clones 2015A 222 (1.8), 2015A 199 (1.9), 2015A 152 (1.9), 2015A 137 (1.9), 2015A 59 (1.9), 2015A 230 (1.9) & 2015A 93 (1.9) recorded less colour intensity values denotes light coloured juice after cane extraction. The standard 87A 298 significantly recorded a high color intensity value of 2.2. Among the clones tested, sugarcane clone 2015A 222 recorded a colour intensity value of 1.8 correspondingly recorded higher sucrose per cent (19.45) with purity of 95%, low reducing sugars per cent (0.21) and low dextran per cent (4.25) which is an indication for less deteriorated cane after juice extraction over other clones tested which attracts consumers preference.

PH-271

Chili leaf curl virus from Maharashtra is beta satellite associated DNA-A begomo virus

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Chili leaf curl disease (ChiLCD) has been a major limitation to chili cultivation in India. Epidemics of ChiLCD have been a serious problem observed in various chili growing districts of Maharashtra. Thus present study aimed at precise identification and further molecular characterization of ChiLCV. Present study detected the presence of *Chili leaf curl virus* (ChiLCV) associated with ChiLCD in Maharashtra. The ChiLCD affected chili plants were exhibiting various symptoms such as leaf curling, smaller leaves, stunted growth bearing of least flowers and fruits. Total of nine infected samples, 5 from Vidarbha region and 4 from Marathwada region were collected and subjected to polymerase chain reaction (PCR) using coat protein (CP), DNA-A, DNA-B and betasatellite specific primers. The six samples detected with 520 bp size amplicon corresponding to CP gene. The 520 bp amplicon were gel eluted and sequenced. BLAST results of the sequence information revealed 99% similarity with ChiLCV isolates from GenBank database. Sequence analysis of the CP gene revealed the identity of ChiLCV associated with the ChiLCD of chili in Maharashtra, India. Moreover, the phylogenetic analysis suggested the clustering of these isolates from two different regions within same clade and corresponds to the ChiLCV *Geminiviridae*. The PCR results indicated that ChiLCV from Maharashtra governs DNA-A genome along with betasatellite molecule.

PH-272

Physiological loss in weight and sprouting behaviour of arrowroot cultivars during ambient storage condition

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Arrowroot (*Maranta arundinacea*) is an important vegetable crop cultivated for its edible starch rich rhizome. The experiment was conducted to study performance of twelve arrowroot cultivars (TAR-18-1, TAR-18-2, TAR-18-3, TAR-18-4, TAR-18-5, TAR-18-6, TAR-18-7, TAR-18-7, TAR-18-8, TAR-18-9, TAR-18-10, TAR-18-11, TAR-18-12) with respect to physiological and sprouting behaviour at different stages of maturity under ambient storage condition. Weight loss is phenomenon associated with rhizome in storage mainly due to transpiration and sprouting. Highest physiological loss in weight of arrowroot rhizome after 8 month maturity was noticed in cv.TAR-18-6 (33.33%) compare to minimum physiological loss in weight (17.07%) during thirty days of storage. With the increase of maturity after 10 month of planting minimum physiological loss in weight noticed in cv. TAR-18-12 (8.12%) and highest PLW (16.53%) cv.TAR-18-6, advance of maturity at 11 month after highest PLW observe in cv. TAR-18-6 (9.60%) and minimum PLW cv. TAR 18-3 (4.24%). Sprouting observe after at 11 month of planting highest sprouting noticed in cv. TAR-18-4 (83.33%) and lowest cv.TAR-18-1 (50%) during 21 days of storage condition. Storage temperature and relative humidity play an important role in the physiological changes of fresh produce.

PH-273

Development of abiotic stress tolerant climate smart horticulture crops

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Global food security is threatened due to the climate change in the near future which definitely causes a mere shortage of food to the ever growing population. Horticulture is one of the important sectors of agriculture and importance of horticultural crops is widely acknowledged in many aspects of innovation, production, quality maintenance, for uplifting economic condition of farmers, entrepreneurs and in providing nutritional security to the people. With the increasing fast growth of population, improving economic condition and awareness of importance of fruits, vegetables and flowers, demand for horticultural products is gradually increasing. Improvement in horticulture crop is also required to sustain in the climate change condition and make the Climate Smart Horticulture crop. Research on crop resistance or tolerance to abiotic stresses (heat, cold, drought, flood, salt and pH etc.) has not received much attention. However, that is changing as a result of the research and publicity of global warming. ''Adaptive research'' aiming at adapting the horticultural industry to climate changes is becoming popular. Environmental stress is the primary cause of crop losses world-wide, reducing average yields for most major crops by more than 50%. The response of plants to environmental stresses depends on the plant developmental stage and the length and severity of the stress. Plant breeders translate these findings into stress-tolerant crop varieties by using all tools available that include germplasm screening, MAS, plant transformation, and conventional breeding methods.

PH-274

Effect of paddy straw incorporation on growth and yield attributes of low land rice

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A field experiment on "Effect of paddy straw incorporation on growth and yield attributes of low land rice" was conducted at Agronomy experiment field of Central farm, College of Agriculture, Bhubaneswar during rabi-2020.The experiment was laid out in completely randomized block design with six treatments of paddy straw incorporation practices with or without additional inorganic fertilizer and was replicated four times. The treatments were comprised of common RDF (80:40:40::N: P2O5:K2O kg/ha) with paddy straw(residue) removal (T1), paddy straw (residue) burning (T2), paddy straw incorporation (T3), paddy straw incorporation +20 kg N/ ha (T4), paddy straw incorporation + 20 kg N/ ha+20 kg P2O5/ha (T5) and paddy straw incorporation + waste decomposer (T6). The results showed that highest plant height, tiller number, leaf number, SPAD and LCC were registered in T5 followed by T4 and T6. These parameters are highly correlated with grain yield. The growth analysis during different period of growth of the rice cultivar, Lalat, in respect to LAI, CGR, SLA, LAR, LAD, total chlorophyll, total carbohydrate, amino acid and protein contents were found correlated with grain yield. These parameters were found highest in T5 followed by T4 and T6. The total biomass was found significant among the treatments and was highest in T5 followed by T4 and T6. Grain yield and straw yield were found highly correlated with total biomass (r2=0.70) and physiological growth traits (LAI, SLA, CGR) which was prominently significant in T5 with a tune of 4.94t/ha and 5.21t/ha respectively followed by T4 and T6. T5 was also found highest in yield attributing parameters like number of panicles, panicle weight, filled grain per panicle, 1000-grain weight. The high percentage of C, H, N, S concentration and high ratio of C:N, C:H implies good quality grain harvested in T5. The soil microbial population and status after harvest was also found high inT5 because of paddy straw composting in rice field. Thus, paddy straw incorporation coupled with chemical fertilizer had significant effect on rice growth and yield with proper maintenance microbial population in soil when the crop is treated with T5 with booster application of 20 kg/ha of N and P in the form of urea and DAP respectively.

PH-275

Field Evaluation of nitrophenolate levels for yield enhancement in cucumber

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The sex expression of cucumber is determined by genetics as well as environmental factors such as photoperiod and temperature. An experiment was conducted at College of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad during the year 2019 to know the influence of Sodium para nitrophenolate ($C_6H_4NNaO_3$) on flowering and yield of cucumber variety of Dharwad local. The treatments consist of six different levels of $C_6H_4NNaO_3$ @ 0.3% SL, ethrel @ 250 ppm and control. Sodium para nitrophenolate significantly affected the formation of number of male and female flowers. Highest number male flowers per plant were observed in the treatment 2ml/l $C_6H_4NNaO_3$ (70.7) followed by 5 ml/l $C_6H_4NNaO_3$ (62.1) compared to control (water) which recorded the least (47.8). Number of female flowers per plant were highest (18.7) in 2 ml/l $C_6H_4NNaO_3$ followed by Ethrel 250 ppm (17.7) compared to control (water spray) which recorded the least number of female flowers per plant (10.0). The ratio of male to female flowers was lowest (4.52) in 3ml/L followed by 2ml/L $C_6H_4NNaO_3$ (4.52) compared to control (6.03). Highest number of fruits per plant (15.0) was observed in 2ml/L $C_6H_4NNaO_3$ treatment followed by 3 ml/L $C_6H_4NNaO_3$ (12.7) compared to control which recorded the least (6.0). The fruit yield differed significantly among the treatments. Highest fruit yield per plant was recorded in 3 ml/L $C_6H_4NNaO_3$ (2.55kg) followed by 2 ml/L $C_6H_4NNaO_3$ (2.35 kg) compared to control (0.86 kg). Fruit yield per hectare also differed significantly. Highest fruit yield of 300 q/ha was recorded in 2 ml/L $C_6H_4NNaO_3$ followed by 3ml/L $C_6H_4NNaO_3$ (266 q/ha) when compared to control (90 q/ha).

PH-276

Study of apoplasmic sugar status during *Pseudomonas syringae pv* tomato *T1* infection in tomato plants

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Pseudomonas syringae pv tomato *T1* known to cause bacterial speck disease of tomato worldwide. In India, the southwest region is highly affected from this disease. *Pseudomonas syringae* species is among the well-studied inhabitant of the leaf apoplast where various molecular and physiological processes including nutrients transport, plant-bacterial interactions and defence responses occurs. Apoplastic fluid contains sugars, amino acids, organic acids and inorganic mineral ions that serve as a source of nutrients for bacterial pathogens. This nutrient rich environment of apoplast act as a preferable site for colonization and multiplication of *P. syringae pv* tomato T1. After pathogen infection, dynamic changes occur in status of apoplastic sugars, amino acids and other metabolites. In this study, we have critically analysed the alteration in levels of various sugars including, sucrose, glucose and fructose by untargeted and targeted metabolite analysis via GC-MS. We demonstrate that these apoplastic sugars which are elevated after pathogen infection in tomato plants also serve as source of nutrient for *P. syringae pv* tomato T1.

PH-277

Foliar effect of ethrel on fruit set and yield of different varieties of cucumber under net house condition in winter season

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The present investigation was carried out in net house condition of the Department of Plant Physiology, Bhubaneswar (20^0 15' N, 85^0 52' E, 26msl), containing normal N, K and medium P soil (<16 kg/ha; 0-15 cm layer, pH5.4) collected from Central Farm, OUAT, Bhubaneswar, Odisha for 75 days (day/night temperature of $23^0/16^0$C, RH~70%, bright sunlight) to study the effect of ethrel @ 300mg/l on cucumber. The pots were arranged as per factorial completely randomized design (FCRD) in two replications with two treatments as two factors, one being the 20 cucumber cultivars and the other as two chemical sprayings, i.e., ethrel@300ppm and water. Foliar spraying of ethrel to twenty cucumber genotypes viz: Vishwas 20, Priya, Rajkanya, Gangotri, Maha Prasad, Kheera Hara, Lamba, Seven Star, Basumati, Rohan, Dash, Barsha Nandan, Machara Sosa, Green Long, Padmini, Manish, Green Sona, Barsha Rani, Mohine, Adimata, Chaitali, was done when the plant attained two fully grown leaf the ethrel@300ppm and water was sprayed once and the second spraying was done 7 days after 1st spray. Spray application of ethrel at 300 ppm increased vine length (133.50 cm), maximum number of leaves per plant (24.53), maximum leaves area (4084 cm^2), more number of primary node per plant (18), percentage of fruit set per plant (88.56), number of female flowers per plant (17.50), number of fruit per vine (15.50) and highest yield per vine (2.98 kg) in the popular cultivar Rohan than control and other cultivars.

PH-278

In vitro efficacy of biological agents against aflatoxin producing fungi isolated from chilli, peanut and rice - analysis with ultra high performance liquid chromatography with fluorescence detector (UHPLC-FLD)

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Aflatoxinsare "hidden poison" due to their adverse effect on humans and animal which causes chronic, tereogenic and carcinogenic effects. These are the mycotoxin responsible for severe infection, majorly affects kidney, liver damage and also cases cancer.Cereals, nuts and spices are the major susceptible commodities in which these aflatoxin contamination occurs, due to which these are the major concern in food safety and security in all around the globe. Aflatoxin contamination is a serious concern given their hepatotoxic properties and their widespread occurrence during cultivation, harvest, drying, storage, transit and distribution and responsible for pre-harvest and postharvest infection. It is very crucial and important approach to study the control the growth of these mycotoxin producing fungi during harvesting and post harvesting procedures. In our current study, we have isolated the Aflatoxin producing fungi form the peanut, chilli and rice and checked the antagonistic effect of biological control agents against them. The study involve, analysis of the mycotoxins from contaminated food samples (chilli, peanut, rice) by using extraction with immune-affinity column cleanup and an Ultra high performance liquid chromatography with fluorescence detector (UHPLC-FLD) followed by the isolation of fungal pathogen from this contaminated samples. Further the studies on aflatoxin production from these fungi and antagonistic effects of biological control agents in which we have used two bacterial *spp* (*Bacillius spp*. and *pseudomonas spp*). and two *fungal spp* (*Trichoderma harzianum*) on the control of growth of these fungi.

PH-279

In vitro shoot induction of Manjri Medika Grapes (*Vitis vinifera* L.) using lateral bud

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Micro-propagation is commercial technology of tissue culture used around the world. An efficient, rapid and reproducible *in vitro* plant regeneration protocol was developed for *vitis vinifera cv*. Manjri Medika using lateral bud explants on chee and pool (C2D) medium combined with various concentration of plant growth regulators like BAP @ 0.5 mg/l, 1.0 mg/l, 2. 0 mg/l and NAA @ 0.05mg/l. The surface sterilization was done with 0.1% $HgCl_2$ for 8 min for getting pure cultures. The browning problem was minimizes by addition of ascorbic acid and citric acid into the culture medium. The results showed that 0.5 mg/l BAP gives, high number of shoots (2.23), maximum shoot length (2.20 cm) & low percentage of contamination for initiation. For multiplication, C2D medium fortified with 0.5 mg/l BAP +0.1 mg/l IBA, 0.5mg/l BAP+o.5mg/l IBA and 0.5mg/l BAP. Among these, the maximum shoots multiplication was obtained on C2D medium containing 0.5mg/l BAP +0.1 mg/l IBA. This protocol play a big role for mass multiplication of grapevine culture program.

PH-280

Method development for analysis of aflatoxins (B1, B2, G1, G2) and ochratoxin A in chilli by using UHPLC-FLD and LC-MS/MS

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Chilli powder, a much used spice, majorly gets contaminated with aflatoxins (AFs) and ochratoxin A (OTA), creating menace to human and animal health. These toxins are secondary metabolite of fungi *Aspergillus spp*., contaminate the chilli crop during post-harvest processing such as drying, handling, storage and packing. As there exists no any validated method for simultaneous analysis AFs and OTA in chilli powder, it is very important develop a method for analysis and monitoring of these toxins for ensuring the food safety and promoting international trade. In this study, we developed and validate a simple, sensitive and rapid method for simultaneous analysis of AFs and OTA in chilli powder without derivatisation. The method involve homogenised sample was extracted with methanol-water followed by, immunoaffinity column clean-up and analysed using UHPLC-FLD and LC-MS/MS. The performance was evaluated through intra- and inter-laboratory validation where 12 accredited laboratories were involved. Also, For UHPLC-FLD, the LOQs of AFs and OTA were 0.25 and 1 ng/g respectively. Though, in case of LC-MS/MS the LOQs were achieved at 1 ng/g for each AF and OTA. The method is sensitive, simple and rapid for the analysis of AFs and OTA in chilli matrices. Considering its performance-efficiency and alignment with the national and international regulatory guidelines, this method can be implemented for the routine analysis of AFs and OTA in chilli powder to determine the toxins contaminated during pre-harvesting and post harvesting procedures. This will resolve to the global concerns with respect to the multi-mycotoxin analysis in chilli.

PH-281

Influence of biofertilizers and growth regulators on seed germination and seedling vigour in aonla

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The present experiment on Influence of biofertilizers and growth regulators on seed germination and seedling vigour in aonla (*Emblica officinalis* G.) was conducted at Horticultural College and Research Institute, Periyakulam with the aim to study the effect of biofertilizers, chemicals and growth regulators on the seed germination and seedling growth in aonla. The field experiment was laid out in a Factorial Randomized Block Design (FRBD) with ten treatments and replicated thrice. The 50 seeds were sown for each replication. Observations such as germination percentage, shoot length, root length, dry matter production, vigour index, time to reach buddable thickness, height of the plant (90 and 120 days after sowing) were recorded and analysed statistically. The present study results revealed that fresh seeds treated with Azospirillum + Phosphobacteria+0.5% KNO_3 for 8 hours (T6) recorded the highest germination percentage (52.08%), and one year old seeds treated with Azospirillum+Phosphobacteria+200 ppm GA_3 for 8 hours(T7) showed higher germination percentage of 49.17% which was significantly superior than other treatments. The control (T10) registered the lowest germination percentage for both types (18.25%; 16.19%). The same treatments were found to induce higher shoot length (8.61 cm; 7.97 cm), root length (2.99 cm; 2.69 cm), dry matter production (262 g; 248 g) and vigour index (2.77.47; 278.40), whereas the control exhibited the lowest values for above parameters. In the case of time taken to reach buddable thickness, fresh seeds treated with Azospirillum + Phosphobacteria+0.5% KNO_3 for 8 hours(T6) took lesser time of 111.83 days when compared with other treatments. One year old seeds treated with Azospirillum+Phosphobacteria+200ppm GA_3 for 8 hours (T7) recorded the shortest days (113.27 days) reach to buddable thickness. Fresh seeds treated with T6 treatment recorded the highest plant height at 90 and 120 days after sowing (14.89 cm; 19.01), whereas one year old seeds treated with Azospirillum + Phosphobacteria + 200ppm GA_3 for 8 hours registered the highest plant (14.72 cm and 18.52 cm). Control (T1) noticed the shortest height for both fresh and one year old seeds (14.50 cm; 18.39 cm and 14.21 cm; 18.02 cm).

PH-282

Evaluation of bio-efficacy and phytotoxicity of glyphosate 41% SL against weed flora in grape vineyards

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The study was evaluated for the bio-efficacy and phytotoxicity of Glyphosate 41% SL against the complex weed flora in grapevines. The experiment was carried out ICAR- NRC Grapes, Pune with seven treatments replicated thrice. The treatments were imposed at 3-4 leaf stage of weeds in vineyards. All the weed population was uniformly distributed in vineyards. All the treatments significantly reduces the weed density over untreated control. The highest weed density was recorded with untreated control while, the negligible weed density was recorded in hand weeding followed by Glyphosate 41% SL @ 4000 ml/ha at 15^{th}, 30^{th}, 45^{th} days after application. Least dry weight g/m^2 was recorded with Glyphosate 41% SL @ 4000 ml/ha followed by Glyphosate 41% SL @ 3000 ml/ha whereas, the maximum dry weight of weed g/m^2 was recorded with untreated control at 45^{th} Days after application. Highest weed control efficacy (%) was recorded with Glyphosate 41% SL@ 4000 ml/ha followed by Glyphosate 41% SL @ 3000 ml/ha whereas, the negligible weed control efficacy (%) of was recorded with untreated control. The highest yield (kg/vines) was recorded with hand weeding treatments followed by Glyphosate 41% SL @ 4000. The highest benefit: cost ratio was recorded in the treatment Glyphosate 41% SL (4000 ml/ha) (1:1.99), while least in control treatment (1:1.77). Applications of Glyphosate 41% SL @ 4000 ml/ha in grapevines showed highest weed control efficacy (%) and yield per vine (kg/vine) in this investigation.

PH-283

Survey for elite type mango by using inflorescence, leaf, fruit and pulp descriptors

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Variations in plants can be characterized or evaluated by using visual, physical and biochemical attributes. This study aimed at determining diversity in mango germplasm from the, to identify the best genotype for table and juice purpose. A survey was conducted to collect, characterize and document the unique mango grown by the farmers of semi-arid climate of Parbhani district (Maharashtra). A total of 29 International Plant Genetic Resources Institute (IPGRI) descriptors for mango (3 for inflorescence,8 for mature fruit, 9 for ripe fruit, 8 for leaf and 1 for stone character) were selected for use in the assessment of 30 mango accessions from this district. The observations were taken from flowering, leaf, mature and ripe fruit characters during the year 2019-20. Among the different accessions, accession 15 (12.4cm) and 20(16cm) had maximum fruit length, whereas accession 22 (240g) had large fruit weight. The highest pulp weight and juice (%) were recorded in the accession 9, 22& 24 (150 g each) and accession 24 (65.78%) respectively. Skin thickness was observed thicker in accession15 (1.77mm). Considering the fruit length, fruit and pulp weight, flesh colour and Juice percentage observed during this study, it can be concluded that the accession9, 20, and 22 are suitable for juice purpose whereas accessions like 15 is suitable for table purpose being good in juice percentage, pulp weight, Turpentine flavour and firmness of flesh, fruit size, skin thickness. The accession 24 is suitable for both the purposes.

PH-284

Controlled irrigation enhances post-harvest leaf quality in Indian mulberry

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Mulberry (*Morus species*) tree is commercially cultivated for rearing silkworm (*Bombyx mori*) and supply of quality foliage is crucial for silk industry. Post-harvest leaf moisture loss is one of the major issues which reduce leaf quality and affects silkworm feeding behaviour. In harvested leaves, stomatal transpiration is insignificant due to the closure of stomata and hence water loss is mainly contributed by cuticular transpiration. Therefore, any approach to increase cuticular resistance will have beneficial effects on leaf quality. In our previous study, we demonstrated that epicuticular wax content and crystal morphology play an important role in leaf moisture retention capacity (MRC) in mulberry. In the present study, we attempted to increase MRC by altering leaf surface wax load by controlled irrigation. Two genotypes of mulberry namely, *Dudia White* and *Mattigere Local* were raised in large-sized pots and fully established plants were maintained under100, 60, and 40% soil water/field capacity (FC)by following gravimetric approach in rain-out shelter. The response of mulberry to different water regimes was monitored by observing morphological features, chlorophyll content, and gas exchange parameters. Leaves were harvested and evaluated for MRC under laboratory conditions. There was a significant increase in MRC at 40 and 60% compared to 100% FCs. Controlled irrigation resulted in increase in leaf epicuticular wax deposition. The percent increase was 10.1 and 28in 60 and 40%moisture regimes, respectively, compared to 100% FC. This study demonstrated that controlled irrigation can enhance MRC and thus leaf quality besides saving water for subsequent irrigation or alternative land use.

PH-285

Extension of postharvest shelf life of *Capsicum annuum* L. by application of putrescine and chitosan-based coating through antioxidative defense

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Postharvest shelf life of fruit is very important in term of its commercial value and transport for maintaining the global food supply chain. It is necessary to use biocompatible nontoxic coating material to delay postharvest fruit ripening to reduce the use of toxic material like paraffin, silver etc. In this context, we have examined effect of Chitosan (CHT) and putrescine (PUT) both separately and in combination (under 90% relative humidity,25°C) on postharvest shelf life of *Capsicum* fruit with reference to different qualitative indexes and physiological responses as well as Reactive Oxygen Species (ROS) metabolism. PUT and CHT treatment directly modulated quality indices like color, water loss and firmness as well as development of O_{2^-} and H_2O_2 in fruit coat. PUT and CHT treatment cause reduction of respiratory flux, decreased total soluble solid and helped to sustain ascorbic acid content during the postharvest storage. Additionally, total polyamine content under all treatments showed good correlation with activity of ROS quenching enzyme and also withO_{2^-} and H_2O_2accumulation.Under both PUT and PUT+CHT treatment significantly down-regulated cell wall softening enzymes like cellulase and pectin methyl esterase. Among all treatments under combination of PUT and CHT fruits sustained better enzymatic antioxidation capacities evidenced by higher enzymes like guaiacol peroxidases, glutathione peroxidase, catalase, ascorbate peroxidase, superoxide dismutase, glutathione reductase and NADPH oxidase indicating their roles on fruit coat softening. On close observation it has been observed that combination of CHT and PUT performed better than their individual effect in shelf life extension of *Capsicum* fruit. Hence, PUT and CHT in combination can effectively increase shelf life of *Capsicum* fruit at postharvest storage.

PH-286

Physiological basis of cane regulation and gibberellic acid (GA_3) treatment on early bud induction in grape (*Vitis vinifera* L.) cv. 'Fantasy seedless'

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Grape though a temperate crop, is well adopted in sub tropics and tropics. In management of this crop pruning is an important tool. Gibberellins are plant hormones that govern growth and direct several developmental processes including stem elongation, germination, dormancy, flowering, sex expression and leaf and fruit senescence**.** 25 canes per vine exhibited the earliest bud burst (4.65) than the other treatments and the maximum days taken for bud burst in canes regulated 50 canes per vine and control (7.56) respectively. The similar trend of bud burst was recorded during second season (2019) of growth. In pooled results, significantly, the earliest bud burst was recorded with respect to 25 canes per vine (4.41) where as bud burst occurred late (7.30 and 7.50) in control and 50 canes per vine respectively. In interaction effect of first year (2018), the earliest bud burst (3.89) was recorded in treatment 25 canes per vine with 30 ppm of GA_3 which was statically on par with 25 canes per vine with 40 ppm of GA_3 (4.22) and bud burst delayed in the treatment 50 canes per vine without GA_3 treatment (7.89).

PH-287

Influence of leaf anatomy and photosynthetic traits on the yield of rice

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In recent decades, improving the yield potential of rice is the priority of breeding program in order to meet the demand of burgeoning population because yield potential has stagnated since the release of IR64. Consequently, understanding the physiological and leaf anatomical traits that are having positive association with higher yields is critical to utilize these traits effectively in breeding programs for yield improvements in rice. Therefore, an experiment was conducted to understand the association between leaf vein traits, photosynthetic rate and yield in 20 popular rice varieties of Tamil Nadu. The observations were recorded on the fifth leaf of the primary tiller. Among the traits studied, a significant variation in photosynthetic rate versus yield and vein density versus yield was observed among all the cultivars of rice. Furthermore, a strong association between the total number of minor veins, photosynthetic rate and leaf width was observed. Among the rice cultivars studied, CO 43 recorded the highest vein density in addition to higher photosynthetic rate (28.06 µmol $CO_2 m^{-2} s^{-1}$), higher yield (62.89 g), and biomass (80.49g) followed by CO(R) 50 and CO43 SUB 19-24, whereas DRR DHAN 40 and CO 51 registered significantly a lesser number of veins and lower photosynthetic rate along with lesser grain yield when compared with other cultivars. The positive correlation among leaf vein density, photosynthetic rate and grain yield suggested that the increased vein density could effectively have enhanced the partitioning of assimilates from the source to the sink tissues and hence, the increased grain yield. Also, the effective partitioning of assimilates to the sinks lead to increased demand for assimilates that resulted in increased photosynthetic activity in leaves. Hence, these traits could be utilized for phenotyping rice germplasm for yield improvement through breeding programs.

PH-288

Application of *Pseudomonas fluorescens, Bacillus subtilis* and *Trichoderma viride* leads to changes in antioxidant enzymes, proline, and lipid peroxidation under salinity stress in lentil (*Lens culinaris* Medik.)

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The study was carried out to evaluate the influence of application of *Pseudomonas fluorescens, Bacillus subtilis* and *Trichoderma viride* on antioxidant enzymes, proline and lipid peroxidation to decrease the impact of salinity stress on lentil (*Lens culinaris* Medik.), a salinity sensitive crop. A pot experiment was conducted with contrasting set of genotypes (tolerant vs. sensitive) under salinity stress in completely randomized design with three replications. Microbial inoculation was done through seed priming @10 mL or 10 g/kg seed. Seeds were then sown in plantation pots (dia.× height=250×250 mm) filled with field soil having salinity 4.0 dSm^{-1} EC. Activity of antioxidant enzymes, proline, and lipid peroxidation were assessed in leaves at flowering stage. Results showed that antioxidant enzymes *viz.,* catalase, peroxidase, and superoxide dismutase were significantly increased with application of microbes in both the genotypes in saline soil however increase was more in tolerant genotype. The lipid peroxidation decreased by application of microbes in saline soil. Proline content was enhanced by the microbial inoculation in saline soil. The study conclusively proved that combined application of *Pseudomonas fluorescens, Bacillus subtilis* and *Trichoderma viride* had synergistic response in ameliorating salinity stress and positively increased the activity of antioxidant enzymes and proline but decreased lipid peroxidation in leaves. This can be an important additional approach to decrease the impact of salinity stress on lentil crop.

PH-289

Mobile agricultural dryers – A boon in post-harvest management chain

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Around 3.3 mt or 2.7 per cent of the total food produced in India alone is squandered with poor post-harvest management chain. Of the different losses incurred, poor drying is of prime importance, since it is the root cause of various losses like fungal and insect infestation/poor shelf life. Optimum range of moisture for storage of grain various with crops. Generally, cereals are stored at 12-14 percent and oil seeds at less than 8 per cent. Present day majority of the farmers are practicing natural ways of drying that is sun drying. There are oodles of drawbacks associated with this. Few to mention, it is labour intensive, temperature cannot be controlled, overheating/under drying are often worrisome in this process. With the advancements in science and technology in various fields, day to day life has become very easy. Technology has already infiltrated in the field of agriculture to a great extent. One of the advances in the present scenario of post-harvest management chain is the mobile mechanical dryers. The agricultural dryer is the ideal solution for both small and more structured farms, as it allows to treat cereals safely and optimizing times and costs. To mention few major profits that can be obtained, are a greater safety for storage, elimination of the onset of molds and aflatoxins, reduction of waste, higher product quality and productivity, increase and maximization of profits. Mobile dryers pose additional advantage of drying the produce when and where ever farmer is interested. These are tractor driven tank like structures with a working capacity of more than 100 t per day. These are multi-crop dryers operates by eliminating moisture through evaporation by creating difference in partial pressure of water vapour between the surface of the product and surrounding air. It is a resourceful technology that can boost the profits of farmers through maintaining quality. Thus, these mobile dryers can lead to the prosperity of farmers by reducing his dependence on unpredictable natural sunlight. Last but not least, Food we save is equal to food we produce.

PH-290

Variability of peroxidase and polyphenol oxidase enzyme activity among diverse accessions of pearl millet flour during storage

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Pearl millet is known as a super grain because of its nutritional quality and ability to grow even under extremely adverse environmental conditions. The main hurdle in the popularity of pearl millet is its poor keeping quality and the development of off odor and browning of the flour during storage. The factor responsible for the browning of the flour is the higher content of phenolic compound, which is a favorable substrate for peroxidase (POX) and poly phenol oxidase (PPO) enzymes. To analyze the influence of storage on the POX and PPO enzyme activity in the pearl millet flour, 22 pearl millet genotypes were examined at intervals of 10 days andup to 20 days. A large variation in POX and PPO enzyme activity was observed in freshly milled flour and it varies from 47-121 nM DMAP/min/mg protein and 0.08-0.23 U/mg protein respectively among the pearl millet genotypes. A decrease in POX and PPO activity has been observed during the storage period of flour, and the extent of the reduction varies from genotype to genotype. Similarly decrease in the PPO activity during the storage period was observed. A storage period of 20 days further reduced the PPO activity by 50-82% in genotypes under study.A decrease in enzyme activities during storage may be due to decreased accessibility of the enzyme to the substrate, increased hydrogen bonding between water and either enzyme active site or substrate, a pH shift, increased intra-enzymatic hydrogen bonding or the formation of enzyme polymers etc.

PH-291

Enzyme hydrolytic reaction during sprouting enhanced sweet perception, nutritional quality as well as shelf life of the pearl millet flour

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The aim of this study was to utilize most nutritious pearl millet flour as routinely as wheat flour by improving its shelf life through most inexpensive methodology of "sprouting". The soaked pearl millet grains were subjected to a process of sprouting at different duration of time period and optimized the sprouting period of 48 hrs based on highest hydrolytic activities of α-amylase, protease and lipase. Activities of hydrolases such as α-amylases and proteases which acts on starch and proteins respectively were increased and lead to increased levels of free glucose and amino acid contents. Breakdown of S-L (starch-lipid) and P-L (protein-lipid) complexes due to higher hydrolytic reaction resulted in release of free lipids into flour matrix. Increased lipase activity catalyzed the lipids, as a result the free fatty acids levels were increased. The released glucose, amino acids and fatty acids into the flour matrix were used for the process of germination. As a consequence of higher utilization of free fatty acids during the process of germination is suggested to linked with reduced activities of oxidative enzymes like LOX, POX, PPO. Further thermal treatment of hydrothermal and near infrared rays was found to be highly effective in enhancing the shelf life of the sprouted flour through reduction of rancid causing oxidative enzymes. Hydrolytic reaction in the sprouted flour matrix enhanced the taste of the end product by improved sweet perception also helped in increased nutritional enhancement in terms of starch and protein digestibility.

PH-292

Pearl millet based: "Nutri-High Protein Atta" developed based on "vital wheat gluten regeneration" technology and by a method of fortification of defatted peanut powder with superior dough quality

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India's protein consumption is much lower than the 48 gms/day that is recommended by the Indian Council of Medical Research (ICMR). A 2017 survey shows that 73% of Indians are deficient in protein intake due to which India is facing the double burden of malnutrition, with 38 percent under nutrition (46.6 million) in children under the age of five and about 15 percent obesity and overweight (14.4 million). India's nutrition programmes which includes majorly rice and wheat and there are no protein foods being provided under most of these programmes – possibly due to lack of availability, affordability. Considering these facts in view, we have developed a product called "Pearl millet based: Nutri-High Protein Atta" by a method of fortification of defatted peanut powder (DPP) in pearl millet based nutria-mix with superior dough quality. Fortification of DPP in pearl millet based nutria-mix was also optimized with the ratio of 50:30:10:10 (pearl millet flour: chickpea flour: DPP: vital wheat gluten) to meet 60% of recommended daily value of complete protein with superior dough quality (as soft as wheat dough) for preparation of ranges of bakery products and chapattis. The product meets the daily value (DV) of protein (A protein which composed of required daily amount of essential amino acids) upto 60%. A product of "Pearl millet based: Nutri-High Protein Atta" has been approved for commercialization by zonal technology management and business planning and development unit, ICAR-IARI [No:23-14/ITMC/ZTM/2021]. The technology developed has the potential to move as a sustainable alternative to rice and wheat; as a new staple food owing to its easy availability throughout local markets, supermarkets and e-Commerce sites.

PH-293

Genotypic variation in physiology, yield, nutrient uptake and their efficiency of wheat varieties grown in vertisols of India

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Agricultural crop production per unit area has to be increased to bridge the gap between supply and demand of food grain. Nitrogen (N) and Phosphorus (P) are two major indispensable macro-nutrient elements for crop production in modern agriculture with significant environmental and production costs. The current status of nutrient use efficiency (NUE) in different cropping systems is low for these nutrients for example, 30-50% for Nitrogen (N) and 15-20% for Phosphorus (P). Increasing NUE in wheat crop would reduce fertilizer inputs and would in turn reduce associated environmental concern. Hence, evaluation and use of wheat cultivars with higher NUE can contribute to higher crop growth with optimal inputs without compromising grain yield. To address these, a field experiment was carried out to assess genotypic variation in Nitrogen and Phosphorus uptake and their efficiency in wheat in vertisols of India in the *rabi* season (2020-2021) at of ICAR-Indian institute of soil science Bhopal (India). The experiment was carried out under four levels of nutrients (0% NPK, 100% NPK, 50% N+100% PK and 100% NK+50% P) with 120 genotypes. Agro-morphological, physiological and yield parameters including nutrient uptake, apparent nutrient recovery, agronomic and physiological efficiencies were assessed. The selected genotypes exhibited varying degree of response w.r.to leaf area, plant biomass, yield, chlorophyll content, nitrate reductase enzyme activity, photosynthetic rate and nutrient use efficiencies. The genotypes identified with higher nutrient use efficient traits can be utilized in breeding programs to better exploit the constrained ecosystem with reduced impact on environment

PH-294

Characterization of root traits for drought tolerance in *rabi* sorghum genotypes

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Root systems play a critical role in the uptake of water and nutrients, and responds to various edaphic stresses, such as drought, salinity, water logging and nutrient deficiencies. The current study aimed to characterize phenotypic variability in root system traits of 18 *rabi* sorghum lines under stress and non stress conditions at Regional Agricultural Research Station, Vijayapur. Root traits such as root fresh and dry biomass, length, volume and number of roots per plant was measured. At maturity the fresh root biomass decreased under stress conditions compared to non stress. Phule Suchitra recorded significantly higher fresh root biomass (67.50 g) followed by VJP 2405 (52.50 g) and CRS 95 (51.50 g). The dry root biomass was also maximum in Phule Suchitra (6.97 g) followed by M 35-1 (6.59 g). Genotype RSV 1850 recorded maximum root length (45.00 cm) under stress condition followed by RSV 1876 (42.50 cm) compared to check M 35-1 (28.50 cm) indicating a key role in drought tolerant mechanism. Root length decreased by 28.26% under stress. Root volume was measured by displacement method and the check variety Phule Suchitra (8.23 cm^3) recorded maximum root volume compared to other genotypes. The mean root volume (5.90 cm^3) under was comparatively less than non stress (12.92 cm^3). The total root number per plant decreased by 22.0% under stress conditions. However, CRS 99 (38.50) recorded significantly higher root number followed by CRS 89 (35.50). The study reveals that, genotypes with trait specific root characters may be considered for efficient water acquisition and better adaptation to abiotic stress.

PH-295

Physiological and biochemical basis for seed quality deterioration and storability of groundnut

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Seed deterioration has been ascribed to physical, physiological, bio-chemical and pathological detrimental changes occurring in seeds leading to death and has been characterized as inexorable, irreversible, inevitable, and minimal at the time of physiological maturity and variable among kinds of seeds. Quality deterioration in oilseed crops such as groundnut pose a major threat during storage as their seeds are hygroscopic in nature and highly sensitive to moisture content. Absorption of moisture may result in caking, hydrolytic rancidity, mould growth and insect attack. These factors reiterate the need for having a packing technology that would prevent or slow down such seed quality deterioration in long term storage. So, a lab experiment was carried to study Physiological and biochemical basis for seed quality deterioration and storability of groundnut during long term storage. The seed of groundnut crop was packed in gunny, HDPE and vacuum packed polythene bags. The results of the study were revealed that seeds stored in vacuum packed bags maintained higher values for germination per cent (89.2 & 88.8 %), total seedling length (21.27 7& 21.20 cm), and SVI (1896 & 1882) of groundnut seeds irrespective of storage conditions i.e. cold storage and ambient storage, respectively after 18 months of storage period compared seeds stored in gunny and HDPE bags. While, the maximum moisture content of groundnut seeds (13.93 %) was observed in gunny bags at cold storage followed by HDPE bags at room temperature (10.52 %). Lower moisture content (8.41 and 8.31 %) was observed in vacuum packed seeds at cold storage and room temperature, respectively. While, the seeds stored in vacuum packed bags maintained higher values for hydrolytic enzymes viz., amylase (3.36 & 3.33 mg maltose released/min), lipase (27.39 & 27.36 meq. free fatty acid /min/g), and protease (11.11 & 11.08 mg amino acid released /min/ml) of groundnut seeds irrespective of storage conditions i.e. cold storage and ambient storage, respectively after 18 months of storage period compared seeds stored in gunny and HDPE bags.

PH-296

Study of secondary metabolites in *Aristolochia bracteolata* Lam. under water stress

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Aristolochia bracteolata Lam. is one of the worst weeds of black cotton soil of drought prone area of Baramati. Secondary metabolites and their distribution implies that they are of prime importance for survival. In present investigation attempt have been made to identify response of secondary metabolites in a weed *Aristolochia bracteolata* Lam. under water stress. Mature potted plants were imposed to 3 levels of short term water stress. Secondary metabolites namely proline, polyphenols and tannins were estimated in leaf, stem, root and statistically analyzed. Overall proline, total polyphenols and tannins showed positive correlation to severe stress when compared to control. Significant rise in proline content in leaf followed by stem and root observed under water stress. Polyphenol and tannin content has increased considerably in all parts but more pronounced effect is seen in root. These finding supports that drought stress stimulates production of secondary metabolites in weed *Aristolochia bracteolata* Lam. As this plant is also medicinally important these findings could be used for mass cultivation of this plant for sustainable weed management.

PH-297

In vivo identification of new antioxidants and upscaling of antioxidant potential of *Argemone maxicana Linn* (Family: *Papaveraceae*)

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Plant parts (leaves and stem) and callus with medicinal properties play an increasingly significant role in pharmaceutical industries and local remedy for their functions on disease prevention and ailment. The present investigation centered over callus formation and antioxidants of *Argemone maxicana* plant parts (Leaf, stem and callus), led to sustained mass production of bioactive compounds from callus cultures Both Leaf and stem explants induced callus on Murashige and Skoog (MS) media but leaf explants did not respond well for callus induction due to high amount of yellow latex containing phenolics. Although stem explants responded very well on MS containing media supplemented with different concentration and combination of plant growth regulators. Callus induction was recorded from young stem of *Argemone maxicana* (L) on MS (Murashige and Skoog) media, supplemented with different concentration and combination of PGRs (Plant Growth Regulators) such as NAA (0.5-1.0 mg/L), KN (0.5-2.0 mg/L) and BAP (0.5-1.5mg/L). The best degree of callus induction was recorded on MS media with 1.0NAA+0.5 BAP mg/mL and 1.0NAA+2.0KN mg/mL concentration and combinations. The free radical scavenging assay of 2,2-diphenyl-1-picrylhydrazy (DPPH) and Ferric ion reducing antioxidant power (FRAP) for various extracts fraction of *Argemone maxicana* leaves, stem and callus (stem) have been examined. The ethanolic extract of *Argemone maxicana* plant parts and callus showed highest total flavonoids content (0.0656±0.0008 mg RUT (Rutin equivalent)/100 g and total phenolics content (1.63±0.94 mg GAE (Gallic acid equivalent)/100 g. *Argemone maxicana* has an ability to accumulate phenolics and flavonoids contents which advocate as strong anti-oxidant. *In vitro and in vivo* GC-MS analysis showed various important anti-oxidant compounds such as1,3-propanediol,2-(hydroxymethyl)-2-nitro- or isobutylglycerol, nitro-, squalene, dibutyl phthalate, 6-alpha-cadina-4,9-diene,9,(-)- , stigmast-5-en-3-ol, (3.beta.)-, vitamin E,1(2H)-Naphthalenone, octahydro-4a, 8a-dimethyle-7(1-methyle)/valeranone, 1, 2-benzendicarboxlic acid and di isooctyles being reported from the cultures for the first time. These bioactive compounds are also useful in the treatment of various ailments such as inflammation, rheumatism cancer and jaundice etc.

PH-298

Chemical priming: an approach to induce disease resistance in *Curcuma longa* L.

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Seed priming is an effective method to enhance germination and growth under stressful conditions. The present study examined the effects of different rhizome priming techniques namely Hydropriming, Halopriming and Chemical priming on the emergence, growth and resistance in *Curcuma longa* L. The most effective reagents and their pre-optimized concentrations based on preliminary experiments were used in this study. Three different turmeric varieties, namely Prabha, Prathibha and Pragati were primed and allowed to grow in grow bags along with the control rhizomes. Rhizomes were halo-primed in 250nm NaCl for 12hrs, and hydro-primed for 12hrs. Chemical priming that involves treatment of rhizome with potassium nitrate in different concentration [50Mm, 100mM, 150Mm, 200Mm, 250Mm, 300Mm]. Rhizome primed with 200Mm KNO_3 showed the highest growth rate. Moreover, the overall growth of plants is enhanced due to the seed-priming treatments. Most halo-primed and hydro-primed plants are highly sensitive to diseases, but no disease has been found in the KNO_3 primed plants. Hence chemical priming provides more disease resistance than other primed plants. It also showed more chlorophyll and MDA. Proline level increased in the turmeric leaves in response to increased stress conditions. Present study suggested that chemical priming with potassium nitrate is an alternative and more effective method to increase tolerance in turmeric varieties when exposed to different abiotic and biotic stress conditions.

PH-299

Jasmonic acid regulates macronutrient (N, P, K^+) deficiency response in crop plants

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Macronutrients (N, P and K^+) are essential for sustainable plant growth and productivity. Deficiencies of these macronutrients in the soil necessitate excessive use of expensive and polluting chemical fertilizers. Thus, need of the hour is to develop crop plants with high nutrient uptake and use efficiency (NUE). Alteration in the root system architecture (RSA) is the most promising strategy to combat nutrient deficiency and improve NUE. Morphophysiological analysis suggests that macronutrient deficiency negatively affects primary and lateral root growth in rice and chickpea. Amongst various phytohormones, Jasmonic acid (JA), is known to regulate RSA. Fine tuning of JA level by regulating its biosynthesis may help in achieving desired RSA. Therefore, to understand the role of JA in macronutrient deficiency, genome-wide molecular characterization was performed for the JA biosynthesis genes in rice and chickpea. These gene belong to different enzyme families, including PLA1, LOX, AOS, AOC, OPR, ACX and JAR1. *In-vitro* expression and activity of selected proteins confirmed their authenticity as enzymes. qRT-PCR analysis in roots and shoots showed that expression dynamics under macronutrient deficiency was significantly altered, as several genes induced in response to deficiency of one or multiple nutrient (N, P and K^+) at different time points. Many genes were significantly induced in the vegetative developmental stages, particularly in root. In addition, JA biosynthesis genes showed significant differential expression under the treatment of different phytohormones, and abiotic stresses, such as drought, salinity and cold. These findings indicate the novel role of JA in modulating RSA and thus, regulating macronutrient deficiency response in rice and chickpea.

PH-300

OsCPK29 regulates intine development and pollen maturation in rice

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Pollen development and its germination are obligatory for the reproductive success of flowering plants. Control of pollen fertility is not only important to reduce the yield loss but also helps in hybrid breeding. Here, we report a novel Calcium-dependent Protein Kinase controlling rice fertility through regulating pollen development. OsCPK29 is expressed mainly in mature anther and exclusively localizes in the nucleus. *OsCPK29* knockdown rice plants exhibit reduced fertility, set fewer seeds and produce collapsed non-viable pollen grains that do not germinate. Cytological analysis of anther semi-thin sections during different developmental stages suggested that pollen abnormalities appear after the vacuolated pollen stage. Detailed microscopic study of pollen grains further revealed that they were lacking the functional intine layer although exine layer was present. Consistent with that, downregulation of known intine development-related rice genes were also observed in *OsCPK29* silenced anthers. Furthermore, it has been demonstrated that OsCPK29 interacts *in vitro* as well as *in vivo* with MADS68 transcription factor which is a known regulator of pollen development. Therefore, phenotypic observations and molecular studies suggest that OsCPK29 is a novel regulator of pollen development in rice and may perform its nuclear functions by interacting with MADS68. This work will contribute to the understanding of male reproductive development in rice, which will help in controlling rice fertility and production.

PI-301

Jasmonic acid and its methyl ester manifest anti-senescence responses by accentuating anti-oxidant machinery and curtailing microbial growth in ray florets of *Cosmos sulphureus* Cav.

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Jasmonates have been emerging as novel and eco-friendly anti-senescence molecules that improve the quality indices and storage life of horticultural products. Jasmonates act by inducing various physiological and biochemical changes in cells such as activation of the antioxidant system, accumulation of proteins, sugars and other osmolytes, besides regulating the expression of genes involved in environmental stresses like senescence. The present work aims at ascertaining the efficacy of jasmonic acid (JA) and its methyl ester; methyl jasmonate (MJ) in delaying postharvest senescence in ray florets of *Cosmos sulphureus* in view of its immense potential in cut flower industry. The flowers were collected from Kashmir University Botanic Garden at pre-anthesis stage and transported to laboratory in distilled water. The flower buds were re-trimmed obliquely and exposed to JA and MJ at doses of 10, 20 and 30 µM and 0.10, 0.20 and 0.30 µM respectively. Another set of flower buds held in distilled water represented control. Our findings elucidated that the flowers of control exhibited early senescence symptoms and survived for 4 days only. In contrast JA at 20 µM and MJ at 0.20 µM delayed senescence of ray florets significantly by 4 and 3 days respectively. It was established that jasmonates accentuated antioxidant potential and membrane integrity, besides augmenting metabolites such as sugars, proteins and phenols in petal tissues. Furthermore, these molecules facilitated continuous upward flux of solution in floral stems by limiting the microbial growth in experimental vials.

PI-302

Appraisal of phytotoxicity of *Delonix regia* against invasive weed species

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Delonix regia (Boj. Rx Hook.) Raf an attractive tree species planted along road sides, open spaces and parks for shade and ornamental purpose. Shedding of dried leaves takes place frequently and not much vegetation is observed under the canopy of the tree. Phytotoxic potential of dried dropped leaves of *D. regia* was studied against two aggressive weeds *Alternanthera tenella* Colla and *Senna tora* (L.) Roxb. Seed germination of *A. tenella* and *S. tora* was inhibited due to treatment of leaf leachates (1%, 3%, 5% and 7%) with maximum inhibition due 7% as -66.7, -80.76, -62.96, -51.61% in *A. tenella* and -71.42, -57.58, -53.42, -43.33% in *S. tora* at 24h, 48h, 72h and 96h stages. In *A. tenella* root length (-13.4, -24,74, -26.5 and -43.29%) and fresh weight (-8.86, -32.91, -39.24, -67.08%) were reduced and shoot growth (22.22, 37.3, 9.25,11.11%) was increased due to leaf leachate treatment. In soil bioassay stimulation of root and shoot length was observed due to leaf leachates. In *S. tora* leaf leachates caused decrease in shoot length (-7.38, -1.34, -8.38%) and fresh weight (-17.92, -63.41, -19.4, -35.82%) and increase in root length (2.9, 9.88, 9.33) was observed. Total phenolic content was higher in 7% leaf leachate 22.93 mg/100ml which followed by 5% (20.16 mg/100ml), 3% (18.45 mg/100ml) and 1% leaf leachate (5.58 mg/100ml). Large number of phytochemicals are detected in leaf leachates and Tetrapentacontane, Dotriacontane, Nonacosane, Pentanol, Hexatriacontane, 1- Pentanol are common phytochemicals detected. Alterations in germination and seedling growth of weed species may be due to synergistic effect of phytochemicals present in leaf leachates.

PI-303

Potassium and GABA induces the activation of defense systems, nitrogen assimilation and growth of wheat plants under salt stress

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Salt stress is one of the most prevailing abiotic stresses that possesses a great impact on growth and development of crop plants and delimits their productivity. Cereal crops including wheat plants are the major source of food across the world. However, salt stress induced adversities have negatively affected the grain yield and productivity of wheat plants. This increases a great concern on food availability and security for rapidly growing population. Both K (essential macronutrient) and GABA (signaling molecule) participate in plethora of plant responses, but the interactions between these two molecules still remain vague and not clearly deciphered. Taking this into scenario, we have evaluated the effects of potassium (K; 25 mg kg^{-1} soil) and γ-aminobutyric acid (GABA; 2 mM) on salt (NaCl; 100 mM) stressed wheat plants. In this study, the application of K and GABA were found significant in ameliorating the salt stressed induced responses by modulating the detoxification system including ascorbate-glutathione (AsA-GSH) pathway and glyoxalase system. The activated defense systems were found effective in decreasing the accumulation of oxidative stress markers in salt stressed wheat plants. Further, K and GABA treated plants showed improved nitrogen, chlorophyll, and relative water contents, plant dry mass, and enhanced ribulose 1,5-bisphosphate carboxylase (RuBisCO) activity under salt stress. These findings suggest the effective role of K and GABA in promoting the growth of wheat plants under salt stress condition. This study also provides an intricate relationship between K and GABA mediated responses for inducing salt tolerance mechanism in plants.

PI-304

Sustainability through agroforestry to mitigate the effect of climate change

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Agroforestry is the intentional integration of trees and shrubs or ecologically sustainable land use system introduced into crop and animal farming systems to create environmental, economic, and social benefits. In India the current area under agroforestry is estimated at 25.32 Mha, or 8.2% of total geographical area of the country. Agroforestry system plays a crucial role in mitigating climate change because it sequesters more atmospheric carbon in plant parts and soil than conventional farming. It helps global carbon sequestration, involved in carbon capture and the long-term storage of atmospheric carbon dioxide along with reduction of greenhouse gas emissions. The climate change is expected to lead to unpredictable seasons in the future which lays a greater pressure on agricultural systems, food production and food prices for which agroforestry is found to be a viable option to help buffer farmers against the adverse impacts of climate change and helps in boosting food production and provide alternative sources of nutrition and income under adverse climatic conditions for the crop and enhances the overall plant biomass, crop productivity, soil fertility improvement, soil conservation, nutrient cycling, micro-climate improvement, carbon sequestration, bio drainage, bio energy and bio fuel etc. It also mitigates the effects of drought, prevent desertification and restore degraded soils. The silvi-pastoral system of agroforestry that adds trees to pastures is considered to have the greatest potential among the agroforestry practices to mitigate the climate change with highest carbon storage capacity.

PI-305

Water logging tolerance in plants

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Water logging is described as a circumstance of soil wherein extra water inhibits gas exchange of roots with the atmosphere. Water logging is a completely extreme risk that is affecting crop's growth, production and productiveness to an amazing extent. The situation of water logging is located in lots of geographical zones and is consequently taken into consideration as a threat globally. Water logging takes place over significant areas and adversely affecting 10% of the worldwide land area. It affects plants growth and development by inhibiting respiration of roots, as it blocks oxygen supply to roots and causes a severe decline in energy status of root cells affecting important metabolic processes of plants. In the absence of the oxygen, plants shift from oxidative phosphorylation to fermentation. During this fermentation procedure only two ATP per glucose molecule is produced instead of 38 ATP during oxidative phosphorylation. The critical organic result of water logging is the deficiency (hypoxia) or whole absence (anoxia) of oxygen with inside the soil surroundings which restricts the growth, improvement and sooner or later yield. Water logging is also called as anoxia, anaerobiosis or flooding.

PI-306

Impact on agriculture under changing climatic condition

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India being mainly an agricultural country the economy and further its growth purely depends on the varies of the weather and in particular the extreme weather events. The socio-economic impacts of the extreme weather events such as floods, cyclones, hail storm, thunderstorm, heat and cold waves have been increasing due to large growth of population and its migration towards urban areas which has led to greater vulnerability. Extreme positive departures from the normal maximum temperature result in heat wave during the summer season. When actual T_{max} remains ≥ 45^0C, heat-wave condition is declared irrespective of normal T_{max}. Heat stress causes multifarious, and often adverse, alterations in plant growth, development, physiological processes, and yield. Heat waves recorded to have negative impact on photosynthesis which is associated with Rubisco inactivity and higher maintenance respiration. Increasing temperature above threshold increases the grain filling rate by increasing rates of cell division in the endosperm tissue and enhancing metabolic rates. Occurrences of extreme low temperature in association with incursion of dry cold winds from north into the sub-continent known as cold waves. The actual min temperature (T_{min}) of a station should be reduced to wind chill effective min temperature (WCTn); cold-wave condition is considered when WCTn ≥ 10^0C. The negative impacts of cold waves on production from frost are associated with sterility and the abortion of formed grains around anthesis. In addition to temperature the duration of freezing temperatures is important in determining the damage. Flood is an extreme condition in which water cannot be drained adequately by stream discharge to prevent overflow of channel banks or infiltration, runoff, or evaporation to prevent excessive "ponding" on the surface. Frequencies of occurrence as well as intensity of heavy and very-heavy rainfall events have highly significant increasing trends over Central India. The effects of increasing precipitation variability on the forage yield and root length. They reported that the Grass yield decreased with higher precipitation variability. Flood proved the worst and reported to crop loss by 75 per cent and significant loss to human being.

PI-307

Agroforestry: Viable alternatives for ensuring green fodder production around the year

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Agroforestry is the integration of agricultural crops and livestock production systems that can be directly used to enhance agro biodiversity, rural livelihood and to meet the demand of green fodder throughout the year. Considering this fact, a study was done at Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana to assess the productivity of fodder crops under poplar based agroforestry system. In February 2016, poplar was planted in six different spacing of 3× 3 m, 4×3 m, 5×3 m, 6×3 m, 7×3 m and 8×3 m. In this study, fodder crops (sorghum during *kharif* season and oat and berseem during *Rabi* season) were intercropped in different spacing's of poplar and compared with control in three replications. The results revealed that the maximum DBH (13.92 cm), basal diameter (16.90 cm) and crown spread (6.79 m) attained in 8×3 m spacing while maximum height (9.61 m) is attained in 3×3 m spacing. The highest pH (7.94) and EC (0.27 dS/m) were recorded in 8×3 m spacing while highest SOC (0.47 %), N (158.5 kg/ha), P (16.8 kg/ha) and K (343.8 kg/ha) were recorded in 3×3 m spacing. Green fodder biomass of sorghum (38.45 t/ha), berseem (64.56 t/ha) and oat (52.62 t/ha) was recorded higher in wider spacing (8×3 m) as compared to sole crops. The maximum light intensity (672.4 Lux) was recorded in 8×3 m at 1.00 pm in the month of July, 2018. Higher value of BCR was observed for poplar with oat (2.44) followed by poplar with sorghum (2.31) and poplar with berseem (2.28) under 3×3 m spacing indicating that closer spacing of 3×3 m of poplar is more economic than the other spacing's due to more number of trees per unit area and more production of wood.

PI-308

Assessment of morphophysiological responses of *Andrographis paniculata* medicinal plant under differential application of salinity stress

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Andrographis paniculata is an important medicinal plant. Salinity stress is harmful for plant growth and crop productivity. Influence of salinity stress i.e. effect of NaCl salt (Na^+) was measured in plant *Andrographis paniculata* to investigate the survival capability of sensitive and tolerant variety of the said plant. *Arabidopsis thaliana* (model plant) is used as control plant for salinity stress experiments. Morphological and physiological parameters are analysed under different dosages of salinity like 0 mM (control), 50 mM, 100 mM, 150 mM and 200 mM on the plants growing in controlled environment with sterile condition. The morphological and physiological parameters like, primary root length determination, no. of lateral root counting, proline content measurement, chlorophyll content measurement, stomata density counting was performed. Studies revealed that *Andrographis paniculata* is a moderate salt tolerant plant. This screening may help to identify the salinity stress tolerance mechanism in the *Andrographis paniculata* plant. This stress analysis may also help to understand the effect of osmotic stress and ion stress also. We propose that *Andrographis paniculata* could serve as suitable medicinal plant model for elucidating the stress-relevant genetic determinants in genome-level analysis also. Other than that, osmotic stress also increases the contents of secondary metabolites in the said plant. Further research regarding related to the role of salinity stress in secondary metabolite production enhancement can be possible.

PI-309

Changes in morphological and biochemical properties of *Rhododendron campanulatum* D. Don along a Treeline Ecotone in Western Himalaya

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Treeline species of the mountain regions are highly sensitive to the impact of global climate changes. In recent years the treeline species encroachment in alpine grassland has been reported from many parts of the world. *Rhododendron campanulatum* D. Don is a shrub or shrub tree, which extended its distribution from timberline to upper alpine zone. It is an important shrub species of the treeline ecotone in Western Himalaya that belongs to the Ericaceae family. Changes in morphological and biochemical properties of *Rhododendron campanulatum* D. Don were determined along a treeline ecotone in Western Himalaya. For the morphological and biochemical study of *R. campanulatum* two different habitats i.e., above and below the treeline zone were selected. The present study reported that the several morphological traits of *R. campanulatum* such as plant height, diameter, canopy cover, leaf length, width, leaf area and specific leaf area is decreased with increasing elevation but leaf thickness is increased with increasing elevation. The plant height 5.76 m (($p<0.001$) and specific leaf area (SLA) 69.43 cm^2/g ($p<0.001$) was found maximum in below the treeline and minimum 2.04 m ($p<0.001$), 63.54 cm^2/g in above the treeline. The biochemical properties showed variation in both habitats. The chlorophyll content and total phenolics content was found maximum below the treeline zone than above the treeline zone. The present study reveals that the *R. campanulatum* has successfully adapted itself above the treeline zone and it may influence the mountain ecosystem in future.

PI-310

Regulated expression of *At*DREB1a in chickpea confers better adaptation in parched condition

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Chickpea is an important grain legume widely grown in India and drought (limiting water) is one of the major abiotic constraints accounting to about 40–50% yield losses annually. The plant transcription factors (TFs), Dehydration responsive element binding proteins (DREBs) play pivotal role by regulating the expression of many stress inducible genes leading to enhanced abiotic stress tolerance. Genetically engineered chickpea lines harbouring transcription factor, Dehydration Responsive Element-Binding protein 1A from *Arabidopsis thaliana* (*At*DREB1a gene) driven by stress inducible promoter rd29a were developed and assessed under dry down experiments in Containment Facility. Performance of chickpea lines were assessed based on key physiological traits imparting drought tolerance *viz*. plant water relation characteristics, chlorophyll retention, photosynthesis, membrane stability and water use efficiency. Transgenic chickpea lines exhibited longer chlorophyll retention capacity, higher relative water content and osmotic adjustment under severe drought stress, as compared to control. The enhanced drought tolerance in chickpea lines were manifested by undeterred photosynthesis involving enhanced quantum yield of PSII, electron transport rate at saturated irradiance levels and maintaining higher relative water content in leaves under relatively severe soil water deficit. Lower values of carbon isotope discrimination (CID) in chickpea lines indicated higher water use efficiency, compared to control. Chickpea lines exhibiting better osmotic adjustment resulted in higher seed yield by modifying important physiological traits, with progressive increase in water stress, as compared to control.

PI-311

Performance of Arbi (*Colocasia esculenta*) under agroforestry system : Source of income and climate mitigation

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Due to climate change farmer have been facing many challenges because of adverse effect on agricultural productivity & farmer's income. In these scenario adoption of agroforestry system become a mitigation tool as well as increases the farmers income. In this context an experiment was conducted during the year 2019-20 to evaluate the performance of Arbi (*Colocasia esculenta*) under Eucalyptus tereticornis based Agroforestry System in Plains of Chhattisgarh". In this experiment we found that yield was obtained 118.66 qha-1 in fertilizer treatment and lowest 104.12 qha1 in T-2 where no fertilizer was given, which was reduced by % 12.06with statistically significant variation. In case of variety we found that that Indira Arbi-I produced better yield 114.286 q/ha as compare to Arbi-CG-II which produced 108.19 q/ha with non significant variation. The crop registered better growth and yield performance in T-1 (RDF) treatment. The cultivation of colocasia as cover crop showed better growth & yield performance, while the farmer can get extra income on harvesting of Eucalyptus. Thus Eucalyptus + Colocasia farming was found beneficial in economical point of view, as well as tree component gives various environmental benefits for mitigation of climate change.

PI-312

Morphological and anatomical variations of *Plectranthus amboinicus* (Lour.) Spreng towards copper stress

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Heavy metals are generally toxic for plants interfering the metabolism and physiology of growth. Toxicity symptoms are expressed morphological changes as growth retardation. *Plectranthus amboinicus* is a semi-succulent perennial plant belongs to the family *Lamiaceae*, and is extensively used in Indian traditional medicine. Copper (Cu) is an essential element for normal plant growth when present in lesser quantity, while in excessive amount it may exerts toxicity in plants. Studies related to Cu toxicity are very scanty particularly in medicinal plants. Therefore, the present study was carried out to evaluate the morphological and anatomical variations and absorption and translocation of Cu in *P. amboinicus* with respect to Cu toxicity. One set of rooted propagules in half diluted Hoagland nutrient medium supplied with different concentrations of $CuSO_4$ were taken as experimental and another set without $CuSO_4$ as control. Out of these, at 80 µM $CuSO_4$, the plant exhibited about 50% growth retardation and this concentration is taken for further experiments. The analyzed growth rate in terms of shoot length, root length, leaf area and tolerance index at the intervals of 4 days. After 20 days of $CuSO_4$ exposure, free hand sections of plant parts were taken and used for SEM –EDAX studies. The SEM results revealed that, the roots are the primary site of Cu localization and that is confirmed by the EDAX. The results are also well explained and interpreted in terms of some morphological & anatomical parameters and physiological dynamics of nutrition in general and that of Cu in particular.

PI-313

Impact of different agrochemicals on growth parameters and yield for drought stress alleviating of groundnut (*Arachis hypogaea* L.) crop

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A field experiment was conducted at UAS Raichur, Karnataka to know the effect of different agrochemicals on growth parameters and yield of ground nut crop. The experiment was laid out in RCBD with 3 replications during summer season (2014-15). The experiment consisting of 12 treatments,T_1= Control, T_2 = Stress plot, T_3= T_2+ Foliar application of KCl (1.0 %), T_4= T_2+ Foliar application of Triacontanol (2.0 mL/L), T_5 = T_2+ Foliar application of Alachlor (20 ppm), T_6 = T_2+ Foliar application of Methanol (2 %), T_7 = T_2+ Foliar application of Kaoline (6%), T_8 = T_2+ Foliar application of Atrazine (100 ppm), T_9 = T_2+ Foliar application of Nitrobenzene (20 ppm), T_{10}= T_2+ Foliar application of Salicylic acid (500 ppm), T_{11} = T_2+ Foliar application of CCC (100 ppm) and T_{12} = T_2+ Foliar application of water. Growth parameters were computed using ICAR-WASP - Web Agri Stat Package 2.0 and all the growth parameters were differed significantly at different growth stages. All growth parameters were recorded at 45-65, 65-85 DAS and at harvest. T_1 (irrigated plot) recorded significantly higher NAR (0.042,0.119 and 0.029 g/dm^2/day) and lowest in T_2 (0.023 0, 0.094 and 0.047g/dm^2/day). CGR was highest in T_1 (0.00052, 65-85 and 0.00158 g/cm^2/day) whereas lowest at T_2(0.00021, 0.00148 and 0.00171 g/cm^2/day). RGR was higher in T_5 (0.083, 0.080 and 0.081 g/g/day) and lowest in T_2 (0.062, 0.061 and 0.034 g/g/day). Pod yield was highest in T_1 (29.6 q ha^{-1}) and lowest in T_2 (19.9 q ha^{-1}).

PI-314

Agroforestry : A sustainable environmental practice for climate change scenario

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In twenty – first century, global climate change due to increased levels of carbon dioxide and greenhouse gases has become a serious environmental issue. Climate change affect food security by decreasing both food availability as well as food accessibility. To survive the unexpected intensified consequences of climate change there is urgent need of climate change mitigation and adaptation. Agroforestry has the potential to promote anthropogenic climate change resilience. It is a land management practice where trees and crops are grown in interacting combinations. This integration of agriculture and forestry has been frequently seen since time immemorial as a traditional land-use system. It is a shining approach which merges century's old knowledge with modern science in a system that helps the farmer's to achieve potentially big and transformative outcomes. Agroforestry practices are receiving huge attention as it supplements fuel, fruits, fibers, fodder and provide food security and other environmental benefits. Furthermore, agroforestry offers great opportunities to combat climate change by mitigation strategies like carbon sequestration potential or by adapting to the changing climate like creating the microclimate, decreasing the greenhouse gases and increasing the biodiversity. Focusing these four goals, this study investigated co-benefits and adverse side-effects of agroforestry practice. However, the full potential of agroforestry will only be achieved if the challenges to agroforestry implementation are recognized and the most efficient and sustainable solutions are made widely known. Therefore, the purpose of this review is to explore these challenges and to determine the most suitable set of solutions for each challenge that combines local effectiveness.

PI-315

Impact of elevated CO_2 and temperature on stomatal behaviour and physiological parameters of two genotypes of groundnut

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The global atmospheric CO_2 concentration is rising at a high rate of approximately 2.5 ppm/year. Presently the levels of CO_2 concentration have crossed 410 ppm, which is the highest in last 2 million years. When CO_2 concentration increases, it makes the atmosphere warmer by trapping more heat. Temperature and CO_2 plays an important role in overall plant growth. In order to assess the impact of elevated CO_2 and temperature on two ground nut genotypes viz. Dharani and K-9, an experiment was conducted in the Free Air Temperature Enrichment (FATE) facility with ambient conditions and with elevated CO_2 (550ppm) and elevated temperature (ambient +3°C) conditions. Groundnut, being a C3 crop, responded to elevated CO_2 levels for different anatomical, yield and physiological parameters. It was found that adaxial surface stomatal density was more than abaxial surface stomatal density in both the genotypes under both ambient and elevated CO_2 conditions. Enhanced CO_2 and temperature decreased the stomatal density on both the surfaces of the leaves in both the genotypes which resulted in decreased total stomatal density. Higher increase in photosynthetic rate in Dharani (13.32%) than in K-9 while better Water Use Efficiency in with higher response in Dharani (5.8%) was observed under elevated CO_2 concentration showing that plants efficiency to utilise water was more under elevated CO_2 conditions than in ambient conditions. Increased reproductive biomass and better Harvest Index was observed in Dharani under elevated CO_2 conditions. Though the two genotypes responded differently, Dharani was more responsive to elevated CO_2 than K-9.

PI-316

Effect of growth-stage dependent foliar applied nano- and chelated-iron on yield and Fe mobilization in rice

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Rice, a major staple crop, has relatively low grain Fe content. Biofortification through foliar application might increase grain Fe content as well as improve overall plant growth. We evaluated different Fe formulations [(Fe-citrate, Fe-EDTA, $FePO_4$, nano-Fe oxide, and humic acid (HA+Fe)] in rice (var. MAS 946-1). Single foliar application was given at different growth stages: tillering (set 1), anthesis (set 2), and grain-filling (set 3) while set 4 plants were sprayed twice (anthesis and grain-filling), and set 5 plants were sprayed thrice (all stages). The foliar application at tillering showed minimum effect on grain-yield and grain Fe (GFe) content as compared to anthesis or grain-filling. In all five sets, a significant correlation was observed between shoot Fe at harvest (SFe_H) and grain-yield indicating SFe_H promotes grain-yield. In all sets, HA+Fe application enhanced (>70%) grain-yield as compared to control. Similarly, maximum GFe content was recorded in HA+Fe treatment in all sets except set 5. In the sets 1, 2, and 3, grain-yield and Fe use efficiency (FeUE) were significantly correlated. The GFe concentration obtained maximum with nano-Fe (4mM) in set 4 and set 5. We provided evidence that GFe content was primarily contributed by Fe mobilization from shoot and not root, as evident from significant correlation between GFe content with Fe mobilization efficiency index (FeMEI). Thus, foliar application of HA+Fe was promising in improving grain yield and GFe content by single spray either at anthesis or grain-filling stage while nano-Fe application twice at anthesis and grain-filling would improve GFe concentration.

PI-317

Effect of organic plant growth promoters on yield attributes and yields of maize in western Rajasthan

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An experiment was conducted for from *kharif* (2019) to *rabi* (2019-20) at the experimental farm of College of Agriculture, Agriculture University Jodhpur Rajasthan. Experiment was laid out in split plot design with three replications comprising six weed management treatments in main plot i.e. Stale seedbed + two hoeing at 20 & 40 DAS, Stale seedbed + hoeing with power weeder at 20 DAS + hoeing at 40 DAS, Stale seedbed +hoeing at 20 DAS + straw mulch (5 t ha^{-1}) at 30 DAS, Stale seedbed + black plastic mulch at sowing (25 micron), Weed free check (up to 60 DAS) and W_6-weedy check while the sub plot treatment were five organic nutrient management practices viz, 100% RDN through FYM, 75 % RDN through FYM + seed treatment with *beejamrut* + spray of *jeevamrut* at 500 l ha^{-1} at sowing and 30 DAS, 100% RDN through vermicompost, 75% RDN through vermicompost + seed treatment with *beejamrut*+ spray of *jeevamrut* at 500 l ha^{-1} at sowing and 30 DAS and 75 % RDN through vermicompost (75 % as basal + 25 % as top dress at 30 DAS) + seed treatment with *beejamrut* + spray of *jeevamrut* at 500 l ha^{-1} at sowing and 30 DAS. The same layout was used for sowing of mustard as residual crop in next season with recommended packages of practices. Plant growth as well as yield was recorded for maize as well as for mustard as per standard protocols. Integrated weed management treatments significantly improved the various growth attributes viz., plant height, dry matter accumulation by plants, LAI, CGR, NAR recorded at various stages of crop and cob girth and cob length at crop harvest, grain and stover yield of maize. Further, the use of organics (manures and fermented manures) application to maize significantly improved the various growth attributes viz., plant height, dry matter accumulation by plants, LAI, CGR, NAR recorded at various stages of crop and cob girth and cob length at crop harvest, grain and stover yield of maize. Among the weed management treatments, the treatment comprises stale seedbed +hoeing once at 20 DAS+ application of straw mulch @5 t ha^{-1} was significantly superior and was at par with weed free check but significantly superior over weedy check.

PI-318

Assessment of integrated nutrient management on yield in nagpur mandarin

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Mandarin *Citrus reticuleta* is a major fruit crop in Yavatmal district. It is an irrigated crop required critical nutrient management for better orchard management. Soils of Yavatmal district is black cotton soil mostly vertisols, entisols and incept soils. Mandarin is growing on jambheri i.e. rangpur lime and rough lemon rootstock under the present soils conditions. Mandarin is successfully grown in such soils pertaing to well drained condition of soils. Soil fertility is of medium type with organic matter av. at 0.2 to 0.5. Potash is found in ample quantity in soils of this district. Av. Rainfall of the district is 950 mm. Rains are well distributed with 90 to 120 rainy days. However from past certain years, irregularity in rainfall may lead soil sometimes in stress condition and sometimes cause premature fruit drop due to unfavourable climate. Therefore, nutrient management with timely irrigation are the major practices that not only contribute the quality but assured high yield also. As a traditional practice farmers were applying nutrients in inadequate dose. Hence on farm trials in farmers orchards were conducted to assess the recommended INM practice with use of biofertilizers on yield of Nagpur mandarin. Application of 75% RDF (50 kg FYM + 900 g N + 300 g P2O5 + 300 g K_2O/tree) + 100g PSB + 100g *Azospirillum* + 100 g *Trichoderma*/tree were assessed against farmers practice of unrandom nutrient application through chemical fertilizers. It was observed that, application of 75% RDF+ 100g PSB, *Azospirillum* and *Trichoderma* each/tree recorded higher yield and B:C Ratio with 40.53% increased yield over farmers practice.

PI-319

Cultural and morphological characterization of most widely used antagonist in India, *Trichoderma* spp.

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Use of Biological control agents becomes key element of sustainable agriculture which maintain ecological balance and shows antagonism against many major problematic plant pest and diseases of world. Among the all BCAs, *Trichoderma* species are most extensively studied species in fungal genera. In order to utilize full potential of *Trichoderma* species as an antagonist against target phytopathogenic fungi in several ways, it becomes essential to have systemic knowledge concerning to the behavior of these fungi. Despite of that, widely used biocontrol agent in India, species of *Trichoderma* genus is not well identified. For years, characterization of this most important and common biocontrol agent remained problematic due to variability in phenotypic characters. So present study carried out for characterization of an antagonist used for management of predominant soil borne fungal pathogens i.e. *Trichoderma* spp. Accordingly 20 *Trichoderma* isolates were grouped into 4 different *Trichoderma* spp. i.e. *T. hamatum* (6 isolates), *T harzianum* (7 isolates), *T. koningii* (3 isolates) and *T. asperellum* (4 isolates). These isolates of *Trichoderma* spp. were subjected to the cultural studies by growing on Potato dextrose agar plates and accordingly sorted them into groups of respective species on basis of macroscopic colony characters like growth rates, pustule formation, pigmentation showing defined characteristics for that respective species. Further, the observations recorded for growth characteristics were confirmed by microscopic studies. The microscopic features of *Trichoderma* isolates were identified on the basis of shape and colour of conidia, mycelia form and presence of chlamydospores.

PI-320

Differential response of chickpea genotypes under soil moisture stress

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Water stress adversely affects morphology and physiological processes of plant, resulting in reduced growth, development and yield of crop. Chickpea, an important legume crop, that provide protein component of diet of millions across the world, this crop is grown in marginal and resource poor growth environments and hence, highly vulnerable to adverse effect of water stress during critical growth stages and the drought tolerance is one of the objectives of chickpea improvement program. In order to identify promising traits and genotypes for water stress tolerance, 22 chickpea genotypes were evaluated under well watered and water stressed conditions. Moisture in well-watered pot was maintained through automatic water station in the phenomics whereas as water-stress was imposed by withdrawing irrigation 30 days after sowing. For investigation on root traits, plants were grown *in vitro* on MS media and 5% PEG to induce stress. Data indicated that SPAD chlorophyll meter reading, chlorophyll fluorescence, total chlorophyll content, relative water content and plant dry biomass were decreased by 19.24, 10, 30.11, 7.97 and 50%respectively in water stressed plants as compared to well watered plants. Overall, JG-16 and IPC (L19-1) out performed other genotypes including local checks under water-stress. The root length, number of root hairs and root biomass were decreased by 38.46, 50.46 and 50.56% respectively in water stress genotypes as compared to control. JG 16 had better root growth under stress as compared to Digvijay indicating potential of former cultivar to serve as genetic resources for root system architecture trait for improvement of chickpea yield under water stress conditions.

PI-321

Sustainability agriculture on saline soil

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The use of salted soils and salted water in a system known as saline agriculture is an innovative strategy for increasing land and water availability. This concept is not new; for example, in the last three decades, the use of seawater for food production in coastal deserts has been proposed. As a result, the following is a proposed definition for saline agriculture: Profitable and enhanced agricultural operations utilizing saline land and saline irrigation water with the goal of improving production through the sustainable and integrated use of genetic resources (plants, animals, fish, insects, and microbes) while avoiding costly soil recovery measures. Seawater, salt-contaminated phreatic sheets, brackish water (from, for example, estuaries), drainage water from other plantations irrigation, drainage water from humanized areas, such as sewage, or even water derived from aquaculture waste are all examples of saline water that can be used in halophyte crop irrigation. It's been reported that 50% of irrigation systems are vulnerable to salt contamination or water logging, owing to poor water quality, leaching, and increasing water tables. In light of human population pressures, technological advancements, and the increase of salinized soils and decline of arable area usable by traditional agriculture, it is obvious that using these salinized soils in alternative agriculture might be considered a solution to meet food demand.

PI-322

Identification of ascorbic acid rich chickpea cultivars as source of drought tolerance for genetic improvement of chickpea in semi-arid region

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Drought induces a number of changes in plants including oxidative damage. Ascorbic acid (AsA) also called as vitamin C, is one of the universal non enzymatic antioxidant having substantial potential of scavenging ROS and modulating a number of fundamental functions in plants under stress condition. Chickpea is the most important leguminous crop growing across the world but drought is one of the limiting factors. In this context, experiments were conducted to optimize phenotyping protocol to assess genetic variation in endogenous AsA. National Plant Phenomics Facility was used to assess dynamics of AsA accumulation in the fresh leaves of popular cultivars of chickpea to determine the appropriate time and level of soil moisture to collect sample for AsA during soil moisture depletion. Experiments revealed that AsA accumulation reached its peak when the soil moisture reached 30% field capacity. Then this protocol was employed to screen106 diverse chickpea genotypes for genetic variation in AsA accumulation in response to depleting soil moisture. Two distinct sets of genotypes differing in levels of AsA were selected based on the experiments conducted twice for evaluating their yield performance in field. The field data revealed that high AsA accumulating genotypes viz., BDNG-2018-15, PG 1201-20, C-19315 and C-19186 exhibited more drought tolerance with minimum reduction in yield attributes when compared with popular cultivars. These high endogenous AsA accumulating chickpea genotypes can serve as potential genetic resource for breeding program that aim at improved chickpea cultivars for drought prone areas.

PI-323

Drought-induced biochemical and epigenetic changes and their association with drought stress tolerance in contrasting rice (*Oryza sativa* L.) genotypes

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Plants being sessile in nature have evolved strategies to cope with a variety of environmental stresses. They differ in the degree of tolerance to abiotic stresses due to the differences in their adaptive biochemical, physiological and molecular mechanisms. In the present study, comparative analysis of three rice cultivars (N-22, IR-64 and IR-64 DTY1.1) was carried out to understand biochemical and epigenetic changes due to drought stress. The findings indicated that drought stress decreased chlorophyll content, but post stress recovery was better in N-22 (a drought tolerant genotype). IR-64 DTY1.1 showed a comparable performance but IR-64 could not recover. Total phenolic content (TPC) and antioxidant activity (AO) increased in N-22 and maintained higher in IR-64 DTY1.1 under drought stress, but decreased significantly in IR-64. More importantly, on withdrawal of stress N-22 and IR-64 DTY1.1 maintained higher TPC and AO activity but failed to recover. Lipid Peroxidation (LP) was observed to increase considerably in IR-64 and in IR-64 DTY1.1 under the stress, but significant change was observed in case of N-22. Post stress recovery in the level of (LP) in IR-64 DTY1.1 was found to be better compare to that in IR-64. This comparative analysis confirmed drought tolerant nature of IR-64 DTY1.1. Global cytosine methylation (5-mC) in the shoots of rice genotypes was found to vary under control, drought stress and post recovery conditions. Basic 5-mC level (under control condition) in N-22 and IR-64DTY1.1 was high. Moreover, 5-mC level further increased due to drought stress in N-22 and IR-64 DTY1.1, but it increased considerably in IR-64. Interestingly 5-mC level after recovery from the stress in IR-64 DTY1.1 was observed to be similar to that of N-22. This indicates the increase in methylation in IR-64 DTY1.1 is due to the introgression qDTY1.1 QTL in the IR-64 background, making it drought tolerant.

PI-324

Study the association of physiological parameters with pod yield of groundnut (*Arachis hypogeal* L.)

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The experiment was laid out in randomized block design with three replications involving fifteen genotypes. The observation on different plant characters such as plant height, number of branches, number of leaves, number of pods, photosynthetic rate, transpiration rate, stomatal conductance and post harvest observations were recorded. The plant height, number of branches, number of leaves, leaf area were increasing rapidly up to 100 DAS and slowed down there after. Dry matter of leaf, stem, pod per plant differed significantly throughout the growth period. 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 flowering stage and decreased at pod development stage. The genotype significantly differed in respect of yield per plant. The highest dry pod yield (kg/ha) was recorded by the genotypes, RHRG-1309, RHRG-1305, RHRG-1348 due to significant favourable yield contributing characters like number of pods per plant, pod yield and kernels yield per plant, harvest index (HI). Therefore, it can be conclude that the significant variation in pod 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, pod weight, kernels weight, harvest index etc. were observed to be the major yield contributing characters. However, to arrive at definite conclusion more detailed studies are needed.

PI-325

Effect of endophytic bacteria on seed health and seed quality in cucumber

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Endophytes promote plant growth through nitrogen fixation, phytohormone production, nutrient acquisition, and by conferring tolerance to abiotic and biotic stresses. Bacterial endophytes that are beneficial to plant growth and development. Microbiome rich soil stimulate plant growth and yield and vice versa. The Bacterial endophytes reside in the internal plant tissues which may be a favourable environment for N-fixation that minimizes competition with other microbes in the rhizosphere as well as possibly providing a micro aerobic environment that is necessary for nitrogenase activity. Devasting pathogens lead to 15% to 30% crop losses annually. Chemical pesticides are the major source of crop protection but their uncontrolled and widespread usage has posed a serious threat to the sustainability of agriculture and stability of an ecosystem. Twelve isolates of Trichoderma species from Andaman and Nicobar Islands have been evaluated for their biocontrol potential in both vitro and field conditions during 2009-09,2009-10 and 2010-11 against *Fusarium oxysporum f. sp. lycopersici* causing wilt of tomato. In dual culture test, the isolates Th-CARI-50, Tv-CARI-85 and Th-CARI-61 were most effective against the test pathogen in the hyperparasitic action. The biopriming of seeds with Trichoderma and bacterial antagonist as shown significant over control in the germination behaviour of tomato seeds. The isolates Th-CARI-50 was proved most effective in inducing germination (92%), lowest disease (16.4%) and highest reduction of disease incidence (80%) followed by Tv-CARI-61, Th-CARI-85, Tv-CARI-73, Tv-CARI-130 and the isolate Tv-CARI-100 was least effective (54.9% RDI). The treatment (Th-CARI-50) was most effective in improving field emergence (90.2%) of tomato seedlings, reduction in fusarial wilt disease incidence (78.8%) and corresponding yield increase (138%) of tomato under field condition followed by Tv-CARI-73, Th-CARI-85, Tv-CARI-61. Due to presence of trichoderma spp. Well establish in soil system will readily available and compete with other pathogen for root exudates, nutrient and space, whereas the treated seed microbes acts as protective cover over the other mircoorganisms. The combined application the microorganisms through seed and soil showed better result than seed and soil application alone.

PI-326

Morpho-physiological traits and yield in safflower as influenced by foliar application of humic acid and NAA

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In order to investigate the influence of foliar application of humic acid at 300, 400 and 500 ppm and NAA at 25 ppm and 50 ppm and their combined effects on morpho-physiological traits and yield of safflower (*Carthamus tinctorus* L.), a field experiment was conducted at farm of Botany section, College of Agriculture, Nagpur during the *rabi* season of 2018-2019. The experiment was arranged in randomized block design and replicated thrice consisting twelve treatments. The foliar sprays at 40 and 70 DAS showed significant changes in all the growth parameters i.e. plant height, leaf area, dry matter, number of branches, seed yield ha^{-1} and harvest index. Combine application of 300 ppm humic acid + 50 ppm NAA gave significantly higher results in all parameters under study. Also, the highest per cent increase in yield over control was observed in same treatment.

PI-327

Suitable age of the root stocks for softwood grafting in jackfruit (*Artocarpus heterophyllus* L.)

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Jackfruit is a popular fruit in several tropical and sub-tropical countries. It is regarded as "poor man's fruit" in eastern and southern parts of India. The botanical name of jackfruit is *Artocarpus heterophyllus* Lam. and earlier it was botanically known as *Artocarpus integrifolius* Auct. belonging to the family Moraceae and its chromosome number is 2n=56. Jackfruit is a dicotyledonous compound fruit. The studies on softwood grafting in jackfruit plants were carried out from September 2016 to May 2017 at the Department of Fruit crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakualm. The experiment location is situated at an elevation of 300 m above mean sea level, at 100 North latitude and 77.80 East latitude. The experiment was carried out with the main objective of "Standardize the age of rootstock for softwood grafting in jackfruit. Seeds were collected from local and the rootstocks were raised in polythene bags. Scions of Palur-1 jackfruit variety were grafted in the raised rootstock in different period. The experimental design adopted was Factorial Complete Randomized Design (FCRD) with three replications with ten plants for each replication. Two growing conditions viz., C1 (mist chamber) and C2 (shade net house) were compared with different age of the rootstock viz., 15, 30, 45, 60, 75, 90, 105, 120 and 135 days old rootstocks. The observation recorded is Number of days taken for graft union (days), Days taken for sprouting (days), Number of sprouts per graft, Length of sprouts (cm). Among the above observation the best result observed at grafting on 30 days old rootstock (i.e. A_2-30 days old rootstock). Number of days taken for graft union (days) is least on grafting done on 30 days old rootstock took the least number of days for graft union 24.07 days where as the maximum number of 27.96 days taken for graft union grafting on 135 days old rootstock, days taken for sprouting (days) is minimum number of days taken for sprouting was 19.48 days whereas the maximum number of days taken for sprouting was taken 20.58 days. Number of sprouts per graft the maximum sprouting was recorded 1.00 sprouts per graft on 30th day and 1.28 sprouts on 60th followed by 2.08 sprouts on 90th day, length of sprouts (cm) maximum length of sprouts as 2.87 cm on 30th day, 3.67 cm on 60th day and 3.94 cm on 90th day.

PI-328

Mitigating the impact of terminal heat stress/elevated temperature on wheat

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This study endeavors to quantitatively cognize the impact of changes in biochemical and antioxidant enzyme activities due to climate change on wheat at vegetative stage and reproductive stage of crop. This experiment was conducted and evaluated for wheat crop using two chemicals salicylic acid and oxalic acid and meteorological data from a field site at Students Instructional Farm of the Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Rabi* seasons of 2015-16 and 2016-17. This experiment was planned under FRBD (Factorial Randomized Block Design) with three replications and two date of sowing *viz.*; 25th November and 25th December with two varieties NW-5054 and NW-2036.Results clearly indicated that biochemical and antioxidant enzyme activities were adversely affected by time of sowing due to onset of high temperature during crop growth and particularly grain filling. All the treatments reduced the detrimental effect of heat stress on both the varieties by improving biochemical and antioxidant enzyme activities which ultimately helped in obtaining higher yield.

PI-329

Global warming and their effect on earth

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Global warming is the long term heating of the earth. The gradually heating of the earth surface, oceans and atmosphere caused by human activities by the burning of fossil fuels. The major gases which involve in global warming is Carbon dioxide (CO_2), methane Chlorofluorocarbons (CFC), nitrous oxide and water vapours. There are so many causes of the global warming like Industrial activity, Agricultural activity and Deforestation. The biggest cause is that burning of fossil fuels like oil, gas and coal, they release CO_2 into air and causing the planet to heat up. Over the last 100 years the earth temperature has risen 1°C or approximately 1.2° Fahrenheit. In the oceans there is huge carbon sink and it holds approximately 50 times as much as carbon present in the atmosphere. During the climate change, huge number of people suffers from many type of diseases, flood and drought. The demand of fossil fuels is reduced which also reduced in the global warming. The international action is taken by the world scientific and political communities and we move to non-fossil energy.

PI-330

Importance of sowing time and role of nitrogen in sorghum

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Among the all cereal crop Sorghum (*Sorghum bicolor* (L.) Moench) is one of the most important crops which are vigorously grown for food, fodder and fuel in the semi-arid region. Although there is widely reduction in the area of sorghum in Asia, by using high yielding hybrids in particular area the production level has been maintained. Sorghum is staple food of more than 500 million people of 30 countries over world. Sorghum is the fifth most important cereal crop in the world after rice, wheat, corn and barley. Sorghum is cultivated in high temperature and dry conditions. The proper sowing time whether it is *kharif* or *rabi* is most important to get maximum yield of sorghum. As the time of sowing varies the physiological traits like leaf area index at 50% flowering, biomass at different stages of crop growth as well as number of root, its dry weight and root to shoot ratio all these varies with time of sowing. The Physiology of Sorghum sown in September illustrated that highest total biomass at flowering as well as at maturity along with this harvest index were also highest compared to October and November sowing sorghum. The physiological traits of roots of sorghum cultivated in *rabi* season has occurred more number of root, its dry weight and root to shoot ratio as it all these traits shows lower in sorghum which is cultivated in *kharif* season. Soil also plays important role to show all these parameters of shoot and root, which were higher in medium soil compared to shallow soil. As the Nitrogen plays significant role in decent growth and improvement of sorghum. The lack of nitrogen results in lower the crop photosynthesis and seed growth consequently the physiological parameters like height, number of tiller and number of panicle per m^2 were affected significantly by complementary application of nitrogenous fertilizer on sorghum compared to application of organic fertilizer. Although excess application of fertilizer is influenced badly as it results in lower yields along with this it has harmful effect on soil health. The water use efficiency and grain yield are affected due to nitrogen dose, both of this are achieved by more at application of nitrogen 80 kg/ha.

PI-331

Evaluation of double haploid wheat genotypes for physiological and agronomic traits under water stress conditions

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The reductions in agricultural land and productivity from its fragmented area have made it difficult for the increasing population to have adequate and balanced nutrition. Global warming and climate change have emerged as major threats in recent times, limiting the crop productivity by altering the optimum growing conditions for crop plants. The unprecedented changes in rainfall and temperatures have checked crop production drastically. These anomalies have necessitated the need to identify the genotypes which adapt the environmental changes. Wheat is one of the major food crops consumed worldwide whose yield is affected by water stress. The present study was carried out to identify double haploid wheat genotypes carrying improved physiological and agronomic traits such as canopy temperature (CT), chlorophyll content (SPAD), vegetation cover and biomass production, normalized difference vegetation index (NDVI), days to heading, days to maturity, grain yield, and biomass under restricted irrigation conditions and rainfed conditions in the peninsular zone of India. The physiological parameters were found to be associated with grain yield under drought stress. Results revealed that DH 435 exhibited the best adaptation as indicated in highest yield in restricted irrigation condition with high NDVI (0.87), high SPAD (59.7), and low CT (24.9°C) whereas DH 989 showed better performance in rainfed conditions with higher yield with high NDVI (0.81), high SPAD (51.3) and low CT (25.5°C). These genotypes provide a valuable genetic resource for further studies to understand physiological mechanisms contributing to resilience under restricted moisture conditions.

PI-332

Physiological response of wheat cultivars under temperature stress

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Increasing temperature and consequent changes in climate adversely affect growth and development of wheat crops. Field experiment was conducted at Student's Instructional Farm of the Acharya Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya (UP) during *rabi* season of 2020-21. The experiment was planned under SPD (Split plot design) with three replications. Three varieties *i.e.,* V_1 (PBW-343), V_2 (HD-2967) and V_3 (Halna) were grown at different times *i.e.,* D1 (30th November), D2 (15th December) and D3 (30th December). The treatments were consisted with early and late stages in which D_1, D_2 were early and D_3 was late. All the growth contributing traits and biochemical analysis were done at 60, 75 and 90 DAS. Results indicated that growth attributes such as plant height, number of tillers per plant and dry matter per plant were greatly influenced with the date of sowing. When late sown variety was planted early all the growth attributes showed drastic reduction with respect to late sowing (30th December). However, V_1 (PBW-343) and V_2 (HD-2967) showed comparatively good performance in terms of growth attributes when sown early *i.e.,* D_1 (30th November) and D_2 (15th December). Total soluble sugar content in leaves of V_1 and V_2 were reduced greatly in late sown condition *i.e.*, D_3 (30th December). But reduction in these parameters was less in V_1 (PBW-343) and V_2 (HD-2967) as compared V_3 (Halna) at early sowing *i.e.,* D_1 (30th November). In the delayed shown condition, V3 (Halna) performed very well as compared to V_1 (PBW-343) and V_2 (HD-2967).

PI-333

Evaluation of ornamental flowering plants for vertical gardening

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The experiment was conducted to evaluate 20 plant species for their suitability to vertical garden. The treatments consisted of *Antirrhinum majus*, *Callistephus chinensis, Begonia* spp, *Calendula officinalis*, *Celosia cristata, Cosmos bipinnatus, Crossandra infundibuliformis*, *Zinnia elegans*, *Dianthus caryophyllus, Tagetespatula*, *Gazania linearis*, *Lantana camara, Viola tricolor* var. *hortensis*, *Pentaslanceolata, Petunia X atkinsiana, Portulaca grandiflora, Salvia officinalis, Catharanthus roseus*, *Torenia fournieri* and *Gomphrena globosa,* replicated twice in a completely randomized design for two seasons *i.e.* summer and winter. These plants were observed for the most essential parameters like plant height, area coverage, number of flowers, size of flowers, and duration of flower crop for two seasons *i.e*. summer and winter season. The result indicated a significant variation among all the 20 flowering plants for almost all the attributes studied. For both the season all 20 plant spp performed well. While in case of area coverage, *Portulaca grandiflora*, *Antirrhinum majus*and *Dianthus caryophyllus* were found best suited for summer season. Whereas*, Pentas lanceolata, Begonia* spp, *Portulaca grandiflora and Petunia X atkinsiana* were found best performing for winter season. For the flowering attributes, like more number of flowers, *Pentas lanceolata, Torenia fournieri, Gomphrena globosa* and *Begonia* spp, for desirable flower size plant spp like *Petunia X atkinsiana, Gazania linearis, Dianthus caryophyllus* and *Viola tricolor* var. *hortensis* were found best for both, summer and winter season. While for more flowering duration, *Antirrhinum majus, Begonia* spp, *Catharanthus roseus* and *Gomphrena globosa* were found suitable for summer season. Whereas, for winter season *Antirrhinum majus, Cosmos bipinnatus, Zinnia elegans* and *Begonia* spp were found best. Thus, the findings of the present study reveals that, for summer season the ornamental flowering spp *viz., Begonia* spp, *Dianthus caryophyllus, Toreniafournieri, Gomphrena globosa* and *Catharanthus roseus,* while for winter season *Begonia* spp, *Petunia X atkinsiana, Dianthus caryophyllus, Tagete spatula*, *Zinnia elegans*, *Catharanthus roseus,* and *Salvia officinalis,* are mostly suitable for vertical gardening. Overall study shows that *Begonia* spp and *Dianthus caryophyllus* are found suitable for vertical gardening.

PI-334

Dragon fruit: A new host for oriental fruit fly, *Bactrocera dorsalis* (Tephritidae: Diptera)

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The Oriental fruit fly, *Bactrocera dorsalis* (Hendel.) (Diptera: Tephritidae) is a polyphagous pest in tropical horticulture, causing economic damage to more than 150 species of fruits including mango, guava, sapota, custard apple etc. By considering its pestiferous nature a study was conducted with a aim to understand the abundance and diversity of fruit flies infesting dragon fruit under changing climatic condition scenario. Dragon fruit (*Hylocereus* spp.) or pitaya is native of Central America and recently introduced super fruit in India belongs to the family Cactaceae. It is a climbing vine cactus species which is high-value crop and received worldwide recognition as a fruit crop. It is getting tremendous popularity among growers because of its attractive fruit colour and mouth-watering pulp with nutraceutical value, excellent export potential and highly remunerative in nature. Because of succulent fruit with more pulp the crop manifested susceptibility to attack of insect pests. Our investigation revealed that the insect pests associated with dragon fruit were fruit flies which infest the fruit which is an economical part of the fruit. Three species of fruit flies *viz*., *Bactrocera dorsalis, B. zonata* and *B. correcta* were found infesting dragon fruit. Among the three, oriental fruit fly, *Bactrocera dorsalis* was found in abundant to inflict damage to dragon fruit.

PI-335

Genome wide identification, *in silico* characterization and expression analysis of RNA helicase gene family in chickpea (*Cicer arietinum* L.)

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The RNA helicase enzymes are an important class of enzymes which are known to influence almost every aspect of RNA metabolism. The vast majority of RNA helicases belong to the SF2 superfamily and these can be further categorized into three separate families i.e., the DEAD (Asp-Glu-Ala-Asp), DEAH and DExD/H-box families, based on the motif composition for the motif II. In chickpea, this gene superfamily has not been characterized until now. A genome wide analysis across the chickpea genome led to the identification of a total of 150 RNA helicase genes which included 50 *DEAD*, 33 *DEAH* and 67 *DExD/H-box* genes. These were distributed across all the eight chromosomes, with highest number on chr. 4 (26) and least on chr. 8 (8). Gene duplication analysis led to identification of 15 paralogous gene pairs with Ka/Ks values being < 1 for all the gene pairs, indicating towards the proteins being under negative selection. The drought responsiveness of few of these genes was analysed by studying their gene expression profiles, in two different accessions, the cultivated variety ICC 8261 (kabuli, *C. arietinum*) and the wild accession ILWC 292 (*C. reticulatum*), through qRT-PCR. These genotypes were selected based on their drought responsiveness in a field experiment, during which seven different accessions were characterized for physiological traits like RWC and MSI and various root morphological traits, under both well watered (C) and drought stress (T) conditions. The percentage reduction of RWC and MSI for the drought stressed plants over the control plants was found to be least (~5%) for ICC 8261 and ILWC 292 after withholding water for 24 days for the stressed plants. The genes *CaDEAD46* and *CaDEAD50* were both significantly upregulated ($p < 0.05$, FC > 8) in ICC 8261 as compared to the wild chickpea accession, in response to drought stress. These proteins share a high degree of homology (>70 % sequence identity, > 80% query coverage) with the strs (stress response suppressor, DEAD-box) proteins of *A. thaliana*, which are negative regulators of stress responsive transcription factors. This study thus provides a detailed analysis of the structure and function of RNA helicase gene family in chickpea and allows identification of drought stress responsive helicase genes.

PI-336

Phytochemical analysis of leaf protein concentrate (LPC) from cauliflower leaf

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Cauliflower (*Brassica oleracea* L.) is a belong from the family Brassicaceae for use in food and Leaf used in animal feeds. Yield and composition of protein concentrates extracted from fresh Leaf of Cauliflower distributed extensively is a potential source of Leaf Protein Concentrate (LPC). Present study envisages the phytochemical investigations to assess the availability and commercial viability of LPC of Cauliflower Leaf. Samples of plant leaves were collected from field (India) and contents of LPC were isolated. Proximate analysis of LPC for nitrogen, protein, fat, ash and carbohydrate content revealed their concentration in appreciable quantities making it a potential source of nonconventional protein. LPC has important biochemical characteristics, which establish the usefulness and potential of leaves of this plant to be used as animal fodder for better milk production and rich source for protein for human consumption.

PI-337

Black soldier fly, *Hermetia illucens* (Stratiomyidae: Diptera): A novel protein feed for poultry and fisheries

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In the recent years, insects have received wide attention as a potential source of protein both for humans and livestock. Insects have high reproductive rate and can be cultured easily, have high feed conversion efficiency and can be reared on bio-wastes. Aquaculture Industry in India is rapidly growing with a target of annual fish production to 15 million tonnes by the year 2020. There is a increase in feed cost ranging from 40-70% has made aquaculture feed a very costly input in fish production system. Insect species can be a source of high protein when replaced fully or partially with the fish meal. The insects have high nutritive quality, are easy to reproduce and culture with higher biomass producers. The various group of insect species like black soldier fly, house fly, storage pests, orthopterans, silkworm pupae are some of the important candidate species. Black Soldier Fly (BSF), *Hermetia illucens* is an insect belonging to the order of Diptera, family of Stratiomyidae. BSF is a harmless insect with a potential to solve two of modern agriculture's growing problems namely, serve as an alternative protein source for animal feeds (Poultry and Fish) and helpful in converting organic wastes into a fortified, complete manure for agriculture. BSF is a rich source of protein (32-56%), Chitin (8%), Lipids (38%), Crude fibre (20.7%), Ash (9.8%). As the larvae/pupae of BSF enriched with all the feed components can be used as a fresh feed or frozen, freeze dried or meals for feeding the poultry and fish. The bio-waste generated from house hold kitchen, restaurants, catering etc. need to be converted into the fortified, well balanced manure which can be used agriculture. BSF is one of the potential candidate insect species that can be employed in converting bio-waste into manure. BSF has higher feed conversion efficiency, therefore use less feed; less land, have great acceptance from poultry and fish as part of their natural diet and are mostly omnivorous and therefore grow on different substrates.

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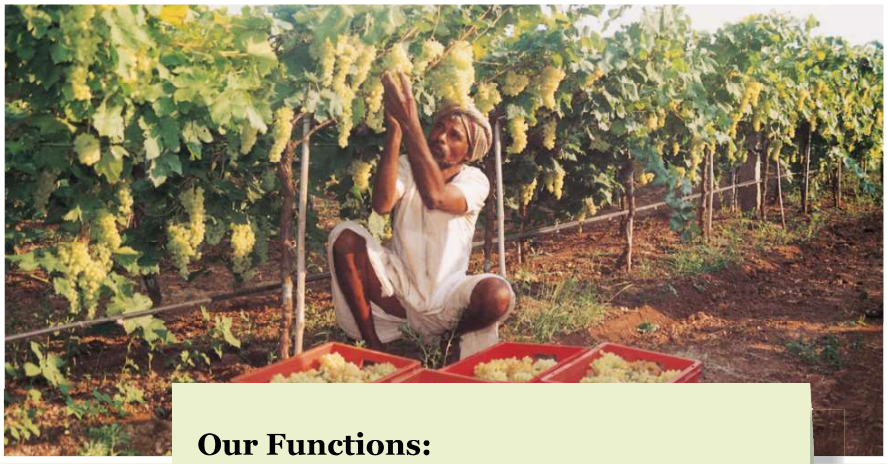
National Bank for Agriculture and Rural Development



Our Mission: Promote sustainable and equitable agriculture and rural prosperity through participative financial and non financial interventions, innovations, technology and institutional development for securing prosperity.

- **Research and Development on matter of importance pertaining to agriculture, agricultural operations and rural development including the provision of training and research facilities.**
- **Consultancy services related to Agriculture & Rural Development through subsidiary (NABCONS).**

Our Functions:

- Provide Credit/Refinance for production credit and investment credit to eligible banks and financing institutions.
- Development functions undertaken through Farm Sector Promotion Fund (FSPF), Financial Inclusion Fund (FIF), Watershed Development Fund (WDF), Tribal Development Fund (TDF) Rural Infrastructure Development Fund,(RIDF) etc.
- Supervisory functions in respect of Cooperative Banks and Regional Rural Banks.

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