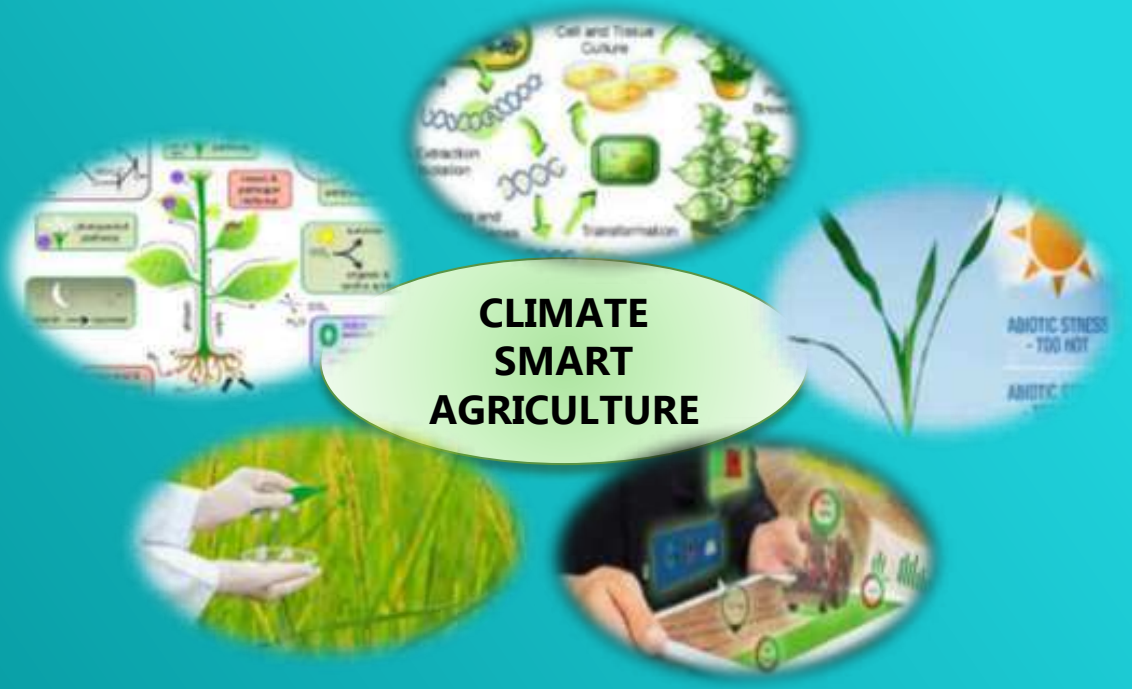
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National webinar on

Plant Biological Interventions for Climate Smart Agriculture (PBICSA-2020)

30th JULY, 2020



Proceedings-cum-Abstract Book

Editors

Sareeta Nahakpam

Sweta Sinha

Rafat Sultana

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Plant Biological Interventions for Climate Smart Agriculture (PBICSA-2020)

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Vice Chancellor
Bihar Agricultural University, Sabour

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Abstracts included in this book are responsible of the respective authors and not necessarily that of organizers

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Foreword

In recent years, agriculture is facing a new challenge to meet the increasing global food demands under the severe threats of climate change. Global warming induced high temperature and erratic rainfall patterns caused unpredictable drought, flooding and salinity stresses that adversely affect crop production. Agricultural system being one of the most vulnerable systems to changing climate, making this system resilient and sustainable will not only increase agricultural productivity but also green and healthy environment. Therefore, at present scenario of changing climate, maintaining and sustaining agriculture through climate smart agriculture intervention has become prerequisite.

Development of climate smart crop varieties will provide production stability in the adverse ecologies and support farmer's income and livelihood. In this regard, modern agricultural system can only be reformed through multidisciplinary approaches bridging from conventional breeding to modern biotechnological tools, from sequencing to genome assembly, genotyping, marker discovery and genome editing, together with improved bioinformatics methods should be incorporated to make crop varieties more resilient against the climate change scenarios.

Within these frame of references and to the insight of bringing several scientist working on different field of biological sciences, a consortium of knowledge sharing for pertinent resolution of climate smart crop, a webinar "Plant Biological Interventions for Climate Smart Agriculture" is the right platform. I am pleased to witness the promising mitigation strategies from eminent speakers of different disciplines. Discussions were made even more prompt with 750 participants across the country and abroad.

I am particularly thankful and congratulate to all the eminent speakers for keeping their views making the webinar meaningful. I hope the discussion and deliberation of experts in this webinar will help to make effective strategies for climate smart agriculture. Hence so over, Proceeding-cum-Abstract book of this webinar will excel the scientific communities for better implementation of modern tools and techniques for development of climate resilient agriculture. I congratulate the organising committee and editors for bringing this publication.

(Ajoy Kumar Singh)

PLANT BIOLOGICAL INTERVENTIONS FOR CLIMATE SMART AGRICULTURE

Scientific Programme

10: 00 – 10:05 AM **Opening remarks and welcome address**
Dr. Sareeta Nahakpam, Organizing Secretary

10: 05 – 10:10 AM **Convener's remark**
Dr. R.K. Sohane, Director Extension Education

10: 10 – 10:20 AM **Inaugural address and Chairman's remark**
Dr. A.K. Singh, Honourable Vice Chancellor

Technical Session

Time	Name of Eminent Speakers	Topics
10:20 – 10:55 AM	 **Dr. M. L. Jat** Principal scientist, CIMMYT, New Delhi	**Could COVID-19 Drive Farmers To Adopt Climate Smart Agriculture Practices? Example From India's Breadbasket**
10:55 – 11:30 AM	 **Dr. Amelia Henry** Senior Scientist, IRRI, Phillipines	**Recent Root Research for Drought Tolerance in Rice**
11:30 – 12:05 PM	 **Dr. Kavita Shah** Professor, IESD, BHU, Varanasi	**Climate Change, Stress Resilience and Management of Crops for Food Security: Issues and Challenges**
12:05 – 12:40 PM	**Dr. Ravi Gopal Singh**  Cropping systems Agronomist CIMMYT, Mexico	**Weed and Weed Management**

12:40 – 1:15 PM	 **Dr. Anita Babbar** Professor, Plant Breeding & Genetics, JNKVV, Jabalpur	**Genetic Enhancement for Improved Adaptation in Pulses to Climate Change**
1:15 – 1:50 PM	 **Dr. Ranjan Das** Professor, Crop Physiologist, AAU, Johrat	**Crop Response to Climate Change**
1:50 – 2:25 PM	 **Dr. Rupesh Deshmukh** Ramalimga-swamy Fellow, NABI, Mohali, Punjab	**Genome sequencing for plant science**
2:25 – 3:00 PM	 **Dr. Hena Dhar** DST-Inspired Faculty,, NABI, Mohali, Punjab	**Role of Microbes in Climate Change: Mitigation and Adaptation**
3:00 – 3:35 PM	 **Dr. S. Elayabalan** Assistant Professor, IIAT, Trichy, Tamil Nadu	**Application of Artificial Intelligence Technology for Agriculture**

Valedictory **3: 35 – 4:45 AM** **Vote of Thanks** **Dr. Rafat Sultana**

TABLE OF CONTENTS

Sl No.	Details of abstract	Page No.
1	**An approach towards mitigating food insecurity through climate smart agriculture and sustainable intensification** Vandana Kumari	1
2	**Characterization of Chickpea (*Cicer arietinum* L.) Genotypes for Heat Tolerance** Sanjay Kumar, Anand Kumar, Chandan Kishore, Ravi Ranjan Kumar[1], Rakesh Deo Ranjan and Awadesh Kumar Pal	2
3	**Sustainable use of kitchen waste and smart agricultural practice** Pampi Ghosh and Debabrata Das	3
4	**Rapid generation-advancement system techniques for Industrial Scale Rice Breeding Program** Digvijay Singh, Satyendra, Abhishek Kumar	4
5	**Comparative drying method study in different flowers with respect to quality dry flower products preparation** Deepti Singh, Sweta Sinha and Sareeta Nahakpam	5
6	**Modern digital sensors & imaging techniques to study abiotic stresses in crops** Prashant. B. Kardile and G.S.Pawar	6
7	**Water productivity of paddy based cropping sequences in PAP canal command area of Tamil Nadu** C.Sudhalakshmi and S.Rani	7
8	**Impact of climate change on agriculture** Kumari Rashmi, Sanjay Sahay, S.S. Mandal, B. Singh and Sweta Sinha	8
9	**Impact of climate change on perennial fruit production and quality** Farhana Khatoon, Neha Sinha, Nisha Kumari	9

10	**Climate smart agriculture and food security** **Mansukh Singh Jatana**	10
11	**Effect of climate change on the genetics of aroma in scented rice** **M. Burman, A. Baghel and S.K.Nair**	11
12	**Impact of climate change on yield of banana due banana rhizome weevil (*Cosmopolites sordidus*)** **Shyam Babu Sah, R. N. Gupta, Manoj kumar, B.B.Singh and Ruby Saha**	12
13	**Phytochemical analysis and antioxidant activity of leaves extract of *Mimosa amara*** **T. Sivakumar**	13
14	**An overview of emerging strategies for enhancing plant abiotic stress tolerance based on genetic manipulation and the use of chemical priming** **Vandana Kumari**	14
15	**Genomics and breeding approaches for enhancing stress resilience in crops** **Mahendar Singh Bhinda**	15
16	**Climate smart agriculture approaches to sustainable food production** **Dr. Rakhi Sarraf**	16
17	**Climate-Smart Agriculture for sustainable food security** **A.S.Tigga**	17
18	**Role of cluster frontline demonstration in enhancement of Horse gram (*Macrotyloma uniflorum* (Lam.) production in upland farming situation for rainfed area of North Chotha Nagpur region in Jharkhand** **D.K. Raghav, Anjani Kumar, Dharmjeet Kherwar, Indrajeet and A.K Singh**	18

19	**Genetically modified plants *vis-à-vis* insect pollinators.** **Vipul**	19
20	**Climate smart agriculture and food security** **Ashvinder Kour Kala**	20-21
21	**Arbuscular Mychorrhizal fungi: Bioresource for increasing plant growth and Phosphorus nutrition in plants** **Kasturikasen Beura, Amit Kumar Pradhan, Mahendra Singh and Shweta Shambhavi**	21
22	**Impact of gibbberellic acid on growth responses in Aflatoxin B1 treated seeds of maize (*Zea mays L.*)** **Nitu Kumari and Kumari Ragini**	22
23	**Heterosis breeding for quality production in Marigold (*Tagetes* spp.) under hot and humid conditions of Uttarakhand** **Deepti Singh, Sweta Sinha and Sareeta Nahakpam**	23
24	**Molecular marker assisted gene staking for stress tolerance in crops** **Swapnil, Kumari Rashmi, S.S. Mandal, Sweta Sinha, Birender Singh and Sanjay Sahay**	24
25	**Improved soil health through biological intervention in conservation agriculture** **Vikas Kumar**	25
26	**Climate smart agriculture practices to deal with climate variability** **Shivani Ranjan, Sumit Sow**	26
27	**Climate-Smart Agriculture: A boost production in tribal district of Chhotaudepur, Gujarat** **B. L. Dhayal**	27
28	**Effect of different sources of fertilizers on maize yield and yield attributes under irrigated conditions in red soil** **Shivamurthy D, Prasanna P. M and B. A. Badiger**	28-29

29	**Effect of foliar application of nutrients on seed yield and quality in foxtail millet** Bharamaraj Badiger, Prasanna P.M and Shivamurthy D	29-30
30	**Climatic conditions for the development of charcoal rot disease** Ramesh Nath Gupta and S.B.Sah	30-31
31	**Rapid Clonal Propagation of Sugarcane Variety through Tissue culture** Amit Kumar	31
32	**Floriculture and landscaping in the era of climate change** Shyama Kumari and Subhashish Sarkhel	32
33	**Effect of abiotic factors on the growth of *Spirulina platensis* in anaerobically digested distillery effluent medium** Kumaresan, G	33
34	**Validating gene specific STS markers linked to thousand kernel weight in wheat** Snigdh Das, Ibtesam Anjum, Abhisek Chatterjee, Anirban Maji, Md. Nasim Ali	34
35	**6- Benzyl Amino Purine alleviates drought stress effect in tomato under drought** Chandrasekaran, P, R. Sivakumar and M. Vishnuveni	35
36	**Breeding rice for anaerobic germination through marker assisted interventions** Yogendra Kumar, Sareeta Nahakpam, Kumari Rashmi and Sweta Sinha	36-37
37	**Heat stress alter physiological and biochemical Traits with Grain Yield in Wheat (Triticum aestivum L.)** Amrita Kumari, R. D. Ranjan, Chandan Roy, Awadesh Kumar Pal, S. Kumar , Anand Kumar and Birender Kumar	37-38
38	**Response of newly released wheat (*Triticum aestivum* L.) varieties to different sowing dates under changing climate**	38-39

	condition in Central Brahmaputra Valley Zone of Assam T.P.Saikia, P.K.Bordoloi, K.K.Sarma and Ranjana Chakraborty	
39	Conservation agricultural practices and seed priming impart favourable changes on stress physiological traits of pea under rice fallow in acidic soil of Meghalaya Yanglem Sofia Devi, Vishram Ram, Krishnappa Rangappa, Mayanglambam Homeshwari Devi and E Precila Patton	39-40
40	Remote sensing and GIS application in agriculture under changing climate Mohammad Sharif and Abdul Mosawer Niazi	40-41
41	Plant propagation in organic agriculture Lakshmi Hijam, S.Sadhu, B. Maying, B.Teja, Anjan Roy and Moumita Chakraborty	41-42
42	Effect of salinity stress on antioxidant enzyme activities in spider lily cv local Ahir. M.P and Alka Singh	42-43
43	Stress conditions: Impact on resistance gene expression in rice against bacterial blight disease Ashwarya L. Tandon, Maumita Berman and N. R. Rangare	43-44
44	Climate Smart Agriculture: an approach for sustainable food security Ahir Ankit K	44-45
45	Anti-oxidative defence mechanism during abiotic stress in horticultural crops Ankita Sharma* and Jhilick Banerjee	45-46
46	Horticulture: A hope for earning health and wealth in Covid-19 pandemic situation Anupam Tiwari	46-47
47	Recent developments in plant science to address climate change Arati Laddimath	47-48

48	**Biocontrol potential of *Streptomyces* sp. for the management of bacterial leaf blight disease in rice crop** N. Jaivel, R. Rajesh and P. Marimuthu	48
49	**Impact of biochar compost on soil fertility status** M. Vetrivel	49
50	**Breeding Approaches in Sesame** Sima Sinha and Tapash Dasgupta	50
51	**Evolutionary approaches toward C_3 to C_4 rice: Biochemical, physiological and molecular basis.** Rahul Singh, Dharamsheela Thakur, Renu, Abhishek Kumar, S.P. Singh and Satyendra	51
52	**Climate Smart Agriculture: an approach for sustainable Agriculture** Neha and Gajender	52-53
53	**Climate smart agriculture and food security** Monashi Joshi	53
54	**Impact of Climate change and sustainable climate smart approaches in seed spices** Rajeshwari. N, Shoba H, Namita. B.R and Yogeeshappa.H	54
55	**Awareness and adaptation strategies of climate smart agriculture** Harsha S Mendhe, S.S.Sadaphal, Neha K Chopde, Seema Thakre	55
56	**Climate smart traditional agricultural practices for ensuring food security** Sumit Sow, Shivani Ranjan	56
57	**Climate smart agriculture for sustainable food production through gramin krishi mausam sewa** Birendra Kumar, Sushant Sarkar and Rakesh Deo Ranjan	57
58	**Climate smart pest management: Building resilience of farms and landscape to changing pest threats** G. Sangeetha, G. Subash and S. Karthickeyan	58

59	Cold stress and its alleviation in vegetable crops Pankaj Kumar Ray, Ashutosh Singh, Amit Kumar Pandey and Umesh Singh	59
60	Countering the effects of climate change in crop productivity by genomics Som Subhra Dutta	60
61	Crop Improvement: Conventional to Molecular Approaches Alok Kumar, Ranjita Kumari and Sunil Kumar Jatav	61
62	Assessment of different methods of direct seeded rice cultivation on productivity and profitability of Rice crop Vinod Kumar, M. K. Singh and S. Tyagi	62
63	Soil interventions to build up climate smart agriculture and sustainable food production Buddha Priya Mourya, Sonal Rani, Megha Bhadani, Shubham Jaiswal	63
64	Review on High-throughput Plant Phenomics (HTTP) is tool for improving crop yield in future food production R. Vinoth, S.Vijay, J.Mary lisha and V.Baskaran	64
65	Water productivity of paddy based cropping sequences in PAP canal command area of Tamil Nadu C.Sudhalakshmi and S.Rani	65
66	Allelochemicals is an eco-friendly approach for the management of plant parasitic nematodes Dr. T. Senthilkumar	66
67	Climate Change threatening food security M.Ramya	66-67
68	Erratic rainfall: Dries our hope or sinks our mission to food security? Sittal Thapa	67-68
69	Biological interventions for enhancing saffron productivity in Kashmir I. Rethinapriya, B.J. Shelshiya, S. Karthickeyan	68-69

70	Speed breeding for accelerated varietal development to combat changing climate Rajat Sharma	69-70
71	Genomics assisted breeding for climate change resilient crops Jhilick Banerjee and Ankita Sharma	70-71
72	Genomics in improving crop productivity under changing climatic scenario Asif. M. Rather, S. Narayan, K. Hussain, A.A. Malik, T. A. Bhat, M. A. Hajam, M. A. Wani, E. A. Parray, S. A. Mir	71-72
73	Genetic diversity and trait association studies in groundnut R. S. Ganvit, P. K. Jagtap and P. M. Mistry	72
74	Role of microbes in climate change mitigation and adaptation Hena Dhar	72-73
75	Implications for future climate resilient crops and role of calcium in plant stress resistance Rashmi Banoriya	73-74
76	Productivity and profitability of jute (*Corchorous olitorius*) in semmanchal area of Bihar Rama Kant Singh, Reeta Singh, Pankaj Kumar and S.K. Singh	74-75
77	Livestock in a changing climate: Production system transitions as an adaptation strategy for agriculture G. Sangeetha, G. Subash and S. Karthickeyan	75-76
78	Water stress in relation to fruit production K. Karuna, Abhay Mankar, Ruby Rani and Sanjay Sahay	76
79	Marker assisted introgression of semi-dwarfing gene in Katarni rice and evaluation of agronomic traits for yield in backcross derived lines Suvidha Kumari, Kumar Vaibhav, Kumari Neha, Sundaram Bharti, S.P. Singh, Satyendra, Anand Kumar, P.K. Singh and Mankesh Kumar	77

80	Molecular mechanisms and advance plant breeding strategies for drought tolerance in crop plants R. D. Vekariya and A. A. Patel	78
81	Climate smart agriculture approaches to sustainable food production Monika Kumari and A. S. Tigga	79-80
82	Effect of varieties and methods of planting on photosynthetically active radiation of rice under organic farming C. Navin Kumar, N. Thavaprakaash and S. Panneerselvam	80
83	Need of genotyping platforms and high throughput SNP chips for crop improvement Deepak katkani, Pratik Kumar and Anita Babbar	81
84	Character association for seed yield and yield attributes in niger germplasms P.K. Jagtap and P.M. Mistry	82
85	Recent development in plant science to address climate change Manish kumar	82-84
86	Genomics and breeding approaches for enhancing stress resilience in crops Thummar Parag R.	85
87	Approaches of climate smart agriculture to mitigate climate change and sustainable food security S. Pazhanisamy and Rodda Chandana Devi	85-86
88	OMICS Approaches in Crop Improvement for Stress Tolerance in Crops: to mitigate the Climate Change Jaishreepriyanka, R	86-87
89	Effect of climate change, variability, and extreme temperature and rainfall events on agricultural production	87-88

	and food insecurity in Madhya Pradesh Sanjay Jain and V.K. Verma	
90	Principal component analysis for drought tolerant attributes in rice Himanshu Shekhar Garg, Sudeshna Panja, Nitesh Kumar, Chandan Bhattacharya, P.K. Bhattacharya and Subhra Mukherjee	88
91	Remote sensing: A boon towards climate smart horticulture. Saurav Kumar, Sareeta Nahakpam, Kumari Karuna	89
92	Comparing impacts of climate change and mitigation on global agriculture by 2050 G. Sangeetha, B.J. Shelshiya and S. Karthickeyan	90
93	Plant genetics innovations: A new approach adapting agriculture to climate change Rajeswari Das and Dr. Mukesh Kumar	91
94	Growth and production of mustard varieties with different pruning intensities under *Dalbergia sissoo* based agrisilviculture practice in Madhya Pradesh Poornima Malviya, Rahul Dongre, B.D. Ghode and Yashpal Singh	92
95	Hormonal regulations of physiological process in plants G.Priyadharshini	93
96	Implication of low cost phenotyping for crop improvement Ravi Kesari, Tribhuwan Kumar and Sareeta Nahakpam	94
97	Metablomics as a plant defensive mechanism towards abiotic stress Rehan	95
98	Study on effect of foliar spray in different orders of tillers in the long duration rice variety (*Oryza sativa* L.) ADT 50 B. Rohini	96
99	Sustainable food production through climate smart Integrated farming system S.P.Sangeetha, K.R.Latha and A. Renukadevi	97

100	**Auxin and auxin regulations to salinity stress** Sareeta Nahakpam, Manoj Kundu and Russiachand Heikham	98-99
101	**Genomics and breeding: A potential approaches for enhancing stress resilience in crop plant** Abhishek Kumar, Rahul Singh and Digvijay Singh	99-100
102	**Integrated weed management in India** D. Saveetha	100
103	**Management of corm rot disease of saffron incited by *Fusarium oxysporum*** Sabiya Bashir, Mohammad Najeeb Mughal, Shabeena Majid , Sabeena Naseer, Seerat un nissa, Zahida Rashid, Z. A. Dar, S.A. Hakeem and Faisal Rasool	101
104	**Genomics and breeding approaches for enhancing stress resilience in crops** S.Sharvesh	101-102
105	**Climate-smart technologies for drought vulnerability** B. J. Shelshiya, G. Sangeetha and S. Karthickeyan	102-103
106	**Sustainable cultivation of tomatoes under climatic extremities** Shirin Akhtar, Deepak Maurya and Tirthartha Chattopadhyay	103-104
107	**Emerging challenges and opportunities for sustainable agriculture** Neha Sinha, Santosh kumar Chaudhary, Farhana Khatoon and Ravi Pratap	104-105
108	**Integrated approach for enhancing seed yield and quality in Foxtail Millet (*Setaria italica.*)** Swarnalatha Devi.I and Parimala.K	105
109	**Temperature stresses in crop plants** Ashutosh Singh, Amit Kumar Pandey, Umesh Singh and Pankaj Kumar Ray	106
110	**Wastewater treatment using rhizofertilizer and biochar** Karthikeyan G and Sara Parwin Banu K	107

111	**Maize: A scope for crop diversification** Jyoti Rani, Kumari Rashmi, Sweta Sinha, Sanjay Sahay, Ankita Sinha and Urusha Zareen	108
112	**Activation of transcription factor improve drought tolerance in rice** Diksha Kumari, BishunDeo Prasad and Padmanabh Dwivedi	109
113	**Oxidative stress and photosynthetic reduction in plants under Zinc excess** Amit Kumar Pradhan, Kasturikasen Beura, Mahendra Singh and Sunil Kumar	110
114	**Zinc in combination with Arbuscular Mycorrhizal (AM) fungi and zinc solubilizing bacteria on growth and yield of maize (*Zea mays* L.) in black and red soil** Suganya A and A. Saravanan	111
115	**Genetic analysis of seed components in sesame** Aladji Abatchoua MMI	112
116	**Pyramiding of multiple disease resistance genes in tomato** Brij Kishore Kushwaha, Renu, Deepti Singh and Sweta Sinha	112-113
117	**Climate smart agriculture approaches to sustainable food production** Archana.P.V.	113-114
118	**Summary report and key recommendations**	115-116

ABOUT THE WEBINAR

Climate change has a significant impact on agriculture, as agricultural crops display a high level of sensitivity in changing climatic scenario. The relationship between climate change and agriculture is a two-way street that adversely affects one another limiting agriculture production and productivity. Agriculture has contributed substantially to the problem of climate change with increased greenhouse gas emissions and contributed major stake in decline of world food production. Agricultural production must therefore be resilient to various climate events, such as scarce availability of ground water, sunlight intensity, extreme temperatures and seasonal variations. Crop diversification, efficient water use, improved soil management practices, together with the development of biotic-abiotic stress resistant crops can help to reduce some of the negative impacts caused by climate change and developing agricultural strategies to secure and sustainable agriculture. This is the reason for emerging interest to climate smart crop which not only reveal production enhancement but also ensures a sustainable agricultural systems that minimises climate impact. Hence, understanding crop responses at phenotypic, physiological, biochemical and genotypic levels will be rewarding. Therefore, a comprehensive multidisciplinary guided action is needed to transform and reorient agricultural systems in changing climate, to secure agricultural production in more sustainable way. This webinar aims to critically evaluate recent trends in understanding climate change impacts on agriculture and mitigation strategies that will enable us to secure our agricultural ecosystems.

Thematic areas:

1. Recent developments in plant science to address climate change
2. Genomics and breeding approaches for enhancing climate stress resilience in crops
3. Potential mechanisms and enzyme chemistry for abiotic stress management
4. Climate smart agriculture approach to sustainable food production

This e-proceedings-cum-abstract book contains abstracts submitted during the National webinar held on 30 July, 2020. The outcome of this webinar in a form of proceedings and recommendation has been included at the end of this book.

ABSTRACTS

An approach towards mitigating food insecurity through climate smart agriculture and sustainable intensification

Vandana Kumari

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Abstract

Climate change disrupts food markets, posing population-wide risks to food supply. Climate smart agriculture (CSA) proposes an alternative 'climate-wise' framework to foreground the inherently political dimensions of food and agriculture in an era of climatic change. With its emphasis on improving risk management, information flows and local institutions to support adaptive capacity, CSA provides the foundations for incentivizing and enabling intensification. Researches in East Africa have revealed that Banana-coffee intercropping in elevated temperature regions; multiple cropping, crop rotation, agroforestry, carbon sequestration, agriculture allied sectors etc can contribute to mitigation and storing an additional carbon per ha in the soil. The sustainable intensification (SI) of livestock production systems could contribute enormously to both adaptation and mitigation. The use of stone bunds can lead to nutritional benefits, while also allowing farmers to cope with changing weather (adaptation to wetter or drier climates). Soil fertility is often improved as a result of more manure being applied, and increased tree cover contributes further mitigation benefits. Thus, these techniques are climate smart form of sustainable intensification. There are increasing possibilities for low-income countries to orientate production along pathways that are both more sustainable and more productive to mitigate food insecurity. The assessment of technology preferences is based on farmers' current level of understanding about benefits and costs of individual CSA technology. Farmers prefer some risk mitigation technologies such as crop insurance, agro-advisories and rainwater harvesting that can be supported by the government. Therefore, farmers' preferences for CSA technologies may differ based on their expectations of financial support from the government and other agencies. Similarly, their preferences may differ based on the combination of CSA technologies and their potential benefits for adaptation to climate change. There is need of these issues to be further explored.

Keywords: climate smart agriculture, food security, sustainable intensification, climate change

******

Characterization of chickpea (*Cicer arietinum* L.) genotypes for heat tolerance

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Abstract

Chickpea (*Cicer arietinum* L.) is the third most important food legume crops of the world, occupying an area of 14.56 m ha with a production of 14.78 million tons (FAOSTAT, 2019). Chickpea crop frequently experiences a combination of abiotic stresses in the field in which drought and terminal heat stresses are the major factors for lowering the grain yield. Due to increase in temperature during grain filling stage chickpea crop experiences terminal heat stress which causes seed shriveling and ultimately reducing the hundred grain weight. The performance of 50 chickpea genotypes were evaluated under terminal heat stress conditions based on fourteen morpho-physiological traits. The 50 germplasm of chickpea were sown in normal and late to expose them terminal heat stress for two consecutive years. Fourteen morpho-physiological traits were studied in normal and late sown conditions during *rabi,* 2017-18 and *rabi,* 2018-19. The genotypes were categorized into three groups namely tolerant, intermediate and sensitive on the basis of heat susceptibility index (HSI). Tolerant genotypes performed physiologically better in terms of higher grain filling duration (GFD), chlorophyll content (SPAD value), canopy temperature depression(CTD) at vegetative stage (55DAS) and pod filling stage (108DAS), test weight and harvest index under heat stress conditions. Genotypes Sabour chana-1, ICCV15112, GNG2215, BRC-1048-15, BRC-1058-16 and PBC501 were found to be heat tolerant. Physiological trait like GFD, HSI, HI, SPAD value and CTD value were found to be most important contributor in grouping of genotypes and showed positive significant correlations with grain yield. The large genetic variation was found among the genotypes based on physiological traits. This finding suggest that chickpea genotypes are found to differ in their ability to respond to heat, thereby tolerant genotypes, which could be useful as genetic stock to develop chickpea tolerant varieties in breeding programs.

Key word: Terminal Heat Tolerance, Morpho-physiological Traits, Chickpea Germplasm.

******

Sustainable use of kitchen waste and smart agricultural practice

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Abstract

Agriculture is a boon to get food, fodder, medicine and various items that are important too. It is urgent requirements of human being and that cannot be produced in industry which is natural. Man and its environment are ecologically so sound that each and every item is very tightly bond like a garland. Living and non living components, their interactions heavily influence the growth and development of living creatures. By and large, we use various plants and plant produces that are harvested after cultivation. In field farmers use huge quantity of chemical and synthetic fertilizers even pesticides that affect the environment and gradually influence our complete environment. Negative and ill effect is bio-magnification which directly or indirectly influences our health. Scientists argued that, we need eco-friendly bio-fertilizers and bio-pesticides rather than chemical fertilizers and chemical pesticides. To cope up the ill effect, we need organic manure and organic farming also. Every day we, the town people use vegetables and other biological food items and discard huge waste. Municipal corporation collect huge quantity of bio-waste which is mainly kitchen based. To minimize the waste as kitchen products and get benefit through organic farming, it is essential to start organic farming in each house. It is based on open space to set up such garden and indigenous technique used to utilize the kitchen waste. Present paper reflects ideas on organic farming which could be a boon to get vegetables from own garden. So, we can get fruits, vegetables, ornamentals and medicinal herbs in a sequential way to manage the waste in a crucial way. Hope that it would be a general model for everybody to manage the environment in a fruitful way.

Keywords: Organic farming, Kitchen waste, simplified model, management.

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Rapid generation-advancement system techniques for Industrial Scale Rice Breeding Program

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Abstract

Conventional varietal development program takes around 10-12 years to develop new rice varieties. However a breeding program has longer breeding cycle for developing variety then farmers will not get early benefit from the new variety. Speed breeding in controlled environment growth chambers can accelerate plant development for research purposes, including phenotyping of adult plant traits, mutant studies and transformation. A new plant breeding method—the biotron breeding system (BBS)-can rapidly produce advanced generations in rice (*Oryza sativa* L.) breeding. This method uses a growth chamber (biotron) with CO_2 control, accompanied by tiller removal and embryo rescue to decrease the period before seed maturity. However, tiller removal and embryo rescue are laborious and impractical for large populations. The higher CO_2 concentration significantly decreased DTH, but tiller removal and root restriction had little effect on DTH and drastically reduced seed yield. BBS (the sBBS) that eliminates the need for tiller removal and embryo rescue, but controls CO_2 levels and day-length and maintains an appropriate root volume. Using the sBBS, one could reduce the interval between generations to less than 3 months, without onerous manipulations. Now a day, BRRI developed single seed descent (SSD) method along with Field Rapid Generation Advance (FRGA) was applied for this purpose. Previously, rice breeders applied RGA technique in the greenhouse and also in trays but not in the field that limits the accommodation of large number of crosses with bigger population is troublesome in terms of cost effectiveness, nutrient and pest management. BRRI has developed raised per flat bed based FRGA technique for managing bigger breeding population (3000-4000 progenies per cross) and rapid cycle breeding which is different from IRRI FRGA system. BRRI has tested the BRRI developed FRGA system and breeders are effectively applying this FRGA technique for industrial scale variety development program.

Keywords: single seed descent (SSD), biotron breeding system (BBS), FRGA, BRRI

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Comparative drying method study in different flowers with respect to quality dry flower products preparation

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Abstract

Dry flowers in floriculture sector provide an excellent opportunity in augmenting farmer's income throughout the year despite of the ill hazards of the climatic vagaries faced in open field conditions. Presently, among all the horticultural produce, Indian floricultural industry is having a major share in the export of dry flowers and its value added products. Flowers on drying can be easily converted into different valuable products which have a high demand in International market. Dry flower market has grown exponentially as consumers are becoming eco-conscious and prefers eco-friendly and biodegradable products of dry flowers alternatively to fresh flowers. There are wide ranges of wild/ unutilized/ underutilized plant species that can be dried from one or the other drying method and can successfully be commercially exploited in different forms. Dehydration technology helps in maintaining original colour and shape of flowers for long term utilization with a little care. With the sustainable help of other family members, farmers can easily generate 1.5 times to 5 times profit by the utilization of dry flowers along with the home available waste materials for making floral handicrafts. This is a very easy technology through which women folk or even physically challenged people can also be benefited. This technology is a source of extra income which can overcome farmer's depression during crop failures in field.

Key words: Dry flowers, climatic vagaries, dehydration, eco- conscious

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Modern digital sensors & imaging techniques to study abiotic stresses in crops

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Abstract

Climate change is a global concern currently; rising temperatures are leading to a severe threat for sustainable crop yields and global food production. High-temperature stress is the second most important stress after drought, which can strike crop plants at any time and impose severe limitations to crop growth and development & ultimately treats to food security. Modern management of agricultural resources is a complex endeavor that is now benefiting from a convergence of technical advances in information sciences, geographic positioning capabilities, and digital sensor systems with artificial intelligence and imaging analysis tools. This technology is highly useful in assessing various abiotic and biotic stresses in different crop and also very useful in detecting and management of various crop issues even at small farm holdings. The future brings tremendous prospects for integrating the spatially and temporally rich information provided through remotely sensed multi- and hyperspectral imagery with the capabilities of management-oriented crop simulation models. Digital Sensors with spectral & hyperspectral techniques , imaging analysis in plant research is growing rapidly, ranging from basic research at the cell and sub-cellular level to biotechnology or remote sensing of plant canopy reviewed in It is used to visualize photosynthetic heterogeneity caused by not only abiotic and biotic stress factors but also by natural heterogeneity in several physiological processes. Since from last 5-6 years rapid high-throughput plant phenotyping methods, which exhibit great potential to enhance selection efficiency for plant breeding. Spectral & Hyperspectral sensor technologies, remote-sensing technologies, three-dimensional (3D) imaging techniques, Root phenomics techniques like Mini rhizotron, MRI, Positron, UAV's, Drones, Robotic monitoring in fields and virtual plant technique, can provide the basis for phenotyping. Such measuring methods can be carried out in the field or the laboratory to collect massive data, thereby facilitating high-throughput phenotyping. Integrative plant biology requires that we scale from the gene to the biochemical process, the plant, the whole plant, and, ultimately, the canopy and crop. Such emerging tools and techniques & their use in agriculture hold immense potential with respect to the development of crop genotypes with enhanced resilience to climate change which is much-needed development.

Keywords– Digital, Sensors, imaging techniques, abiotic stresses, crops.

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Water productivity of paddy based cropping sequences in PAP canal command area of Tamil Nadu

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Abstract

Parambikulam Aliyar Project (PAP) is an interstate multipurpose project between Tamil Nadu and Kerala. Rice – rice- green manures is the predominant cropping system practiced for ages by the farmers. During 2016 and the years followed, mean annual rainfall of the region was 59.4 % less than the average annual rainfall of 808 mm and posed great impediment for the cultivation of paddy. Farmers incurred huge loss by sacrificing the second crop. Hence research has been envisaged for identification of low water requiring alternative crops for PAP command area through assessment of water productivity of diverse cropping sequences. An experiment was laid out in Field No. A3 of Coconut Research Station, Aliyarnagar during 2016 – 19 in sandy loam soil (*Fluventic Ustropept)* to evaluate rice based cropping systems *viz.,* rice – blackgram, rice – sesame, rice – sunflower, rice – castor and rice – groundnut, for water use efficiency under water scarce situations. The test varieties were CO50 (rice), CO7 (groundnut), CO2 hybrid (sunflower), YRCH 1 (castor) and TMV 7 (sesame). Water consumption and water use efficiency were assessed through Parshall Flume. Rice equivalent yield was higher in rice – blackgram system followed by rice – groundnut system and was the lowest in rice - sunflower system. Water use efficiency was higher in rice – sunflower system (3.70 kg / ha- mm) followed by rice – castor system (2.44 kg/ha- mm) and was the lowest in rice – sesame system (1.50 kg/ha- mm). Benefit cost ratio was higher in rice – blackgram system (2.389) followed by rice – groundnut system (2.154). Rice – blackgram and rice – groundnut is highly rewarding cropping systems for water scarce conditions in PAP command area of Tamil Nadu.

Keywords: Blackgram, Groundnut, Rice, Water use efficiency, Water scarce

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Impact of climate change on agriculture

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Abstract

Agriculture and climate change are internally correlated with each other in various aspects, as climate change is the main cause of biotic and abiotic stresses, which have adverse effects on the agriculture of a region. Changing climate is predicted to have a wide range of negative impacts on plant physiology metabolism, soil fertility and carbon sequestration, microbial activity and diversity that will limit plant growth and productivity, and ultimately food production. The land and its agriculture are being affected by climate changes in different ways, e.g., variations in annual rainfall, average temperature, heat waves, modifications in weeds, pests or microbes, global change of atmospheric CO2 or ozone level, and fluctuations in sea level. The threat of varying global climate has greatly driven the attention of scientists, as these variations are imparting negative impact on global crop production and compromising food security worldwide. According to some predicted reports, agriculture is considered the most endangered activity adversely affected by climate changes. Food security and ecosystem resilience are the most concerning subjects worldwide. Climate-smart agriculture is the only way to lower the negative impact of climate variations on crop adaptation, before it might affect global crop production drastically. In this review paper, we summarize the causes of climate change, stresses produced due to climate change, impacts on crops, modern breeding technologies, and biotechnological strategies to cope with climate change, in order to develop climate resilient crops. Revolutions in genetic engineering techniques can also aid in overcoming food security issues against extreme environmental conditions, by producing transgenic plants. In the future, farmers who adapt their farming practices for the production of crops that promote health rather than provide calories are predicted to profit, and as a result the planet could become greener and healthier.

Keywords: Soil fertility, climate change, agriculture, breeding, crop adaptation

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Impact of climate change on perennial fruit production and quality

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Abstract

The amount of greenhouse gases on earth surface is gradually increasing. These greenhouse gases like CO_2, CH_4, N_2O Causes the earth to warm up quickly and result in global warming. The effect of global warming is now visible in many parts of the world. Global warming causes rise in temperature which leads to shifting in the agro climatic zones. Each fruit crop requires a specific temperature range from minimum to maximum within which a crop will survive. This shifting causes serious problem in fruit production. Its impact was seen on different crop. Litchi requires a specific climate but due to changing climatic condition its production decreases. It has also a great impact on temperate fruit production. Increase in atmospheric CO_2 altered the quality of the produce. Weather conditions during flowering, pollination and subsequent fruit growth determine the production quantity and quality. Other problems of climate change are disease pest outbreak, different types of stress. There is a need to find economic options to mitigate climate change for sustainable fruit production.

Keyword: Global warming, Greenhouse gases, Temperate, Sustainable

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Climate smart agriculture and food security

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Abstract

A range of CSA technologies, practices and services have been initiated in climate-smart villages as adaptation strategies for coping with climate risks to ensure stability and sustainability in agricultural production. The farmers using CSA adaptation strategies were found to have achieved higher output, yield and return compared to those who did not. There are exciting opportunities for scaling out and immense potentials of these strategies for enhancing crop yields and farm incomes and reducing greenhouse gas emissions. Strengthening agricultural extension service and agricultural finance to achieve smart farming practices/technologies by linking climate finance to traditional agricultural finance could play a significant role in scaling out the CSA practices and technologies to make agriculture more sustainable and climate-resilient and a viable source of livelihood and food security for millions of farmers in the country. Zero budget natural farming as a climate-resilient farming system can enhance food and nutritional security, enabling farmers to improve soil fertility and yields through lower costs, risk and irrigation requirements, thus protecting the ecosystem by improving soil organic matter, water retention and biodiversity and reducing air and water pollution as well as greenhouse gas emissions.

Keywords: climate smart agriculture, food security, zero budget natural farming

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Effect of climate change on the genetics of aroma in scented rice

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Abstract

Chhattisgarh is blessed with a rich diversity in aromatic rice. Aromatic rice emit specific aroma in fields, at harvesting, in storage, during milling, cooking and eating. The characteristic aroma and flavor of the aromatic rice is brought about by concentration of volatile compounds. One such is 2-acetyl-1-pyrroline, a "pop-corn"-like flavor compound which has been reported to contribute maximum in aroma of rice. Aroma development is influenced by both genetic factors and environment. In most rice varieties aroma is controlled by a single recessive gene located on chromosome 8 of rice genome (*Oryza sativa* L.). Aromatic rice production also contributes to global climate change through the emission of CH_4 and N_2O. Climate change due to global warming and depletion of the ozone layer is already being experienced across the world. Global warming is the phenomenon in which green house gases such as CO_2, CH_4 and N_2O, act as a shield and trap solar heat and keep it from escaping into outer space, thereby increasing Earth's mean surface temperature. This paper aims to study the effect of climate change on the genetics of aroma in scented rice.

Keywords: Rice, aroma, global warming, climate

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Impact of climate change on yield of banana due banana rhizome weevil (*Cosmopolites sordidus*)

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Abstract

Banana is important fruit crop in India. Organic Banana has great promise for safer and sustainable development of horticulture and it has getting increased attention in recent years throughout the India and world. Field preparation and other agronomical practices done organically. Plantation of G9 variety of Banana done in BPSAC, Purnea farm. Banana is attacked by many insect pest of which Banana Rhizome weevil (*Cosmopolites sordidus*) is important pest . Larva are damaging stage and its tunnels, interfere with root initiation, plant nutrition and water transport, resulting in plant stunting, delayed maturation , reduced fruit size and bunch weight and even plant snapping or toppling . Larval tunnels also provide entry points for secondary pests. It causes yield losses of between 20 and 100%. Climate change affects each region differently, and its impacts observed gradually. Due to changes in climate population build up of Banana Rhizome weevil (*Cosmopolites sordidus*) fond high in the month where as previously it was low.Development of new cultivars of tolerant to high temperature, resistant to pest and diseases, short duration and producing good yield under stress conditions, as well as adoption of hi –tech horticulture can minimize the effect of climatic change.

Keys word: Banana, climate change, yield**,** Banana Rhizome weevil

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Phytochemical analysis and antioxidant activity of leaves extract of *Mimosa amara*

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Abstract

In the current research work has been examined on the antioxidant activity and phytochemical analysis of the leaf extract of mimosa amara (Roxb). Phytochemical analysed were extracted from the leaves of M. amara using the various solvents ethanol (ETOH), ethyl acetate (ETOAC) and dimethyl sulfoxide (DMSO).These phytochemicals include steroids, alkaloids, terpenoids, tannins, triterpenoids, xantho proteins, philobatannins, flavonoids, aminoacids, saponins, aromatic acids, phenolic compounds, carbohydrate, reducing sugar, proteins and they were separated by the standard methods. The antioxidant activity was estimated using 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity. Different solvents such as (ETOH), (ETOAC), (DMSO) extract revealed significant ($P<0.01$) antioxidant activity in a dose-dependent manner. Its IC50 values (12.03±0.24; 13.05±0.23; 14.02±0.33µg mL-1) were compared to the IC50 value of the reference standard ascorbic acid (04.10±0.12; 05.04±0.20; 06.03±0.31µg mL-1) which suggested that the Mimosa amara is a potent antioxidant. The evaluation of phytochemical screening of leaf extracts indicated the presence of terpenoids, steroids, alkaloids, tannins, triterpenoids, xantho proteins, aminoacids, saponins, aromatic acids, phenolic compounds, philobatannins, flavonoids, carbohydrate, reducing sugar, and proteins. This study also performed that the various solvent extracts of M. amara leaves contain bioactivity. The mixture should be isolated to ensure the functions of the individual compounds.

Keywords: Mimosa amara, Alkaloids, steroids, polyphenols, antioxidant activity

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An overview of emerging strategies for enhancing plant abiotic stress tolerance based on genetic manipulation and the use of chemical priming

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Abstract

Due to population explosion, gradual increase of industrialization, global warming, increase salinity and uneven distribution of precipitation, the soil environment, plant faces different stresses (biotic like pathogens and abiotic include heavy metals, salinity, drought, flooding and temperature) which have a negative impact on growth and development. So, there is an urgent need for new strategies that do not rely on pesticides or single resistance genes, the exploitation of the capacity of the plant immune system in combination with other strategies may hold the potential to achieve better protection of crops. Therefore, gene discovery and genetic manipulation will continuously develop in the future as a promising approach for enhancing abiotic stress resistance. With increasing knowledge on plant response to abiotic stress and molecular understanding of gene networks underlying the physiological processes, transgenic approach targeting a unique gene has become possible. The generation and use of genome-edited variants is a great addition to the current breeding tool box. Transcriptome sequences information will assist in identifying various genes governing various important traits and will help in identifying the target sites for genome editing and genetic transformation. Recent research on chemical priming and molecular biology has provided further understanding of the mode of action of specific signaling molecules in plant stress resistance. Utilization of chemical agents as a protectant to improve abiotic stress resistance in plants is highly promising. The enhancement of ethylene production which leads to inhibition of root growth and correspondingly growth of the plant as a whole can be achieved by treating the plants with chemical substances inhibiting ethylene biosynthesis or ACC deaminase enzyme produced by rhizobacteria as biological inhibitor. These achievements are important for agriculture in stressed areas and may open up opportunities for the development of crop stress management in the near future.

Keywords: abiotic stress, crop stress management, genetic transformation, chemical priming

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Genomics and breeding approaches for enhancing stress resilience in crops

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Abstract

Climate change is expected to extremely affect every aspect of life on the Earth. It will cause radical changes in the environment as well as ecology and thus will severely impact agriculture also. Therefore, it poses a severe confront for global food security. To cope up this, we need strategy for climate-resilient agriculture to maximize crop production with minimal or no damage to the environment. This would demand changes in the approaches to crop improvement, and in the deployment of recent techniques involving genomics in crop research. Designer crops have to be developed with enhanced competence for the efficient use of sun light, nutrients, and water; they also have to robust the system of conservation agriculture including zero tillage. Through buffering of biotic and abiotic stresses, increased on-farm genetic diversity can be important to maintaining yield stability across time and space. Inclusion of on-farm selection of diverse evolutionary breeding populations within and across fluctuating environments has the potential to greatly increase the scope of genotypically plastic cultivars capable of adaptation to unpredictable climate-induced environmental change. More recent genomic technologies have expedited breeding and trait development to yield the resilient production systems that are needed to ensure future harvests. Therefore, future food security will require reducing crop losses due to environmental factors, including climate change, as well as transformative advances that provide major gains in yields.

Keywords: Genomics, Plant breeding, stress, resilience

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Climate smart agriculture approaches to sustainable food production

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Abstract

Climate-smart agriculture (CSA) is a methodology that helps to guide activities needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. Climate-Smart Agriculture (CSA) is a way to help the people who manage agricultural systems respond effectively to climate change. The CSA method trails the triple objectives of sustainably increasing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible. Agriculture is one of the largest sectors that sustain livelihood to maximum number of people and contribute to climate change. Hence, a climate-smart approach to sustainable food production is the necessity of hour. Traditional agriculture is getting increased responsiveness worldwide in context of sustainable food production in changing climate. Agriculture as a climate-smart approach for the sustainable food production and also deliberates the correlation between climate change and agriculture.

CSA goals to challenge various main objectives which are sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible. Climate change justification and adaptation are two prime needs to reduce global warming impacts. Attaining the goals of eradicating hunger and poverty by 2030 while addressing the climate change impacts need a climate-smart approach in agriculture. Climate-smart agriculture (CSA) is based on the objectives of sustainably enhancing food production, climate adaptation and resilience and reduction in GHGs emission. CSA is an approach for developing agricultural strategies to secure sustainable food security under climate change.

Keywords: Sustainable, agriculture, climate, greenhouse gases, global warming

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Climate smart agriculture for sustainable food security

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Abstract

Climate-Smart Agriculture (CSA) is not a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts. CSA relates to actions both on-farm and beyond the farm, and incorporates technologies, policies, institutions and investment. Different elements of climate-smart agricultural systems include: Management of farms, crops, livestock, and aquaculture and capture fisheries to balance near-term food security and livelihoods needs with priorities for adaptation and mitigation. Ecosystem and landscape management to conserve ecosystem services that are important for food security, agricultural development, adaptation and mitigation. Services for farmers and land managers to enable better management of climate risks/impacts and mitigation actions. Changes in the wider food system including demand-side measures and value chain interventions that enhance the benefits of CSA. Climate-Smart Agriculture is an approach to help the people who manage agricultural systems respond effectively to climate change. The CSA approach pursues the triple objectives of sustainably increasing productivity and incomes, adapting to climate change and reducing greenhouse gas emissions where possible. The majority of the world's poor live in rural areas and agriculture is their most important income source. Developing the potential to increase the productivity and incomes from smallholder crop, livestock, fish and forest production systems will be the key to achieving global food security over the next twenty years. Climate change is expected to hit developing countries the hardest. Its effects include higher temperatures, changes in precipitation patterns, rising sea levels and more frequent extreme weather events. All of these pose risks for agriculture, food and water supplies. Resilience is therefore a predominant concern. Agriculture is a major source of greenhouse gas emissions. Mitigation can often be a significant co-benefit of actions to strengthen adaptation and enhance food security, and thus mitigation action compatible with national development priorities for agriculture is an important aspect of CSA. Farmers are the primary custodians of knowledge about their environment, agro-ecosystems, crops, livestock, and local climatic patterns. Adapting to CSA must be related to local farmers' knowledge, requirements and priorities. Local projects and institutions support farmers to identify suitable climate-smart options that can be easily adopted and implemented.

Key words: CSA, adaptation, climate, resilience.

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Role of cluster frontline demonstration in enhancement of Horse gram (*Macrotyloma uniflorum* (Lam.) production in upland farming situation for rainfed area of North Chotha Nagpur region in Jharkhand

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Abstract

The cluster front line demonstrations were conducted at farmer's field in Ramgarh district of Jharkhand during kharif season from 2016-20 by Krishi Vigyan Kendra Ramgarh. These demonstration were conducted in 225 demonstration in 90 ha areas in 7 villages under real farm situations prevailing farmers practices were treated as control for the comparison with recommended practice. The size of one demonstration was 0.4 ha . The result of cluster front line demonstration showed a greater impact on farmers due to significant increase in crop yield, higher than FP. The results revealed that improved seed of Birsa Kulthi 1+ seed treatment (*Trichoderma viridi* 5g/kg + *Rhizobium* sp. 25g/kg + PSB 25g/kg) + Foliar spray of NPK 19:19:19 @ 2.5kg/ha at 40 days crop stage and spray of Neem oil1000ppm @2.5ltr/ha during flowering period; recorded average highest yield 7.65q/ha as compared to 5.15q/ha in farmers practice (control plot). The economics were calculated as average gross return of Rs 28969.00/ha and net profit is Rs. 11171.5 in demonstration plots and average gross return of Rs 18582.5/ha and net profit is Rs. 4907.5/ha in farmers practices plot (control). The Benefit: Cost ratio was also calculated in demonstration 1.61 and Control plot 1.43, respectively. The average yield were also increase 32.33% with technology gap 2.53q/ha and extension gap 2.51 q/ha, respectively. It can be concluded that the pulses production could be enhanced by encouraging the farmers through adoption of recommended technologies which were followed in the CFLDs.

Keywords: Horse gram, FLD, Yield, B:C ratio

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Genetically modified plants *vis-à-vis* insect pollinators

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Abstract

India ranked 5th in global cultivation of GM crops in 2018. Bt cotton is the only GM crop approved for commercial cultivation in the country (Anonymous, 2018). Currently, all commercialized genetically engineered insect resistant crops are based on crystalline (Cry) proteins encoded by genes derived from the soil dwelling bacterium *Bacillus thuringiensis* (Bt) (Duan *et al*, 2008). More than one-third of crops are pollinated by insects and other animals, among which honey bees account for about 80% of the total pollinating insects (Klein *et al*, 2007). Annual monetary loss of Horticultural/Agricultural production due to lack of proper/optimum bee pollination in India is 3000 crores (Goyal *et al*, 1996). The honey bee *Apis mellifera* is the most important pollinator species around the world (Free, 1993), with populations present in all countries growing GM crops (James, 2009), including Bt cotton (Han *et al*, 2010). Pollen is the sole protein source of *A. mellifera* colonies (Decourtye, 2010), and pollen of many important crops, including cotton, is collected by foraging bees (Malone and Burgess, 2009). Adults and larvae of *A. mellifera* are directly exposed to transgenic material via pollen consumption of GM crops, which are planted in mass monocultures (Hendriksma, 2011). There is no significant impact on survival, rate of pollen consumption by larvae and adults bees, total haemocyte count (THC), SOD (Superoxide dismutases catalase) activities, body weight of pre-pupae (larvae after feeding Bt crop's pollen), feeding behaviour and foraging activities.(Lin Niu *et al,* 2013, Biao Liu *et al,* 2005, Hendriksma *et al,* 2011). To date, few studies have assessed the potential negative impacts of Bt cotton on *A. mellifera* (Han *et al*, 2012).

Keywords: Pollinator, *Apis mellifera*, GM crops, Honey bee.

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Climate smart agriculture and food Security

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Abstract

Agriculture is considered to be "climate-smart" when it contributes to increasing food security, adaptation and mitigation in a sustainable way. This new concept now dominates current discussions in agricultural development because of its capacity to unite the agendas of the agriculture, development and climate change communities under one brand. In this opinion piece authored by scientists from a variety of international agricultural and climate research communities, we argue that the concept needs to be evaluated critically because the relationship between the three dimensions is poorly understood, such that practically any improved agricultural practice can be considered climate-smart. This lack of clarity may have contributed to the broad appeal of the concept. From the understanding that we must hold ourselves accountable to demonstrably better meet human needs in the short and long term within foreseeable local and planetary limits, we develop a conceptualization of climate-smart agriculture as agriculture that can be shown to bring us closer to safe operating spaces for agricultural and food systems across spatial and temporal scales. Improvements in the management of agricultural systems that bring us significantly closer to safe operating spaces will require transformations in governance and use of our natural resources, underpinned by enabling political, social and economic conditions beyond incremental changes. Establishing scientifically credible indicators and metrics of long-term safe operating spaces in the context of a changing climate and growing social-ecological challenges is critical to creating the societal demand and political will required to motivate deep transformations. Answering questions on how the needed transformational change can be achieved will require actively setting and testing hypotheses to refine and characterize our concepts of safer spaces for social-ecological systems across scales. This effort will demand prioritizing key areas of innovation, such as (1) improved adaptive management and governance of social-ecological systems; (2) development of meaningful and relevant integrated indicators of social-ecological systems; (3) gathering of quality integrated data, information, knowledge and analytical tools for improved models and scenarios in time frames and at scales relevant for decision-making; and (4) establishment of

legitimate and empowered science policy dialogues on local to international scales to facilitate decision making informed by metrics and indicators of safe operating spaces.

Keywords: food security, climate smart agriculture, social-ecological systems, sustainable agriculture

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Arbuscular Mychorrhizal fungi: Bioresource for increasing plant growth and Phosphorus nutrition in plants

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Abstract

Phosphorus (P) nutrition to the crops can be enhanced by the inclusion of microbial inoculants like plant-growth-promoting rhizobacteria and arbuscular mycorrhizal fungi (AMF). AMF have been widely reported to be able to improve the soil nutritional status along with the growth and development of plants. They also protect the plants against root pathogens and impart drought resistance to crops. AMF characteristically colonize the roots of host plants and facilitate the promotion the plant growth, which may be attributed to the increased uptake of nutrients particularly P thus improving the P nutrition to plants. A significant progress in research advocating root morphological development and distribution has been conducted in recent years. AMF have been widely reported to be able to improve the soil nutritional status along with the growth and development of plants. AMF synthesize organic compounds like siderophores which help in the desorption of P into labile pools in soil. By producing organic acids, AMF can also solubilize the partially soluble or insoluble sources of P which are a part of the crystalline mineral structure in the soil. Organic exudates like citrates when released into the rhizosphere are effective in increasing the P availability to plants by mobilizing the less soluble Fe and Al phosphates or P fixed in form of insoluble Calcium phosphates. Mycorrhizal fungi filaments in the soil can thus be termed as true extensions of root systems and are more effective in nutrient and water absorption than the root themselves. Still, elaborate root research as a whole in response to AMF infection is limited, challenging and necessary.

Keywords: Phosphorus, AM fungi, root growth, siderophores

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Impact of gibbberellic acid on growth responses in Aflatoxin B1 treated seeds of maize (*Zea mays L.*)

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Abstract

Climate change impact on agricultural crop production and Adverse impact of aflatoxin on Plant System are now well established in *zea mays L.*, *vigna radiata, cow pea* (Prasad et al.1996, Tripathi and Mishra, 1980). Aflatoxin B_1 is known to interfere with the synthesis of GA_3, stimulated enzyme which is primary required during seed germination and seedling growth (Black& Altschul, 1965). The significant effect of rainfed Maize seeds, we have investigated climate change effects on this crops and decreases up to 15% by mid-century due to climate change. These declines can subsequently harmed. Aflatoxin contamination influences by changing of climate, by direct influencing of mycotoxin like *Aspergillus flavus* on maize seeds that includes changes in the alterations to fungal community structure and quantity of aflatoxin producers in the environment. Gibberellic acid induced seed germination and seedling growth in aflatoxin B_1 treated seeds of maize higher percentage of germination and comparatively better health of the seedling was recorded in the seeds given alternate treatment of Gibberellic acid and aflatoxin B_1 or vice- versa. Gibberellic acid stimulates the germinating cells of maize seeds to produce mRNA molecules that code for hydrolytic enzymes. Pre- treatment of seeds with gibberellic acid however, exhibited better so far, the seed germination and seedling growth is concerned.

Keywords: *Aspergillus flavus, zea mays L.*, Gibberellic acid, Aflatoxin B_1, mRNA.

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Heterosis breeding for quality production in Marigold (*Tagetes* spp.) under hot and humid conditions of Uttarakhand

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Abstract

Thirty six F_1s of marigold (Tagetes spp.) in a diallel set involving nine parents (excluding reciprocals) were evaluated to study the magnitude of heterosis at the Department of Horticulture, College of Agriculture, Pantnagar. The characters studied were days taken to bud initiation, bud length, bud diameter, days taken to flowering, flower diameter, length and breadth of floret, peduncle length, number of petals/flower, number of whorls/flower, average fresh and dry weight of flower, number of flowers/plant, flower longevity, flowering duration, shelf life of flowers and flower yield/m^2. Appreciable heterosis was observed for all the characters and the performance of F_1 hybrids were better than the mid, better and standard parent. Considering the economic traits like earliness to flowering, number of petals/flower, average fresh weight of flower, number of flowers/plant, flower longevity, flower yield and shelf life, cross combinations Sutton Yellow x Crackerjack Mix (SY x CM), Pusa Basanti Gainda x Pusa Narangi Gainda (PBG x PNG), Pusa Narangi Gainda x Late Summer (PNG x LS), Sutton Yellow x French Dwarf (SY x FD) and Sutton Yellow x Late Summer (SY x LS) were found to be best for different floral attributes and are recommended for the commercial exploitation of heterosis under hot and humid conditions of Uttarakhand.

Key words: Heterosis, diallel crosses, marigold, F_1 hybrids

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Molecular marker assisted gene staking for stress tolerance in crops

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Abstract

Molecular markers have extensively been used for tagging and mapping of genes and QTLs conferring resistance to biotic and abiotic stresses. The identification of large numbers of DNA markers dispersed throughout the genome of any species and further, the use of these markers to detect associations with trait of interest increase the practicability of Marker- assisted selection (MAS). These tools have also been used for screening of germplasms, fingerprinting, and marker-assisted breeding in crop systems. In breeding programs, one of the most anticipated and frequent cited benefits of molecular markers is the Marker assisted backcrossing (MAB) in which the goal is to incorporate a major gene from an agronomically inferior source(donor-parent) into an elite cultivator or breeding line (recurrent parent). It is routinely applied in breeding programs for gene introgression. The plant varieties developed by marker assisted backcrossing are developed in a significant short span of time as contrary to the conventional backcross breeding and thus this is rapid and time saving beneficial technique. Regarding the recent yield issues, ecological problems, and enhancing populations, characters related to environmental stress tolerance, disease resistant, mineral and osmotic requirement, etc. should be the public attention. Molecular-aided selection pyramid target traits in a single progeny more conveniently and precisely in few selected generations and little accidental harms. As it is a cost-effective and less time-consuming strategy, it can be suggested for long-term improvement in stress tolerance of economically important crops with some limitations. Moreover, since molecular markers are not influenced by environmental factors and are detectable at all stages of plant growth, screening for stress tolerant plants can be done early at seedling stage, thus, saving time, space and resources.

Keywords: Molecular, markers, selection, stress and breeding

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Improved soil health through biological intervention in conservation agriculture

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Abstract

Conservation Agriculture (CA) systems aim at enhancing soil health, productive capacity and function as a precursor to sustainable production intensification. Nutrient management in CA must be formulated within this framework of soil health which is a biologically-based phenomenon. CA systems of production fall within the second paradigm approach to soil system management and sustainable production intensification, and are defined by three key principal elements, namely: no mechanical tillage and minimal soil disturbance; permanent organic soil cover specially by plant organic matter and cover crops; and diversified crop rotations in the case of annual crops or crop associations in case of perennial crops, including legumes. These three elements in various combinations aim at establishing and sustaining healthy soil systems that can offer the best crop and livestock productivities and environmental services within the prevailing ecological and socio-economic conditions while optimizing the use of agrochemicals with biological interventions. In CA systems, the main principle to keep in mind is that farmers should fertilize their soils rather than their crops. Thus, nutrient management practices in CA systems would need to include paying attention to the following four general aspects, namely that: (i) the biological processes of the soil are enhanced and protected so that all the soil biota and microorganisms are privileged and that soil organic matter and soil porosity are built up and maintained; (ii) there is adequate biomass production and biological nitrogen fixation for keeping soil energy and nutrient stocks sufficient to support higher levels of biological activity, and for covering the soil; (iii) there is an adequate access to all nutrients by plant roots in the soil, from natural and synthetic sources, to meet crop needs; and (iv) the soil acidity is kept within acceptable range for all key soil chemical and biological processes to function effectively.

Keywords: Conservation agriculture, Biological intervention, Nutrient management

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Climate smart agriculture practices to deal with climate variability

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Abstract

Increase in population and food consumption patterns indicates that at least an increase of 70% is needed in agriculture production to meet demands by 2050. We can see that the pressure on agriculture is increasing day by day, this can be due to increasing population, changing consumption pattern, urbanization, climate change, loss of biodiversity, land degradation, water scarcity. Climate change is affecting food production on a large scale, seasonal changes like cold seasons are becoming warmer resulting in an increase of outbreak of new insect pests, drought affected areas are increasing, sea levels are rising. Climate smart agriculture can be a potential solution to all these problems; it is an approach towards sustainable development to ensure food security and to cope of with climatic changes. Three pillars of climate smart agriculture are increasing agricultural productivity and income of the farmers sustainably, adoption and building resilience to climate change, reduction in the emission of greenhouse gases. Climate smart agriculture practices for crop management are crop rotation introducing new varieties like drought resistant varieties, maintaining crop diversity. For soil and water management technologies like drip irrigation, contour planting, conservation agriculture, Direct seeded rice (DSR) can be practised. Tools like nutrient expert based on Site specific nutrient management (SSNM) that provide nutrient recommendation for a field in the presence or absence of soil testing data has been proved effective in climate smart agriculture. Climate change will definitely lead to decrease in agriculture production so these technologies are important for ensuring food security in future.

Keywords: Climate smart agriculture, Crop rotation, Drip irrigation, DSR , nutrient expert

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Climate-Smart Agriculture: A boost production in tribal district of Chhotaudepur, Gujarat

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Abstract

Climate smart agriculture (CSA) is an approach that helps to human being for actions needed to transform and regenerate the agricultural systems to effectively support for development and ensure food security in a changing climate for the live beings of world. Climate smart agriculture has the various obstacle objectives for enhancing the production and productivity in climate changing scenario that are, sustainable increasing agricultural production and Productivity; effect of climate change on crop; reducing the green house gases & global warming. The present investigation was carried out in Chhotaudepur district of Gujarat which is located in the eastern part of the State of Gujarat. The boundary of Chhotaudepur district touches to Vadodara, Panchmahal, Dahod, Narmada and State of Madhya Pradesh and Maharashtra. The Chhotaudepur district is an important tribal majority sustainable farming approachable district in the Gujarat state. CSA is an approach to increase the technical, physical policy and investment on environment to get sustainable agricultural growth for food production under climate change & Minimize the global warming effect on crops. A number of strategies can be develop & adopted to achieve the objectives of climate smart agriculture. For example, use of integrated farming & integrated renewable energy technologies for farming like mechanical farming equipment, dairy farming, Goatry, piggery, poultry, fish culture, wind mills, solar panels, bio energy-operated water pumps and bio gas are very important for energy smart food production systems & sustain in the locality. Resource conserving technologies like zero tillage, natural farming, and organic farming permits the farmers to growing wheat after rice or cotton harvest. The emergence of newly developed varieties which are tolerant to heat, drought and salinity is also a better option for farmers to enhance the income in low cost inputs. KVK established the weather observatory under "DAMU' project for weather forecast and early warning systems will be provided to Chhotaudepur district farmers for helpful in the minimize the threats of climate losses & get the maximum production with good planning.

Keywords: Climate smart agriculture, Weather, Global warming, Production, Natural Resource conservation technologies, Integrated farming

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Effect of different sources of fertilizers on maize yield and yield attributes under irrigated conditions in red soil

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Abstract

Maize (*Zea Mays* L.) is the most important cereal crops in India and Karnataka State after paddy crop. In India, maize is emerging as third most important crop after rice and wheat similarly in Karnataka maize is second major cereal crop after rice. Maize is grown in a wide range of production environments, and it can grown in all three seasons due to photo insensitive character, hence called 'queen of cereal'. Its importance lies in the fact that it is not only used for human food and animal feed but at the same time it has become an important raw material in food processing, poultry, dairy and ethanol industry and along with its traditional uses makes it one of the fastest growing cash crop in the world as well as India and Karnataka. Maize is an exhaustive crop, the nutrient requirement cannot be supplied only through native nutrient reserves, and hence the additional nutrient requirements have to be met from fertilizers. Further, in Northern Karnataka maize yield is low due to imbalanced application of fertilizers and no use of secondary nutrients. So mitigate this problem, in market some crop specific or specialized fertilizers are available. Therefore to overcome this imbalance and no use of secondary nutrients this experiment was carried out at Hanumanamatti, Karnataka during summer season 2019 under irrigated situation. The experiment was layout in Randomize Complete Block design (RCBD) with seven treatments viz., T_1 - Farmers practise: 95: 70:75:35 kg/ha, T_2 - RDF: 120: 60: 40 kg/ha (UASD package), T_3 - RDF (150:60:40 kg/ha) + 25 Kg $ZnSO_4$/ha (National level), T_4 – RDF (180:80:80:30 kg/ha) + 25 Kg $ZnSO_4$ (As per DMR), T_5 – RDF (120: 60: 40 kg/ha) – CNS grade, T_6 – RDF (150:60:40 kg/ha) -CNS Grade, T_7 - RDF (180:80:80:30 kg/ha) – CNS grade and replicate three times and remaining all other agronomic aspect are followed as per package of practices in all treatment. Among the nutrient treatment, T_7 - RDF (180:80:80:30 kg/ha) – CNS grade fertilizer recorded higher grain yield (56.82 q/ha), stover yield (91.02 q/ha) as compared to other fertilizer treatments. It followed by T_4 – RDF (180:80:80:30 kg/ha) + 25 Kg ZnSO4 and T_5 – RDF (120: 60: 40 kg/ha) – CNS grade. The lowest yield was recorded in farmers' practices. Similar trends were followed with respect to nutrients uptake and economics

returns. In all the three RDF dosage, the CNS grade fertilizer sources applications are more effective and more economics as compared to non CNS grade fertilizer sources.

Keywords: Maize, yield, fertilizers, irrigation

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Effect of foliar application of nutrients on seed yield and quality in foxtail millet

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Abstract

Millets are the significant food and fodder crop in semi arid areas with amazing in their nutrient contents. They are rich in fibre, non-starchy polysaccharides with few unique nutrients, since they have superior quality proteins and essential amino acids, they have recognized as Nutritious grain. India is the world's biggest producer of millets which accounts for more than 40 per cent of world consumption. Among the millets, foxtail millet is a dry land crop grown throughout the year in varied type of soils. The higher output and productivity could be achieved in any crop through the use of superior quality seeds and suitable management strategies. Keeping this in view, the studies were conducted to know the effect of foliar nutrient application, time of application and their interaction on seed yield and quality. The study on effect of foliar nutrient application and time of application on seed yield and its quality in foxtail millet was laid out during *Kharif* season 2017-18 at Agriculture Research Station. Hanumanamatti, UAS, Dharwad, Karnataka, India. The experiment consist of five foliar Nutrient application *viz.,* F1: Urea @ 2%, F2: DAP @ 2%, F3: 19:19:19 (N: P: K) & @ 2%, F4: Vermiwash @ 5% and F5: Control (Water Spray) and two stages of foliar application: viz., T1: Flowering and T2: Panicle initiation stage. Foliar application of nutrients exhibited significant variation on seed yield and quality components of foxtail millet. Vermiwash @ 5% foliar application recorded higher seed yield per plant (2.22 g), Seed yield (14.44 q/ha) and seed germination (90.3%) compared to control (1.65g, 10.69 q/ha and 82.3% respectively). Among the different stages of foliar application, Panicle initiation stage recorded significantly higher seed yield per plant (2.03g), seed yield (13.22 q/ha) and seed germination (87.0%) compared to flowering stage which recorded 1.91g,

12.40q/ha and 82.7% respectively. There were no significant differences between foliar application of nutrients and at different stages on seed yield and quality parameters. However, numerically higher seed yield per plant (2.31 g), Seed yield (15.00 q/ha) and seed germination (90.0 %) were recorded in interaction between Panicle initiation stage and foliar nutrient application of vermiwash, From the studies, it is concluded that application of vermiwash @5% spraying at panicle initiation stage found to be effective for obtaining higher seed yield and quality in foxtail millet.

Keywords: Foxtail millet, seed yield, foliar spray, nutrients

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Climatic conditions for the development of charcoal rot disease

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Abstract

Charcoal rot caused by *Macrophomina phaseolina* is a destructive disease in all sesame growing areas throughout the world. Management of charcoal rot disease relies on understanding the interaction of host plant and pathogen under influence of various environmental factors. Weather factors play an important role in the development of charcoal rot at different growth stages of sesame. Under field conditions, development of disease is influenced by different weather variables, prevailing 30noculums load along with nature of pathogen and cultivar. In present study, progression of charcoal rot disease was assessed with cultivar HT 1 and HT 2 sown in three dates at fifteen days intervals during *kharif* seasons. The percent disease incidence was found non-significant during early observations subsequently showed significant difference in both cultivars. Later observations showed reduction in rate of disease incidence might be changed environment for growth and development of the pathogen. The sharp and highest increase in disease incidence (%) was recorded on third week of August to fourth week of August. During this period, occurrence of high temperature, actual vapour pressure, wind speed, evaporation with more sunshine hours and low relative humidity resulted in congenial conditions for severe infection by the pathogen. It was apparent from results that high temperature and low relative humidity play important role in the development of charcoal rot disease under field

conditions. The quantitative relationship between charcoal rot disease progressions and weather factors on sesame varieties during different dates of sowing revealed that disease incidence was positively correlated with maximum temperature, evaporation and sunshine hours.

Keywords: Charcoal rot, *Macrophomina phaseolina*, relative humidity, temperature

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Rapid Clonal Propagation of Sugarcane Variety through Tissue culture

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Abstract

Standardization of protocol for induction of callus and regeneration of plantlets was established through in-vitro culture using young meristem of sugarcane variety CoS 98259 as an explants. The multiple shoot regeneration at various frequencies was observed by using different concentration and combination of growth regulators. the highest percentage of callus induction was observed in MS medium supplemented with 2.5 mg/l, 2-4 D. the best response in term of multiple shoot induction was observed on MS medium with BAP 2.0 mg/l + NAA 0.5 mg/l. when in vitro shoot lets were inoculated on to the half strength MS basal media supplemented with 3.0 mg/l NAA, rooting was more profuse. Rooted shoots were transplanted in green house for hardening and their survival rate was 90% in the field condition.

Keywords: MS media, Growth regulator, callus, Shooting

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Floriculture and landscaping in the era of climate change

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Abstract

The global climate change will have imperative effects on biological processes of each and every crop over the next decades. Changes in the timing, duration and plenty of flowering have the potential to disturb ecological relationships amid plants, pollinators, herbivores along with flower parasites as well as pathogens. Climate change appears to have changing flowering patterns in the entire world. Changes in the timing of one part of the flora and fauna can have a ripple effect disturbing other areas. Flowers due to global warming are losing down their fragrance. The chemical compounds present in the flowers that are liable for the aroma are drying up rapidly although the scent in flowers last longer in colder climate as plants can retain their essential oils for a extended period of time. Therefore, the most viable approach towards these problems could be screening and development of novel short duration, temperature and drought tolerant ornamental cultivars in view of climate change. There is a need of re-orientation of agro-technologies particularly water and disease pest management for open field/ protected cultivation of floricultural crops targeting enormous domestic and global market. Flower crops will affect directly with the climate change issues however landscaping with the trees, shrubs, and climbers and other plants will mitigate this affect considerably. The prospective of landscaping features to develop the energy efficiency of residential colonies, business houses and public buildings can be utilized. Appropriate use of trees, shrubs, climbers and ground covers can amend the climate around homes and public buildings to cut down heat gains in summer and heat losses in winter. There is as much as a 30% decrease in cooling and heating charges through cautious landscape planning. Trees can decrease temperature by as much as 8-10^0 F. Trees, shrubs and groundcover plants can also shade the ground and pavement around the home. The trees serve as windbreaks shows energy savings up to 23 per cent. A good landscape plan should also save water. Energy conservation can be an additional advantage of landscaping in order to conserve our natural world and natural resources as well as fulfilling, to some extent, the scarcity of energy.

Keywords: climate change, floriculture, landscaping, tree, flower

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Effect of abiotic factors on the growth of *Spirulina platensis* in anaerobically digested distillery effluent medium

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Abstract

Spirulina platensis is a photoautotrophic mesophilic cyanobacterium. *Spirulina* cultivation requires temperature, light intensity, and nutrient content. This microalga has been studied and used commercially its therapeutic and antioxidant potential. In addition, several studies have reported its ability to use CO_2, its immune activity, and use as an adjuvant nutritive factor in the treatment of obesity. The objective of this study is the production of biomass of *S. platensis* using different rates of agitation, nitrogen source, quantity of micronutrients and luminosity. A 2^4 experimental design with the following factors: stirring (120 and 140 RPM), amount of nitrogen (1.5 and 2.5 g/L), quantity of micronutrients (0,25 and 0,75 mL/L) and luminosity (11 and 15 W) was used. Fermentation was performed in a 500 mL conical flask with 250 mL of anaerobically digested distillery effluent culture medium and 10% inoculum in an incubator with controlled stirring and luminosity. Fermentation was monitored using a spectrophotometer (560 nm), and each fermentation lasted 15 days. Of the parameters studied, luminosity is the one with the highest significance, followed by the amount of nitrogen and the interaction between stirring and micronutrients. Maximum production of biomass for 15 days was 2.60 g/L under the following conditions: luminosity15W; stirring, 120 RPM; source of nitrogen, 1.5 g/L; and micronutrients, 0.75 mL/L.

Keywords*:* *Spirulina platensis,* human food, biomass, luminosity, agitation, temperature

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Validating gene specific STS markers linked to thousand kernel weight in wheat

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Abstract

Wheat (*Triticum aestivum*) popularly known as bread wheat is the second most important cereal after rice in India. Twenty four germplasm of bead wheat collected from All India Coordinated Research Project (AICRP) on Wheat & Barley, Bidhan Chandra Krishi Viswavidyalaya were evaluated based on thousand kernel weight (TKW) and using 8 gene- specific STS markers associated with thousand kernel weight. Highly significant variations among 24 genotypes ($P<0.01$) in respect of TKW was found in this study**.** The overall analysis of genetic parameters demand the use of molecular markers for the selection of genotypes with high TKW *vis a vis* high yielding genotypes in wheat. A total five clustres were formed to group 24 genoptes of wheat selected for the present study. Strikingly, the Cluster V consists of three genotypes that are having higher TKW i.e. SAWSN3258, ESWYT132 and HRWSN215. Out of 8 markers, 7 markers did not produce any amplicon. The dominant Su2-SNP-185/589H2 STS produced an amplicon of 423 bp called HapH allele. Among the 15 wheat genotypes, those were subjected to screen with Su2-SNP-185/589H2 STS marker, 10 genotypes morphologically characterized as high TKW, produced the HapH allele, three morphologically categorised as low TKW genotype did not produce any band. But two genotypes though morphologically grouped into Low TKW group were observed with HapH allele which may be explained as the environmental influence on phenotype.

Keywords: Wheat, gene, STS marker, kernel weight

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6- Benzyl Amino Purine alleviates drought stress effect in tomato under drought

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Abstract

Drought stress affects agriculture productivity and yield. It is an important factor, which harms more than 50 per cent of crop yield worldwide. This affects physiological process of plant at different stages and reduces the yield and quality of crop. Plant growth regulators (PGRs) and pink-pigmented facultative methylotrophs (PPFM) have been found to play a key role in the integration of the responses expressed by plants under stress conditions. They have been found to influence water uptake effectively under stress conditions, either by increasing membrane permeability or by increasing the internal concentration of osmotically active solutes. This Pot culture study was aimed to know the impact of PPFM and PGRs on alleviating the drought stress effects in tomato variety PKM 1. Foliar spray of PPFM (1%, 2%, 3%) and five plant growth regulators under drought condition created based on field capacity of soil. 50% field capacity was maintained throughout the growth period for induction of drought and 100 per cent field capacity maintained as absolute control. Transpiration rate performed using portable Photosynthesis System. Chlorophyll Stability Index (CSI) and xylem anatomy by Scanning Electron Microscopy were studied. CSI is an indicator of the stress tolerance capacity of the plants and is a measure of integrity of membrane. A higher CSI helps the plants to withstand stress through better availability of chlorophyll, leading to increased photosynthetic rate, dry matter production and higher productivity. Among the treatments, highest chlorophyll CSI was noticed in the foliar spray of 100 ppm Benzyl amino purine (6- BAP) treatment (64.59%). Transpiration rate determines the significance of various physiological processes along with their impact on biomass production and yield. Foliar spray with 6-BAP increased the transpiration rate by 32.96 % while compared to stress control. Changes in the size of tracheary elements and change in their organization as aggregation of xylem vessel elements was obvious. 6-BAP (87.44 + 79.51 µm) sprayed plant showed larger trachery element size in terms of length and width grown under drought stress. This study indicated that 100 ppm of 6-BAP could be effectively improving drought tolerance capacity of tomato crop under drought by improving chlorophyll CSI, transpiration rate and root xylem diameter followed by PPFM (2%).

Key words: Drought, tomato, 6-BAP, chlorophyll stability index, transpiration rate and root xylem

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Breeding rice for anaerobic germination through marker assisted interventions

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Abstract

Tolerance to flooding during germination conditions or anaerobic germination (AG) is an important trait for direct seeded rice. Direct seeding also offers the advantage of earlier crop maturity, thus leading to double or even triple rice cropping. However, the yield of direct seeded rice under farmers' field conditions is lower than that of transplanted rice because flood-prone and uneven fields or heavy rainfall shortly after sowing could lead to poor crop establishment as most rice varieties are susceptible to flooding during germination. However, flooding just after sowing protects the seeds from rats and birds and is also a viable means of weed control. When flooding occurs just after direct seeding, tolerant rice genotypes germinate faster and their coleoptiles grow at a relatively faster rate to emerge from flooded soils. These genotypes are also capable of forming roots and leaves in shallow water depths. Genetic variation in the ability to germinate and establish in flooded soils has recently been observed in rice and a few landraces were identified that are tolerant, among which Khaiyan, Khao Hlan On, Nanhi and Ma-Zhan were found to be very promising. A major QTL *qAG-9-2* associated with tolerance of flooding during germination have been recently identified from Khao Hlan On, a landrace from Myanmar on chromosome 9, having a LOD score of 20.3 and explaining 33.5 % of the variation for this trait. The QTL region was subsequently cloned and revealed as a trehalose-6-phosphate phosphatase gene, *OsTPP7*, is the key player underlying the tolerance to anaerobic germination. Under anaerobic germination stress, *OsTPP7* escalates sugars and amino acid pools, promotes anaerobic metabolism and increases transcripts associated with elongation growth. Thus, introgression of QTL for anaerobic germination will enable improved crop establishment in direct seeded systems and enhance stress resilience. To date, very few tolerant to anaerobic

germination varieties have been developed through the MABC programme and it is expected that more varieties will develop for farmers in the near future to satisfy specific regional needs.

Keywords: Anaerobic germination, Marker, QTL, Rice

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Heat stress alter physiological and biochemical Traits with Grain Yield in Wheat (Triticum aestivum L.)

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Abstract

Wheat (*Triticum aestivum* L.) is the most cultivated food crop worldwide due to its wider adaptability to different agro-climatic conditions. Wheat production is vulnerable to climatic changes particularly under temperature and drought stress. High temperature either at early or late stages is a major yield production constrains. Crop growth and productivity are prominently affected by high heat and less water availability. Globally, about 7.0 million hectares of wheat is affected by heat stress since early stages of crop growth and 40% of the irrigated wheat growing areas in the faces heat stress at terminal stages of crop growth . Heat stress along with low water availability at reproductive stage (terminal growth phase of wheat crop) is major contributing factor towards less wheat production in tropics and subtropics. Flag leaf plays a pivotal role in assimilate partitioning and stress tolerance of wheat during terminal growth phase . High temperature not only hastens the phonological stages of crop development but also reduces grain filling duration which ultimately results in yield reduction. High temperature of 37.6°C and 37.2°C at anthesis and booting stages respectively decreased grain yield by 50% under well watered conditions. Heat stress, particularly the stress appears at the time of flowering to grain filling stages causing severe yield loss in wheat. Heat tolerance is complex phenomena that include adjustment in morphological, physiological and biochemical traits of the crop. Present investigation was carried out to understand the effect of terminal heat stress on different traits of

wheat. The experiment was conducted in three dates of sowing as timely sown, late sown and very late sown to expose the crop to heat stress at later stages of the crop growth. Significant genetic variations for all the traits evaluated under three conditions indicated the presence of variability for the traits. Trait association analysis revealed that flag leaf chlorophyll content and MSI at seedling stage; MDA at reproductive stage had direct relationship with grain yield. While under very late sown condition MDA and RWCat seedling stages were found to be highly correlated with grain yield. It indicates that MDA, RWC at seedling stage and days to booting, days to milking plays important role in very late sown condition that can be used as selection criteria in breeding programme.

Keywords: Chlorophyll, Heat Stress, MDA, RWC, MSI, Wheat

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Response of newly released wheat (*Triticum aestivum* L.) varieties to different sowing dates under changing climate condition in Central Brahmaputra Valley Zone of Assam

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Abstract

A field experiment was conducted at the Tokowbari Farm of the Regional Agricultural Research Station, Shillongani, Nagaon during *rabi*, 2018-19 to assess the performance of new wheat varieties under timely, late and very late sown condition in changing climatic condition. The experiment was laid out in Split Plot Design replicated three times. The treatment comprised of 3 dates of sowing at 30 days interval *i.e.,* 7th November, 7th December and 7th January allocated in main plots and nine wheat varieties viz., HD 2733, PBW 575, DBW 71, HD 3249, DBW 39, DBW 187, HD 2967, HI 1621 and HD 3271 in sub plots. The soil of experimental plot was sandy clay loam in texture having low nitrogen (265.6 kg /ha), medium in phosphorus (17.5 kg/ha) and potassium (246.1 kg/ha) with a soil of pH 5.4. Wheat varieties produced significantly higher grain yield (43.67 q/ha) when sown on 7th Nov'18 as compared to 7th Dec'18 (40.61 q/ha) and 7th Jan'19 (29.54 q/ha). There was a significant decline in grain yield from 43.67 q/ha to 29.54 q/ha when wheat sowing was delayed from timely (7th November to very late sown (7th

January) conditions due to change in climatic condition that caused significant reduction in number of ear heads /m^2, and 1000 grains weight. The average yield decline due to delayed sowing was 7.0 % when sown in 7th December and to 32.4 %, when sown in 7th January. Interaction between variety and sowing time was significant for grain yield. Among the varieties significantly higher grain yield (42.96 q/ha) was obtained with DBW 71 over the rest of the eight varieties. PBW 575 was the earliest maturing with maturity duration of 107 days while HD 2967 took 123 days to mature.

Keywords: Wheat, varieties, climate change, Ear head/m^2, 1000 grain weight, grain yield.

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Conservation agricultural practices and seed priming impart favourable changes on stress physiological traits of pea under rice fallow in acidic soil of Meghalaya

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Abstract

A site specific field study in a split plot design conducted to evaluate the effect of conservation agricultural practices *viz.,* sowing at 15 days before harvesting (DBH) of rice by dibbling method (S_1), sowing at harvest of rice with residue by dibbling method (S_2), sowing at harvest of rice with residue removal (S_3), sowing at 15 days after harvesting (DAH) of rice with residue by dibbling method (S_4), sowing at 15 DAH of rice with 30% of crop residue by dibbling method (S_5) & sowing at 15 DAH with conventional practice (S_6) with selected priming treaments *viz.,* 10 mM H_2O_2 (P_1), 1.5% KH_2PO_4 (P_2) & control (P_3) on important physiological traits of pea in acidic soil under rice fallow. SPAD chlorophyll meter reading (43.52), total chlorophyll content (1.05 mg g^{-1}), carotenoid content (38.58 µ g g^{-1}), leaf thickness (324.72 (µm), relative water content (83.61%), photosynthetic rate (21.49 µmol m^{-2} s^{-1}), stomatal conductance (123.18 m mol m^{-2} s^{-1}), transpiration rate (3.12 m mol m^{-2} s^{-1}) and Fv/Fm (0.82) were found significantly higher

under S_1 treatment at flowering stage. However, canopy temperature (28.45 ^{0}C) and leaf internal CO_2 concentration (237.27 ppm) were noticed higher at S_6 treatment while WUE (8.78 A/E) was found higher at S_4. Among seed priming treatments 10 mM H_2O_2 was found significantly increased chlorophyll content, chlorophyll fluorescence and related stress physiological parameters are at par with 1.5% KH_2PO_4. However, control (P_3) recorded increased canopy temperature, leaf internal CO_2 concentration and WUE at flowering stage. Therefore, pea sowing at 15DBH with 10mM H_2O_2 was promising for higher Pea productivity under acid soils in mid-hills of Meghalaya.

Keywords: Pea, Conservation agriculture, Seed priming, Physiological traits and Flowering stage

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Remote sensing and GIS application in agriculture under changing climate

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Abstract

Agricultural production is highly vulnerable to variation in climate, soil and topography of different regions. Increasing food needs of growing population demand the efficient use of natural resource in comprehensive manner. Remote Sensing and Geographical Information System (GIS) offer an abundant opportunity to monitor and manage natural resources and agriculture field at multi-spectral and multi-spatial resolution. Agricultural has remained essential activity of nation in production of food in sufficient quantity and quality for the well being of the people. Spatial information on agricultural practices is crucial for agricultural planning. Timely and reliable information on agricultural basis to be beneficial to producers, managers and policy planners for taking decision for security of food and import/export and economic impact. Certain agencies in India are involved in monitoring of land utilization/cropping pattern at national or state level. The data collected from remote sensing are organized in GIS help in analysis and about crop and agricultural strategies. The integrated use of remotely sensed data GPS, GIS, enable consultants and natural resource managers and

researchers in government agencies, conservational organizations, and industry to develop management plans. An attempt made in present study to analysis and evaluate the information regarding the application of remote sensing techniques for crop monitoring, crop condition assessment and yield estimation for sustainability of agricultural and natural resources under changing climatic scenarios. Remote sensing analyzed data can provide timely, synoptic, cost efficient and repetitive information about the earth's surfaces and existing agricultural ecosystem transformation.

Keywords: Remote sensing, climate change, yield assessment, GIS

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Plant propagation in organic agriculture

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Abstract

Organic agriculture is gaining societal, political and scientific recognition for its contribution to sustainable agriculture. The organic farming system differs fundamentally from conventionally agriculture in the management of soil fertility, weeds, diseases and pests. Organic farmers depend greatly on conventionally bred and produced varieties, but require varieties better adapted to organic farming systems for further optimisation of organic agriculture. This includes a greater need for 'reliable' varieties contributing to higher yield stability. Growing organic food depends on suitable varieties and growing methods. The establishment of breeding programmed based on the specific objectives of organic agriculture is an important prerequisite to further increase the efficiency and yield stability of organic food production. Furthermore, the choice of high quality organic seed and plant propagation material of suitable varieties is an important key to successful organic farming, allowing for improved yield and product quality, for crop resilience, considerate use of non-renewable resources and for increased genetic and species diversity. This practice describes the principles of plant propagation in organic farming, as well as the importance of the use of traditional varieties and their conservation. Until recently the

seed industry and main stream science have paid very little attention to organic propagation. The expertise of conventional seed companies to produce organic seed without the use of chemical-synthetic protectants and inorganic (easy releasing) nitrogen fertilizers is still limited and causes initial problems and failures with organic seed production. Besides (regular) basic and technical expert knowledge on seed production in general, additional knowledge and expertise need to be built up for scaling-up and optimizing organic seed production. The main problems encountered are (seed-borne) disease and pest management, and weed control. It is a great challenge for the seed sector to supply the organic market with sufficient quantities and adequate quality of organically propagated seed of current varieties. With the step of producing organic seed at a larger scale the commercial seed sector has now become economically involved and needs support not only from the organic sector to define their desired characteristics but also from research to remove several obstacles to enable further improvement of organic propagation and breeding strategies.

Keywords: Propagation, organic, sustainable

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Effect of salinity stress on antioxidant enzyme activities in spider lily cv local

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Abstract

Under inappropriate environments, plants responses by changing their metabolisms to maintain homeostasis that acclimation abilities are different among species and varieties. Saline tolerance of different ornamental plants is an alternative way to overcome soil salinity and poor quality irrigation water *i.e*. saline water of some areas in coastal belts of Gujarat. This study aims to select salinity tolerance bulbous flowering plants from mostly used commercial ones. Commercial grown bulbous plant spider lily cv Local was grown in polythene bags and irrigated with water of different salinity levels (2.0, 4.0, 6.0, 8.0, 10.0 and 12.0 dSm^{-1}) along with the control (best available water) to evaluate different bio-chemical parameters *i.e.* catalase (CAT), superoxide dismutase (SOD), peroxidase (POD), sucrose synthase (SoS) and

glutathione reductase (GR) activities as well as amount of chlorophyll content. It was found that the CAT, SOD, POD, SoS and GR exhibited increase trends nearly the same pattern in salinity responses but with different activity levels. The maximum activities of CAT (23.35 µmol/min/g protein), SOD (35.33 µmol/min/g protein), POD (84.17 µmol/min/g protein), SoS (0.58 µmol/min/g protein) and GR (1.14 µmol/min/g protein) were observed in irrigation with 12.0 dSm^{-1} salinity level. Furthermore, the chlorophyll content was decrease with increase in salinity level of irrigation water.

Keywords: Spider lily, salinity stress, antioxidant enzymes

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Stress conditions: Impact on resistance gene expression in rice against bacterial blight disease

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Abstract

Gene x Environment (GE) interactions is well known in influencing the gene expression. Bacterial blight (BB) of rice is the most important disease influencing heavy losses under congenial conditions in all the rice growing areas of the country in general and in Chhattisgarh rice bowl in particular. In the present studies response of resistance genes identified against BB is studied under Chhattisgarh condition. Twenty nine genotypes, with resistance genes mentioned in parenthesis i.e. IRBB-1, IRBB-3, IRBB-4, IRBB-5, IRBB-7, IRBB-8, IRBB-10, IRBB-11, IRBB-14, IRBB-50, IRBB-51, IRBB-52, IRBB-53, IRBB-54, IRBB-55, IRBB-56, IRBB-57, IRBB-58, IRBB-59, IRBB-60, IRBB-21, Zenith, BJ-1, IR-20, Jawa-14, Tetep,TKM-6, RP Bio-226 and TN-1 were evaluated under 5 stress conditions [dry, wet/ saturated water, alternate wet and dry (24 hrs. wet and 24 hrs. dry), low humidity and high humidity conditions] in pot studies during *Kharif* and *Rabi* seasons. After artificial inoculations with the bacterial suspension of *Xanthomonas oryzae* pv. *oryzae*, the causal organism of BB, observations for disease development were recorded at 7, 14 and 21st days. The genotypes IR-20 (with *Xa 4*) and RP- Bio 226 recorded least percent severity in all the stress conditions during the three observations recorded at 7 days intervals. Confirming that the resistance factor in these genotypes are expressive under the stress susceptible TN-1 and Tetep (*Xa 1* + *Xa 2* + *Xa 12*);

IRBB-10 (*Xa 10*); IRBB-11(*Xa 11*); IRBB-14 (*Xa 14*) and IRBB-50 (*Xa 4 + xa 5*) showed susceptibility in all the stress conditions after 21st day, the most accepted resistance evaluation period under artificial inoculated conditions. The genotypes IRBB-56 (*Xa 4 + xa 5 + xa 13*); IRBB-55 (*Xa 13 + Xa 21*); IRBB-59 (*Xa-5 + xa-13 + Xa-21*) and IRBB-21 (*Xa 21*) also showed resistance all the stress conditions. Non significant interaction between the genotype and different stress conditions were recorded for percent disease severity at 7 days observation. However, 14th and 21st day observation there were interactions were significant between the stress condition and genotype clearly indicating the cumulative influence of G x E on resistance expression and percent disease appearance. The genotypes TN-1 and Tetep (*Xa 1 + Xa 2 + Xa 12*); TKM-6, IRBB-10 (*Xa 10*); IRBB-11(*Xa 11*); IRBB-14 (*Xa 14*) and IRBB-50 (*Xa 4 + xa 5*) showed moderately resistance to susceptibility score. Among the five stress conditions high humidity and alternate dry and wet conditions (commonly persists during rice cropping period) favoured the interaction of G x E towards more percent disease than other conditions.

Keywords: Rice, bacterial blight, resistant gene

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Climate Smart Agriculture: an approach for sustainable food security

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Abstract

Climate smart agriculture (CSA) can be defined as sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change and reducing greenhouse gases emissions. CSA is an approach to increase the technical, policy and investment on environment to get sustainable agricultural growth for food protection under climate change. A number of strategies can be adopted to achieve the objectives of climate smart agriculture. For example, use of integrated renewable energy technologies for farming like wind mills, solar panels, pyrolysis units and bio energy-operated water pumps are very crucial for energy-smart food systems. Resource conserving technologies (RCTs) like zero tillage permits the farmers to plant wheat soon after rice or cotton harvest in order to avoid warm weather detrimental for grain filling. The emergence of newly developed varieties which are tolerant to heat, drought and

salinity is also a better strategy of CSA. It is necessary to differentiate regions and crops that are very much prone to climate change so that these should be repositioned to more appropriate areas. The weather forecast and early warning systems will be very helpful to minimize the threats of climate losses. Information and Communications Technology (ICT) can efficiently help administrators and researchers in planning the contingency programs. Computer aided crop simulation models can guide to find out the possible risk of climate variation on future crop yields, climate smart agriculture development and mitigation procedures. The crop models permit variation of environmental factors such as the water regime and temperature and simulate the crop response through many estimated growth parameters like crop yield.

Keywords: Protection, communication, technology

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Anti-oxidative defence mechanism during abiotic stress in horticultural crops

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Abstract

Horticultural crops when subjected to abiotic stresses such as drought, salinity, temperature extremes, herbicide treatment and heavy metal toxicity due to seasonal occurrences often get exposed to oxidative stresses as the fine balance between the reactive oxygen species (ROS) production and antioxidative activity of the plants gets disrupted. ROS including hydrogen peroxide (H_2O_2), superoxide anions ($O_2^{\bullet-}$), hydroxyl radical (OH•) and singlet oxygen ($^1O_2$) are generated as a by-product of the physiological metabolism which leads to oxidative damage to lipids and nucleic acids, protein degradation, and pigment bleaching causing cell death. ROS plays a vital role as a response to stresses by the activation of stress response and defense pathways. The plants possess specific enzymatic antioxidant mechanism which includes Superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione peroxidase (GPX) and non-enzymatic antioxidant mechanisms including carotenoids, phenolic acids, anthocyanins and flavonoids to protect themselves against cytotoxic effects and fine modulation of low levels of ROS for signal transduction of genes involved in stress tolerance, osmolyte accumulation and other systematic responses. In the past few decades, experiments on whole plant culture, *in vitro*

callus culture and genetic engineering has shown tremendous results in developing tolerance towards abiotic stresses. ROS scavenging enzymes can be used for screening of the tolerant genotypes of tomatoes, eggplants, peppers, melons, okra and other vegetables to several abiotic factors to cope with current environmental challenges.

Keywords: Abiotic stress, antioxidant, ROS, oxidative damage, vegetables

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Horticulture: A hope for earning health and wealth in Covid-19 pandemic situation

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Abstract

The COVID-19 pandemic is a health and human crisis threatening the food security, nutrition and employment of millions of people around the world. Millions of people were already suffering from hunger and malnutrition before this situation. In the longer term, the combined effects of COVID-19 itself, as well as corresponding mitigation measures and the emerging global recession could, without large-scale coordinated action, disrupt the functioning of food systems. Such disruption can result in consequences for health and nutrition of a severity and scale unseen for more than half a century. In this situation, horticultural crops can play an important role to fulfill population need because, these are production efficient than any other group of crops. Horticulture, an emerging sector in agriculture and accounts for 30.4 % of Indian agriculture GDP from merely 12.53% of total cropped area. These crops are almost 5.4 times more production efficient than food grains. Horticultural crops are an important gradient of our diet as they are nutritionally rich as compared to other foods. Fruits and vegetables are rich sources of vitamins, minerals, antioxidants, enzymes, carbohydrates, salts and proteins and are now becoming an important part of average household's daily meals. Application of bio-fortification and cost effective productivity enhancing technologies boost both production and nutritional quality in various horticultural crops. In the situation of Covid-19, where many industries is struggling, there is not much change has been observed in the economy of the rural

area of India due to the system of agriculture. Export of Shahi litchi, Dashehari Mango, Alphanso Mango from India to developed countries in judicious as well as high price through e-marketing are noteworthy example of earning money in Covid-19 situation.

Keywords: COVID-19, food security, nutrition, horticultural crops

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Recent developments in plant science to address climate change

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Abstract

Climate-smart agriculture (CSA), as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of sustainable development goals. Climate change exerts adverse effects on crop production. Plant researchers have therefore focused on the identification of solutions that minimize the negative impacts of climate change on crops. Many crop management practices like increasing water infiltration, reducing evaporation and increasing storage of rainwater in soils, will help land users in areas projected to receive lower levels of precipitation adapt to climate change. Soil Water evaporation can be reduced through better management practices like maintaining crop residue, mulching, and deficit irrigation. Phytopathogens cause estimated crop losses of up to 20–30% annually. Changing climatic conditions, particularly global warming, are considered to favors pathogen expansion and increase the aggressiveness of infestation. The effects of climate change can be beneficial, evidence suggests that pest problems overall are likely to become more unpredictable and larger in amplitude. Predicting the direct effects of climate change on pests is complicated by the interacting influences of increasing atmospheric CO2 concentrations, changing climatic regimes and altered frequency/intensity of extreme weather events The importance of genetic mechanisms in the heat stress responses of crop plants is described in the review by Janni *et al.* (2020), who evaluate the potential roles of different processes in increasing crop resilience and productivity. A metabolite pro- filing analysis of winter wheat genotypes revealed a significant increase in sugars, sugar-alcohols, and phosphate in the more temperature-tolerant genotypes (Impa *et al.*, 2019). Government policies and regulatory instruments need to provide clear direction and guidance to all stakeholders to enable

appropriate planning for climate change adaptation and mitigation, as well as the effective creation and targeting of resources and funds.

Keywords: Plant science, Phytopathogen, Government policies, Climate change

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Biocontrol potential of *Streptomyces* sp. for the management of bacterial leaf blight disease in rice crop

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Abstract

The *Streptomyces* strain possessing antimicrobial activity and siderophore producing ability was developed into a biocontrol formulation for the management of bacterial leaf blight disease in rice caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*). The selected isolate (GenBank KC954629) shown to produce bioactive secondary metabolites through chromatographic separation. Two novel antimicrobial compounds with moderate antioxidant activity were isolated from the culture broth. The biocontrol formulation was developed using the dried spores and mycelium of strain with soluble starch as carrier material. The biocontrol potential of the developed formulation was assessed both under pot culture and field trials. A 0.4 percent of formulation was found to be the optimum concentration for bacterial leaf blight disease management in rice under pot culture and field conditions. The reduction in disease incidence was observed to be about 56.6% and 37.4% over the control under pot culture and field trials respectively. Application of developed formulation increased the activity of peroxidase (PO), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL), superoxide dismutase (SOD) and phenol content of the rice plants.

Keywords: bacterial leaf blight, biocontrol, *Streptomyces*, *Xanthomonas*

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Impact of biochar compost on soil fertility status

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Abstract

India's long term food security requires a balance between increasing crop production, maintaining soil health and environmental sustainability. Maintaining soil fertility without affecting the ecological balance is present challenge to ensure national food security. In this context, the biochar can be a great solution. Biochar is the product of thermal degradation of organic materials in the absence of oxygen. The feature which adds to biochar's beauty is that it offers a potential opportunity to address the burning issues facing world agriculture, *viz*., improvement of soil health and mitigation of climate change (Sohi *et al*., 2010). Groundnut is one of the most important food and cash crops of our country. But, the productivity of groundnut in India is very low; the rain dependent cultivation and decline in soil fertility status are the important reason for very low productivity. By keeping all above facts, A field experiment was conducted at APAC farm, Kalavai to study "Impact of Biochar Compost on Soil Fertility Status and Yield of Groundnut". The experiment comprised of seven treatments laid in RBD with three replications. The experiment results reveals that the bulk density of biochar treated plots recorded a significant decrease at harvest while, soil porosity were significantly improved. The pH and EC of the soil were not markedly influenced by the imposed treatments. But there is a slight increase in the pH and EC in the Biochar applied treatment plots. The organic carbon content of soils was significantly high in treatments with biochar. The highest organic carbon content recorded in the RDF + Biochar @ 5.0 t + EM applied treatment plot. The available nitrogen, phosphorus and potassium were significantly increased in biochar imposed treatments over control. The high level of available NPK content was recorded in RDF + Biochar @ 5.0 t applied treatment plot. From this study, it can be concluded that usage of biochar make agriculture sustainable and economical and would reduce greenhouse gases, improve carbon sequestration.

Keywords: Biochar, Soil fertility, Available nutrients, Climate change and Food Security

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Breeding Approaches in Sesame

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Abstract

Sesame (*Sesamum indicum* L., 2n=2x=26), which is also known as til is an important oilseed crop from Pedaliaceae family. Sesame is major source of excellent oil quality and known as "Queen of oil seeds". In present scenario, 60 percent of oil is imported to meet the requirement of our country. Hence, there is a need to upgrade breeding approaches for the development of high yielding variety coupled with high oil content and tolerance to stressful conditions. In sesame crop indeterminate growth habit, synchronous maturity, development of non-shattering cultivars and seed retention in the capsule are major areas that need to be worked on. Breeding for oilseeds include conventional and non-conventional breeding methodologies. Conventional plant breeding is the development of cultivars using traditional tools for enhancement of plant genome within the natural genetic boundaries of the species. Characterization and conservation of naturally existing variation in a crop is fundamental part of conventional breeding. Morphology, another aspect of conventional method, is a basic tool to estimate genetic differences among sesame genotypes. Hybridization is one of the feasible breeding approaches for development of elite cultivars to broaden the genetic base. Whereas, non-conventional plant breeding is the development or improvement of cultivars using new era tools such as molecular approach, tissue culture and mutation for manipulating plant genome. The non-conventional approach of breeding brings certain advantages such as accuracy in phenotypic screening especially in the case of complex trait, screening for desired traits in the initial stage, selection of the right plant before flowering and reduced cycle time. It also decreases the space required for breeding as only selected germplasms are propagated. These tools together with conventional approaches are beneficial for sesame improvement programme.

Keywords: Breeding, conventional, non-conventional, molecular

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Evolutionary approaches toward C_3 to C_4 rice: Biochemical, physiological and molecular basis.

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Abstract

Population of the world is increasing with an alarming rate leading to increase in demand of food supply. With decrease in availability of arable land the only way left to feed the surging population is to enhance productivity of the major crops. Recently an attempt is made to increase the rice yield potential by altering the C_3 photosynthetic pathway in rice. Being a member of C_3 photosynthetic family, carbon dioxide (CO_2) is fixed by enzyme Rubisco (Ribulose 1,5 bisphosphate Carboxylase/ oxygenase enzyme) producing three carbon compound Phospho-Glyceric Acid (PGA). Rubisco can also react with oxygen in C_3 plants to activate another metabolic process called photorespiration which is an energy wasting process. On the other hand C_4 plants which have CO_2 concentrating mechanism within their leaves have minimum level of photorespiration and thus it perform well under high temperature as well as require less water. In addition Rubisco from C_4 species is more efficient than from C3 species in terms of carboxylation. This novel approach to modify the photosynthesis system of rice is a difficult process because the C_4 pathway is very complex and many important factors controlling the mechanism are still unrevealed. For the purpose to alter the C_3 photosynthetic pathway, C_4 rice consortium was recognized which started the practical research work of C_4 rice engineering since 2009. Based on the study of the evolution of C_4 from C_3 species, a set of genes which regulate leaf anatomy and biochemical processes have to be inserted into rice and expressed in an appropriate manner which is currently not possible with conventional plant breeding techniques. Therefore, genetic engineering must be involved to improve the photosynthetic pathway of rice which would provide sufficient opportunity to enhance the yield potential. Genetic engineering provides precise way to introduce genes of interest from distantly related species. To engineer the photosynthetic pathway from C_3 to C_4 in rice, C_4 rice consortium began the simultaneous gene discovery and engineering of already known genes into rice aiming to form C_4 rice with Kranz type anatomy. In addition, some important C_4 genes were cloned from

maize and transformed into rice. Transporters over expressed in the C4 metabolic pathways were recently identified through proteomics of maize bundle sheath and mesophyll cell cells and are being transformed into rice. This process of C_3 to C_4 photosynthetic conversion in rice is under pipeline and could boost the rice production in near future.

Keywords: Rubisco, Potorespiration, Carboxylation and Genetic engineering.

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Climate Smart Agriculture: an approach for sustainable agriculture

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Abstract

Climate Smart Agriculture is an approach for developing agricultural strategies to secure sustainable food security under climate change. CSA provides the means to help stakeholders from local to national and international levels identify agricultural strategies suitable to their local conditions. CSA is one of the 11 Corporate Areas for Resource Mobilization under the FAO's Strategic Objectives. It is in line with FAO's vision for Sustainable Food Agriculture and supports FAO's goal to make agriculture, forestry and fisheries more productive and more sustainable. It also explores the links among the components of CSA (productivity, adaptation and mitigation) and their contribution to achieving the goal of sustainable agricultural development. Despite the potential of CSA to attain sustainable agriculture, poor connections exist among the components of CSA at the field level. More importantly, the concept is sometimes poorly understood by various levels of stakeholders. The concept of climate-smart agriculture (CSA) covers the way forward for food safety in a changing climate. Climate smart agriculture is not a new agricultural system, neither a set of practices. CSA is a new approach to help guide actions to transform and reorient agricultural systems to effectively and sustainably support development and food security under a changing climate. CSA is composed of three main objectives: 1. sustainably increasing food security by increasing agricultural productivity and incomes; 2. adapting and building resilience to climate change ; 3. developing opportunities for reducing greenhouse gas emissions compared to expected trends. The aims of this concept are to improve food security, help communities adapt to climate change and contribute to

climate change mitigation by adopting appropriate practices, developing enabling policies and institutions and mobilizing needed finances.

Keywords: Climate smart agriculture, CSA, resilience, climate change, sustainable agriculture

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Climate smart agriculture and food security

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Abstract

In the 21st century, sustainable food production has become the one of the major challenges due to prevailing of global environmental problems such as climate change, increasing population and natural resource degradation. Among all, climate change is taken as the greatest threats to agriculture system. Therefore, climate smart approach is the need for sustainable food production. Climate Smart Agriculture (CSA) is an approach for transforming and re-orienting agricultural systems to effectively support food security under the observed changes in climate. A number of strategies such as use of integrated renewable energy technologies like wind mills, solar panels, etc is done for energy smart food systems in farming. Resource conserving technologies (RCTs) like zero tillage that permits the farmers to plant wheat soon after rice or cotton harvest so that grain filling is determined before arrival of warm weather. The emergence of newly developed varieties which are heat, drought & salinity tolerant is also one of the strategies of CSA. It is very necessary to relocate the crops to appropriate areas from climate change prone areas so as to maintain crop quality. CSA takes into consideration the diversity of social, economic and environmental contexts including agro-ecological zone. The minimization of climate losses threats can be done by weather forecasting. Geographical Information System (GIS) is used to analyze various risk and hazard cause across different geographical regions on crop yield. Information and Communication Technology (ICT) can efficiently help administrators and researchers in planning contingency programs. Computer aided crop stimulation models can guide to find climate Smart agriculture development and mitigation procedures.

Keywords: Climate change, resource conserving technologies, food security, Information and Communication Technology

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Impact of Climate change and sustainable climate smart approaches in seed spices

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Abstract

Changes in Climate during critical stages of crop growth and development cause heavy yield loss and affect quality particularly in seed spice crops where quality is more important than quantity. Frequency, intensity and duration of stresses like high temperature, excess and limited moisture and salinity likely to increase the extent of damage / loss. These stresses either individually or in combination would significantly influence production, productivity and quality of horticulture crops. In spices major climate change effects are frost damage, incidence of aphids and powdery mildew unseasonal rainfall, hailstorm damage, soil degradation. In the same way due to climate change event of cloudiness, fog, cold winds may hinder the pollination and also may increase the incidence of pest and diseases like *Alternaria* blight in Cumin, Stem gall disease in coriander, Yellowing in cumin, Aphids on Coriander and cumin, Reddening in cumin. In management of frost use of raised bed, drip irrigation with acid fertigation will reduce the damage. Use of temporary plastic walls against frost in fenugreek and root cracking in coriander. Sowing of fennel crop on 1st September and 15 September is ideal time to escape from seed midge infestation in fennel. Off season cultivation of coriander for green leaf purpose. Other mitigation strategies use of precision and protected cultivation practices, use of IDM and IPM methods to manage pest and diseases, following cropping and farming system practices to improve risk bearing ability, adopting weather smart practices, following proper soil and nutrient management, Water and Energy saving practices and along with all these knowledge upgradation of current technologies. Further, identifying suitable genotypes which are tolerant to abiotic stress, widening the genetic base of germplasm and selection of suitable varieties may be short duration, hardy in nature are the future research needs which may associate in achieving sustainable food production.

Keywords: Climate change, climate smart approaches, frost, seed spices

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Awareness and adaptation strategies of climate smart agriculture

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Abstract

Climate smart agriculture is an integrated approach which sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals. Global agriculture will be under significant pressure to meet the demands of rising populations using limited, often degraded, soil and water resources that are predicted to be further stressed by the impact of climate change. The study was conducted in Gadchiroli district of MH. During the year 2018-19, Gadchiroli district was randomly selected for the study. It covers 12 Tahsils, out of 12 Tahsils, two Tahsils namely, Chamorshi and Mulchera were randomly selected. From each tahsils, two villages and from each village, 25 respondent were selected. Thus the total sample for the study was 100 respondents. The findings of the study reveal that, the (51.50%) of the respondents had medium age group, 55.17 per cent medium size of family group, 21.00 per cent functionally literate, 62.83 per cent farming experience group, 47.83 per cent small size of operational land holding, 65.17 medium (100,000/- to 1,500,000/-) income group, 76.17 agriculture as their primary occupation followed by majority 79.50 per cent of respondents had dairying as their secondary occupation. As far as social participation is concerned about 62.00 per cent, 55.83 per cent personal localities contacts, 61.83 per cent personal cosmopolite contacts, and 66.00 of the respondent had medium mass media participation group. Majority (65.67%) of the respondents had medium level of awareness fallowed by high level (17.50%) awareness and (16.67%) of low level of awareness regarding climate smart agriculture.In case of adaptation, most of the farmers (79.17%) have taken adaptation strategies like short duration varieties; on the other hand, 71.67 per cent have crop-livestock system, 71.67 per cent mixed cropping, 76.67 per cent and 60.00 per cent of the respondents were adopted animal manure and compost in their farm. Majority (81.67%) of the respondents were constraints faced by poor support of local and national authorities with climate related issue(Rank I), followed by 79.33 per cent lack of financial resource (Rank II), and 78.50 per cent lack of knowledge about adaptive practices (Rank III), respectively.

Keywords: Climate smart agriculture, adaptation, food security

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Climate smart traditional agricultural practices for ensuring food security

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Abstract

In order to satisfy the food need of a worldwide population expected to arrive at 9.1 billion in 2050 and more than 10 billion by century's end will require significant changes in agricultural production systems. Climate change is the greatest threats to agricultural system in the socio-ecological and economic perspectives of the twenty-first century. Green revolution however, has increased agricultural production several folds but at the tremendous natural expense including climate change. It risked the ecological integrity of agro-ecosystem by serious utilization of fossil fuels, natural resources, agrochemicals and heavy farm machinery. Therefore, improving the crop land management through wide range of traditional agricultural based practices have the potential to deliver co-benefits in the form of reduced Green House Gases (GHGs) emissions or enhance carbon storage in soil as well as increased carbon sequestration therefore contributing to climate change mitigation. Climate smart agricultural practices include organic compost, cover crop, agroforestry, integrated crop animal farming, intercropping and crop rotation especially with leguminous crop. These practices enhance agricultural sustainability and also help to foster the soil organic matter and improve soil fertility. Indigenous Technological Knowledge (ITK) reorients agricultural systems to promote food security. Climate smart traditional agricultural practices are the key for mitigation of climate change through by an increase in agrobiodiversity and resilience of agroecosystems. It not only enhance food security at largeholder farmer level but also at smallholder level and is also effective in increasing system resilience through sustainable food production.

Keywords: Agroforestry, Climate change, Crop rotation, GHG, ITK

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Climate smart agriculture for sustainable food production through gramin krishi mausam sewa

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Abstract

Sustainable food production is one of the major challenges of the twenty first century in the era of global environmental problems such as climate change, increasing population and natural resource degradation including soil degradation and biodiversity loss. Food and Agriculture Organization (FAO) estimates that feeding the world population will require a 60 percent increase in total agricultural production. Climate risks to cropping, livestock and fisheries are expected to increase in coming decades, particularly in developing countries where adaptive capacity is weaker. Climatological information plays a pivotal role in the entire crop production system right to beginning from selecting the most suitable crop, varieties, field preparation up to post harvest operations and marketing system; and if provided in advance can be helpful in inspiring the farmer to organize and activate their own resources in order to reap the benefits by judicious application of costly inputs. It becomes more and more important to supply meteorological information blended with weather sensitive management operations before the start of cropping season in order to adapt the agricultural system to increased weather variability. Bihar agricultural university is rendering weather forecast based District level Agro meteorological Advisory Services to the farmers in the Bihar state under the scheme "Gramin Krishi Mausam Sewa (GKMS)" since monsoon 2009. GKMS provides advance weather information along with crop specific agromet advisories to the farming community by using state of the art instruments and technology through efficient delivering mechanism (Text SMS, Media,Voice SMS,WhatsApp etc.) of the information which ultimately enables farmers to take appropriate actions at farm level. This present system of delivering the services at district to block level with dissemination up to village level to meet the end users' requirements in both the irrigated and rainfed systems and facilitate the agriculture risk management effectively. Therefore, a climate-smart approach to sustainable food production is the need of hour.

Keywords: Krishi mausam sewa, climate smart agriculture, food security

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Climate smart pest management: Building resilience of farms and landscape to changing pest threats

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Abstract

Climate change is affecting the biology, distribution and outbreak potential of pests in a vast range of crops and across all land uses and landscapes. Up to 40% of the world's food supply is already lost to pests; the reduction in pest impact is more important than ever to ensure global food security, reduced application of inputs and decreased greenhouse gas emissions. Climate-smart pest management (CSPM) is a cross-sectoral approach that aims to reduce pest-induced crop losses, enhance ecosystem services, reduce the greenhouse gas emissions intensity per unit of food produced and strengthen the resilience of agricultural systems in the face of climate change. Through the implementation of CSPM, crop production, extension, research and policy act in coordination towards more efficient and resilient food production systems. CSPM involves the implementation across farms and landscapes of holistic approaches mostly based on selected existing practical management methods with the aim to achieve the co-benefits of enhanced mitigation of, and strengthened resilience to, climate change. CSPM seeks to support multiple stakeholders to act in coordination and at scale to revise and reinforce pest management approaches, as well as develop an appropriate enabling environment to more effectively manage evolving climate change-induced pest threats and invasions. Development of effective CSPM will require political leadership to build and resource the necessary linkages.

Keywords: CSPM, pest management, pest threats, climate change, stakeholders, practical management

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Cold stress and its alleviation in vegetable crops

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Abstract

The complex interaction of cold stresses with environmental and organism variables in exercising influence on human performance is a problem. Low temperature stress has been reported as one of the most restraining environmental factors for agricultural crops, particularly vegetables which adversely affect a series of morphological, physiological, biochemical and molecular changes in vegetables crop. More than 50% of agricultural production loss is due to abiotic stress and losses due to low temperature were estimated to about 7.1 %. Usually, chilling and freezing stress lead to chlorsois, necrosis, membrane damage, changes in cytoplasm viscosity and changes in enzyme activities leading to the death of plants. It affects the reproductive stage of plant with delayed flowering, pollen sterility, ovule abortion and reduced fruit sets. In potato, frost damage reduced to be yield by 10-15% cold stress induces the accumulation of proline, an osmoprotectant. Cold temperature extremes results in freeze-induced membrane damage, membrane fluidity. Multiple form of membrane damage can occur as a consequence of freeze induced cellular dehydration. Foliar spray of 0.15% ammonium molybdate, pre soakage treatment with GA_3 and proline, reduce the low temperature stresses. Application of paclobutrazol, uniconazole and use of cryoprotectants may be a viable to overcome the cold stress in crops. Use of plant growth regulator to induced cold resistance tolerance in plant is one of the possible approaches. Foliar application of salicylic acid increased cold tolerance in cucumber. Moreever, the application salicylic acid increase the content of zinc and abscisic acid and prevent the reduction cytokinene under stress condition.

Keywords: Cold stress, Alleviation, Vegetable crops, Abiotic stress

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Countering the effects of climate change in crop productivity by genomics

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Abstract

Global climate change is predicted to impose a serious threat to the stability of agricultural productivity worldwide. The direct outcomes of which will be global food insecurity and ultimately social unrest and famines in certain cases. Thus the need of the hour is to develop efficient crop varieties whose productivity will be resilient to climate change. For meeting this challenge genomics appear to be a promising tool for exploring the stress responsiveness of varieties and development of climate change resilient crops. Application of modern genetic approaches like Next Generation Sequencing (NGS) and bioinformatics allows the search for superior alleles adapted to extremes of environmental conditions in a relatively short time from a few years to just a few months. Genome editing seems to be the most promising approach as it could be conveniently exploited to enervate homozygous mutants for multiple target genes in a single generation. Also genome editing tools enable specific nucleotides in the genome of an individual to be hanged. Many tools like engineered nucleases (ZFN's and TALEN's) and RISPR-Cas9 and techniques like TILLING are now available for genome engineering that can be implemented for editing the regulatory machinery that control yield improvement under stress conditions to improve crop productivity and enhance sustainable food production. Thus, the induction of modern genomics approaches has transformed Molecular breeding to Genomics assisted breeding the main benefit of which is that the data obtained from seedling can be used to predict the phenotypic appearance of mature individuals without the need for extensive phenotypic evaluation over the years. Therefore, to meet the demand of the human population amidst the increasing volatility of climate we must apply genomics based approaches to speed up our current breeding approaches.

Keywords: Climate change, Genomics, Stress tolerance, Breeding

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Crop Improvement: Conventional to Molecular Approaches

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Abstract

Conventional breeding technologies include domestication, introduction, selection, mutagenic breeding and somaclonal variation etc. Molecular breeding include marker assisted selection (MAS), omics technology and genetic modification like genetically modified organisms (GMO) with specific changes in genome by genetic engineering. The main goal of breeding is to increase stable yield, which depends on the genetic potential and tolerance/resistance to biotic and abiotic stresses. There is relative increased demand of food with the increasing volume of world population. Conventional breeding methods no more remain viable to overcome this situation because the continuous application of conventional breeding methods in a given species could lead to the narrowing of the gene pool from which cultivars are drawn, rendering crops vulnerable to biotic and abiotic stresses and hampering future progress. The Molecular biology revolutionizes the production of agriculture and farming methods. For obtaining high yield with good quality, a number of techniques including tissue culture, mutagenesis and transformation have been used. Advance functional genomics studies give better understanding of plant genome and help in modifying it. RNA interference, next generation sequencing and nanotechnology have become a new promising technique for improving crop according to future need. In addition to food obtained directly from genetically modified plants containing GM ingredients or GM derived ingredients, the standard process of food production can be improved by adding different genetically modified microorganisms as sources of enzymes. However, a lot of controversy is connected with GM food, including biological safety, ecological effect and particularly economic aspect due to law for GMO plants patenting in order to protect intellectual property.

Keywords: Crop Improvement, Conventional breeding, GMO plants, Molecular biology

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Assessment of different methods of direct seeded rice cultivation on productivity and profitability of Rice crop

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Abstract

The On-farm trial was conducted during *Kharif* season year 2019-20 for "Assessment of different methods of Direct seeded rice cultivation on productivity and profitability of rice crop at farmers fields of Munger district. The On-farm trial was conducted in randomized block design with three technical options *viz*. Line sowing of direct seeded rice followed by irrigation and then dust mulching, Line sowing of direct seeded rice along with broadcasting of dhaicha seed and 30 days after sowing of dhaincha crop killed by application of Bispyribac sodium 25 g a.i/ ha (brown manuring) and farmers practice (Broadcasting of seed in fields in dry soil) and keeping with 08 farmers fields (replications). Line sowing of direct seeded rice along with broadcasting of dhaicha seed and 30 days after sowing of dhaincha crop killed by application of bispyribac sodium 25 g a.i/ ha (brown manuring) was recorded significantly lower population of total weeds (8 m^{-2}) over line sowing of direct seeded rice followed by irrigation and then dust mulching (19 m^{-2}) and farmers practice (63 m^{-2}) at 30 says after sowing in direct seeded rice crop. Line sowing of direct seeded rice along with broadcasting of dhaicha seed and 30 days after sowing of dhaincha crop killed by application of bispyribac sodium 25 g a.i/ ha (brown manuring) was recorded significantly highest grain yield (43.0 q/ha) over line sowing of direct seeded rice followed by irrigation and then dust mulching (36.6q/ha) and farmers practice broad casting of rice seed in dry soil (30.5 q /ha). However, highest gross returns (Rs.74574 per ha), net return (Rs. 44336 per ha) and B:C ratio (2.46) was obtained with line sowing of direct seeded rice along with broadcasting of dhaicha seed and 30 days after sowing of dhaincha crop killed by application of bispyribac sodium 25 g a.i/ ha (brown manuring) over farmers practice broad casting of rice seed in dry soil and line sowing of direct seeded rice followed by irrigation and then dust mulching of on-farm trial at farmers fields.

Keywords: Direct seeded rice, mulching, productivity, irrigation, sowing

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Soil interventions to build up climate smart agriculture and sustainable food production

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Abstract

Day by day our climate is changing and to survive in this changing environment our agricultural Practices and management would have to be changed.We should ensure that crops that we are cultivating in our field is climate resilient otherwise they would not give optimum yield and quality.Also they will not ensure food security and healthy life to our over increasing population.We should adapt to this changing climate especially our cultivation practices and crop which are being cultivated in our field. Plant breeding and genetical approach will ensure climate smart agriculture approach through the use of hybridization and genetic engineering approach.By using these techniques we can establish climate smart agriculture which will ensure food security as well as sustainability.Along with crop management,field management as well as irrigation management practices we should also adopt soil management practices too in our field so that we would be able to make climate smart agriculture. Soil management practices that we should follow in our field may include addition of green manures,vermicompost,organic residues as well as farm yard manures etc.Organic matter addition to the soil ensure availability of organic acids,chelating agents,useful gases and various substances beneficial for sustainable crop production and hence to achieve sustainable food production.We should manage oil soil according to our changing climate by addition and various management practices that are discussed above.Since soil provide shelter to various microorganisms which are beneficial for our crops.Rhizosphere of any plant is one of the best example of this.So we should ensure healthy environment to the rhizosphere and make sure that organisms residing in their vicinity must be climate resilient.It will lead to healthy plant and in turn they will ensure sustainable food production.

Keywords: Genetical approach, Soil management practices, Climate resilient, Rhizosphere

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Review on High-throughput Plant Phenomics (HTTP) is tool for improving crop yield in future food production

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Abstract

Plant genetics and breeding is one of the best ways to increase the productivity of major food and feed crops worldwide. However, the discipline of crop improvement must evolve to meet the increasing challenges of climate change. Modern techniques for crop improvement rely on both DNA sequencing (genotyping) and accurate quantification of plant traits (phenotyping) to characterize germplasm and experimental populations to identify useful genes/QTLs. Despite recent advances in genomics, a lack of suitable phenotyping data (phenomics data) has led to poor results in gene/QTL discovery, limiting progress in genomics-assisted crop improvement programs. Therefore, acquisition of high-throughput, effective and comprehensive trait data needed to understand the genetic contribution to phenotypic variation has become an acute need Sustaining and increasing crop yields with the advantages afforded by modern genetics tools now depends on rapid advancement of phenomics. More noticeably, sustainable plant productivity to provide sufficient food for the increasing human population has become a thorny issue to scientists in the era of unpredictable global climatic changes, appearance of more tremendous or multiple stresses, and land restriction for cultivation. Thus high-throughput phenotyping platforms allowed screening of large plant populations, germplasm collections (core collections) breeding material and phenotypic trait acquisition coupled with decreased labor input achieved by automation, remote control and data (image) analysis pipelines amenable to high-throughput. Progress has been already made, but more research is required to fully utilize genomics and molecular breeding tools in crop improvement this review article.

Keywords: Phenotyping, climate change, gene, QTL, high-throughput and molecular breeding

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Water productivity of paddy based cropping sequences in PAP canal command area of Tamil Nadu

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Abstract

Parambikulam Aliyar Project (PAP) is an interstate multipurpose project between Tamil Nadu and Kerala. Rice – rice- green manures is the predominant cropping system practiced for ages by the farmers. During 2016 and the years followed, mean annual rainfall of the region was 59.4 % less than the average annual rainfall of 808 mm and posed great impediment for the cultivation of paddy. Farmers incurred huge loss by sacrificing the second crop. Hence research has been envisaged for identification of low water requiring alternative crops for PAP command area through assessment of water productivity of diverse cropping sequences. An experiment was laid out in Field No. A3 of Coconut Research Station, Aliyarnagar during 2016 – 19 in sandy loam soil (*Fluventic Ustropept)* to evaluate rice based cropping systems *viz.,* rice – blackgram, rice – sesame, rice – sunflower, rice – castor and rice – groundnut, for water use efficiency under water scarce situations. The test varieties were CO50 (rice), CO7 (groundnut), CO2 hybrid (sunflower), YRCH 1 (castor) and TMV 7 (sesame). Water consumption and water use efficiency were assessed through Parshall Flume. Rice equivalent yield was higher in rice – blackgram system followed by rice – groundnut system and was the lowest in rice - sunflower system. Water use efficiency was higher in rice – sunflower system (3.70 kg / ha- mm) followed by rice – castor system (2.44 kg/ha- mm) and was the lowest in rice – sesame system (1.50 kg/ha- mm). Benefit cost ratio was higher in rice – blackgram system (2.389) followed by rice – groundnut system (2.154). Rice – blackgram and rice – groundnut are highly rewarding cropping systems for water scarce conditions in PAP command area of Tamil Nadu.

Keywords: Blackgram, Groundnut, Rice, Water use efficiency, Water scarce

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Allelochemicals is an eco-friendly approach for the management of plant parasitic nematodes

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Abstract

In the process of evolution, higher plants have acquired a number of biosynthetic pathways through which a variety of secondary metabolites are synthesized and accumulated. Wide arrays of these compounds are released into the environment in appreciable quantities *via* root exudation and as leachates during litter decomposition and are known to play a major role in allelopathy as allelochemicals. Allelochemicals are plant chemicals that may be beneficial or inhibitory to other organisms. In the alter case the effect is called allelopathy. A large number of plants, specific plants parts or their products have been tested in vitro for their nematotoxic and nematostatic attributes. The extractives of several plants prepared in water or in organic solvents such as methancol, thanol, chloroform, hexane etc. have been found active against several economically important plant parasitic nematodes like *Meloidogyne* sp., *Pratylenchus* sp., *Tylenchulus* sp. and *Glododera* sp. The most nematicidsal plants reported were *Achyranthus aspera, Azadirachta indica, Calotropis procera, Datura stramonium* and *Leucaena leucocephala* etc. allelochemicals in plant protection is more important, since future pest management strategies will rely heavily upon non chemical methods which are safe to environment.

Key words: Allelochemicals, root knot nematode, *Meloidogyne* sp., *Calotropis procera, Achyranthus aspera*

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Climate Change threatening food security

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Abstract

Climate change is a threat multiplier for hungry and undernourished people. Combined with conflict, it destroys livelihoods, drives displacement, widens inequalities, and undermines

sustainable development — including our goal of zero hunger by 2030. Climate change is a threat multiplier for hungry and undernourished people. Higher temperatures, water scarcity, extreme events like droughts and floods, and greater CO2 concentrations in the atmosphere have already begun to impact staple crops around the world. Maize and wheat production has declined in recent years due to extreme weather events, plant diseases, and an overall increase in water scarcity. According to the Food and Agriculture Organization of the United Nations, the unpredictable yield for cereal crops in semi-arid regions of the world (like the Sahel region of Africa) is at least 80% the result of climate variability. Countries with high levels of hunger are often also highly vulnerable to climate change, and have a low capacity to adapt. Climate change affects food production and availability, access, quality, utilization, and stability of food systems. In short, it impacts all aspects of the food system. Extreme weather-related disasters are increasing and reduce the yields of major crops. Higher levels of CO2 reduce the nutritional value of crops. The global food system contributes about one-third of greenhouse gas emissions. About ⅔ of food are lost and wasted from farm to table. These losses therefore exacerbate climate change without improving food security or nutrition. Climate change and conflict combined destroy livelihoods, drive displacement, widen inequalities, and undermine sustainable development. Ending hunger and undernutrition in a changing climate demands large-scale action.

Keywords: Climate, Threat, Food and change

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Erratic rainfall: Dries our hope or sinks our mission to food security?

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Abstract

Water is the most important life-sustaining resource on which the entire agricultural system relies on. Vagaries in rainfall pattern brought about by the climate change have established a serious threat towards sustainable food production system. Too little rain at one place and too much at other has led to desertification and swampy wetlands which continuously shrank the cultivable land. Study on rainfall trend revealed that precipitation is in decreasing trend with an average of 3.7 mm reduction per month per decade and assumed to reduce by further 10-20% in

the near future. Development of the cultivars with increased water use efficiency is the need of hour as agriculture enterprise requires substantial amount of water. Among several strategies, identification of the stress tolerant QTLs and genes and engineering them in our cultivars without any yield penalty is the best way out. Exploration of the suitable donors, pyramiding of these genes scattered over the wild relatives through various breeding and biotechnologically orchestrated approaches could help tackle the threat. Several molecular studies have identified genes like Sub1A, SNORKEL1 and SNORKEL2, qAG, LGF1, ZmEREB180, HEMOGLOBIN2, RAV1 and so on which contribute tolerance to waterlogging in rice and maize. Several drought related QTLs for height (qHT), deep root length (qDRL), total water uptake (qTWU), leaf area (qLA) and several other QTLs has been identified and new researches are going on continuously. Knowledge of these associated genes and QTLs help in development of climate adaptive germplasms by altering the expression patterns of endogenous stress-responsive genes or by the medium of introgressed exogenous genes could pave the way out from this uncertainty led by climate change.

Keywords: Rainfall; Genetic approach; Waterlogging; Drought

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Biological interventions for enhancing saffron productivity in Kashmir

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Abstract

The present study was conducted at Biological interventions for enhancing saffron productivity in kashmir, Department of Agriculture, Faculty of TNAU to enhance the production quality of saffron. The heterogeneity found in the saffron population for morphological, developmental and yield component traits are primarily due to genetic and environmental factors. Development of high yielding genotypes using the existing gene pool of saffron applying the biological tools shows potential for improving the productivity of this crop. A survey undertaken to study the extent of variation revealed wide spectrum of variability in saffron flowers and corm samples collected from saffron growing aresa of kashmir, thus implying a great scope for saffron improvement. Flowers completely devoid of style and anthers and freaks with 4-5 stigmas were observed from the natural population. Collection and evaluation of saffron clones revealed possibility of increasing yield and has lead to the identification of 10 elite clones with distinct

yield superiority. Due to the absent of sexuality mutation,breeding approach is another way of creating genetic variability in saffron. An attempt was made to create new variants for economic characters through the induction of mutation using gamma irradiation. Existing saffron population was irradiated with gamma rays from a Co_{60} source at 0.25,0.50,0. 75 and 1kr doses. Delayed sprouting was observed in higher dose(1kr). Higher dose was also associated with decreased corm weight and dry pistil weight/plant due to strong reduction in percentage of flowering plants and number of flowers/plant. Tissue culture shown possibility to regenerate saffron plantlets and in vitro corm development through somatic embryogenesis. Evaluation of in vitro corms under field condition revealed that corm development and survival are directly proportional to initial corm weight. Survival percentage among in vitro corms having average corm weight less than 1 g was only 26%, whereas it was above 88% in above 1g corms. The weight gain after 1 year was 0.25 to 3.54 g.

Keywords: saffron, productivity, in vitro culture, somatic embryogenesis

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Speed breeding for accelerated varietal development to combat changing climate

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Abstract

Keeping in view the changing climate and increasing population, the development of new varieties can't simply rely on conventional breeding approaches which minimum takes 7-8 years. With the evolution of insect-pest and to make plant species resilient to other biotic and abiotic stresses, there is a need to fast track research for rapid varietal development. But generation time of most plant species serves as a bottleneck for the rapid advancement of breeding programs, this necessitates the creating of new protocols or technologies to accelerate plant growth and reduce generation turnover. Speed Breeding approach comes as a rescue in this scenario. In SB photoperiod time is extended with optimal temperature and humidity requirements to fasten the life cycle of plant species. A 22-h photoperiod with supplementary lighting with sodium vapour lamps or mixture of metal halide and light-emitting diode with controlled temperature regime generation time has been drastically reduced. It is not as if the rapid advancement of the life cycle of plant species has some deleterious effect on the plant itself but the plant developed in SB is normal which can be easily crossed and has high seed germination percentage. Due to the

paucity of space in glasshouses or growth chamber crop breeding usually go with Single Seed Descent (SSD) for generation advancement of a large number of segregating plants to generate homozygous lines. SB approach combined with Marker Assisted Selection (MAS) can serve as a robust tool for plant screening even at early vegetative stage and accelerate gene transformation pipelines. It has been demonstrated as a potent tool for adult plant phenotyping for traits such as flowering time, plant height, disease resistance, leaf sheath glaucousness and pod shattering. In short, SB can serve as a futuristic approach for varietal development.

Keywords: Speed Breeding, Varietal Development, Photoperiod, SSD, MAS

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Genomics assisted breeding for climate change resilient crops

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Abstract

Climate change has always been a major cause of crop yield loss worldwide that is expected to speed up further due to global warming. Genomics has come forward to provide a favourable solution in deciphering stress resilience in crops. Genomics allows us to identify underlying genes, alleles as well as Quantitative trait loci (QTL). The recent advances in plant genomics has made it possible for scientists to improve the understandings of crop diversity at species as well as gene level and also provided DNA markers to fasten the genetic improvement. Plant breeders and genebank curators along the world search for morphological and physiological traits in the existing germplasm that provide adaptation to major stresses and climate variability. Moreover the characterization that includes DNA fingerprinting, mapping of desired genes and QTL helps in selecting desirable genotypes for screening against various stresses. Recent advances in genetic mapping and QTL analysis have made the identification of genetic control of agricultural traits much easier therefore allowing Marker assisted selection (MAS), Association mapping (AM) studies and genomic selection of desirable genotypes to be made in breeding programs. Advancement in next generation sequencing (NGS) has lead to the development of genetic markers even in neglected crop species. This will help in the discovery of alleles/genes for particular climate resilient traits by genotyping- by- sequencing approaches. Similarly, genome-wide association studies (GWAS) could be used to identify the genomic regions responsible for

traits of interest. NGS coupled with GWAS increases the mapping of genes/alleles of desirable traits.

Keywords: Quantitative trait loci(QTL), Genotyping, Phenotyping, Marker assisted selection(MAS), Genome wide association studies(GWAS).

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Genomics in improving crop productivity under changing climatic scenario

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Abstract

The UN projects that by 2050 World food production will need to increase by a minimum of 70 % to feed a projected World population of more than nine billion. Climate change affects agricultural productivity worldwide. The increasing frequency of debilitating heat-waves, droughts, torrential rains and other weather extremes experienced across the globe negatively affects agricultural productivity, and is projected to do so. This situation has compelled plant scientists to develop climate change-resilient crops, which can withstand broad-spectrum stresses. Genomics appears to be a promising tool for deciphering the stress responsiveness of crop species with adaptation traits or in wild relatives toward identifying underlying genes, alleles or quantitative trait loci. Increasing the resilience of crops to climate change represents a critical component towards ensuring food and nutritional security, which could be achieved through genetic engineering-based approaches or molecular breeding strategies. Genetic engineering allows direct transfer of beneficial gene(s) or manipulation of existing gene(s) in the crop of interest for generating expected phenotype(s), whereas breeding approaches involve the improvement of germplasm through introduction of novel alleles into target crops by breeding. The genomic resources thus generated will be useful for various plant breeding applications such as marker-assisted breeding for gene introgression, mapping QTL s or identifying new or rare alleles associated with a particular trait. Molecular breeding approaches have proven helpful in

enhancing the stress adaptation of crop plants, and recent advances in high-throughput sequencing and phenotyping platforms have transformed molecular breeding to genomics-assisted breeding (GAB).

Keywords: Genomics, Germplasm, Gene Introgression, Genomics Assisted Breeding

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Genetic diversity and trait association studies in groundnut

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Abstract

Association studies in the present investigation revealed that the genotypic correlations were higher than their corresponding phenotypic correlation for all the characters and the dependent trait. Pod yield per plant was significantly and positively correlated at both phenotypic and genotypic levels with number of mature pods per plant, kernel yield per plant, shelling percent and days to 50% flowering where as kernel yield per plant, number of mature pods per plant. exhibited high and positive direct effects on pod yield per plant. The formation of eleven clusters in the genetic diversity studies suggested the presence of wide genetic diversity among the fourty genotypes. Test weight followed by shelling percent, kernel yield per plant, 100 kernel weight, plant height and days to 50% flowering contributed maximum contribution towards total divergence. Based on the maximum genetic distance, it is advisable to attempt crossing of the genotypes from cluster X with IX, IX with II and cluster VIII with II which may lead to broad spectrum of favorable genetic variability for yield improvement in groundnut.

Keywords: Genetic divergence, Clusters, D2, Correlation coefficient, Groundnut

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Role of microbes in climate change mitigation and adaptation

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Climate change is affecting all ecosystems on earth especially the agriculture sector due to the emerging unfavourable growth conditions for plants like drought and flooding, salinity, change

in pH, temperature and radiations. With growing human population and changing climate scenario there is a need to adopt eco-friendly climate smart agriculture techniques to improve the quantity and quality of food products. One of the major causes of climate change is increased release of greenhouse gases (GHG) into the environment that traps the heat reflected back by the earth's surface leading to extreme weather conditions including global warming and uneven rainfall. Microorganisms are a kind of life form that can thrive in extreme environments and many of them are known to consume GHG like carbon dioxide, methane and nitrous oxide, thereby justify their role in climate change mitigation by reducing the GHG levels in environment. For example, marine phytoplankton can fix CO2 equivalent to terrestrial plants and methanotrophs can utilize methane as a carbon source. Moreover, there are some microbes that contribute towards the release of GHG into the environment and thus it is very interesting to study the microbial aspect of climate change. In agriculture, use of plant growth promoting microbes including bacteria, cyanobacteria and mycorrhiza has several advantages in managing pathogens, pests, and nutrient availability, over the use of chemicals like fertilizers and pesticides. The use of microbes as biofertilizer in agriculture practice not only reduces the use of chemicals but also helps the plant to overcome the biotic and abiotic stresses. Many microbes have been reported to enhance thermo-tolerance, drought and salt stress tolerance, and alleviation of frost injuries and heavy metal toxicity in plants by improving the levels of certain metabolites like amino acids, proteins, polyamines, hormones and sugars etc. that helps the plant in combating these environmental stresses. Thus, it is very important to understand the physiology and metabolism of agriculturally important microbes with versatile characteristics that makes them a key solution to mitigate climate change impacts as well as can be used to alleviate different stresses in plants.

Keywords: Microbes, cyanobacteria, climate change, mitigation

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Implications for future climate resilient crops and role of calcium in plant stress resistance

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Abstract

Climate change is the pushing issue of the current scenario. From shifting weather patterns that threaten food production to the rising of sea levels that increase the risk of catastrophic flooding,

the impacts of climate change are global in scope and not presented in scale pushing diseases and pests into new geographic areas where they are attacking the vegetation and crops and thus threatening the global food supply. Feeding 10 billion population by 2050(UN report) an expansion of nearly 10 times relative to 1960. Considering the above facts the upcoming varieties or crops should not only be high yielding but also be resistant to multiple stresses, pests and diseases. Developing climate resilient crops is the need of the time. Climate resilient crops can be developed by transferring stress resistance from wild genotypes through conventional breeding techniques as well as by genetic engineering .Gene pyramiding or stacking is an approach that enables incorporation of several genes from different parents into single plant. Hence, paving way for developing multiple stress resistance varieties. Calcium is an essential macronutrient involved in plant growth and nutrition with concentrations in shoot in a range of 0.1 to over 5% of dry wt) It plays a structural role by binding the cell walls As per Dominique Robertson external Ca2+ supplementation helps plants to recover plant from stress. It helps in improvement in plant tolerances or resistance to various stresses. It plays a vital role in maintaining both intercellular and extracellular ionic balances under stresses.

Keywords: stress resistance, calcium, climate resilient crops, plant stresses

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Productivity and profitability of jute (*Corchorous olitorius*) in semmanchal area of Bihar

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Abstract

Jute is an important natural fiber crop; belonging to family Tiliaceae commonly known as “Golden fiber”. It is the second most important vegetable fiber next to cotton, in terms of usage, global consumption, production, and availability. But due to low uses of balance nutrient through organic and inorganic manure and fertilizers the status of soil is in decreasing in order and many problems come in these fields. Keeping these facts in mind, Krishi Vigyan Kendra, Katihar conducted a field experiment at farmer field of Katihar district during two consecutive years of 2017 and 2018 to study the productivity and profitability of jute (*Corchorous olitorius*) under integrated nutrient management practices. The experiment was laid out in RBD with four treatments and ten replications. The selected sites were prepared in late March 2017 and 2018 with soil test based nutrients recommendation applied according to treatments The details of

treatments are as T_1- Farmers practice (40:20:20, N:P:K kg/ha), T_2 - 60:30:30, N:P:K kg/ha (RDF), T_3 – RDF + OM (5 t/ha F.Y.M) + bio-fertilizer (azotobacter + psb seed treatment) and T_4 - N:P:K kg/ha (75%) + FYM (25%) (Amount /dose of nutrients requirement of crop is recommended based on nutrient status of soil), respectively. Application of recommended dose of fertilizer with treatment 3 (T_3) have higher fiber yield and provide higher net return with B:C ratio in compare to other treatment i.e. 75 % nutrients with inorganic fertilizers with 25 per cent nutrients with organic matter (T_4), recommended dose of fertilizers applied through inorganic fertilizers (T_2) and farmers practices (T_1).

Keywords: Inorganic fertilizers, bio-fertilizer, FYM, fiber yield

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Livestock in a changing climate: Production system transitions as an adaptation strategy for agriculture

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Abstract

Livestock farming is the world's largest and use sector and utilizes around 60% of the global biomass harvest. Over the corning decades, climate change will affect the natural resource base of livestock production, especially the productivity of rangeland and feed crops. Based on a comprehensive impact modeling chain, we assess implications of different climate projections for agricultural production costs and land use change and explore the effectiveness of livestock system transitions as an adaptation strategy. Simulated climate impacts on crop yields and rangeland productivity generate adaptation costs amounting to 3% of total agricultural production costs in 2045 (i.e. 145 billion US$). Shifts in livestock production towards mixed crop-livestock systems represent a resource-and cost-efficient adaptation option, reducing agricultural adaptation costs of 0.3% of total production costs and simulltaneously abating deforestation by about 76 million ha globally. The relatively positive climate impacts on grass yields compared with crop yields favor grazing systems inter alia in South Asia and North America. Incomplete transitions in production systems already have a strong adaptive and cost reducing effect: a 50% shift to mixed systems lowers agricultural adaptation costs to 0.8%. General responses of production costs to system transitions are robust across different global climate and crop models as well as regarding assumptions on CO fertilization, but simulated

values show a large variation. In the face of these uncertainties, public policy support for transforming livestock production systems provides an important lever to improve agricultural resource management and lower adaptation resource management and lower adaptation costs, possibly even contributing to emission reduction.

Keywords: livestock farming, CO_2 fertilization, natural resources, rangeland, feed crops

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Water stress in relation to fruit production

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Abstract

Water is the life of all living being on the Earth. Life is impossible without water but minimal and excess water create problems in respect of growth, physiological activities, bio-chemical activities, reproductive growth, yield etc. Minimal water causes drought and excess water anaerobic conditions in the root zone. Both the conditions are harmful to the plants which affect growth and morphology of the root, shoots, fruits and ultimately affect yield. Lots of experiments have been concluded and many are going on to show the effect of conventional, drip irrigation and partial root drying (PRD) system on growth, physiological activities, bio-chemical activities, reproductive growth, yield etc. Long term trial on irrigation methods showed that the PRD was more effective in response to vegetative and reproductive growth (De la Hera *et al.,* 2007). It is also noticed that PRD system of irrigation is most suitable for arid region. Under calcareous soil flooding method of irrigation results better in relation to growth and physiology of the plant. No any fruit crops are suitable for flood situation. So study on flood resistant rootstocks of different fruit crops are the today's challenge for the horticulturist to cover most of the area i.e low land area.

Keywords: Water stress, fruit, production, horticulture

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Marker assisted introgression of semi-dwarfing gene in Katarni rice and evaluation of agronomic traits for yield in backcross derived lines

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Abstract

'Katarni Rice' is the most prevalent, ceremonial and finest quality scented rice landrace of Bihar, India being prevalently grown under agro climatic Zone IIIA. This aromatic rice is most preferred rice due to its flavour, palatability and popcorn like essence before and after cooking. However, it is low yielder (25-30 Qtsl/ha) due to its tall and week stature and lodging tendency at the time maturity. To overcome existing problems of Katarni rice, introgression of semi-dwarfing (*sd1*) gene from Rajendra Sweta and BPT5204 was attempted with the help of marker assisted back cross breeding and present study is framed for assessing the background recovery of the backcross lines. Morphological and molecular study in the BC_1F_4, BC_2F_3 families of Katarni x R. Sweta and BC_1F_3 families of Katarni x BPT5205, along with the assessment of background recovery of BC_4F_1 plants of Katarni x R. Sweta and BC_3F_1 plants of Katarni x BPT5204 was performed. The results indicated reduction of plant height in comparison with Katarni in the backcross derived lines along with the retention of aroma. High heritability coupled with high genetic advance was recorded for 1000 grain weight and plant height. Significant positive correlation of yield per plant was exhibited with 1000 grain weight. The path coefficient analysis indicated positive direct effect of 1000 grain weight, kernel breadth, L/B ratio, number of tillers and days of 50% flowering towards yield per plant. Results of background selection revealed high recovery of recurrent parent genome in the plants of BC_4F_1 of Katarni x R. Sweta and BC_3F_1 of Katarni x BPT5204.

Keywords: *badh2*, genetic advance, heritability, Katarni, Marker assisted breeding, *sd1*

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Molecular mechanisms and advance plant breeding strategies for drought tolerance in crop plants

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Abstract

Drought, causing water deficit is a major constraint to plant growth and productivity leading to several severe problems such as decrease in water flux, closing of stomata and reduction in carbon dioxide fixation. This abiotic stress decreases both the growth and productivity of crops by reducing photosynthesis, decreasing seedling fresh weight, germination percentage and biomass. Plant can die of both hydraulic failure and carbon starvation during drought stress. Characters for drought tolerance are mainly associated with low transpiration efficiency, osmotic adjustment etc. Osmotic adjustment involves the accumulation of compatible solutes such as proline, mannitol, sorbitol, fructans, sucrose and oligosaccharides. These osmolytes play a key role in maintaining the osmotic equilibrium and protecting membranes as well as macromolecules. These regulations are found to be related to ABA, CK, ethylene, CDPK, NADP-malic enzyme and phospholipid signaling pathways. Among these, the CK induced delayed senescence has been shown to be effective in increasing the tolerance of plants to water deficit. Over expression of key genes such as DREB transcription factor in these pathways has been found to enhance drought tolerance. Under abiotic stresses how to identify drought-resistance genes and assess their potentials in breeding and how to bridge the gap between theoretical research and crop breeding. To solve this problem we need to establish various methodologies, including breeding and selection in the field, QTL mapping or genome wide association study (GWAS), comparative transcriptome, precise high-throughput phenotyping, and characterization of the drought-resistance genes, to study drought-resistance in different crops. The research topic, aiming to reveal the genetic, epigenetic, transcriptomic, and metabolomic bases of any trait associated with drought-resistance in crops, which can be applied in crop breeding.

Keywords: Drought; Molecular mechanisms; Breeding strategies

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Climate smart agriculture approaches to sustainable food production

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Abstract

Sustainable food production is one of the major challenges of the twenty-first century in the era of global environmental problems such as climate change, increasing population and natural resource degradation including soil degradation and biodiversity loss. Agriculture is one of the largest sectors that sustain livelihood to maximum number of people and contribute to climate change. Climate smart agriculture (CSA) can be defined as sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change and reducing greenhouse gases emissions. Climate change is among the greatest threats to agricultural systems. Green Revolution though multiplied agricultural production several folds but at the huge environmental cost including climate change. CSA is an approach to increase the technical, policy and investment on environment to get sustainable agricultural growth for food protection under climate change. A number of strategies can be adopted to achieve the objectives of climate smart agriculture. For example, use of integrated renewable energy technologies for farming like wind mills, solar panels, pyrolysis units and bio energy-operated water pumps are very crucial for energy-smart food systems. Resource conserving technologies (RCTs) like zero tillage permits the farmers to plant wheat soon after rice or cotton harvest in order to avoid warm weather detrimental for grain filling. The emergence of newly developed varieties which are tolerant to heat, drought and salinity is also a better strategy of CSA. It is necessary to differentiate regions and crops that are very much prone to climate change so that these should be repositioned to more appropriate areas. The weather forecast and early warning systems will be very helpful to minimize the threats of climate losses. Information and Communications Technology (ICT) can efficiently help administrators and researchers in planning the contingency programs. Computer aided crop simulation models can guide to find out the possible risk of climate variation on future crop yields, climate smart agriculture development and mitigation procedures. The crop models permit variation of environmental factors such as the water regime and temperature and simulate the crop response through many estimated growth parameters like crop yield. Therefore, a climate-smart approach to sustainable food production is the need to increased attention worldwide in context of sustainable food production in changing climate.

Keywords: Climate smart agriculture (CSA), Sustainable, Global warming, Resource conservation technologies (RCT), Information and communication technology(ICT) ,Crop simulation model

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Effect of varieties and methods of planting on photosynthetically active radiation of rice under organic farming

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Abstract

Rice is a major cereal grown all over India with different growing season *viz., Kharif, Rabi* and summer. The nutritional status of organic rice varieties is goes on increasing as it yields high nutritive value in terms of food safety and security. Field experiment was conducted at 'O' block of an organic farm, Tami Nadu Agricultural University, Coimbatore to study the relationship of photosynthetically active radiation (PAR) of traditional rice varieties with three different methods of transplanting. Four rice varieties namely Rice CO-52, *Jeeraga samba, Kitchili samba* and Improved White Ponni were grown with three different methods of transplanting *viz.,* random planting (no spacing), line planting (20 x 10 cm) and SRI (25 x 25 cm spacing). Field experiment was laid out in split plot design with varieties as main plot and planting methods in sub-plot. The plot size of each variety with individual planting methods is 5 x 4 m. Sun is the major source of solar radiation where the plants able to synthesize photosynthesis using the natural sunlight. The photosynthetically active radiation ranges from 400 to 700 nm. There are three major light (red, blue and green) contributed to the photosynthesis. Of the three, blue light is required for synthesis of cholorophyll 'a', 'b' and other accessory pigments. The photosynthetically active radiation was measured using line quantum sensor (LICOR). The experiment revealed that non-significant results on photosynthetically active radiation during their growth at panicle initiation and flowering stages respectively.

Keywords: Organic farming, PAR, Traditional rice, LICOR

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Need of genotyping platforms and high throughput SNP chips for crop improvement

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Abstract

There is a speedily rising inclination in the development and application of the molecular marker's assays for mapping of gene and discovery in various field crops and trees. thus far away, recent advances in the Next Generation Sequences (NGS) and Single Nucleotide Polymorphism (SNPs) genotyping significantly quicken the crop improvement if accurately deployed. High throughput SNP genotyping proposals several advantages over the earlier marker systems, including a profusion of markers, rapid processing of large populations.

Numerous genotyping systems to meet various desires and database storage due to the bi-allelic nature of SNP markers. The NGS technologies have permitted rapid whole sequencing of genome, provided that extensive SNP discovery pools to select revealing markers for diverse sets of germplasm. Highly multiplexed fixed array platforms have permitted powerful methods such as genome–wide association studies (GWAS). The normal type of trait – specific SNP markers needs flexible, low – cost systems for genotyping minor numbers of SNPs across bulky breeding populations, using various platforms some as Fluidigm's Dynamic Arrays, Douglas Scientific Array Tape etc. Also genotyping by sequencing (GBS) is quickly becoming popular for low-cost and high-density genome–wide scans through multiplexed sequencing. The development of such platforms looks serious challenges at phenotypic gaps in different crop plants. It is predictable that such genotyping platforms will be attained in major crops in attention of (i) speedy development in gene discovery of important characters (ii) deepened considerate of quantitative traits by new analytical models and population designs (iii) development in cost effectiveness of large-scale genotyping. Genotyping platforms and high throughput chips (SNP) will deliver unprecedented chances to quicken the development of the cultivars with desired yield potential, quality and enhanced adaptation to mitigate the effects of climate change on several cultivars.

Key Words- Next Generation Sequences, Single Nucleotide Polymorphism, genome–wide association studies, Highly multiplexed fixed array platforms.

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Character association for seed yield and yield attributes in niger germplasms

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Abstract

A field experiment comprising of 200 niger germplasms was conducted in augmented block design with 4 blocks during the *kharif*, 2015-16 at Niger Research Station, Navsari Agricultural University, Vanarasi (Gujarat), India to determine the interrelationship between yield and its contributing components in niger (*Guizotia abyssinica*). Significant differences and variation among the different genotypes was observed in the present study. The results revealed that phenotypic correlation was higher in magnitude than genotypic ones due to effect of environmental factors on the associations of characters. Seed yield per plant exhibited the highest significant positive genotypic correlations with days to 50% flowering, number of capsules on branches followed by test weight. However, an interrelation study indicates that plant height and number of branches had a significant positive correlation with capsules per plant and number of seeds per capsule whereas negative significant correlation was observed between branches per plant and test weight (g). In general, trait association study indicates that days to 50% flowering, number of capsules per plant and test weight (g) influences the seed yield more than any other characters. Hence, more emphasis would be given to these characters during selection to improve the seed yield in niger.

Keywords: Character association, correlation, yield, niger

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Recent development in plant science to address climate change

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Abstract

We know that the threat of global warming is related to the rise of the average annual air temperature. Solution of this problem requires searching the ways that will save the vegetable and animal world and the humanity. It is clear that the high temperature is disastrous for plants, Because of versatile capabilities; a man can be adapted to very high and very low temperature.

The same cannot be said about plants – they cannot "ran away" and survive. Only people can save plants.Long before the issues of global warming arose, scientists especially, biologists and ecologists were interested in plant photosynthesis and the problem of respiration energy in the conditions of high temperature. The purpose of the study was to investigate the impact of high temperature on plant growing, its drought resistance, immunity and breeding, photosynthetic ability of carbohydrate biosynthesis, etc. The essence of these two phenomena – photosynthesis and respiration – is well known. We can only add that people cannot exist without plants; though, plants can exist without people. The atmosphere is enriched with released carbon dioxide more by microorganisms and fungi than people.Starting from the second half of XIX century, separation of oxidation and phosphorylation was considered as the main reason of plant death in unfavorable environmental conditions. Already at that time it was thought that in the breathing process, efficiency of energy change was one of the cardinal issues of biology as it defined the mechanism of plant stability and sustainability. The impact of very high and low temperatures, light, water, carbon dioxide, mineral salts, stress factors (drought, soil salinity level, nutrient salt deficit), also air pollution (sulfur and nitrogen dioxides) on crop photosynthetic activity was studied. Scientists tried to determine how affects of the listed environmental factors were reflected on the first stages of solar energy conversion and dark reactions, also on functional properties and activity of membranes. Great attention was paid to the study of the mechanisms that enabled plants to adapt to adverse environmental conditions; explained those biological resources and potential of plants that ensure migration of crops to relatively undesired zones, for example, from southern to northern regions. It was ascertained that the plant productivity greatly depends on the speed and efficiency of photosynthesis, specific environmental conditions and nutrients essential for plant growth.The best temperature range for almost all plants is 10–35°?. The photosynthetic activity of the leaves outside these boundaries sharply decreases and is irreversibly lost. As temperature generally affects all photosynthesis reactions, certainly, it is difficult to precisely determine the impact of temperature on CO2 assimilation level. It is clear that raising the temperature up to a certain level will enable plants to produce more energy, raise their biological potential, increase vitality, immune capacity, yield and nutritional value. But what should be done in order to "force" the plant to withstand the high temperature? What feeding regime, which mineral and physiologically active substances, and what percentage, what kind of soil and environmental conditions should be maintained for plants, how to change agro-chemical, agricultural and land-reclamation measures to make plants normally develop in the changed conditions? What genetic-selective measures should be taken in order to facilitate the task? Methodological side

of this and other similar researches should be identified by scientists. In general, the approach is as follows: firstly, it should be determined how different plants react to growing temperature and how their physiological, morphological, anatomical characteristics and development are changed accordingly. Alongside with this, the basic biochemical parameters of plants (e.g. features of respiration and photosynthesis) should be studied: breathing coefficient of efficiency, amount of emitted heat, intensity of oxidative and photosynthetic phosphorylation, breathing energy effects, ADP/ATP and respiration ratio, synthesis of proteins, fats, carbohydrates and other important compounds (for example, chlorophyll, vitamins), etc. In each separate case it is essential to determine whether the temperature impact on the object lies in the zone of tolerance, or causes damage. Obviously, different plants respond diffently to certain temperature. Therefore, only setting the temperature points will not be enough. Other features should also be pointed, for example, air humidity, lighting, atmospheric pressure, etc. It is known that plants are significantly affected not only by high temperature, but also by the degree and duration of lighting.

Keywords: Global warming, Temperature, Photosynthesis, Respiration, Sustainability

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Genomics and breeding approaches for enhancing stress resilience in crops

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Abstract

Environmental change is currently unequivocal, especially as far as expanding temperature, expanding CO2 focus, across the board liquefying off ice and rising worldwide normal ocean level, while the expansion in the recurrence of dry spell is entirely plausible yet not as certain. However, atmosphere changes are not new and some of them have had sensational effects, for example, the presence of leaves around 400 million years back as a reaction to an intense abatement in CO2 fixation, the introduction of horticulture because of the finish of the last ice age around 11 000 years prior and the breakdown of civic establishments because of the late Holocene dry spells somewhere in the range of 5000 and 1000 years ago. The atmosphere changes that are happening at present will have an antagonistic impact on food creation and food

quality with the least fortunate ranchers and the least fortunate nations most in danger. The antagonistic impact is a result of the normal or plausible expanded recurrence of some abiotic stresses, for example, warmth and dry season, and of the expanded recurrence of biotic burdens. Furthermore, environmental change is additionally expected to cause misfortunes of biodiversity, for the most part in more peripheral environments. Plant rearing has tended to both abiotic and biotic anxieties. Procedures of adjustment to atmosphere changes may incorporate a more exact coordinating of phenology to dampness accessibility utilizing photoperiod-temperature reaction, expanded access to a set-up of assortments with various span to get away or maintain a strategic distance from unsurprising events of worry at basic periods in crop life cycles, improved water use productivity and a re-accentuation on populace rearing as developmental participatory plant reproducing to give a cushion against expanding eccentrics.

Keywords: Genomics, Stress, phenology, productivity

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Approaches of climate smart agriculture to mitigate climate change and sustainable food security

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Abstract

Rapid growth of the global population and changing dietary habits are driving up the demand for food. Nevertheless, sustainable food production is one of the major challenges of the 21st century in the era of global environmental problems such as climate change and natural resource degradation. Climate change is among the pronounced threats to agricultural systems. Climate change disrupts food production, food markets and posing population-wide risks to the food supply. Climate change jeopardized the ecological integrity of agroecosystems by intensive use of fossil fuels, natural resources, agrochemicals and machinery. Agriculture is one of the largest sectors that sustain a livelihood to the maximum number of people and contribute to climate change. Therefore, climate-smart agriculture approaches are an option for mitigating climate change and enhancing food production. Climate-smart agriculture (CSA) is a sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate

change and reducing greenhouse gas emissions. Climate-smart agriculture are an approach to increase the technical, policy and investment on the environment to get sustainable agricultural growth for food production and protection under climate change. Several approaches can be adopted to achieve the objectives of climate-smart agriculture like the use of integrated renewable energy technologies for farming like windmills, solar panels, pyrolysis units and bio energy-operated water pumps are very crucial for energy-smart food systems. Resource conserving technologies (RCTs) like zero tillage or no-tillage practices to avoid warm weather and reduced greenhouse gases emission. The emergence of newly developed climate-resilient varieties that are tolerant of heat, drought and salinity is also a better approach of CSA. Hence, climate-smart agriculture approaches would be the best way to mitigate climate change and sustain food security.

Keywords: CSA, climate resilient, food seciruty

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OMICS Approaches in Crop Improvement for Stress Tolerance in Crops: to mitigate the Climate Change

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Abstract

The changing trends in the global temperature and precipitation, and their impacts such as drought, floods, new pests and pathogens, in addition to the rise in global population and human interventions pose as a major threat not only to environment and humanity, but also to agriculture and food security of our world. Development of stress tolerance crops to mitigate the adversities of the climate change has been the major objective of researchers for decades. Studies in stress breeding gave better understanding of the mechanisms of stress tolerance, gene or QTL identification, and interaction of genetic and environmental factors. Application of tools such as genomics, transcriptomics, proteomics, metabolomics, and phenomics to study the complex machinery of growth, development and responses to stress could prove to be of great significance to overcome the biotic and abiotic stress in crops. Developments at large, in the area of Genomics in the past decade, has led to efficient identification of genes and genomic loci of important traits and their applications in breeding for stress tolerance. Many databases with

omics data were being generated for various crop species, which provides means to mine for novel genes and proteins. Integration of these tools could serve as a key to decode the enigma of gene structure, function, metabolic pathways and regulatory mechanisms of the complex stress related traits. Besides, molecular biology and biotechnology could provide a strong platform for the introgression of desirable traits in crops, thus bridging the gaps. They could serve as potential approach for the mitigating the present climate crisis and also for sustainable agricultural growth.

Keywords: omics, genomics, transcriptomics, proteomics, metabolomics, stress breeding, climate change

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Effect of climate change, variability, and extreme temperature and rainfall events on agricultural production and food insecurity in Madhya Pradesh

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Abstract

Climate change is defined as change in climate over time, weather due to natural variability or as a result of human activity. Agriculture is extremely vulnerable to climate change. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Although there will be gains in some crops but overall impacts of climate change on agriculture are expected to be negative, threatening global food security. Higher temperatures eventually reduce yields of desirable crops and encouraging weed and pest proliferation. Studies on crop weather relationship revealed that crops are highly sensitive to interannual variations in climate. Year-to-year fluctuations in temperature and precipitation lead to large annual losses for Indian farmers. As the temperature rises conditions will become more favourable for pests such as grasshoppers to complete a number of reproduction cycles thereby increasing their population which also lead to further yield losses in cop yield. The purpose of adaptations and mitigation options to address the impact of climate change on agriculture is therefore to attempt a gradual reversal of the effects caused by climate change and sustain development. There is several mitigation and adaptation measures might be helpful to reduce the adverse impact of climate

change. These methods fall into broad categories of under crop/cropping system- based technologies, use of resource–conservation technology and socio- economic and policy interventions. Some other key mitigation technologies in agriculture are improved cultivation, management to reduce CH_4 emissions, improved energy efficiency, breeding of heat- and drought-resistant crop varieties make them flood or drought resistant which may help us to adapt to our changing environment. These measures are discussed to suggest effective strategies among them to combat climate change with special reference to India.

Keywords: Food insecurity, climate change, agriculture, rainfall, temperature

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Principal component analysis for drought tolerant attributes in rice

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Abstract

Drought stress is one of the leading constraints to Rice (*Oryza sativa* L.) production. Breeding for drought tolerance in rice using novel genetic resources is an important mitigation strategy. This study aimed to determine the level of drought tolerance among diverse rice genotypes using drought tolerance traits and proline analyses and to establish correlation of proline content and that traits under drought-stress conditions in order to select promising rice genotypes for breeding. 38 genotypes with 4 checks have been shown at two locations and two environment (stress & non stress condition). Analysis of variance, Pearson's correlation coefficient, principal component and stress tolerance index were calculated. Genotypes with high yield performance under stressed and optimum conditions maintained high values for yield components. Proline content significantly increased under stress, but weakly correlated with agronomic traits under both normal and water limited conditions. The positive correlation observed between grain yield and proline content under-drought stress conditions provides evidence that proline accumulation might ultimately be considered as a tool for effective selection of drought tolerant genotypes. The study selected 15 genotypes with high grain yields under drought stressed conditions and favourable adaptive traits useful for breeding.

Keywords: Drought tolerance, proline content, water stress, DSI, Tolerance Index

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Remote sensing: A boon towards climate smart horticulture.

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Abstract

Inappropriate management practices of land declined the quality of land and yields of crops. A number of factors such as climate, soil properties and nutrients, crop nutrients, crop canopy volume and biomass, water content, disease, weeds, insects and crop variety are responsible for variability in crop yields. For better management and to bring more area under horticulture crops, updated and accurate database is necessary for systematic planning and decision making as horticulture crops play significant role in improving the productivity of land, generating employment, enhancing exports and providing food and nutritional security to the people. Remote sensing is an advanced tool, can be use effectively as it aids in gathering and updating information from a distance to develop scientific management plans. Various sensors such as microwave radiometers, laser meters, magnetic sensors and cameras collect electromagnetic information to derive accurate, large-scale information about the Earth's surface and atmosphere. The spatial data can be more easily collected and recorded with the observation tools like yield monitors, airborne optical RS and soil-sensing instrumentation, enable the horticulturists to make more informed decisions related to desired productivity outcomes. RS technology from ground, air, or space-based platforms are capable of providing detailed spectral, spatial and temporal information on vegetation health, and vigour and has significant crop yield estimation applications. Same data can be analyzed in different ways for different applications. These data and images are digital, so can easily be quantified and manipulated. RS is advancing quickly and showed potential for applications in crop biomass detection, soil properties, soil moisture and nutrient content, green fruit counts, crop yield estimation, damage by biotic and abiotic stresses.

Keywords: RS, Climate, Spatial, Optical

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Comparing impacts of climate change and mitigation on global agriculture by 2050

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Abstract

Systematic model inter-comparison helps to narrow discrepancies in the analysis of the future impart of climate change on agricultural production. This paper shows a set of alternative scenarios by five global climate and agro-economical models. Covering integrated assessment (IMAGE), partial equilibrium (CAPRI, GLOBIOM, MAgPIE) and computable general equilibrium (MAGNET) models ensures a good coverage of biophysical and economic agricultural features. These models are harmonized respect to basic model drivers, to assess the range of potential impacts of climate change on the agricultural sector by 2050. Moreover, they quantify the economic consequences of stringent global emission mitigation efforts, such as non-CO_2 emission taxes and land-based mitigation options, to stabilize global warming at 2ºC by the end of the century under different Shared Socioeconomic Pathways. A key contribution of the paper is a vis-à-vis comparison of climate change impacts relative to the impact of mitigation measures. In addition, our scenario design allows assessing the impact of the residual climate change on the mitigation challenge. From a global perspective, the impact of climate change on agricultural production by mid-century is negative but small. A larger negative effect on agricultural production, most pronounced for ruminant meat production, is observed when emission mitigation measures compliant with a 2ºC target are put in place. Our results indicate that a mitigation strategy that embeds residual climate change effects (RCP2.6). However, this is partially due to the limited impact of the climate change scenarios by 2050. The magnitude of price changes is different amongst models due to methodological differences. Further research to achieve a better harmonization is needed, especially regarding endogenous food and feed demand, including substitution across individual commodities and endogenous technological change.

Keywords: Agro-economical models, climate change effects, mitigation challenge, global warming, computable general equilibrium, partial equilibrium

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Plant genetics innovations: A new approach adapting agriculture to climate change

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Abstract

Agriculture can adapt to climate change by opting development of new genotypes of plants as a solution. The development of agricultural productions systems with greater climate resilience is an important strategy in dealing with climate change. Conventional plant breeding usually relies upon selection in the target production environment. In this way breeding adapts varieties to the test environment and climate change as it impacts on the testing environment. Selection for performance under optimal growth conditions and nutrition has been shown to also improve yield in less favourable situations. However, more rapid climate change may require a more proactive approach to climate adaptation especially for species for which genotypes with long production life or plants with a long life (such as trees). Genomics is providing a key platform for the understanding of the response of plants to the environment and the breeding of better adapted crop varieties that might anticipate future climate changes. Advances in tools for analysis of plant performance are also supporting the development of optimal agronomic practices. Consumers will continue to demand taste, convenience, healthy and safe food and sustainably and ethically produced food, despite the greater challenges of climate in the future. Improving the nutritional value of foods in response to climate change is a significant challenge. Genomic sequences of relevant germplasm and an understanding of the functional role of alleles controlling key traits will be an enabling platform for this innovation.

Keywords: Genotype, genomics, breeding, sustainability

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Growth and production of mustard varieties with different pruning intensities under *Dalbergia sissoo* based agrisilviculture practice in Madhya Pradesh

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Abstract

The present investigation was taken up with 20 years old agrisilviculture system (*Dalbergia sissoo*+ mustard) during *rabi* season of 2018-19 under AICRP on Agroforestry, Department of Forestry, JNKVV, Jabalpur, M.P. The planting geometry of *Dalbergia sissoo* was 5× 5 m. The treatment combinations involved four pruning treatments (viz., no pruning, 25% pruning, 50% pruning and 75% pruning) and one open (without tree) in main plot and three mustard varieties (viz., JM-3, Urvashi and NRCDR-2) in sub plot. The experiment was laid out in strip plot design with four replications. The soil of the experimental area was medium black. Clay sandy loam with pH 6.0 (acidic), high in organic matter (0.81), medium in available nitrogen (288.1 kg ha^{-1}), high in available phosphorus (20.38 kg ha^{-1}) and low in available potash (170 kg ha^{-1}). In intercropping with *Dalbergia sissoo* three mustard varieties were sown in 45 cm row spacing. The result revealed that crop under open condition recorded significantly higher plant height (144.10 cm), number of branches/plant (5.49), number of siliqua/plant (165.44), length of siliqua (5.96 cm), number of seeds/siliqua (14.53) and 1000 grain weight (4.90 gm). Open condition (without tree) recorded significantly higher grain yield (652 kg ha^{-1}) which was significantly superior to other pruning treatments. Among different pruning treatments 75% pruning recorded significantly higher grain yield (495 kg ha^{-1}) at par with 50% and 25% pruning but significantly superior to no pruning which recorded the lowest grain yield (392 kg ha^{-1}). The percent reduction in grain yield under no pruning, 25%, 50% and 75% pruning as compared to open condition was 39.8%, 31.1%, 26.8% and 24.0%, respectively. Mustard variety i.e. urvashi recorded higher grain yield (523 kg ha^{-1}) at par with NRCDR-2 variety (486 kg ha^{-1}) and superior to variety JM-3 which recorded significantly lowest grain yield of 463 kg ha^{-1}. The percent increase in yield under urvashi over NRCDR-2 and JM-3 was 7.0 and 11.4 % respectively. Managed agroforestry system gave higher monetary return (Rs. 64374 ha^{-1}) as compared to unmanaged agroforestry system i.e. no pruning (Rs.64009 ha^{-1}). Under managed agroforestry system mustard+ *Dalbergia sissoo* in 25% pruning recorded higher monetary return (Rs.81210 ha^{-1}) as compared to crop alone (Rs.17427 ha^{-1}) and tree alone (Rs.51420 ha^{-1}).

Keywords: Agroforestry system, Mustard, Dalbergia sissoo, Economics

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Hormonal regulations of physiological process in plants

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Abstract

Phytohormones are regulatory compounds produced in low concentrations and serve as chemical messengers to regulate various plant physiological and developmental processes. They also play essential roles in signal transduction pathways during stress response and regulate internal and external stimuli . Phytohormones comprise five main groups, namely auxins (IAAs), cytokinins (CKs), abscisic acid (ABA), gibberellins (GAs) and ethylene (ET). Salicylates (SAs), jasmonates (JAs), brassinosteroids (BRs), strigolactones (SLs), polyamines, and some peptides represent new families of phytohormones. Functions of plant hormones is controlling cell growth, division, growth and differentiation. Ethylene controls abscission or shedding of leaves, flowers, fruits , aging and ripening. Auxin regulates cell cycling, growth and development , formation of vascular tissue and other parts. And also promote growth and development in embryo, roots and leaves are primarily controlled by transport of Auxin. Cytokinins (CKs) regulate plant growth and development. Ethylene (ET) is a gaseous phytohormone regulating plant growth and developmental processes, including flower senescence, fruit ripening, and petal and leaf abscission, as well as regulating stress responses. Gibberellins (GAs) are carboxylic acids that may regulate plant growth and development. Brassinosteroids (BRs) comprise polyhydroxy steroidal phytohormones which regulate plant growth and developmental processes including root and stem growth, and flower initiation and development. Salicylic acid (SA) is a phenolic compound which regulates the expression of pathogenesisassociated proteins. Jasmonates (JAs) aregrowth and developmental processes such as fruiting, flowering, senescence and secondary metabolism. Strigolactones (SLs) carotenoid-derived compounds. Hormone actions form a signaling network and regulate various systems in plants. Phytohormones interact by activating a phosphorylation cascade or a common second messenger. Furthermore, several phytohormones interact together, forming a defense network against environmental stresses such as JA, SA, and ABA, play a crucial role in regulating signaling pathways.

Keywords: Phytohormones, Auxins (IAAs), Cytokinins (CKs), Abscisic acid (ABA), Gibberellins (GAs), Ethylene (ET)

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Implication of low cost phenotyping for crop improvement

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Abstract

Agriculture is facing many challenges, one of which is to feed the increasing population that too without using more input and more land. Recent abrupt climate change is making stable food production even more difficult and putting pressure on the food production system. One solution to this problem is to continuously improve the productivity of our crops with introduction of newer and better crop varieties in accelerated manner. Introduction of genomics led breeding methods has assisted the improvement of the crops in accelerated manner. Along with genomics, transcriptomics and proteomics is also paving the way towards better crop improvement. Thanks to the cheaper prices in recent years, laboratories all around the world are now able to use these technologies to improve the crop varieties. One of the bottlenecks in these approaches is the lack of the complete understanding towards genotype-to-phenotype relation which is very essential for understanding complex traits such as drought. Though, advent of high-throughput phenotyping has solved this problem, the high cost associated with it is preventing its use in broader scale and thus demands for development of low-cost phenotyping solutions. A considerable progress has been achieved in developing low cost phenotyping solutions which involves the use of low cost image acquisition system and sensors for phenotyping and envirotyping, smart phone and other single board computer such as Arduino and Rasppberry pi for data analysis in conjunction with other open source hardware and software. We hope that ease of availability of these low cost phenotyping technologies will further accelerate and improve the crop improvement programmes in low budget research settings.

Keywords: Agriculture, Phenotyping, low cost, crop improvement

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Metablomics as a plant defensive mechanism towards abiotic stress

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Abstract

Crops are exposed to adverse climatic conditions due to low temperature, heat and water scarcity leading to accumulation of osmolytes in plants causing osmotic stress. Metabolomics approach is applied to identify the specific genes that are responsible for tolerance towards abiotic stress in plants. It is an invaluable tool to investigate stress tolerance in plants that focuses on the biochemical components by associating compounds, such as by-products of stress metabolism, stress signal transduction molecules which play a vital role in acclimation response of plants. The metabolites contribute functional roles in stress tolerance and act as signaling molecules. The metabolomic changes occurring in plants depend upon the stability and catalytic activity of enzymes involved in degradation of some metabolites, to restore homeostasis and to mediate tolerance mechanism. The amount of metabolites so produced is the downstream response of plants towards external stimuli. This *-omics* technology is based upon gene expression, protein interaction and other regulatory mechanisms. The metabolic network of the plant so perturbed due to unfavourable growth conditions need to be modified to maintain key metabolisms and assemble the anti-stress agents like compatible osmolyte, antioxidants and stress responsive proteins. Metabolic profiling and metabolic fingerprinting techniques can be used to conduct a detailed pathway analysis by studying the pattern associated to stress tolerance. The integration of *–omics* along with gene expression data provides accurate markers will help to reconstruct the whole cascade of cellular network for tolerant crop selection in breeding programs.

Keywords*:* Metabolomics, stress tolerance, abiotic stress, signal transduction, metabolites

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Study on effect of foliar spray in different orders of tillers in the long duration rice variety (*Oryza sativa* L.) ADT 50

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Abstract

Rice germinates as a single culm and soon it starts tillering. Tillering is a crucial phenological phase in rice as it greatly influence seed yield. Primary tillers develop from the main culm in an alternate order. After emergence, primary stillers produces secondary tillers in the same order. Secondary tillers bears a third group of tillers, the tertiary tillers. From the tertiary tillers late formed tillers are produced. The growth of tillers and their developmental pattern depends on the time of their initiation. Tiller and panicle emergence dates were successively later for primary, secondary and tertiary tillers.The field experiment was conducted to study the effect of foliar spray in different order of tillers (primary, secondary and tertiary tillers). The foliar spray include T_1 – Control, T_2 - 2% DAP + 1% KCl, T_3 - 2 % MAP + 1% KCl, T_4 – 0.5 % Nutrigold , T_5 – 0.3 ppm Brassinolide and T_6 - 2% Pulse sprout extract which was given at two different stages viz., 10 days before flowering (Heading stage) and 10 days after flowering (seed filling stage). Observations was taken on flag leaf area, chlorophyll content of the flag leaf, total carbohydrates content of the flag leaf (taken at three different stages *viz.,* 50% flowering stage, physiological maturity stage and seed filling stages), filled seeds percentage, 1000 seed weight, germination percentage, vigour index of different orders of tillers, seed yield/plant, seed yield/plot. The results revealed that, foliar spray with 0.3 ppm Brassinolide recorded highest chlorophyll content, total carbohydrates content at all the three stages, highest seed filling percentage (94.6) in primary, (91.5) in secondary, (74.1) in tertiary tillers, highest1000 seed weight (15.98 g) in primary, (15.74 g) in secondary and (14.97 g) in tertiary tillers, highest seed yield/plant (48.56 g), highest seed yield/plot (5.646 Kg) when compared to the other treatments and control. Foliar spray had no effect on germination percentage and vigour index. Among the different orders of tillers the effect of foliar spray was more in tertiary tillers when compared to primary and secondary tillers. The study has shown that the tertiary tiller emerge, flower and mature late thus it is not contributing to economic yield. Hence, it could be recommended that foliar spray with 0.3 ppm Brassinolide would considerably increase the filled seed percentage in all the types of tillers especially in the tertiary tiller.

Keywords: Primary tiller, Secondary tiller, Tertiary tiller, Brassinolide, Seed filling, Seed weight

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Sustainable food production through climate smart Integrated farming system

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Abstract

Most of the years, the farmers experience complete failure of the crop due to non-availability of moisture at the critical stages. This is the reason why conventional agriculture is said to be out and out a gamble. To overcome the failure of partial or complete conventional system through traditional crop activity which are being proactive now, integrating different enterprises to satisfy the income and productivity and utilizing the biomass for soil fertility built up has been identified as a successful venture to give regular income to the farmers. To overcome the problems of small resource poor farmers, diverse and risk prone environments has led to the development of a more holistic, resource based, client oriented and interacting approach, popularly known as integrated farming system. Integrated farming system is a reliable way of obtaining high productivity with substantial nutrient economy in combination with maximum compatibility and replenishment of organic matter by way of effective recycling of organic residues/wastes etc. obtained through integration of various land- based enterprises. A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore to study the integrated farming system for sustainable food production and it resulted that to enhance the productivity and economic returns of farm and farm families crop - horticulture - dairy - goat - poultry - kitchen garden - boundary planting - vermicompost combinations can be adopted successfully in irrigated drylands of western zone of Tamil Nadu instead of cultivating crop alone on same piece of land under irrigated condition. Crop component contributed more towards the net income (36.96%) and major share followed by goat unit (18.02%), dairy (15.51%) and the rest by other components.

Keywords: Integrated farming system, irrigated dryland, sustainable food production

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Auxin and auxin regulations to salinity stress

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Abstract

Auxin is one of the most essentials phytohormones that not only that play integral role in plant growth and development but also responses under several biotic and abiotic conditions. By adopting different physiological changes, plants counteract the problem of oxidative stress. These physiological changes may include adjustment of root growth, stomata closure, increase in epicuticular waxes, osmolytes accumulation etc. Increased accumulation of salt (NaCl) in soil leads to reduced water uptake which ultimately hamper the normal cellular functions. Generally, root system can sensed salinity stress in two different forms - osmotic stress and ionic stress and is one of the key components to withstand different unfavorable conditions of the soil including salinity, presence of heavy metals, drought etc. Auxin plays the crucial role for root developmental process and helps to initiate the development of lateral root primordia (LRP) resulting the emergence of lateral root from primary root. Hence, increased biosynthesis of auxin or application of exogenous auxin helps to increase the number of lateral roots while its deficiency or its restricted polar transportation inhibits the process of lateral root initiation. As in drought stress, the activation of YUCCA6, a flavin monooxygenase encoding gene that functions in the tryptophan-dependent auxin biosynthetic pathway led to enhanced endogenous levels of auxin and improved stress tolerance in Arabidopsis. Moreover, two OsPIN genes, namely OsPIN2 and OsPIN5b were up-regulated by drought and heat stress in rice. Similarly, YUCCA revealed a greater response to salinity stress. The YUCCAs can be divided into mainly root- or shoot-active proteins 30, 31. YUC3, 5, 7, 8, and 9 display distinct expression patterns in the root under high salinity condition. In cucumber it was shown that specific YUCCAs are expressed at high and low temperature and in response to salinity. Despites of distinct YUC members participate in different stress response, and may even antagonize each other to maintain the proper auxin levels in cucumber CsYUC10b is strongly upregulated in response to salinity stress whereas CsYUC10a and CsYUC11 CsYUC11 act against the upregulation of CsYUC10b under salinity stress. However, overexpression of CsYUC11 in the male flower of cucumber enhanced tolerance to salinity stress and regulated pedicel and stamen development through auxin

biosynthesis in *Arabidopsis*. Generally at low salt concentration expression of YUCCAs is low in the epidermis and cortex, and thus auxin levels in these cells would mainly depend on transport. Salt stress also has major effects on auxin transport, and therefore epidermal biosynthesis is likely to affect auxin distribution during stress and is expected to have consequences for growth responses in the root. The expression of auxin efflux carrier (PIN2) get suppressed with reduced abundance of PIN2:GFP at the root tips. These ultimately regulate the transportation of auxin within the plant system both transcriptionally as well as post-transcriptionally resulting reduced root elongation. Further, the reduction of PIN2 carrier under salt stress condition also alters the direction of root growth.

Keywords: Auxin, salinity stress, gene regulation, YUCCA

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Genomics and breeding: A potential approaches for enhancing stress resilience in crop plant

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Abstract

As we know that to feed the global population in upcoming generation and to address the challenge of the no hunger zone' proposed by the FAO (food and Agriculture organization) crop production must be doubled by 2050, in order to achieve this biotic and abiotic stresses are seem to be a big hurdle. To mitigate the problems by exploring natural diversity in the existing plant genetic resource pool as well as developing stress resilience elite genotypes through genomics and new breeding approaches are needed. These breeding approaches includes next generation sequencing technologies, it is now possible to generate on whole genome scale and molecular breeding, it includes marker assisted selection, marker assisted back cross breeding along with marker assisted recurrent selection and genomic selection. These new approaches accelerate the selection procedure in comparison to other conventional approaches. Incorporation of major genes or QTL into widely adopted genotype has been achieved via marker assisted backcross breeding. For building resilience for serious diseases and insects, marker assisted pyramiding for two or more resistance genes are employed. And for complex traits such as drought, marker assisted recurrent selection and genomic selection are employed to increase precision and to

reduce cost of phenotyping. Many researchers have identified several genes which are associated with DNA marker, responsible for resistance to biotic and abiotic stresses; for example in rice (*Oryza sativa* L.) for blast,bacterial blight, brown plant hopper, drought, submergence, salinity; in wheat (*Triticum aestivum*) for rust ,pre harvest sprouting and drought and heat tolerance; in maize(*Zea mays* L.) for turcicum leaf blight, polysora rust banded leaf sheath blight and drought tolerance. Thus, molecular breeding approaches provide a better alternative to plant breeders to develop stress resilient high- yielding cultivar.

Keywords: Genomics, Plant genetic resource, Marker assisted selection and Phenotyping

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Integrated weed management in India

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Abstract

The purpose is to provide the abstract of integrated weed management in India. Integrated weed management is a science based decision making process that coordinates the use of macro and micro environment information. Weed biology and ecology and all available technologies to control weeds by the most economical and ecologically viable methods. The concept of IWM is not new and many advances have been made in recent years in India. The IWM research carried out in India during the last 20 years is reviewed in this paper. Limited ecological studies were carried out a certain problematic weeds. Majority of the research in India on IWM was herbicide based economic analysis revealed that herbicide use in combination with hand weeding was most economical. Weeds are dynamic and it is required to redesign the strategies from time to time for successful management of ever increasing problems of weeds. IWM research in India must broaden beyond herbicide centered weed management. Future IWM research in India must focus on decision making processes, weed biology, ecology, environmentally and economically viable components of IWM practices in cropping systems herbicide resistance, environmental issues related to transgenic plants, and potential benefits of weeds.

Keywords: Crops, economics, herbicides, India, Integrated weed management, non chemical

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Management of corm rot disease of saffron incited by *Fusarium oxysporum*

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Abstract

The intensive cultivation and mono-culturing in saffron growing belts of Kashmir valley together with the continual use of diseased and low grade material resulted in frequent occurrence of saffron corm rot diseases incited by *Fusarium oxysporum.* The disease can be best controlled by cultural practices, soil amendments, soil solarisation, biological and by chemical management. Among various fungal biological control agents tested , *Trichoderma viride* 2 and *Trichoderma viride* 1 reduced disease severity of corm rot when applied as corm treatment 1×10^{-8}spores ml^{-1}. Among the different fungicides evaluated against corm rot, application of carbendazim @ 0.2% as corm dip or drenching provide complete disease control. Use of genotypes known to be resistant to corm rot disease is the best way of management of diseases that can be used as direct introduction or in any hybridization programme. 'Highly resistant' genotypes *viz*., 0.5Kr, 0.75Kr, SMD-1, SMD-3 SMD-27, SMD-146, SD-147, SD-224 SD-45, SD-52, SD-68, with disease score ranging from 0 to 5.0 were identified whereas the genotype SMD-102 and SMD-103 were found to be 'Highly susceptible'.

Keywords: Corm rot, Fusarium, Genotypes, Management, Saffron

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Genomics and breeding approaches for enhancing stress resilience in crops

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Abstract

Climate change affects agricultural productivity worldwide. Increased prices of food commodities are the initial indication of drastic edible yield loss, which is expected to increase further due to global warming. This situation has compelled plant scientists to develop climate

change resilient crops, which can withstand broad spectrum stresses such as drought, heat, cold, salinity, flood, submergence and pests, thus helping to deliver increased productivity. Genomics appears to be a promising tool for deciphering the stress responsiveness of crop species with adaptation traits or in wild relatives toward identifying underlying genes, alleles or quantitative trait loci. Molecular breeding approaches have proven helpful in enhancing the stress adaptation of crop plants, and recent advances in high throughput sequencing and phenotyping platforms have transformed molecular breeding to genomics assisted breeding (GAB). The progress and prospects of GAB for improving climate change resilience in crops, which is likely to play an ever increasing role in the effort to ensure global food security. Ever increasing area under existing abiotic stresses as well as emerging abiotic stress factors and their combinations have further added to the problems of the current crop improvement programmes. However, with the advancement in modern techniques such as next generation sequencing technologies, it is now possible to generate on a whole genome scale, genomic resources for crop species at a much faster pace with considerably less efforts and money. The genomic resources thus generated will be useful for various plant breeding applications such as marker assisted breeding for gene introgression, mapping QTLs or identifying new or rare alleles associated with a particular trait.

Keywords: Climate change, Genomic assited breeding, Abiotic stress, Stress tolerant, Resilient crops.

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Climate-smart technologies for drought vulnerability

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Abstract

Drought is a period of time when an area or region experiences below-normal precipitation. Drought is a predominant cause of low yield world-wide. In arid and sub-arid tracts that include Eastern dry-zone of Karnataka, drought is major factor contributing to climate vulnerability. Reduced rainy days, induced rainfall intensity and intermittent dry spells are major constraints in the region. Improved agricultural practises, viz. selection of appropriate varieties, method of crop establishment, in-situ moisture conservation, ex-situ rainwater harvesting and its effective utilization and effectiveness of real time agro advisory services were demonstrated in chikkamaranahalli cluster, Bengaluru Rural district of Karnataka during 2011-2015. Long duration variety (MR-1) for July sowing, medium duration variety (GPU-28) for August first

fortnight and short duration (GPU-48) for August second fortnight sowing performed better. In-situ moisture conservation through opening conservation furrows between paired rows of pigeon pea under finger millet + pigeon pea (8:2) and groundnut + pigeon pea (8:2) recorded significantly higher yields compared to farmer's practise. Establishment of finger millet through transplanting and direct sowing using modified bullock drawn seed drill recorded higher yield compared to conventional broadcasting. The excess run-off water harvested in lined ponds, used for diversified purpose, viz. protective irrigation at critical stages, nourishing plantation crops, kitchen garden, pisciculture and Azolla cultivation has brought economic sustainability and livelihood security of farmers in rainfed situation. Real time agro advisory decision making on timeless of operation. The climate resilient practises helped in bringing sustainability under vagaries of monsoon.

Keywords: Drought, variety, climate, moisture, pisciculture

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Sustainable cultivation of tomatoes under climatic extremities

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Abstract

Tomatoes are the world's coveted vegetables finding use in almost every household in various ways, viz., for cooking, salads or processed products. Tomatoes are day neutral vegetables, and can also be grown in different seasons, but temperature plays an important role in tomato fruitsetting and thus yield and quality. The ideal temperature for tomato cultivation is 21-24 ℃. Fruit setting is checked if night temperature goes below 13 ℃ or day temperature exceeds 32℃. The colour of tomatoes does not develop properly below 10 ℃ and above 30 ℃, whereas at 40 ℃ the lycopene development mechanism is destroyed. Waterlogging has detrimental effects on the crop leading to wilting. Under the changing climate scenario the sustainable cultivation of the crop can be done by improvised management practices like growing the crop on raised bed for avoiding waterlogging, mulching of the beds to reduce effect of temperature, avoiding training-pruning in summer to shade the fruits with the foliage. Besides, the crop may be grown

under protected structures, where the microclimate may be somewhat controlled to suit the needs of the plants. Climate resilient varieties also play an important role and many varieties tolerant to heat (for example, Arka Vikas, Pusa Sadabahar, Pusa Hybrid-1, etc.), drought (e.g. Arka Meghali) and many others targeting different stresses have been developed. These contribute to sustainable tomato production under climatic vagaries and are utilized by the growers of this crop worldwide.

Keywords: Tomato, climate change, management, resistant varieties

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Emerging challenges and opportunities for sustainable agriculture

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Abstract

The term sustaiable means- able to sustain and agriculture means-to cultivate. As a whole we could say that sustainable agriculture is practicing cultivation of crop at certain pace or level so, as to avail our heredity to our future generation. Sustainable agriculture rests on the principle that we must meet the needs of the present without compromising needs of future. We are ruining and exploiting our natural resources in different ways. To get high yield we over exhaust our lands and then we give continuous fertilizers, polluting our soil, surface and ground water, subside quality food production lacuna by replacing it with irrelevant fooding habits (China the current example i.e. COVID-19). In India most of us are vegetarians so we over feed the crop with excess nutrients and unnecessary enrichment of manure to manage animal and aqua feed diets and adulterate the food products. Orthodox and illogical agriculture practices like burning the thrashes in fields release huge amount of dust and GHG gases which contributes to air pollution. But for surprise only thrashes are not the ultimate source of GHG gas emission- our rice fields contributes 23%, enteric fermentation 59% and manure management 5%. Asia alone contributes 44% in global greenhouse gas emission from agricultural means. Greenhouse gasses are responsible for the rise in temperature by 1.1^{o}C from the last 19th century average and it is expected to grow. These conditions makes survivability difficult and we can overcome these challenges by the means of adopting the new, relevant and scientific farming practices. Such as,

exploiting the potential of exhibiting yield gaps by adopting different cropping system, Converting rain fed area into potential economic field, rain water harvest and appropriate irrigation systems adoptio and digitalizing agriculture market and linking farmers to market by e-NAM and other apps. last but not the least by focusing on precision farming we can alleviate the scourge impact of changing climate on ecosystem and to sustain agriculture.

Key words: sustaiable agriculture, GHG (Green House gases), precision farming.

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Integrated approach for enhancing seed yield and quality in Foxtail Millet (*Setaria italica.)*

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Abstract

Foxtail millet is drought, temperature and pest tolerant and hence gains for the future in an environment of climate change and global warming. Despite these attributes, millets are losing their pride of place both in terms of production and consumption, for a variety of reasons, including policy initiatives which favour cereals. Though they have not enjoyed technological breakthroughs like the green revolution for cereals, their productivity has increased. Confined to poor lands, productivity is further affected and there is a wide gap between potential productivity and productivity in farmers' fields. Millets also have a wide range of soil and moisture requirements. They can be cultivated with minimum effort and can give a high yield. The grains are relatively easy to handle and store because of their low water content. It is becoming very important to increase the yields of millets to feed the growing population. The experiment was conducted with Foxtail millet variety surya nandi with two main treatments and four sub treatments during *kharif*, 2015 and 2016 at Seed Research & Technology Centre, Rajendranagar. The trial was laid out in split plot design with three replications. There was significant difference among the treatments for the characters studied except for Plant height, days to 50% flowering and panicle weight/plot. The treatment N_4P_3 (FYM + 50Kg Urea + 50Kg SP + 50Kg MOP + 2% KH_2PO_4 for 8hr + 3.0gm of Bavistin) significantly recorded higher seed yield /ha (2426 kg/ha) followed by N_3P_3 (2042 kg/ha), N_4P_4 (1994kg/ha) and N_3P_4 (1938kg/ha).

Keywords: Cereals, temperature, Millets, physiological and growth

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Temperature stresses in crop plants

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Abstract

World population is increasing at an alarming rate and is expected to reach about nine to ten billion at the end of year 2050. The growing population results in considerable additional demand for food and it will also contribute towards changing climate, which is an alarming issue to the world's food safety. Due to effect of various abiotic stresses the food productivity is decreasing and to minimize these losses is a major concern for all nations to cope with the increasing food requirement. Temperature stresses are the major environmental factor affecting plant growth, development and also induced morphological, physiological and biochemical changes in plants. High temperature stresses induces the rapid production and accumulation of reactive oxygen species (ROS). This high level of ROS is harmful to all cellular compounds and negatively influences cellular metabolic processes. High temperature stresses induces the change in water relation, accumulation of compatible osmolytes, decrease in photosynthesis, hormonal changes and cell membrane thermo stability. These stresses can cause scorching of leaves and twigs, sunburn on leaves leaf senescence and abscission, fruit discoloration & damage and reduces yield of plants. Super optimal temperature can cause various damages like inhibition of seed germination, and seedling growth, failure of depression, fertilization of female flower expression, severe reduction in the first internodes length, reduced total biomass and premature death of plants. Cold temperature extremes results in freeze-induced membrane damage, membrane fluidity. Multiple form of membrane damage can occur as a consequence of freeze induced cellular dehydration including expansion-inducedlysis, laminar to hexagonal-II phase transitions and fracture jump lesions. Protein denaturation occurs in plant at low temperature which can potentially result in cellular damage.

Key words: Temperature, Abiotic stress, Crop, Yield

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Wasrewater treatment using rhizofertilizer and biochar

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Abstract

Water is an essential commodity, disposal of industrial and urban wastes into them beyond its self-cleaning capacity causes serious threat. In Tamil Nadu, Erode, Dindigul and Vellore districts in specific, are the heart for tannery industries. Chromium, one of the key component present in the wastewater poses severe threat when released into the environment. Cr(III) and Cr(VI) are two forms of chromium that exist in the environment. In tannery effluent, chromium exist as Cr(III), a non-toxic form which when released into the environment, under favorable conditions, gets oxidized to the toxic, soluble, hexavalent form (Cr(VI)). Hence, there is a need to remove the Cr(III) ions from the wastewater before discharging them into the environment. Many studies exists in the remediation of Cr(VI) in the water, but very few studies are there regarding the adsorption of Cr(III) ions from the wastewater. Realizing this, the current research was conducted to assess the potential for vetiver rhizofiltration for chromium in association with Prosopis Wood biochar. Vetiver was grown in rhizoboxes with PWB and sand as medium. Studies using rhizobox and floating bed technology revealed that compared to the individualistic effect of biochar and Vetiver alone, a coupled effect of biochar and Vetiver exhibited significantly higher degree of chromium removal from the ions. Highest removal of chromium concentration was recorded in T_8 (Sand + Vetiver + Cr(III) @ 500 mg kg^{-1} + Biochar (PWB) @ 20 mg L^{-1}) The corresponding removal percent in port 1 and 2 was 20.74 and 11.28% respectively. The highest removal of chromium from tannery effluent was recorded in treatment T_9 (Sand + Vetiver + Tannery Effluent + Biochar (PWB) @ 20 mg L^{-1}). The corresponding removal per cent in port 1 and port 2 was 18.83 and 10.38 % respectively. The biochar and Vetiver association had the highest removal percentage in both the experiments. Keeping this in mind Vetiver and biochar based floating beds can be used to treat waterways contaminated with chromium.

Keywords: Biochar, rhizofertilizer, waste water, chromium

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Maize: A scope for crop diversification

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Abstract

Maize (Zea mays L.) is one of the important staple crop next to rice and wheat which is cultivated all over the world with higher production and productivity. It is taken as main crop in most of the country as its each and every part of the plant can be utilized in different sectors such as food, feed and also for industrial purposes. Maize crop is also known for its versitality as it is grown in all the three seasons viz. kharif, rabi and zaid that's why it is also known as miracle crop. Majority of this crop is that it is taken as cereal crop or, for obtaining grains, but it can be used or, taken at any stage i.e. in early stage, it has highly succulent green vegetative growth that can be used as green fodder, than very early stage of cob when fertilization does not take place called baby corn and later as a green cob and at final and fully matured stage as maize grain. This unique features of particular crop makes it contingent crop(Panda,2010). Selection of above crop stage for the production can lead to the crop diversification within the crop and also value addition. Diversification in any crop creates more opportunity to have maximum value of the crop as many factors affecting crop at matured stage. Maize can be categorized in speciality corn in which baby corn and sweet corn emerging as important and value added product of maize crop. Diversification of such crop may leads to change in cropping pattern as climate and other factors affecting the grain formation or at matured stage of the crop.

Keywords: Maize, crops, agriculture, future scope

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Activation of transcription factor improve drought tolerance in rice

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Abstract

Plant growth and productivity are adversely affected by abiotic stresses such as drought, salinity, and temperature. Drought stress in rice is one of the great limitations of crop productivity worldwide due to its multigene nature, making the production of transgenic crops a challenging prospect. A basic understanding of physiological, biochemical and gene regulatory network is important for developing crop plants with enhanced tolerance of drought stress. Transcription factors (TFs) play an important role in the signal transduction network which starts with stress signal perception to the expression of stress responsive genes. Several transcription factor such as NAC;NAM, WRKY, bZIP, bHLH, MYB have been documented as important regulators in stress response, but molecular mechanism are largely unknown. Recently the functions of an increasing number of plant TFs are being elucidated and increased understanding of these factors in controlling drought stress response has lead to practical approaches for engineering stress tolerance in plants. These transcription factors were ubiquitously expressed and its transcript level was induced by drought, high temperature, salinity stress and abscisic acid (ABA) treatment. The manipulation of native plant regularity networks therefore represents a new era for genetically modified crops. Overexpression of *SNAC3*, *OsABF1* in rice resulted in enhanced drought tolerance.

Keywords: Transcription factors (TFs), NAC;NAM, WRKY, bZIP

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Oxidative stress and photosynthetic reduction in plants under Zinc excess

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Abstract

Heavy metals including micronutrient cations like Zinc potentially trigger oxidative stress in plants thus inhibiting their fundamental physiological functions. Other cations like Fe and Cu actively participate in redox reactions catalyzing the formation of hydroxyl radicals and causing direct oxidative damage, Zn is unable to perform one electron oxido-reductive reactions. But excess Zn in plants leads to oxidative stress producing toxic oxygen species, concomitantly inducing a disruption in metabolic processes like the antioxidant defence system or the photosynthetic electron transport. Oxidative stress mediated by Zn excess in turn increases peroxidation of lipids and membrane permeability also diminishing the sulphydryl content. The mechanism for zinc-induced oxidative stress in the leaf apoplast, root growth zone and xylem, can also be associated with the generation of charge transfer complexes and quinhydrone, because of phenoxyl radical stabilisation by Zn^{2+} in the cell wall or by inhibition of photosynthetic electron transport. In the stroma of the chloroplasts, the biochemical kinetics is driven by Rubisco activity, which is naturally sensitive to toxic amounts of Zn. Although bivalent cations play a major role in the activation of Rubisco and in the equilibrium between CO_2 and O_2 binding, Zn^{2+} can displace Mg^{2+} in the structure of Rubisco, which determines the loss of its activity. Also within the Chlorophyll structure, Mg^{2+} can be replaced with Zn, which impairing the functioning of Light-harvesting complex II. Presence of Zn^{2+} in toxic concentrations also decreases the levels of Chlorophyll a and b along with the a/b ratio. It also tends to inhibit the photochemical efficiencies of Photosystem-II and/or Photosystem-I. The consequent effects of Zn deficiency or its excess on the activity of many anti-oxidative enzymes, concentration of antioxidants and photosynthetic efficiency in plants need elaborate research owing to its importance in nutrient-induced physiological functions.

Keywords: Zinc, oxidative stress, chlorophyll, photosynthesis, plant physiology

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Zinc in combination with Arbuscular Mycorrhizal (AM) fungi and zinc solubilizing bacteria on growth and yield of maize (*Zea mays* L.) in black and red soil

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Abstract

Maize is an important cereal crop which is utilized as a human food as well as raw material for processing industries. However, yield losses are prominent due to the improper nutrient management practices. Hence the study was carried out on "Zinc in combination with Arbuscular Mycorrhizal (AM) Fungi and Zinc Solubilizing Bacteria on growth and yield of Maize (Zea mays L.) in Black and Red soil". Treatment consisted of two factors *viz.,* microbial inoculation (M_1: control, M_2: AM fungi, M_3: ZSB and M_4: M_2+M_3) and graded levels of $ZnSO_4$ (S_1: 0, S_2: 12.5, S_3: 25, S_4: 37.5, S_5: 50 Kg ha $^{-1}$ and S_6: 0.5% foliar spray @ 45 and 65 DAS) replicated three times in RBD. In both the soils, application of AM fungi + Zinc solubilizing bacteria registered taller plants over control followed by Zinc solubilizing bacteria alone. Irrespective of the soils, with regards to Zn levels, S_5 had tallest plants followed by S_4. The treatment combination *viz.,* application of M_4S_5 produced tallest plants under both the soils. In both the soils, the highest root volume was noticed in M_4 followed by M_3. Among the graded doses of $ZnSO_4$ application, S_5 had highest root volume followed by S_4. Among the microbial inoculations, M_4 had longest and heavy cob followed by M_3 and M_2 over control. Irrespective of the microbial inoculations, the highest cob length and cob weight were noticed in S_5.

Keywords: Maize (*Zea mays* L.), Arbuscular Mycorrhizal (AM) fungi, Zinc Solubilizing Bacteria (ZSB), Graded levels of $ZnSO_4$, Growth and Yield attributes.

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Genetic analysis of seed components in sesame

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Abstract

Little genetic information is available for seed yield in sesame. In order to select varieties with high yield, 12 promising lines were genetically screened at Mora (Northern Cameroon) during 2011 crop season for eight characters viz., days to 50 percentage flowering , days from flowering to capsule maturity, plant height, number of branches, number of capsules per plant, capsule length, number of seeds per capsule and number of days to maturity. Six divergent lines were therefore crossed in all combinations using a diallel mating scheme without their reciprocals. Progenies of F1's along with their parents were evaluated during 2013 cropping season in a randomized complete block with three replicates. Preliminary analysis of variance indicated that the genotypes were significantly different for all yield Components ($p<0.05$) indicating the probability of selection. Broad – sense heritability estimates were high for all traits. Narrow sense heritability and GCA /SCA ratio indicated that both dominant and additive gene effects were Significant for these parameters with a predominance of non-additive effects.

Keywords: *Sesamum indicum L..,* yield components, diallel analysis, and narrow sense heritability.

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Pyramiding of multiple disease resistance genes in tomato

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Abstract

Tomato (*Solanum lycopersicon* L.) is the most widely grown vegetable of the world and India is the second largest tomato producer of the world after China. In tomato production, tomato leaf curl disease, bacterial wilt, late blight and root knot nematodes are the major limiting factors.

These diseases are prevalent throughout India and yield losses are also high. There is no effective control measure to manage these diseases. However, sources of resistance to tomato leaf curl disease, bacterial wilt, late blight and root knot nematodes are available. Different major genes/QTLs conferring resistance to tomato leaf curl disease (*Ty1, Ty2, Ty3, Ty4, ty5, ty6*), bacterial wilt (*BW6*, *BW12*), late blight (*Ph2, Ph3*) and root knot nematodes (*Mi1*) have been identified. The molecular markers linked to the resistant genes are also developed. Thus, the availability of molecular markers linked to the resistant genes has opened up opportunities to pyramid multiple resistance genes in tomato in order to produce new biotic stress resistant tomato varieties to enhance stress resilience.

Keywords: Disease, Marker, Pyramiding, Tomato

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Climate smart agriculture approaches to sustainable food production

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Abstract

Sustainable food production is one of the major challenges of the twenty-first century in the era of global environmental problems such as climate change, increasing population and natural resource degradation including soil degradation and biodiversity loss. Climate change is among the greatest threats to agricultural system and one of the most debated issues of the twenty-first century in the socio-ecological and economic perspectives. Agriculture is one of the largest sectors that sustain livelihood to maximum number of people and contribute to climate change. Therefore, a climate-smart approach to sustainable food production is the need of hour. Climate smart agriculture (CSA) can be defined as sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change and reducing greenhouse gases emissions. CSA is an approach to increase the technical, policy and investment on environment to get sustainable agricultural growth for food protection under climate change. A number of strategies can be adopted to achieve the objectives of climate smart agriculture. Wide spread changes in rainfall and temperature patterns threaten agricultural production and increase the vulnerability of people dependent on agriculture for their livelihoods, which includes most of the

world's poor. Climate change disrupts food markets, posing population-wide risks to food supply. Climate-smart agriculture (CSA) in other way can be defined as an approach for transforming and reorienting agricultural systems to support food production and security under the new realities of climate change. Threats can be reduced by increasing the adaptive capacity of farmers as well as increasing resilience and resource use efficiency in agricultural production systems. CSA promotes coordinated actions by farmers, researchers, private sector, civil society and policymakers towards climate-resilient pathways through four main action areas: (1) building evidence; (2) increasing local institutional effectiveness; (3) fostering coherence between climate and agricultural policies; and (4) linking climate and agricultural financing.

Keywords: Climate smart agriculture, Climate change, Agricultural production, Food supply

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Summary report and Key recommendations

One day webinar on the topic "Plant biological interventions for climate Smart agriculture" was organized on 30th of July 2020 under the leadership of Honourable Vice Chancellor Dr. Ajoy Kumar Singh the webinar was inaugurated with Dr. Arun Kumar (Director Planning) as Chairperson and Dr. R.K. Sohane (DEE) convener of the webinar and the organizing secretaries Dr. Sareeta Nahakpam, Dr. Rafat Sultana and Dr. Sweta Sinha.

The webinar has witnessed the maximum registration of 757 participants across the country and around 300 participants were connected online in respective technical sessions. There were 8 lectures given by diverse speakers from different field of sciences. First lecture was given **by Dr. M L Jat, Principal Scientist, CIMMYT, New Delhi** on the topic "Could COVID-19 Drive Farmers To Adopt Climate Smart Agriculture Practices? Example From India's Breadbasket". 2nd lecture by **Dr. Amelia, Senior Scientist, Drought Physiologist, IRRI, Phillipines** enlightened her talked on the root research for drought tolerance in rice. 3rd lecture is delivered **by Dr. Kavita Shah, Professor, IESD, BHU, Varanasi** covered the topic Climate Change, Stress Resilience and Management of Crops for Food Security: Issues and Challenges. 4th speaker **Dr. Ravi Gopal Singh**, **Senior Cropping Systems Agronomist, CIMMYT, Mexico** deliberation was highlighted on weed and weed management. 5th lecture was delivered by **Dr. Ranjan Das, Professor, AAU, Johrat, Assam** on the topic Crop responses to climate change. 6th speaker **Dr. Anita Babbar, Professor, JNKVV, Jabalpur** threw the lights on Genetic Enhancement for Improved Adaptation in Pulses to Climate Change. 7th lecture was delivered by young Scientist, **Dr. Rupesh Deshmukh, NABI, Mohali, Punjab** on the topic Genome sequencing for plant science. The 8th lecture was given by **Dr. S. Elayabalan, IIAT, Tamil Nadu** on the trending topics Application of Artificial Intelligence Technology for Agriculture.

The webinar covered almost all the agricultural issues at present climate scenario and its alternative way to mitigate through new techniques and research practices to improve crop adaptation and enrich sustainable productivity. Through this webinar, we tried to bring all the different scientists working at different disciplines together to have integrated multidisciplinary approaches and to build interactive platform for a relevant agriculture and agricultural base systems. The webinar discussions and the outcome is the promise to benefit the participants and to reframe our research paving a way towards better and hunger free tomorrow by making our agriculture, a climate smart agriculture.

Key recommendations:

1. Conservation agriculture based sustainable intensification of cropping systems can help reduced cost, increased incomes and make agriculture more sustainable for small farmers and the environment.

2. Drought related problems of rice crop can be met by strengthening root phenotyping systems determining different stage drought. Roots show more dynamic responses in terms of osmotic gene expression responses that can be further explored using advanced molecular technology.

3. A multidisciplinary approach is the only possible way to developed climate resilient crop and can only give world's food security.

4. For weed management herbicides are not only option but optimizing crop efficiencies and intensification of crop system has potentials to mitigate changes in climate.

5. Advancement in the physiological research has marked to increased crop potential and development of changing climate resilient crop through photosynthetic enhancement under raising CO_2 and temperature.

6. Pulse breeding imperatives could be enhanced with more advanced interaction of traits defining components of environment and combining multiple stress research based on changing climate.

7. The emergence of next-generation sequencing based high-throughput genotyping approaches have sufficient marker density and can be used successfully in crops for accelerating genomics-assisted breeding programs.

8. Artificial intelligence (AI) is a novel and rapid methods for the timely detection of pests and diseases can/will guide surveillance strategies and have control measures applied in a more targeted and timely manner. Tumaini AI-powered app can help farmers in early identification of pest and diseases and their management.

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