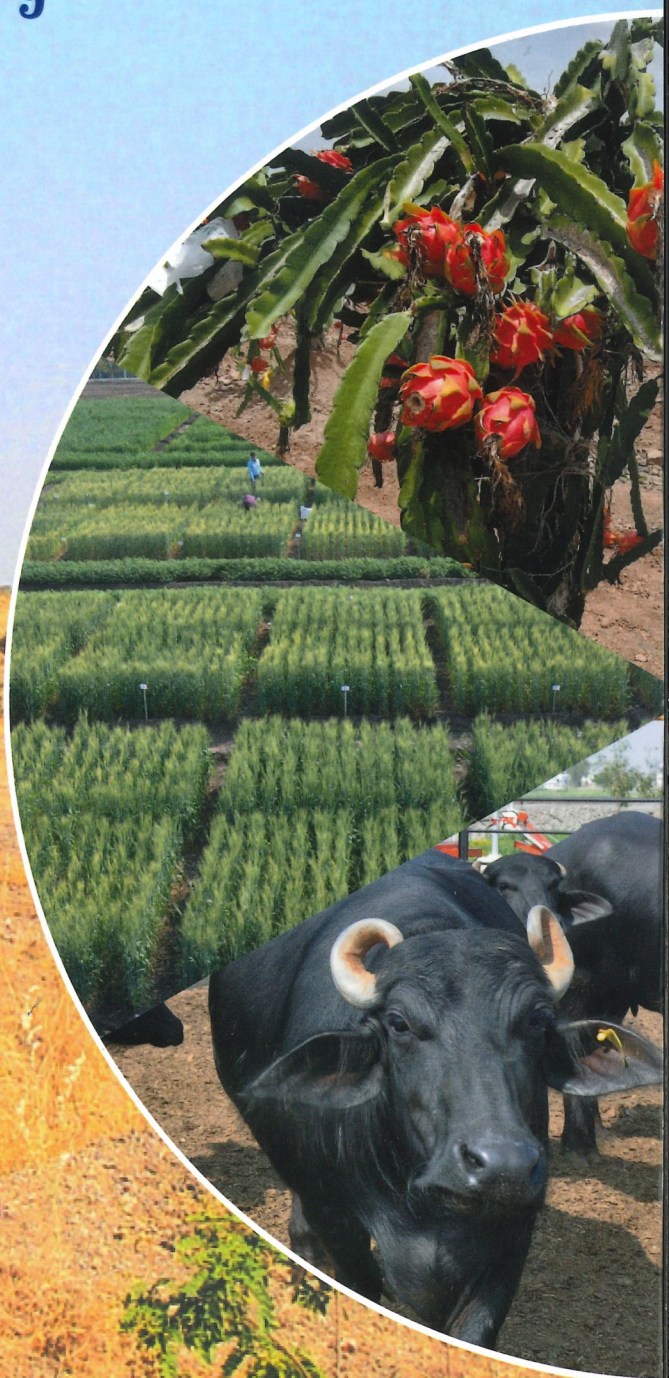
वार्षिक प्रतिवेदन ♦ Annual Report

2018-19



भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

ICAR-National Institute of Abiotic Stress Management

(समतुल्य विश्वविद्यालय) / (Deemed to be University)

मालेगांव, बारामती - 413 115, पुणे, महाराष्ट्र, भारत

Malegaon, Baramati - 413 115, Pune, Maharashtra, India

An ISO 9001:2015 Certified Institute

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(समतुल्य विश्वविद्यालय)
(भारतीय कृषि अनुसंधान परिषद)
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(Deemed to be University)
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ICAR-National Institute of Abiotic Stress Management

Annual Report 2018-19

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Citation : **Annual Report (2018-19)**
ICAR-National Institute of Abiotic Stress Management,
Malegaon, Baramati - 413 115, Pune, Maharashtra, India.

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Cover : Display of various agricultural enterprises of experiments at ICAR-NIASM

भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
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भारतीय कृषि अनुसंधान परिषद, कृषि अनुसंधान एवं शिक्षा विभाग
Indian Council of Agricultural Research, Department of Agriculture Research & Education
कृषि एवं किसान कल्याण मंत्रालय, भारत सरकार
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Prof. Narendra Pratap Singh
Director

Preface

Abiotic stresses such as drought, high temperature, salinity and water stagnation are major constraints for agriculture in India and threaten food security. Though these abiotic stresses existed in the past and are witnessed at present, they can be more frequent, intense and devastating due to climate change. Hence, management of these abiotic stresses will be utmost important for stability in the agricultural productivity across the agro-ecologies including those which face harsh climate and are featured by poor resources. The constraints of global food security and agricultural productivity necessitate to carry out advanced research by multidisciplinary team of scientists using frontier technologies to minimize the adverse impacts of abiotic stresses in agriculture and to develop of climate resilnet crops. It also encourages establishing linkages and wide network with national and international centres to accomplish the task.

The institute aims to provide dynamic mechanisms and robust tools for managing abiotic stresses in present or amplified version in the future for various agro-ecosystems. To accomplish this, ICAR-NIASM has taken lead to carry out research for delivering technologies for the benefit of farming community through basic and strategic research in crops, livestock and fisheries. In the last few years efforts have been made on development of infrastructural facilities such as research farm and procurement of equipments for state-of-the-art laboratories. The foremost achievement of the year has been the identification of promising genotypes of various crops for adaptation to drought and edaphic stresses; improvement of yield and drought tolerance in fenugreek by biopolymer derived from halotolerant Rhizobium strain; development of climate resilient integrated organic farming system model for semi-arid region; establishment of model herbal garden of medicinal and aromatic plant and waste water treatment through multi-approach-based constructed wetland and use in integrated aquaponics.

Institute has also made efforts on human resource development by conducting summer school on 'Climate change and abiotic stress management strategies for doubling farmer's income', farmers fair on pomegrate and organic farming in sugarcane. I extend my sincere thanks to Dr Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Sushil Kumar, Additional Secretary (DARE) & Secretary (ICAR); Shri Bimbadhar Pradhan, Additional Secretary & Financial Advisor (DARE/ICAR); Dr K Alagusundaram, DDG, NRM (ICAR); Dr S K Chaudhari, ADG, Soil & Water Management and Dr S Bhaskar, ADG, AAF & CC for their continued support to ICAR-NIASM. The contributions of various committees in institute development are highly appreciated. I also appreciate the efforts made by the members of the publication committee in compiling this report in time.

June 30, 2019
ICAR-NIASM, Baramati

(Narendra Pratap Singh)

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कार्यकारी सारांश

- मेथी की फसल की पैदावार में पानी की कमी की स्थिति में उपज में सुधार के लिए *राइजोबियम* स्ट्रेन और बायोपॉलिमर के प्रयोग को लाभदायक पाया गया। इसलिए मेथी की सतत खेती के लिए *राइजोबियम* स्ट्रेन और बायोपॉलिमर उपयोग किया जा सकता है।
- गेहूँ के बीजों को हलोटोलरेंट एंटरोबैक्टर के साथ कोटिंग अंकुरण, स्थापना और लवणता सहिष्णुता को बढ़ाता है।
- एरोबिक राइस में टिलरिंग और पैनिकल एमर्जिंग स्टेज में 100 पीपीएम सैलिसिलिक एसिड और 1% $FeSO_4$ का फोलियर स्प्रे के साथ बीजों का उपचार 1% $FeSO_4$ के फोलियर स्प्रे और 0.5% $FeSO_4$ के फोलर स्प्रे और 1% मल्टी माइक्रोन्यूट्रिएंट कॉम्प्लेक्स के फोलियर स्प्रे की तुलना में प्रभावी था।
- डी आर आर–42 की पहचान महाराष्ट्र के अर्ध–शुष्क क्षेत्र में बारिश की स्थिति के लिए बेहतर चावल किस्म के रूप में की गई है, जिसका किसान के खेत में स्थानीय प्रजाति इंद्रायणी से बेहतर प्रदर्शन था।
- भाकृअनुप–राअस्ट्रैप्रसं में फसल के घटक, पशु घटक और कृषि अपशिष्ट और प्राकृतिक संसाधनों के उपयोग सहित जलवायु रेजिलिएंट एकीकृत जैविक कृषि प्रणाली मॉडल विकसित किया गया है।
- अनार की उथली जड़ वाली बागवानी फसल ने ट्रेंच और बरमा रोपण की तुलना में पिट (2 * 1 m^2) में बेहतर प्रदर्शन किया, जबकि गड्ढे और ट्रेंच रोपण में अमरूद और सपोटा प्रदर्शन अनार के बराबर था। काली मिट्टी और मौरम का मिश्रण इन बागों की फसलों में सूखे और तनावरहित तनाव को कम करने के लिए एक अच्छा शमन विकल्प हो सकता है।
- ड्रैगन फ्रूट की पैदावार 14.2 से 19.7 t/ha तीन अलग–अलग मिट्टी के मिश्रणों (100% मुरुम; 50% मुरुम + 50% काली मिट्टी और 100% काली मिट्टी) में भिन्न होती है। ड्रैगन फल की अधिकतम पैदावार मुरुम और काली मिट्टी के मिश्रण से प्राप्त हुई थी।
- गन्ने की फसल में, आंशिक कम से कम वर्ग प्रतिगमन पीएलएसआर पत्ती नाइट्रोजन सामग्री की भविष्यवाणी के लिए उपयोगी मॉडल पाया गया। इसी तरह साइट्रस में, पीएलएसआर को सापेक्ष जल सामग्री की भविष्यवाणी के लिए एक अच्छा मॉडल पाया गया।
- कटा हुआ कचरा और व्यक्तिगत या एसओआरएफ (स्टबिंग शेविंग, ऑफ–बैरिंग, रूट प्रूनिंग और फर्टिलाइज़र प्लेसमेंट) तकनीकों के संयोजन को अपनाने की सतह प्रतिधारण को पारंपरिक गन्ने की रगून प्रबंधन प्रथाओं की तुलना में वृद्धि और गन्ने की पैदावार के लिए बेहतर पाया गया। इन तकनीकों से मृदा स्वास्थ्य में भी सुधार हुआ।
- विटामिन बी–2 10 मिलीग्राम / किग्रा की दर से आहार के साथ प्रवजन बढ़ाने, एंटी–ऑक्सीडेटिव स्टेटस जैसे कि कटेस, सुपरऑक्साइड डिसम्यूटेज, ग्लूटाथियोन–एस–ट्रांसफरेज़ और ग्लूटाथियोन पेरोक्सीडेस में सुधार हुआ, लेकिन आर्सेनिक के साथ उपचारित किए गए मछली में वृद्धि का प्रदर्शन काफी था।
- मेघा हल्दी,एन डी एच–98, लोकडोंग, रोमा भारत के विभिन्न खेती क्षेत्रों से प्राप्त विभिन्न हल्दी किस्मों के बीच पोषक स्ट्रैस के तहत पत्तियों में कुल क्लोरोफिल सामग्री के मामले में बेहतर पाए गए।
- फूल और फली के गठन के चरण में नमी की कमी से खराब बायोमास उपज, उच्च चंदवा तापमान, कम सापेक्ष पानी की मात्रा और मेथी में पर्याप्त नमी वाले भूखंडों की तुलना में तेजी से बढ़े हुए पत्ते के पानी के नुकसान के साथ बड़ी फसल हानि होती है
- राष्ट्रीय औषधीय पौधे बोर्ड, आयुष विभाग, नई दिल्ली की वित्तीय सहायता के तहत 5.0 एकड़ में औषधीय और सुगंधित पौधे का बाग स्थापित किया गया है जिसमें 65 औषधीय प्रजातियां उगाई गई हैं।

- तीन साल के परिणामों के आधार पर यह देखा गया कि क्विनोआ फसल में बढ़ती अवधि के दौरान जलवायु और नमी की उपलब्धता के आधार पर 3 से 6 क्विंटल प्रति हक्टेयर उपज लिया जा सकता है।

- फोल्डस्कोप, एक पोर्टेबल ऑप्टिकल माइक्रोस्कोप जो एक घड़ी की बैटरी के साथ कागज, लेंस और एक प्रकाश उत्सर्जक डायोड से निर्मित किया जा सकता है और पराग व्यवहार्यता अध्ययन के लिए खुले क्षेत्र की स्थिति में इसका इस्तेमाल किया जा सकता है

- पराग व्यवहार्यता का अनुमान लगाने की विधि को विनका रोहीया में मानकीकृत किया गया था और सोयाबीन, ज्वार, गेहूं, छोले और अनार जैसी विभिन्न फसलों में निर्धारित किया गया। इन फसलों में पराग व्यवहार्यता पर अस्थायी भिन्नता और सूखे के प्रभाव का भी अध्ययन किया गया।

- पादप फिनोमिक्स सुविधा में छवि मापदंडों से प्राप्त किए जा सकने वाले संभावित सरोगेट लक्षणों पर ध्यान देने के साथ पौधों की प्रतिक्रियाओं का आकलन करने के लिए ICAR-NIASM में पादप फिनोमिक्स सुविधा में मुंगबीन, छोले, कबूतर और मसूर के साथ प्रयोग किए गए।

- हरे, लाल और नीले पिक्सलों की मात्रा निर्धारित करने के लिए इमेज एनालिसिस कॉन्फ़िगरेशन टूल्स का इस्तेमाल किया गया था, जो कि पत्ती में सेनेसेन्स के बारे में और चना जैसे दलहनी फसलों में होने वाली दर के बारे में भी उपयोगी हो सकता है।

- एन आई आर मान पत्तियों से ऊतक नमी में कमी को प्रभावी ढंग से आँका जा सकता है। Convex hull क्षेत्र, कॉम्पैक्टनेस और eccentricity मिट्टी की नमी में कमी के दौरान पत्तियों की turgidity में परिवर्तन की व्याख्या कर सकता है।

- एक्सेल और आर सॉफ्टवेयर की सुविधाओं का उपयोग करके डेटा संगठन के लिए तरीकों को अनुकूलित किया गया है और बड़े डेटा को संग्रहीत किया गया है। छवि मापदंडों को प्राथमिकता देने के लिए कुछ मशीन लर्निंग एल्गोरिदम को संलग्न करने का प्रयास किया गया था जो डिजिटल बायोमास के साथ निकटता से जुड़े हुए हैं और सरोगेट मापदंडों के रूप में भी उपयोग किया जा सकता है।

- एक्साइज्ड लीफ वाटर लॉस को एक ऐसे लक्षण के रूप में पहचाना गया जो पर्यावरण में नमी को कम करने की क्षमता के आधार पर फसल जीनोटाइप को अलग कर सकता है। सोयाबीन, चना और गेहूं जैसी फसलों में प्रदर्शित एनआईआर सेंसर का उपयोग कर ईएलडब्ल्यूएल का अनुमान लगाने के लिए अप्रत्यक्ष तरीके विकसित किए गए जिसका उपयोग इन फसलों में सूखे की स्क्रीनिंग लक्षणों के रूप में किया जा सकता है।

- पौधों की छवियों से प्राप्त प्रतिनिधि मापदंडों की पहचान करने का प्रयास किया गया। परिणाम इंगित करते हैं कि पौधे के ताजा बायोमास को डिजिटल वॉल्यूम और सीमा बिंदु गणना जैसे छवि–आधारित मापदंडों से भविष्यवाणी की जा सकती है

- आर डब्ल्यू सी , क्लोरोफिल की मात्रा जैसे शारीरिक मानकों को अंगूर में तनाव की स्थिति में ब्लूम व सेटर अवस्था और बेरी विकास विकास चरण में तनाव की स्थिति की तुलना में अधिक सामान्य ट्रीटमेंट में पाया गया। तनाव की स्थिति में, संबंधित सामान्य ट्रीटमेंट की तुलना में क्लोरोफिल की मात्रा दोनों विकास चरणों में कम पाई गई ।

- समय पर और देर से बुवाई की शर्तों के तहत, ईसी –573623, आईसी –549394, आईसी –112051, आईसी –543366, आईसी –549526 और आईसी 549520 को स्ट्रैस पूर्ण परिस्थितियों में बढ़ने के लिए उपयुक्त पाया गया। HD–2189 और नेत्रवती की तुलना में जीनोटाइप ईसी –573623, आईसी –549394, आईसी –112051, आईसी –543366, आईसी –549526 और आईसी 549520 में कम कनोपी तापमान, उच्च SPAD वैल्यू, क्लोरोफिल की मात्रा अधिक पाई गई। इन आशाजनक गेहूं जीनोटाइप्स ने एचडी–2189 और नेत्रावती किस्मों की तुलना में क्रियात्मक टिलर और पैदावार अधिक पाया गया।

- सोयाबीन जीनोटाइप्स जेएस–9752, जेएस–335, ईसी–538828 और जेएस–9560 में *FAD3* और *Farnesyltransferase* जीन की अभिव्यक्ति प्रोफाइलिंग की गई। सोयाबीन जीनोटाइप्स जेएस–9752, जेएस–335 और ईसी–538828 ने *FAD3* जीन की उच्च अभिव्यक्ति को दिखाया और *Farnesyltranserase* (FnsI) (ABA सिग्नलिंग) जीन की कम अभिव्यक्ति थी सोयाबीन जीनोटाइप जेएस–9560 में FnsI की उच्च अभिव्यक्ति पाई गई। सोयाबीन जीनोटाइप्स जेएस–9752, ईसी–538828 और जेएस–335 को सूखा सहिष्णु और जीनोटाइप गड–9560 को सूखे के प्रति संवेदनशील पाया गया।

- सोयाबीन में पत्ती के हरेपन में आनुवंशिक भिन्नता के गैर–विनाशकारी विधि से मूल्यांकन के लिए छवि–आधारित विधि विकसित की गई। आरजीबी रंग सूचकांक, जी / आर जी बी; आर / आर जी बी को क्लोरोफिल मात्रा और SPAD वैल्यू के साथ काफी सहसंबंधित पाया गया। इससे पता चलता है की इस विधि का उपयोग सोयाबीन में पत्तियों की हरियाली में भिन्नता का आकलन करने के लिए किया जा सकता है।

- चना और सोयाबीन में छवि विश्लेषण द्वारा LemnaTec HTS-Scanalyzer और ICAR-NIASM द्वारा विकसित स्वदेशी उपकरण का उपयोग करके सेनेसेन्स की मापन किया गया। इस छवि अधिग्रहण और विश्लेषण उपकरण के माध्यम से हम इन फसलों के तेजी से और साथ ही धीमी गति से सेनेसेन्स करने वाले जीनोटाइप की पहचान कर सकते हैं।

- बायो रेग्युलेटर के अनुप्रयोग ने लंबी अवधि के भंडारण के दौरान कंट्रोल (36.2%) की तुलना में सोडियम बेंजोएट, थीओ यूरिया, पोटेशियम नाइट्रेट और जिबरेलिक एसिड के साथ क्रमशः 17.3.3, 23.94, और 26.2 और 32.2% की बल्ब के वजन घटाने को कम किया। सोडियम बेंजोएट, थाओ यूरिया, पोटेशियम नाइट्रेट को कम वजन घटाने और बल्बों के फिजियोकेमिकल और कार्यात्मक स्थिति में सकारात्मक बदलाव के कारण प्याज की कटाई के बाद के भंडारण की गुणवत्ता को बढ़ाने में बेहतर भूमिका के लिए पहचाना गया।

- बारामती / फलटन क्षेत्र के किसानों के खेतों से चयन किए स्थानीय प्याज का अतिरिक्त / पानी की कमी की स्थिति में उपज प्रदर्शन सभी लाल प्याज की तुलना मे बेहतर था।

- प्याज में नमी के तनाव के लिए 61–80 DAT को सबसे संवेदनशील विकास अवस्था पाया गया। इस स्तर पर, 30–60 DAT और 81–100 DAT पर पानी के स्ट्रैस की तुलना में 11.28–21.50% और 18.18–25.85% क्रमशः की कुल मार्केटेबल उपज में कमी पाई गई ।

- प्याज में जल भराव दबाव को कम करने के लिए पोटेशियम नाइट्रेट (KNO_3 20g/L), थायो–यूरिया (800 पीपीएम) और सैलिसिलिक एसिड (15 μM) उपयुक्त पाए गए। पोटेशियम नाइट्रेट, थायो–यूरिया और सैलिसिलिक एसिड जैसे पीबीआर जल भराव स्थितियों के तहत प्याज के उत्पादन की दृष्टि में लाभ को बढ़ाने में मदद कर सकते हैं।

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Executive Summary

- Application of *Rhizobium* strain and the biopolymer was found to be beneficial for fenugreek crop yield improvement under water deficit conditions. Therefore, application of *Rhizobium* strain and biopolymer is recommendable for sustainable farming of fenugreek.
- Coating of wheat seeds with halotolerant Enterobacter enhanced germination, establishment and confers salinity tolerance in wheat.
- In aerobic rice, seed treatment with 100 ppm salicylic acid and foliar spray of 1% $FeSO_4$ at tillering and panicle emergence stage was effective compared to foliar spray of 1% $FeSO_4$ and 0.5% $ZnSO_4$ and foliar spray of 1% multi micronutrient complex at tillering and panicle emergence stage under moisture stress conditions.
- DRR-42 has been identified as promising rice variety for rainfed conditions of Semi-arid area of Maharashtra which performed better than local check Indrayani at farmer's field.
- Climate resilient integrated organic farming system model, involving crop component, animal component and utilization of farm waste and natural resources, has been developed at ICAR-NIASM.
- Pomegranate being the shallow rooting horticultural crop performed better in Pit (2*1 m^2) than trench and auger planting, while guava and sapota performance in pit and trench planting was comparable to pomegranate. Mixtures of black soil and murrum can be a good mitigation option to mitigate drought and edaphic stresses in these orchard crops.
- Dragon fruit yield varies from 14.2 to 19.7 t/ha in three different soil mixtures (100% native murrum soil; 50% Native murrum soil + 50% black soil and 100% black soil). The maximum yield of Dragon fruit was obtained in mixture of native murrum and black soil.
- In sugarcane crop, Partial least squares regression PLSR was found useful model for prediction of leaf nitrogen content. Similarly in citrus, PLSR was found to be a good model for prediction of relative water content.
- Surface retention of chopped trash and adoption of individual or combination of SORF (stubble shaving, off-barring, root pruning and fertilizer placement) techniques were found better for improvement of growth and cane yield than conventional sugarcane ratoon management practices. These practices also improved soil health.
- The percent weight gain, anti-oxidative status such as catalase, superoxide dismutase, glutathione-s-transferase and glutathione peroxidase improved with application of Vit B-2 @ 10 mg/kg diet, but the growth performance drastically reduced in fish treated with arsenic and high temperature group and fed with control diet.
- Megha turmeric, NDH-98, Lakdong, Roma were found better in terms of total

chlorophyll content in leaves under nutrient stress among the different turmeric varieties procured from different cultivating zones of India.

- In the fenugreek, moisture deficit at flowering and pod formation stage causes huge crop loss with poor biomass yield, higher canopy temperature, lower relative water content and faster excised leaf water loss as compared to adequate moisture plots.
- Medicinal and aromatic plant garden was established in an area of 5.0 acres comprises of 65 species of trees, shrubs and climber species under the financial assistance of National Medicinal Plants Board, Department of AYUSH, New Delhi.
- Based on three year results it was observed that 3 to 6 q ha^{-1} can be harvested depending on the climate and moisture availability during the crop growing period in Quinoa crop.
- Foldscope, a portable optical microscope which can assembled from a sheet of paper, lens and a light emitting diode along with a watch battery and can be used in field condition for pollen viability study.
- Method to estimate percent pollen viability was standardized in *Vinca rosea* and determined in different crops like soybean, sorghum, wheat, chickpea and pomegranate. Temporal variation and effect of drought on pollen viability was also studied in these crops.
- Experiments were conducted with mungbean, chickpea, pigeonpea and lentil in plant phenomics facility at ICAR-NIASM to assess the responses of the plants with focus on possible surrogate traits that can be derived from image parameters in plant phenomics facility.
- Image analysis configuration tools were used to quantify green, red and blue pixels, which could provide fare idea about the leaf senescence as well as the rate at which it occurs in pulse crops like chickpea.
- NIR values could effectively explain the loss of tissue moisture content from leaves. Convex hull area, compactness and eccentricity could explain the changes in turgidity of leaves during soil moisture depletion.
- Methods have been optimized for data organization and handling large data using features of excel and R software. Attempts were made to engage some machine learning algorithm to prioritize the image parameters that are closely associated with digital biomass and also can be used as surrogate parameters.
- Excised Leaf Water Loss (ELWL) was identified as a trait which can differentiate crop genotypes based on their ability to loose moisture in environment. Indirect methods to estimate ELWL using NIR sensors demonstrated in crops like soybean, chickpea and wheat. It can be used as one of the drought screening traits in these crops.
- Attempts were made to identify the surrogate parameters derived from plant images. The results indicate that plant fresh biomass can be predicted from image-based parameters like digital volume and boundary point count.
- Physiological parameters like RWC, chlorophyll content were found more in control than stress condition in grape at bloom & shatter stage and berry growth

development stage. Under stress condition, chlorophyll content was reduced at both growth stages compared to its respective control.

- Under timely and late sown conditions, wheat genotypes EC-573623, IC-549394, IC-112051, IC-543366, IC-549526 and IC549520 were found suitable for growing under drought stress conditions. Promising wheat genotypes EC-573623, IC-549394, IC-112051, IC-543366, IC-549526 and IC549520 showed lower canopy temperature, higher SPAD value, higher chlorophyll content compared to check varieties HD-2189 and Netrawati. These promising wheat genotypes also showed higher functional tiller and grain yield compared to check varieties HD-2189 and Netrawati.

- Expression profiling was conducted of *FAD3* and *Farnesyltransferase* genes in soybean genotypes JS-9752, JS-335, EC-538828 and JS-9560. Soybean genotypes JS-9752, JS-335 and EC-538828 showed higher expression of FAD3 genes and lower expression of *Farnesyltranserase* (Fnsl) (ABA signalling) genes while soybean genotypes JS-9560 showed higher expression of Fnsl. Soybean genotypes JS-9752, EC-538828 and JS-335 were found drought tolerant and genotype JS-9560 was found vulnerable to drought stress.

- Image-based method for non-destructive assessment of genetic variation in leaf greenness was developed in soybean. RGB colour indices such as G/RGB, R/RGB were found to be significantly correlated with chlorophyll content and SPAD values suggesting that the method can be used for assessing the variation in greenness of leaves in soybean.

- Quantification of senescence was done in chickpea and soybean by image analysis using LemnaTec HTS-Scanalyzer and indigenous tools developed at ICAR-NIASM. Through this image acquisition and analysis tools we could identify the fast as well as slow senescing genotypes of these crops.

- Application of bio regulators reduced the bulb weight losses by 17.3, 23.9, 26.4 and 32.2% with sodium benzoate, thiourea (TU), Potassium nitrate (PN) and Gibberellic acid GA, respectively over the control (36.2%) during long term storage. SB, TU and PN were identified to have better role in enhancing post–harvest storage quality of onion as evidenced by reduced weight loss and positive changes in physiochemical and functional status of the bulbs.

- The yield performance of local onion cultivar identified from farmers' fields of Baramati/Phaltan region by selection method was better among the all red onion cultivars in both excess/water deficit conditions.

- 61–80 DAT was found to be most sensitive growth stage for moisture stress in onion. At this stage, total marketable yield reduction of 11.28-21.50% and 18.18-25.85% in comparison to water stress applied at 30-60 DAT and 81-100 DAT, respectively.

- Potassium nitrate (KNO_3 @ 20g L^{-1}), thio-urea (TU @ 800 ppm) and salicylic acid (SA, 15 µM) were found suitable for mitigating water logging stress in the onion. PBRs like KNO_3, TU and SA can help to boost the productions vis-a-vis profitability of onion under water logging conditions.

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1 Introduction

Introduction

Farmers, scientific communities and policy makers are always concerned about adverse impacts of abiotic stresses on agriculture. However, the renewed and immense significance has emerged from increasing concerns that their intensity and adverse impact can amplify manifold with climate change and over exploitation of natural resources. Nevertheless, the abiotic stresses even at present level of magnitude are likely to be major concern as dependence of food security for ever increasing population will tend to incline towards fragile agro-ecosystems. Since the productive land are gradually declining with anthropogenic activities. Therefore, it is a need of well-planned basic and strategic research to manage abiotic stresses in agricultural commodities viz., crop plants, livestock, fish and poultry especially in arid and semiarid regions. In order to address these concerns, National Institute of Abiotic Stress Management (NIASM) was established on February 21, 2009 as one of the national institutes under Indian Council of Agricultural Research (ICAR).

Abiotic stresses like drought, temperature extremes, floods, salinity, acidity, mineral toxicity and nutrient deficiency have emerged as major challenges for production of crops, livestock, fisheries and other commodities. Recognizing the magnitude of the problem, many countries have already initiated special research programs and have set up dedicated research centres to embark upon the adaptations of agriculture to abiotic stresses. With substantial agricultural land in tropics and subtropics, India is more challenged with penultimate combinations of abiotic stresses spatially and temporally. Though the country has witnessed the bumper food grain production during the recent past, the threat of adverse climate on long term productivity cannot be ignored. Therefore, there is an urgent need to take up focused research on this important area and hence institute has definite role to play for food security in India.

Several research institutes of Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAUs) and other line departments are working on abiotic stressors, their efforts are meagre considering the magnitude of the problem. Moreover, new tools have emerged in the areas of conservation agriculture, irrigation technologies, biotechnology, nanotechnology, remote sensing, information technology, polymer science, etc., which have opened up new avenues for crop improvement as well as natural resource management to tackle abiotic stresses. Nevertheless, there is a need to evolve a holistic and systems approach to get the best combination of technologies for agro-ecosystems that are often afflicted with multiple stressors. Therefore, it is of paramount importance to initiate high quality research programmes, which are of global standard and also to capture, synthesize, adopt and apply the technological advances taking place within and outside the country.

Keeping in view the extensiveness of the problem, institute has an additional responsibility to maximize the number of qualified researchers and professionals of impeccable quality in the domain of tackling abiotic stresses. The idea is to equip these researchers and professionals with the skills to innovate and conduct seamless

interdisciplinary research. The institute, which is a Deemed-to-be-University, also plans to focus on imparting education in such specialized areas that are not taught in regular agricultural universities.

Role of the Institute

The institute has a focus on stresses that are caused by excess or deficit of soil moisture, soil salinity, sodicity, acidity, water logging, declining water quality, heat stress, cold wave, floods, sea water inundation, etc. through approaches involving conventional as well as novel techniques for crop improvement, resource management and policy development. In order to accomplish the task, the institute has started implementing important research programmes in a thematic mode through four schools, namely Atmospheric Stress Management, Drought Stress Management, Edaphic Stress Management and Policy Support Research. The institute plans for strategic human resource development for managing abiotic stresses on long term by getting involved in networking mode with national and international institutes. While focusing on abiotic stresses, institute will make efforts to complement the ongoing Research and Development under National Agricultural Research System (NARS) without any duplication of research. It is supposed to generate intermediate products for tolerance to multiple stresses such as gene constructs and stress induced promoters, which will be used by other institutes to get end products of crop, livestock, fisheries, etc.

Mission

To build sustainable livelihood in agro-ecosystems constrained by abiotic stresses by practicing climate resilient farming systems through a deep insight, adaptation techniques, mitigation strategies and acceptable policies by effective convergence of research output.

Mandate

- Basic and strategic research on management of abiotic stresses in crop plants, livestock, fishes and soil microorganisms
- Impart quality education in abiotic stress management and emerge as a Global Centre of Excellence
- Repository of information on abiotic stresses, mitigation strategies and acceptable policies for knowledge sharing and capacity building
- Develop linkages for holistic management of abiotic and biotic stress factors

Objectives

i. To assess and quantify the effects of major abiotic stresses on agriculture and to develop a repository of information on abiotic stress management

ii. To develop screening techniques and evolve stress tolerant genotypes/breeding stock/strains of crops, horticulture, animals, fish and microorganisms through mining and deploying novel genes for tolerance to abiotic stresses

iii. To evolve technologies for mitigation of drought, edaphic and atmospheric stresses through frontier science tools such as nanotechnology, geo-informatics, etc.

iv. To develop human resource through advanced training and capacity building on the use of modern tools and techniques in abiotic stress research and management

v. To conduct policy support research on abiotic stress management in collaboration with institutes/organizations/SAUs

vi. To forge national and international linkages with other organizations working on abiotic stress

Strategy

A six-point hexagonal interlinked strategy is planned to be adopted for accomplishing the vision and goals of the institute and to enhance efficiency and effectiveness of the research endeavours (Fig. 1.1). The institute will focus all its efforts towards gaining climatically sustainable livelihood under the abiotically stressful environment.

Fig. 1.1. Institute's strategy for achieving mandate

The operational strategy of the institute is to focus on basic research on abiotic stresses faced by the country, strategic human resource development, robust databases and amelioration approaches using frontier technologies with the participation of wide network of national and international centres. The comprehensive strategy of the institute prioritizes characterization of the occurrence and magnitude of various abiotic stresses impacting agriculture sector. This will provide a rationale for basic and strategic research that aim at agro-ecology specific stress mitigation and adaptation technologies for crops, horticulture, livestock and fisheries. This will be

facilitated by development of world-class infrastructures and scientific manpower necessary for center of excellence in abiotic stress management.

Assessment of available inputs and their use in a synergistic manner, preventing losses, judicious allocation of inputs among the competing demands for maximizing returns and development of site specific technologies are the means of achieving high resource use efficiencies for sustainable agriculture. NIASM being a Deemed to be University and by virtue of its strategic location, is an ideal place to become a 'Center of Excellence' on abiotic stress research not only in India but also at the global level. It will be the leading center for coordination of abiotic stress research and data repository related to all kinds of drought, edaphic and atmospheric stresses. Joint adaptation and mitigation actions against climate change that can be implemented today across a wide range of land and water resource management solutions should provide both adaptation benefits in short term and mitigation strategies on long term basis.

Status

The Moily Oversight Committee on OBC Reservations recommended the establishment of a dedicated research institute of Deemed-to-be-University status on Abiotic Stress Management. In XI plan, the proposal by Ministry of Agriculture was approved by the Union Cabinet to establish "National Institute of Abiotic Stress Management" with a legal status of Deemed-to-be-University under the Indian Council of Agricultural Research at Gat No. 35, Malegaon Khurd, Baramati, Pune, Maharashtra. After being established as a new institute for abiotic stress management in 2009, NIASM initiated its activities at the camp office at KVK, Sharadanagar, Baramati. The office was then shifted to Gat No. 35, Malegaon Khurd on November 1, 2010 after inauguration of Engineering Workshop by Hon'ble Union Minister of Agriculture and Food Processing Industries. Till January 2015, the office and laboratories were housed in this workshop and specialized cabins. Now all the staff of the institute has shifted to newly constructed Office-cum-Admn block. At the same time substantial efforts have been made to strengthen its human resources for carrying out research, administrative and technical activities. During the current year, the scientific, technical and administrative staff strength is 34, 12 and 5, respectively. Thus the filled up cadre strength is 51 against 105 sanctioned posts (Table 1.1). The institute has initiated research through four schools with multidisciplinary approach (Fig. 1.2).

Cadre Strength

Table 1.1. Cadre strength of the institute as on March 31, 2019

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	21	29
Technical	33	13	20
Administrative	21	05	16
Grand Total	105	40	65

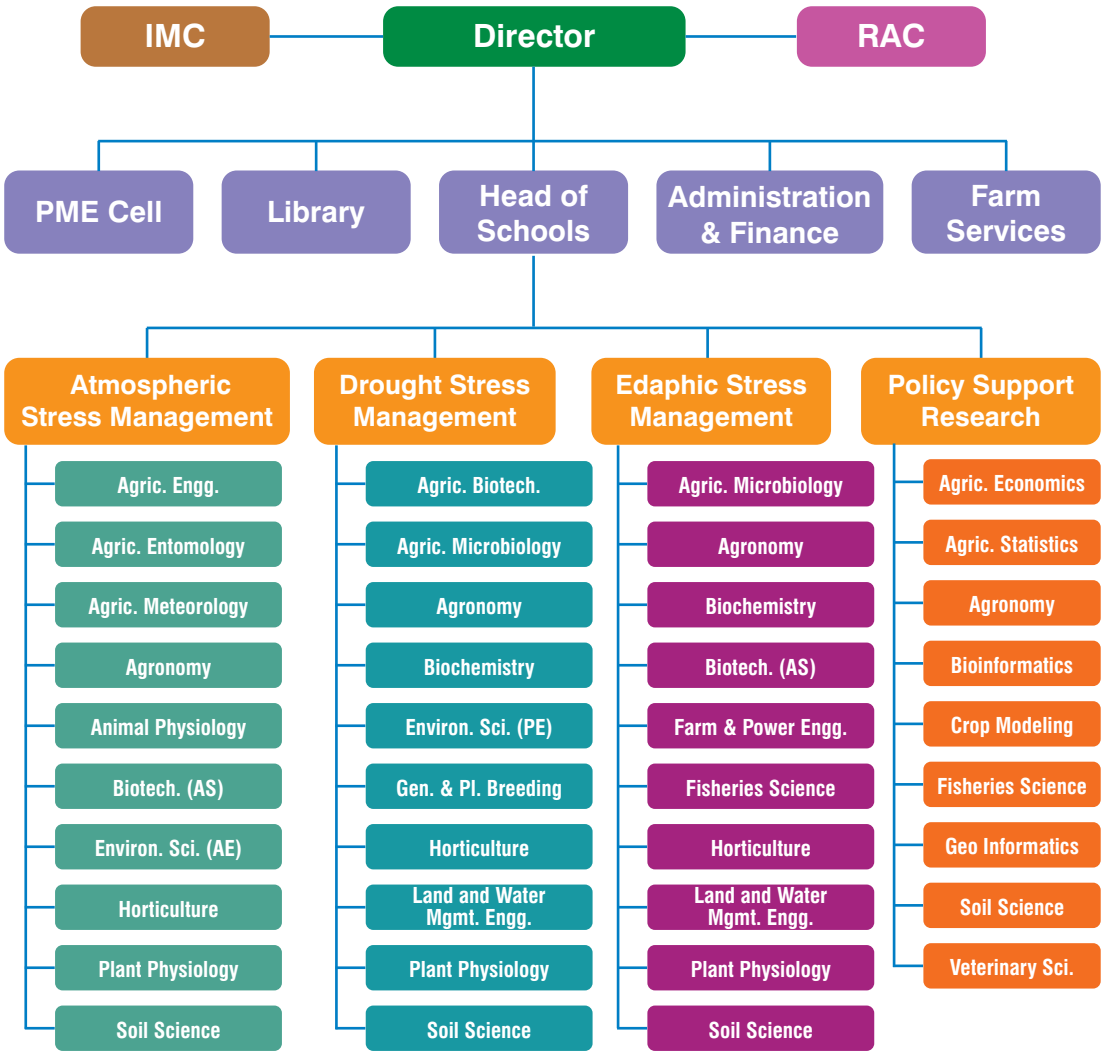

Fig. 1.2. Organogram of the institute

Research Programmes of the Institute

School of Atmospheric Stress Management

- Impact of extreme weather events like elevated CO_2, high and low temperature, freezing injury, etc. on major food and horticultural crops, livestock and fisheries
- Assessment of photosynthesis, growth and productivity of rice and wheat under Atmospheric Brown Clouds (ABC) of black carbon and other aerosols, isolation of relevant genes for conferring tolerance to ABC
- Elucidating metabolic and molecular basis of adaptation of crops, animals, fish and microbes to elevated CO_2 and temperature using "omics" approach as well as systems biology strategies
- Developing Decision Support System (DSS) for mitigating the effect of extreme weather events

School of Drought Stress Management

- Physiological manifestations, perception and transduction of stress signals and regulation of stress responsive gene expression and efficient screening techniques for abiotic stress tolerance
- Mining of genes involved in stress tolerance from indigenous sources for improvement of major food and horticultural crops
- Use of genomics, phenomics, proteomics and metabolomics for enhancing abiotic stress tolerance in major food crops with a focus on wheat, rice, maize, groundnut, pulses, vegetables, mango, citrus, grapes and papaya
- Plant-microbe interactions in the rhizosphere, which enhance drought tolerance

School of Edaphic Stress Management

- Genetic and molecular basis of tolerance and ion homeostasis under salinity, nutrient deficiencies, heavy metal excesses and poor water quality in major food and horticultural crops, animals, microorganisms and fishes
- Soil metagenome studies to mine and isolate novel genes that confer tolerance to above stresses
- Application of nanotechnology and nano-materials for evolving novel products and methods for bioremediation and bio-trapping
- Impact of submergence and anoxia on crop growth and productivity through use of systems biology approach
- Assessment of soil as a sink for greenhouse gases and methods in mitigation of salinity and heavy metal stresses

School of Policy Support Research

- Evolving remediation strategies for moderation of abiotic stresses
- Designing novel management options that provide opportunity for stress mitigation and carbon trading under Clean Development Mechanisms (CDM)

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Weather at ICAR-NIASM

Weather at ICAR-NIASM

Information on weather is of paramount importance for agricultural productivity. Observations of weather parameters are being recorded at this Institute on regular basis and whichwere recorded during April, 2018 to March, 2019, are depicted here. During 2018-19, the monthly mean temperature varied between 20.2°C (January, 2019) and 31.5°C (May, 2018) (Fig. 1.3). Monthly maximum temperature reached its peak in May 2018 (39.6°C) and dipped to 29.4°C in July 2018. For minimum temperature, May, 2018 recorded the highest (23.3°C) and January, 2019 recorded the lowest (10.7°C) value. Daily maximum temperature has reached up to 41.7°C (May 2, 2018) while lowest daily minimum temperature dipped up to 5.7°C (Dec 29, 2018). A heat wave was observed from April 29 to May 05, 2018 as during all the days maximum temperature was reached above 40°C which is more than 1.5°C higher than the normal temperature for each day. A cold wave was observed from Decemer 28, 2018 to January 01, 2019 as during all these days minimum temperature was dipped below 6°C and it was about 1-2°C lesser than the normal temperature for each day. Annual mean monthly relative humidity averaged over the entire year stood at 57% and ranged between 35% and 78% (Fig. 1.4). Higher diurnal ranges in RH were observed in the months of January, February when it was more than 45%. Lowest diurnal range was observed in the month of July (16%) followed by August (17%).

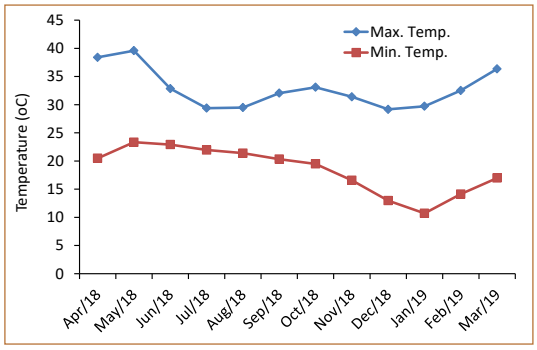


Fig. 1.3. Mean maximum and minimum air temp. during April 2018 to March 2019

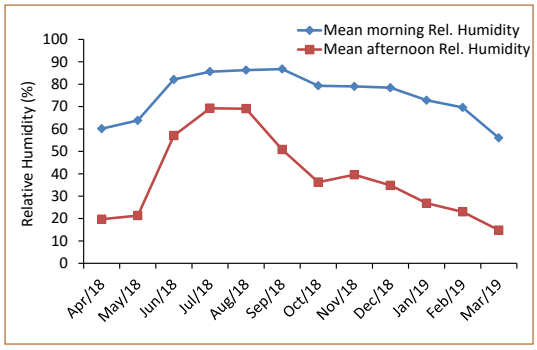


Fig. 1.4. Mean monthly evaporation and morning and afternoon relative humidity

This time rainfall distributed in 23 meteorological rainy days yielded total of 351.2 mm rain (Fig. 1.5). The rain commenced from June 7, 2018 at normal onset of monsoon and withdrew from October 5, 2018. The maximum rainfall was received during June 2018 (143.6 mm) followed by September 2018 (36.4 mm). In the post-monsoon season, highest rainfall occurred in October 2018 (80.8 mm) and during the summer season in April 2018 (14.8 mm). Monsoon rainfall occurred 233.1 mm (42% deficit of normal) in 15 rainy days. A long dry spell was observed during June 25 to 17 September 2018. During this peak monsoon period of 85 Days only 56 mm of rainfall received.

During this year, monthly average wind speed values have been found to vary between 4.1 (January 2019) and 13.8 Km h^{-1} (August 2018) and annual average for the daily wind speed stood at 7.7 km hr^{-1} (Fig. 1.6).

Annual Class A open pan evaporation (Pan-E) aggregates to 2321.7 mm which was about 6 times this year's rainfall. The highest evaporative demand occurred during May 2018 (11.4 mm d^{-1}) whereas the lowest was in December 2018 (4.1 mm d^{-1}). The annual average of daily Pan-E was 6.4 mm.

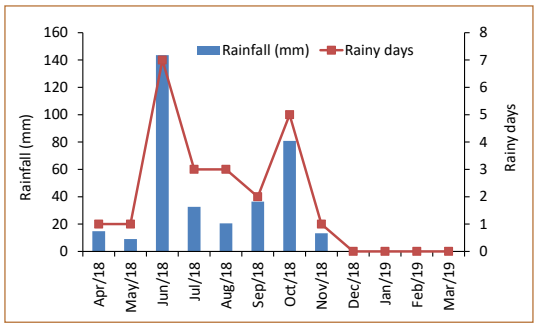


Fig. 1.5. Trend of mean monthly rainfall and number of rainy days

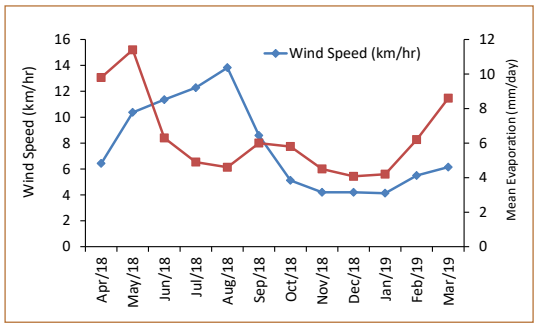


Fig. 1.6. Mean monthly evaporation and morning and afternoon relative humidity

The mean monthly sunshine hour recorded range from 2.1 hours (July 2018) to 9.4 (February 2019). Mean monthly sunshine hours were lower during rainy season compared to rest of the months of the year.

Table 1.2. Mean monthly weather parameters recorded at ICAR-NIASM from April, 2018 to March 2019

Parameters	Months											
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Mean max Temp (°C)	38.4	39.6	32.9	29.4	29.5	32.1	33.1	31.4	29.2	29.7	32.5	36.4
Mean min Temp (°C)	20.5	23.3	22.9	22.0	21.4	20.3	19.5	16.6	13.0	10.7	14.1	17.0
Mean morning RH (%)	60	64	82	86	86	87	79	79	78	73	70	56
Mean afternoon RH (%)	20	21	57	69	69	51	36	40	35	27	23	15
Mean wind speed (km/hr)	6.4	10.4	11.4	12.3	13.8	8.6	5.1	4.2	4.2	4.1	5.5	6.1
Sunshine (Hrs/day)	9.0	8.3	3.2	2.1	2.5	6.6	8.2	8.0	7.6	8.6	9.4	9.0
Total rain (mm)	14.8	9.0	143.6	32.6	20.5	36.4	80.8	13.3	0.2	0.0	0.0	0.0
Total rainy days	1	1	7	3	3	2	5	1	0	0	0	0
Pan evaporation (mm/day)	9.8	11.4	6.3	4.9	4.6	6.0	5.8	4.5	4.1	4.2	6.2	8.6

Table 1.3. Important dates of observations during April, 2018 to March, 2019 with highest and lowest values of weather parameter

Particular of weather parameter	Value	Date
Highest maximum temperature	41.7°C	02 May 2018
Lowest minimum temperature	5.7°C	29 December 2018
Highest rainfall	76.2 mm	22 June 2018
Highest pan evaporation	14.2 mm/day	30 April 2018
Highest wind speed	18.9 km/hr/day	12 August 2018

2 Research Highlights

School of Edaphic Stress Management

School of Edaphic Stress Management

Evaluation of halotolerant rhizobium and PGP based biomolecules for alleviation of drought and salt stress (0XX04473)

KK Meena, GC Wakchaure, CB Harisha, Narendra Pratap Singh

Halotolerant Rhizobium strains and biopolymer improve yield and drought tolerance in fenugreek

Two halotolerant *Rhizobium* strains - I and II were inoculated in drought-exposed fenugreek crop to assess their influence on growth, development and yield. Both the strains were inoculated through seed-coating; with, and without carrier material to determine the most appropriate route of delivery for optimal establishment, and interaction of rhizobium strains with the host plants. The treated seeds were sown in the experimental farm at ICAR-NIASM campus. Two irrigation regimes viz., full irrigation (FI), and restricted irrigation (RI) were maintained. A separate treatment of Rhizobium-derived biopolymer was also included in the form of foliar application.

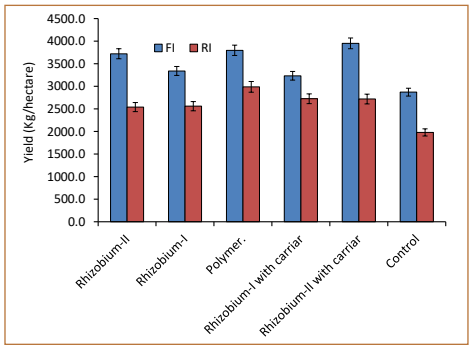
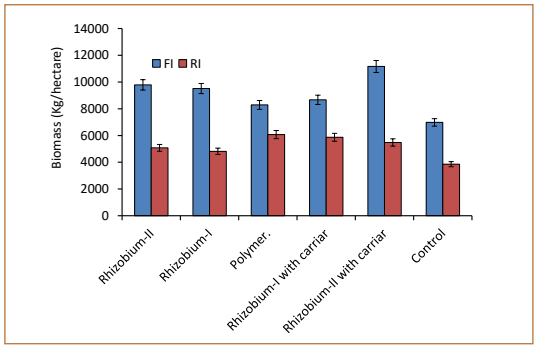


Fig. 2.1. Fenugreek seed yield and biomass under the influence of different treatment and irrigation regimes



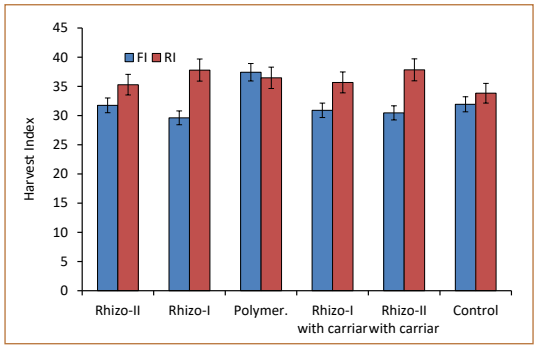


Fig. 2.2. Harvest index of fenugreek crop under the influence of different treatment and irrigation regimes

The experimental outcomes were monitored in terms of different physicochemical traits of the crop including yield, biomass, and harvest index (Figs. 2.1, 2.2). Amongst the all treatments the *Rhizobium* strain-II and Biopolymer enhanced the crop yield and biomass under both the full and restricted irrigation regimes, compared to other treatment; however, rest of the treatments too performed better over the control. Harvest index under restricted irrigation was higher in all the treatments and control, except for the treatment with biopolymer. The overall results successfully demonstrated the beneficiary influence of Rhizobium strain-II, and the

Biopolymer on fenugreek crop under water deficit conditions. Inoculation of the said strains; and treatment with biopolymer is therefore recommendable for sustainable farming of fenugreek.

Isolation and characterization of biomolecule producing bacteria for salt stress alleviation in major crops (IXX10378)

KK Meena

Inoculation with halotolerant Enterobacter enhance germination, establishment and salinity tolerance in wheat

The strain was isolated from the saline habitats of Sangvi region in Baramati area. The strain exhibited exceptional plant growth promoting ability even under adverse conditions in vitro (Table 2.1). Several characteristics of the strain were investigated in different growth media under saline, water deficit, and pH environments. The strain also exhibited tolerance to high salt concentrations. Moreover the strain actively fixed atmospheric nitrogen; and also solubilized mineral phosphate in vitro up to 5% of NaCl.

Production of indole-3-acetic acid (IAA) and exopolysaccharides are also important with respect to plant growth promoting ability of the microbes. In this study, the strain produced fairly large quantity of IAA in presence of the precursor-tryptophan. Ability of the strain to metabolize carbon source under varied pH and salinity environments was also investigated (Table 2.1). Another important characters of the strain included production of IAA and siderophores under water deficit conditions (PEG environment). Overall biochemical traits of the strain indicated high metabolic plasticity.

Table 2.1. Characterization of samples and metabolic plasticity of the isolates

Characteristic	Condition	D3 (Bacterial strain)
Source		Rhizosphere soil of Sugarcane
Electrical Conductivity (dS m^{-1})		7.558
Sidropphore production	1% NaCl	++
	5% NaCl	++
	10% NaCl	-
Catalase production		++
Nitrogen Fixation	1% NaCl	+
	5% NaCl	(+)
	10% NaCl	-
IAA Production (µg ml^{-1})	With tryptophan	15.25
	Without tryptophan (at 5% NaCl)	0.81

Characteristic	Condition	D3 (Bacterial strain)
Phosphate Solubilization	1% NaCl	++
	2% NaCl	++
	5% NaCl	+
	10% NaCl	-
EPS production		-
Sugar Fermntation (Dextrose)	0.5% NaCl, pH 7	++ (24h)
	0.5% NaCl, pH 8	++ (24h)
	0.5% NaCl, pH 9	++ (24h)
	5% NaCl, pH 7	++ (24h)
	5% NaCl, pH 8	+ (24h)
	5% NaCl, pH 9	-
	10% NaCl, pH 7	++ (48h)
	10% NaCl, pH 8	-
	10% NaCl, pH 9	-
	15% Nacl, pH 7	-
	15% Nacl, pH 8	-
IAA production (µg ml-1) in presence of PEG	10% PEG	0.23
	20% PEG	0.30
	30% PEG	-
Sidropphore production at 10% PEG	At 24h	121.06 U
	At 48h	589.26 U
Sidropphore production at 20% PEG	At 24h	-
	At 48h	-

Promising traits of the strain further endorsed the detailed evaluation *in planta*. Therefore an experiment was conducted to investigate ability of the strain to mitigate the salinity stress in wheat. The strain was applied by seed coating technique. Physicochemical traits of the seedlings were keenly monitored. Results highlighted enhancement of important traits including germination, development and physico-chemical status of the seedlings (Fig. 2.3).

The overall results indicated significant improvements in physico-chemical characteristics of the seedlings over the control even at higher salinity, indicating further evaluation of the said strain for mitigation of salinity stress in wheat as well as in other crop plants.

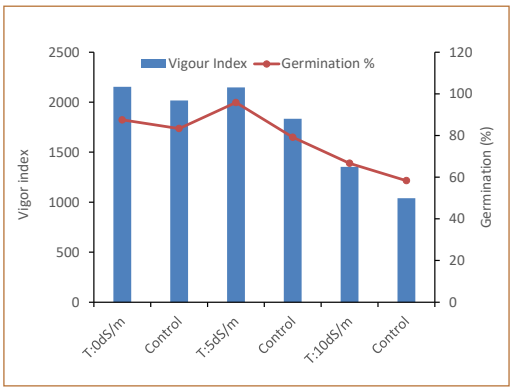


Fig. 2.3. Per cent germination and vigor index at different salinity levels

Raising rice productivity through drought tolerant rice varieties and their matching management practices in rainfed environment of Maharashtra (0XX03978)

Yogeshwar Singh, DD Nangare, Mahesh Kumar, Narendra Pratap Singh

An experiment was conducted during kharif, 2018 to study the impact of agrochemicals and bioregulators in alleviation of drought stress in aerobic rice under Greenhouse conditions. Treatment comprising seed treatment with salicylic acid (100 ppm) & foliar spray of $FeSO_4$ (1%) at maximum tillering and panicle emergence stage has been identified as suitable measure to minimize moisture stress in direct seeded aerobic rice (Fig. 2.4A, B). While use of biopolymer (developed at ICAR-NIASM) along with foliar spray of multi micronutrient complex (@1%) at maximum tillering and panicle emergence stage resulted in 18.4% yield increase under normal irrigation conditions.

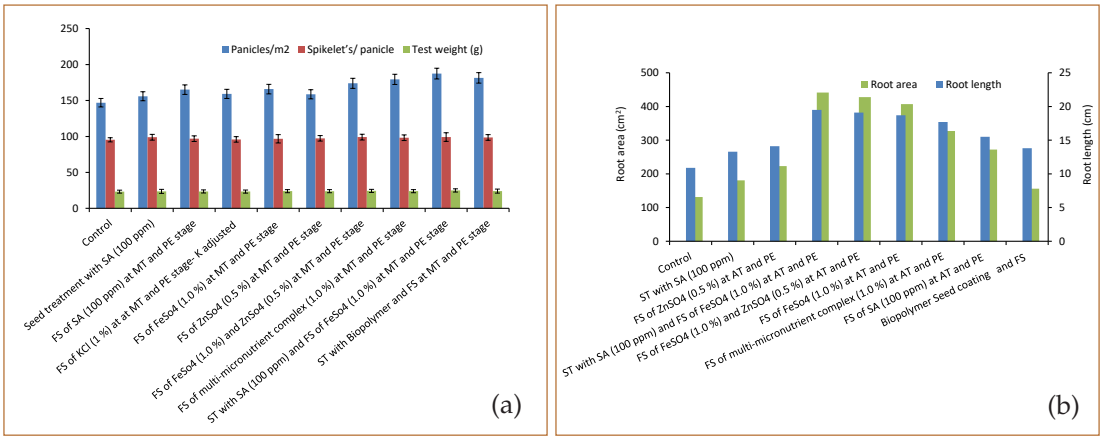


Fig. 2.4. Effect of different treatments on yield attributes (a) and root parameters (b)

Table 2.2. Effect of different treatments on yield of direct seeded aerobic rice

Treatments	SM1 (Ideal soil moisture)	SM2 (Soil moisture stress)
B1	38.7	33.8
B2	40.4	36.5
B3	42.0	37.7
B4	41.4	36.8
B5	43.1	40.6
B6	42.7	39.3
B7	43.8	41.2
B8	43.6	40.0
B9	46.7	43.1
B10	47.0	40.8
CD (P=0.01)	2.9	

Table 2.3. Effect of different treatments on yield attributes and yield of direct seeded aerobic rice

Treatments	Panicles/m^2	Spikelet's/ panicle	Grain Yield (q/ha)
DRR-42	213.09	113.2	49.2
DRR-44	209.4	109.7	46.8
DRR-46	210.4	106.5	45.1
Sahbhagi	200.1	106.7	40.9
Indrayani	204.6	103.1	44.7
CD (P=0.05)	10.9	5.9	3.4

Based on the experiments conducted at farmers field DRR 42 has been identified as potential variety for rainfed conditions of Semi-arid region of Maharashtra which performed better than Indrayani (local check). Problem of crop lodging was noticed in DRR 44 due to which farmers are interested in cultivation of DRR 42.

Development of climate resilient Integrated Organic Farming System Model for Semi-arid region

Narendra Pratap Singh, Yogeshwar Singh, CB Harisha and PB Taware

An experiment entitled "Development of climate resilient Integrated Organic Farming System Model for Semi-arid region" was initiated to develop a farming system model in order to address multiple abiotic stresses. Model is supposed to be developed for small and marginal farmers facing problems of various abiotic stresses. Out of one hectare area 2500 m^2 has been assigned to vegetable crops, 2500 m^2 for sugarcane based cropping sequence, 1000 m^2 for fodder crops, 1000 m^2 for cereals and pulse crops, 2000 m^2 for orchard crops (pomegranate, Sapota, Custard apple, Mango), 100 m^2 pond for storage of water to provide irrigation to crops though drip and 500 m^2 for poultry (Vanaraja, Kadaknath and ornamental breed), goatry (Osmanabadhi breed), cattle (ghir) and compost unit. A solar operated water pump (3 KV) has been installed near water storage pond for supporting irrigation to the crops. Attempts will be make to 100% organic and self-dependent in nutrient requirement of the crops and feed and fodder requirement of the livestock. Mango, lemon, dragon fruit and papaya have been planted along the borders of all the experimental plots. Intercropping of chick pea was done in orchard crops for getting return from orchard field during initial years. Similarly intercropping of drumstick has been done with Napier grass for getting maximum return. To ensure regular and daily income vegetable crops such as bhindi, cowpea, cabbage, tomato, bottle gourd, pumpkin, onion, garlic, coriander and sweet corn crops were planted in an area of 2500 m^2.

(a) Crop component in integrated farming system

(b) Animal component in integrated farming system

(c) Utilization of farm waste and natural resources

Fig. 2.5a,b,c. Climate resilient Integrated Farming System model

Techniques to obviate edaphic stresses in orchards grown on shallow basaltic soils (IXX11584)

Yogeshwar Singh, DD Nangare, Jagadish Rane, Mahesh Kumar, PB Taware

In peninsular India large areas are developed from superficially subdued basalt igneous rocks exist. These lands are porous, shallow in depth, gravelly, low in organic matter, high bulk density and poor water retention capacity. The negative impacts of shallowness in terms of low water retention, hard rocks and murrum etc. are the major constraints for establishment of orchards in these shallow basaltic soils.

An experiment entitled "Innovative Techniques to obviate edaphic and drought stresses on orchards grown on shallow basaltic soils" has been initiated in 2013 at ICAR-NIASM, Baramati on Pomegranate (shallow rooted), Guava (medium rooted) and Sapota (deep rooted) fruit crops to increase economic longevity of theses orchards and to address the issues of edaphic and drought stresses.

Table 2.4. Effect of various treatments on performance of Pomegranate

Pomegranate yield (t/ha)								
Planting method	Without blasting				With blasting			
	Native	Native + spent wash	Native + black	Black	Native	Native + spent wash	Native + black	Black
Auger	13.7	13.9	14.9	11.6	14.2	14.9	17.3	12.3
Pit	15.8	16.0	22.1	-	19.9	-	22.9	-
Pit (2*1)	16.4	-	25.9	-	20.4	-	26.1	-
Trench	14.6	-	19.7	-	19.2	-	22.5	-
FP	13.9	14.5	-	-	-	-	-	-
CD (P=0.05)	2.8							

Table 2.5. Effect of various treatments on performance of Guava

Guava yield (t/ha)								
Planting method	Without blasting				With blasting			
	Native	Native + spent wash	Native + black	Black	Native	Native + spent wash	Native + black	Black
Auger	12.3	12.1	14.5	11.0	15.0	12.1	16.2	11.9
Pit	15.1	14.8	16.7	-	17.1	16.9	20.2	-
Pit (2*1)	15.9	-	18.6	-	18.5	-	22.3	-
Trench	15.4	-	16.1	-	17.7	-	18.7	-
FP	12.0	11.3	-	-	-	-	-	-
CD (P=0.05)	2.4	-	-	-	-	-	-	-

Table 2.6. Effect of various treatments on performance of Sapota

Sapota yield (t/ha)						
Planting method	Without blasting			With blasting		
	Native	Native + black	Black	Native	Native + black	Black
Auger	8.48	9.17	7.98	9.70	10.08	8.59
Pit	9.46	10.39	-	11.15	11.43	-
Trench	9.75	10.08	-	10.82	11.23	-
FP	7.52	-	-	-	-	-
FP + Spent wash	7.70	-	-	-	-	-
CD (P=0.05)	0.61	-	-	-	-	-

Observations made during investigation period clearly indicate that planting method is helping in minimising the negative impact of drought and edaphic stresses. Significant influence of various treatments was monitored on performance of all the three fruit crops having different rooting pattern. Pomegranate being the shallow rooting pattern showed best result in Pit (2x1 m^2) planted orchards which are performing better than trench and auger planting, while in case of guava and sapota pit and trench planting are performing at par. Similarly micro-blasting proved its superiority over without micro-blast treatments in mitigating multiple stresses of these orchards but the impact was more prominent in guava and sapota. It is mainly due to the reason that mico-blasted cracked rocks could further facilitate the root penetration and water conservation. Mixtures of black soil and native murrum have been noticed as a good mitigation option to mitigate drought and edaphic stresses in these orchard crops.

An experiment has been carried out with an objective to develop suitable production technology for introducing dragon fruit (*Hylocerus undatus*) as a new crop

to adopt in low rainfall water scarce zone for rocky land. The results of experiments are very encouraging which has resulted in gaining rapid popularity amongst farmers. In this experiment dragon fruit crop has been planted under three different filling mixtures viz. 100% native murrum soil; 50% Native murrum soil + 50% black soil and 100% black soil. There were total eight harvesting from each plant during the fruiting season. Dragon fruit yield varies from 14.2 to 19.7 t/ha in three different soil mixtures. The maximum yield was obtained in treatment receiving mixture of native murrum and black soil.

Table 2.7. Performance of Dragon fruit under various treatments

Parameters	Native	Black	Mix
Average fruit weight (g)	210.3	189.4	217.4
Yield (t/ha)	18.1	14.2	19.7
Net Return (Rs lakh/ha)	9.88	10.51	14.80

Characterising sugarcane and citrus stress responses to biotic and abiotic stresses through hyperspectral remote sensing (0XX03595)

Yogeshwar Singh, Bhaskar Gaikwad, DD Nangare, Mahesh Kumar

The sugarcane and citrus crop were studied with aim to distinguish crop conditions under non-limiting growth environment and growth environment where crop growth potential has been limited by various factors of abiotic stresses such as atmospheric drought, nutrient deficiency and biotic stress such as insect pest using spectral information acquired through ground based spectrometry. A portable spectroradiometer (ASD FieldSpec4) was used to collect the spectral reflectance data from sugarcane and citrus canopy and leaves. Leaf samples were analysed to determine different biochemical parameters according to standard laboratory producers. Experimental data were analysed using statistical analysis (multivariate models and machine learning techniques).

Multi-variate models used for monitoring leaf biochemical changes

Multivariate models are the way to analyze data using only one dependent and more than one independent variable. Partial least squares (PLS) regression has become a commonly used method to relate spectral data to biochemical concentration in plant canopies and leaves. PLS was used in this study to identify the contributing spectral bands with relating the spectral bands with respect to biochemical parameters. Similarly, Random Forest (RF) Regression and Support Vector Regression (SVR) were applied on both sugarcane and citrus data to identify which model will work better on the given set of field spectral data. These models were applied to leaf biochemical content among reflectance values.

Among these multivariate models, RF was the best model for prediction of various biochemical parameters for calibration and validation (Table 2.8, 2.9) followed by PLSR in both crops. In sugarcane crop, PLSR was the best predicting model for prediction of leaf nitrogen content (R^2 and RMSE of 0.82 and 0.11, respectively),

similarly in citrus PLSR was the best predicting model for prediction of relative water content (R^2 and RMSE of 0.57 and 4.40, respectively). However, among the overall study RF models noted maximum coefficient of determination (R^2) than PLSR and SVR.

Table 2.8. Coefficient of determination (R^2) and root mean square error of multivariate models obtained from spectral signatures and biochemical parameters in sugarcane

Physiological and biochemical parameters	R-square			RMSE		
	PLSR	SVR	RF	PLSR	SVR	RF
Chlorophyll Content	0.60	0.53	0.67	0.29	0.32	0.27
Relative Water Content	0.55	0.52	0.6	4.39	4.17	4.16
Proline Content	0.18	0.33	0.36	1.22	1.27	1.07
Leaf Nitrogen Content	0.82	0.79	0.72	0.11	0.12	0.14
Leaf Phosphorous Content	0.52	0.56	0.55	0.02	0.021	0.02
Total Sugar Content	0.66	0.7	0.69	4.64	4.58	4.41
Reducing Sugar Content	0.57	0.6	0.57	2.21	2.54	2.22

Table 2.9. Coefficient of determination (R^2) and root mean square error of multivariate models obtained from spectral signatures and biochemical parameters in sugarcane citrus

Physiological and biochemical parameters	R-square			RMSE		
	PLSR	SVR	RF	PLSR	SVR	RF
Chlorophyll Content	0.42	0.45	0.52	0.44	0.43	0.41
Relative Water Content	0.57	0.53	0.51	4.40	4.61	4.93
Proline Content	0.41	0.30	0.47	1.40	1.57	1.40
Total Sugar Content	0.28	0.30	0.40	4.14	4.09	3.84
Reducing Sugar Content	0.32	0.35	0.25	2.48	2.43	2.14

Stage wise classification of Sugarcane through principal component analysis and support vector classification

Canopy spectral signature of sugarcane for different stages (tillering, formative, grand growth I, grand growth II and maturity) was collected through ASD FiedlSpec4 and classified with Principal Component Analysis (PCA) and Support Vector Machine (SVM). SVM noted 76.3% overall classification accuracy and PCA was used for visualizing the complex set of data which forms the clusters for five different stages in sugarcane. Confusion matrix generated through SVM showed high classification accuracy for tillering, formative, grand growth-II and maturity stage whereas formative stage showed poor classification result.

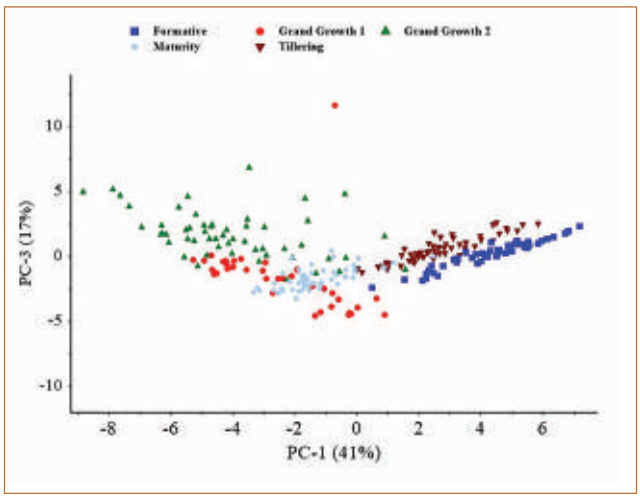


Fig. 2.6. Stage wise classification of sugarcane through PCA

Table 2.10. Confusion matrix for stage wise classification accuracy through SVC

Predicted/Actual	Tillering	Formative	Grand Growth I	Grand Growth II	Maturity
Tillering	144	50	0	34	1
Formative	0	75	0	0	0
Grand Growth I	0	6	134	0	22
Grand Growth II	0	5	0	108	0
Maturity	0	8	10	2	121
Accuracy (%)	100.00	52.08	93.06	75.00	84.03

Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (0XX03432)

Yogeshwar Singh, RL Choudhary, KK Meena, GC Wakchaure, Mahesh Kumar, Paritosh Kumar, Narendra Pratap Singh

Effect of micro irrigation, planting techniques and residue management practices on sugarcane productivity

Sugarcane water requirement is very high (~ 3000 mm) and due to changing climatic scenario inadequate supply of water will result in great yield penalty. Subsurface drip irrigation (SSDI) technique offers many advantages over surface drip irrigation (SDI) such as; reduced evaporation, efficient water use, greater water uniformity and thus reduces the water requirement of the crop. However in case of sugarcane, SSDI is taken up in very less area and mostly advocated with paired row planting technique. Though, paired row planting technique saves the irrigation water and also number of drip laterals and their installation costs but also often have resulted lower cane yield production due to inter-row competition between the paired rows. Thus, standardization of planting geometry of paired rows and spacing of drip laterals for SDI and SSDI under paired row planting systems is needed. In addition to this,

surface retention of crop residues in conjunction with micro irrigation techniques would be helpful in improving hydro-thermal regimes and soil health further. Keeping these things in mind, a field experiment was conducted with six main plot treatments viz., M1: parallel planting of each plant in single rows spaced at 150 cm with surface drip irrigation (PSR-150 cm + SDI); M2: parallel planting of each plant of paired rows by maintaining spacing of 90 cm between the rows and 210 cm between the pairs with SDI (PPR-90-210 cm + SDI); M3: zigzag planting of each plant of paired rows by maintaining spacing of 75 cm between the rows and 225 cm between the pairs with SDI (ZPR-75-225 cm + SDI); M4: ZPR-60-240 cm + SDI; M5: ZPR-75-225 cm + SSDI; M6: ZPR-60-240 cm + SSDI. Two treatment of soil surface cover management practices viz., T1: Residue; covering of soil surface with a live mulch of mungbean followed by retention of mungbean residue and trash as mulch and T2: without residue were accommodated in sub-plots. An absolute control surface irrigation management practices was also maintained to compare the treatment effects.

The amount of applied irrigation water was equal to 100 and 80% of the crop evapotranspiration (ETC) under surface and subsurface irrigation methods. The crop was irrigated at 2 days intervals under SDI and SSDI and at 80 mm CPE under surface irrigation method.

The maximum cane yield (141.7 t ha^{-1}) was recorded under the M5 (ZPR-75-225 cm + SSDI) treatment which was significantly higher by 5-14% as compared to remaining planting and micro irrigation techniques, except M1 (PSR-150 cm + SDI) and M3 (ZPR-75-225 cm + SDI) treatments (Fig. 2.7). While covering of soil surface with live mulch of mungbean followed by retention of mungbean residue and trash in the field improved the cane yield on an average by 11% as compared to without residue retained treatment. This indicated that yield of paired row planted sugarcane could be improved significantly with adoption of zigzag planting, micro irrigation techniques and retaining the crop residues on soil surface.

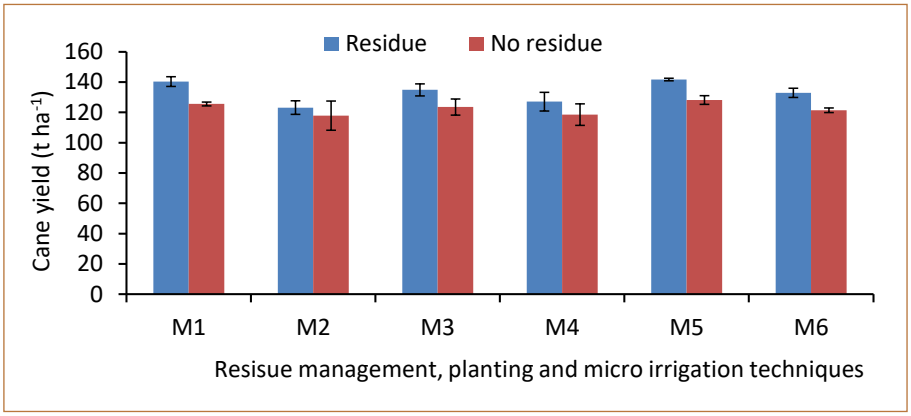


Fig. 2.7. Effect of crop residue, micro irrigation and planting techniques on cane yield of sugarcane

Seed yield of mungbean (3.8-7.9 q ha^{-1}) could also be obtained while growing of mungbean as intercrop with sugarcane for live mulch and recyclable residue (Fig 2.8). The mungbean seed yield of was recorded maximum with M1 (PSR-150 cm + SDI) which was 39-84% higher than rest of the treatments.

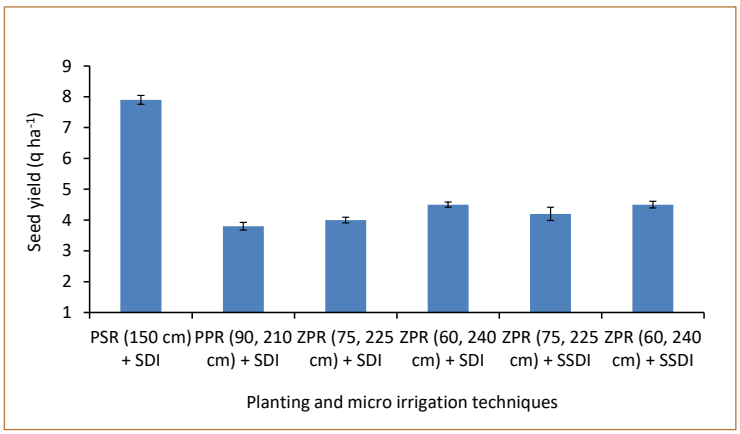


Fig. 2.8. Effect of planting and micro irrigation techniques on seed yield of mungbean

Effect of trash, fertilizer-nitrogen and SORF techniques practices on soil properties

Adoption of SORF techniques along with surface retention of chopped trash and influenced the soil properties significantly ($P \leq 0.05$) over conventional farmers' practices of trash burning and broadcast application of fertilizers. The significantly lower values of bulk density was recorded under surface retention of trash and SORF techniques (CT+SORF) as compared to trash burnt/ removed and control treatments (No-trash + No-N) in surface (0-15 cm) (Fig. 2.9). However, different practices of trash, fert-N and ratoon management did not influence the soil bulk density in sub-surface (15-30 cm) soil layer.

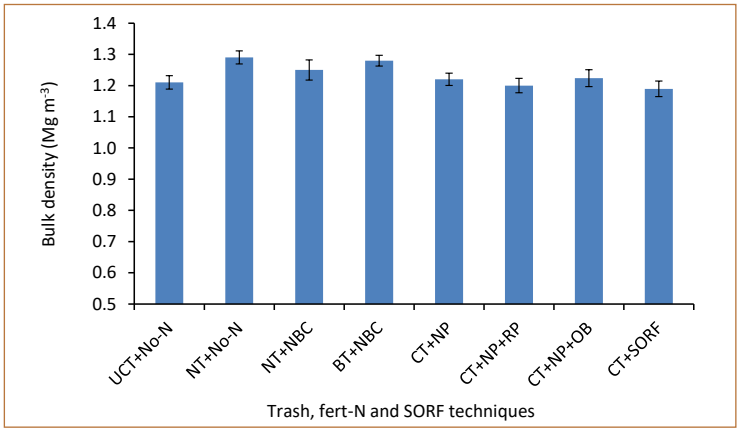


Fig. 2.9. Effect of trash, fert.-N and SORF techniques on bulk density in 0-15 cm soil layer

Soil organic carbon content (SOC) in 0-15 cm soil layer build-up was noticed under the trash retained treatments. The maximum SOC content was recorded under CT+SORF treatment which was closely followed by other chopped trash + N placement treatments. Surface retention of chopped trash improved the SOC content by 6-17% over un-chopped trash/trash removal or trash burnt treatments (Fig. 2.10). Surface retention of trash and other ratoon management practices did not influence the SOC content in 15-30 cm soil layer.

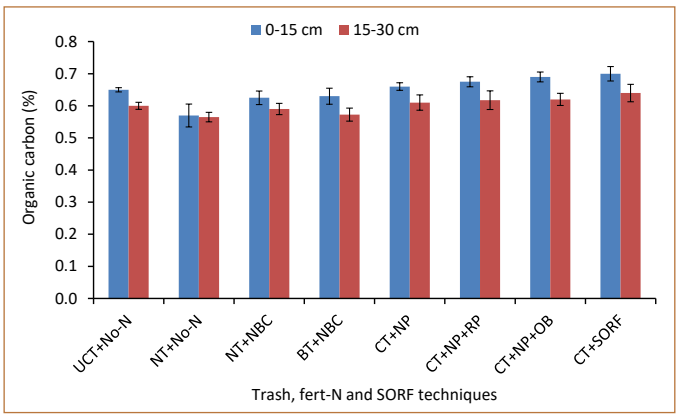


Fig. 2.10. Effect of trash, fert.-N and SORF techniques on organic carbon content in surface (0-15 cm) and subsurface (15-30) cm soil layers

In current climate change scenario whole world is focusing on the technologies for decreasing greenhouse gas emission and environmental degradation. Agriculture is one the major contributor of greenhouse gas emission and mainly of carbon dioxide, nitrous oxide and methane. These emissions depend mainly on the management practices like tillage, fertilizer applications and irrigation etc. Sugarcane is one of the nutrient and water intensive crop of Maharashtra which is growing under various management practices. Conservation agriculture is one of the most adopted technology worldwide including Maharashtra to enhance the resource use efficiency and reduce the environmental degradation. On site crop residue burning is one of the common traditional practices following throughout India for residue management including Maharashtra. A research was conducted to develop a method to monitor the carbon dioxide (CO_2) flux/emission from Sugarcane field under crop residue burnt and residue retained conditions in Maharashtra.

For the sampling of soil carbon dioxide gas emission closed chamber method was used while for their quantification a titration based method is still in standardization stage. In closed chamber method a polypropylene chamber of dimension 30cm length, 30cm width and 40cm height was installed between rows of sugarcane for emitted gas collection. In 24 hour interval the emitted gas mixture was sampled in a syringe after homogenization with 12V DC motorized fan. The collected gas sample of 10ml volume was bubbled in 100ml 1N NaOH solution and allowed to absorb the present CO_2 in the gas mixture for the formation of sodium carbonate (Na_2CO_3). The unreacted NaOH content in the solution was quantified after titration against 0.01N hydrochloric acid in the presence of methyl orange indicator. Carbon dioxide content in the gas mixture was equivalent to the reacted sodium hydroxide or sodium carbonate formed in the solution. Variation in CO_2 flux from sugarcane field under trash burnt and trash retained condition was calculated per month. Based on the collected data since October 2018 the average carbon dioxide emission from sugarcane field was observed 0.43 ± 0.08 kg/ha/month. However, there is no significant difference in carbon emission from the sugarcane field under crop residue burnt and residue retained conditions was observed. In winter month soil CO_2 emission was reported minimum (0.34 ± 0.04 kg/ha/month) which is probably due to less atmospheric temperature and low soil microbial activity.

Effect of trash, fertilizer-nitrogen and SORF techniques on growth, yield attributes and cane yield of sugarcane

A field experiment was conducted with ratoon sugarcane to address the problem of environmental pollution due to trash burning (~10-20 t ha-1) of sugarcane trash, poor sprouting of stubbles, lower nutrient-use efficiency and cane productivity in ratoon sugarcane. There were eight treatment combinations of four methods of ratoon management (root pruning: RP; off-barring: OB; stubble shaving: SS and control), two fertilizer nitrogen (fert-N) application methods (broadcast as the farmer's practice: NBC and placement with multipurpose SORF machine: NP), three methods of trash management (clean cultivation/ no-trash: NT; burnt trash: BT and spreading the trash uniformly in the field after chopping with a trash cutter: CT) and two absolute controls (un-chopped trash without fert-N (UCT+No-N) and no-trash-no fert-N (NT+No-N)). The 50 and 75% of recommended dose of fert-N was applied as basal under broadcast and placement of fert-N treatments, respectively. A multi-purpose SORF machine has been developed and used for stubble shaving, off-barring, root pruning and placement of basal dose of fertilizers as per the treatments (Fig. 2.11).

Un-chopped trash | Chopped trash | Burnt trash | Clean cultivation

Band placement of fert-N (NP) | Root pruning (RP) + NP | Off-barring (OB) + NP | Stubble shaving + OB+RP+NP

Fig. 2.11. Application of treatments in experimental field of sugarcane ratoon

The perusal of data reveals that surface retention of chopped trash and adoption of SORF techniques enhanced the growth and yield parameters of sugarcane significantly ($P \leq 0.05$) over conventional farmers' practices of trash burning and broadcast application of fertilizers (Fig. 2.12). CT+SORF treatment recorded maximum plant height at maturity which was significantly higher as compared to N un-fertilized, N broadcast and N placement treatments, respectively. Surface retention of chopped trash and following either individual or in combination of ratoon management practices i.e. off-barring, root pruning and band placement of fert-N improved the plant height significantly over trash burnt/removed and broadcasting of fert-N treatments by 10-26%.

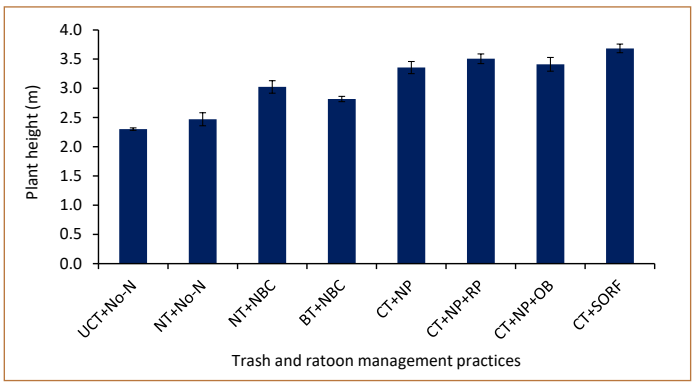


Fig. 2.12. Effect trash, fert.-N and SORF techniques on plant height of sugarcane

Similarly, the maximum numbers of tillers at maturity was also recorded with CT+SORF treatment which was closely followed by CT+NP+RP treatment and both were significantly higher over the conventional trash burnt and broadcasting of fert-N and N un-fertilized treatments (Fig. 2.13). However, surface retention of chopped trash and band placement of fert-N alone did not improve the tillers number significantly over the conventional trash burnt and broadcasting of fert-N treatments, indicated that stubble shaving and root pruning are the important practices for sustaining higher numbers of tillers of ratoon sugarcane.

The yield attributes of sugarcane were influenced significantly due to different trash, fert.-N and ratoon management practices. The maximum values of millable cane, cane length, cane weight and juice yield were recorded with CT+SORF treatment which was significantly ($P \leq 0.05$) higher than the other treatments except in case of millable cane where it was at par with CT+NP+RP treatment (Table 2.11). Surface retention of chopped trash and placement of fert-N in soil (CT+NP) improved the millable cane numbers, cane length, cane weight and juice yields by 15-53, 15-37, 20-43 and 16-40% over the conventional trash burnt and broadcasting of fert-N and N un-fertilized treatments. While pruning of older roots (CT+NP+RP) further improved these parameters over CT+NP by 6, 3, 9 and 14%, respectively. However, these parameters did not improve significantly due to off-barring (CT+NP+OB) over the placement of fert-N (CT+NP). But, cane length, cane weight and juice yields further improved significantly due to stubble shaving (CT+SORF) by 9, 14 and 9%,

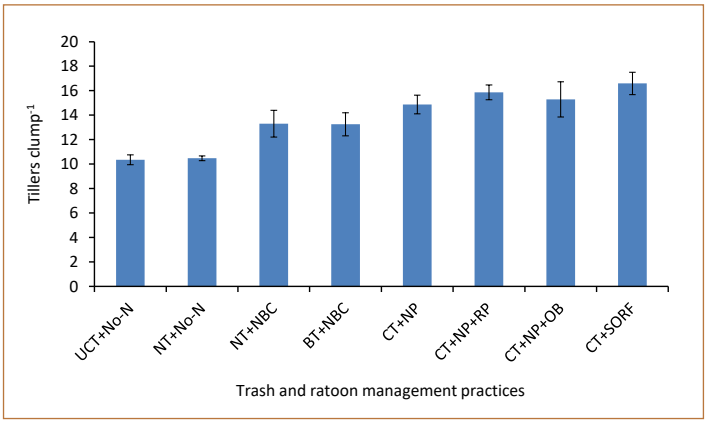


Fig. 2.13. Effect trash, fert.-N and SORF techniques on number of tillers of sugarcane

respectively over CT+NP+RP treatment, indicated the benefits of using SORF techniques together rather than their individual use.

Table 2.11. Effect of trash, fert.-N and SORF techniques on yield attributes of sugarcane

Treatments	Millable cane (1000 ha-1)	Cane length (m)	Cane weight (kg)	Juice yield (ml cane-1)
UCT+No-N	81.36	1.55	0.97	366.3
NT+No-N	86.66	1.63	0.98	384.4
NT+NBC	110.50	1.84	1.18	443.9
BT+NBC	108.02	1.84	1.16	440.2
CT+NP	124.11	2.12	1.39	511.8
CT+NP+RP	132.11	2.18	1.51	584.5
CT+NP+OB	126.20	2.17	1.46	553.0
CT+SORF	140.14	2.38	1.72	639.1
LSD (P ≤ 0.05)	12.1	0.20	0.15	51.7

Surface retention of chopped trash and placement of fert-N in soil (CT+NP) improved the cane yield significantly by 14-21 and 60-66% over conventional trash burnt/removed with N fertilized through broadcasting (NT/BT+NBC) and N un-fertilized with un-chopped trash (UCT+No-N) or without trash (NT+No-N) treatments, respectively. While pruning of older roots along with CT+NP (CT+NP+RP) improved the cane yield significantly by 24% over conventional trash burnt and broadcast application of fert-N. There was no significant improvement in the cane yield due to individual practices of root pruning and off-barring over the CT+NP. But, employing of stubble shaving, off-barring and root pruning practices together improved the cane yield significantly (P ≤ 0.05) by 15, 8 and 12% over individual practices of band placement of ferti-N, root pruning and off-barring, respectively. It indicate that shaving of stubbles, pruning of old roots of sugarcane and band placement of fert-N along with surface retention of chopped trash helps in maintaining of better plant health as reflected in the other growth and yield parameters and thus have contributed in the cane yield production. Thus, surface

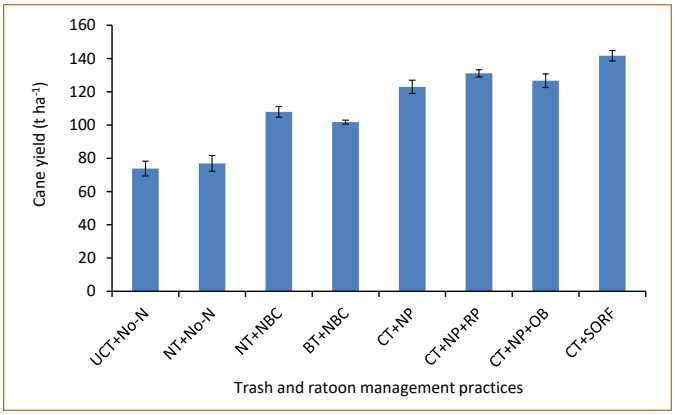


Fig. 2.14. Effect trash, fert.-N and SORF techniques on cane yield of sugarcane

retention of chopped trash and adoption of SORF techniques with application of 75% recommended dose of fert-N as basal improved the cane yield by 39% over conventional trash burnt and broadcast application of fert-N (Fig. 2.14).

Effect of tillage, crop residue and nutrient management practices on sugarcane productivity

A field experiment was conducted with three main plot treatment combination of tillage and nutrient scheduling and application methods viz., M1: laser land levelling (LLL) + conventional tillage (CT) + 10% of recommended dose of fertilizers (RDF; 250:120:120; N:P:K; kg ha^{-1}) applied as basal and remaining 90% doses of fertilizers applied through fertigation, M2: LLL + reduced tillage (RT) by excluding deep tillage + 10% of RDF as basal and 90% through fertigation and M3: LLL + RT + 10% of RDF as basal, 40% through band placement and remaining 50% through fertigation. In M3 treatment, 40% of RDF was band placed with SORF machine rather than broadcasting in standing crop at 60 days after planting of sugarcane. The fertigation was done at 15 days interval started at 15 days after planting as per the treatments. Two treatment of soil surface cover management practices viz., T1: Residue; covering of soil surface with a live mulch of mungbean followed by retention of mungbean residue and trash as mulch and T2: without residue were accommodated in sub-plots. An absolute control with CT without LLL, recommended nutrient and surface irrigation management practices was also maintained to compare the treatment effects.

The results revealed that there was no significant difference in cane yields (var. MS 10001) under conventional tillage (M1) and reduced tillage practices (M2) practices. It indicated that reduced tillage could be adopted without compromising with the cane yield. Furthermore, application of 40% of RDF through band placement and 50% of RDF through fertigation (M3) improved the cane yield significantly over the application 90% of RDF through fertigation (Fig. 2.15 & 2.16). The yield improvement with M3 over M1, M2 and conventional sugarcane management practices (M4) treatments was 11, 8 and 28%, respectively. This might be due to that band placement of 40% of RDF provided the initial boost to the crop growth and remaining 50% applied through drip fertigation helped in sustaining the crop growth during the grand growth stage through synchronized supply of nutrients.

M1: CT + RDF (90% fertigation) | M2: RT + RDF (90% fertigation) | M3: RT + RDF (40% SORF + 50% fertigation)

Fig. 2.15. Effect of tillage and nutrient management practices on performance of sugarcane

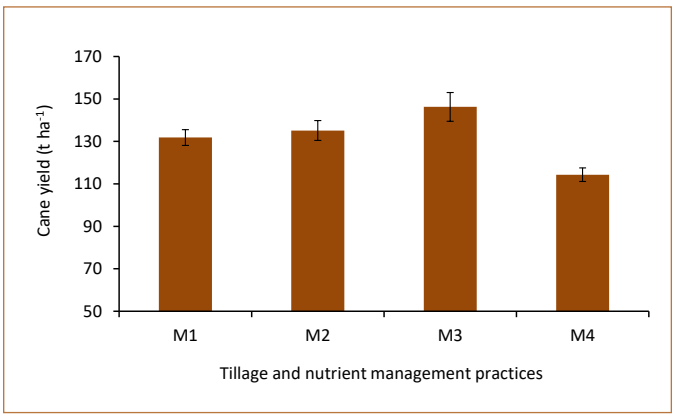


Fig. 2.16. Effect of tillage, residue and nutrient management practices on cane yield of sugarcane

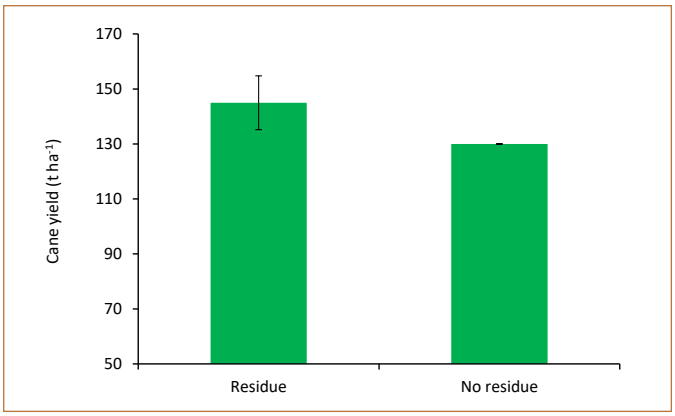
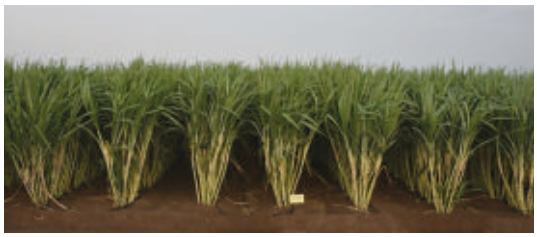


Fig. 2.17. Effect of crop residues (mungbean + trash) on cane yield of sugarcane

Furthermore, covering of soil surface with live mulch of mungbean followed by retention of mungbean residue and trash in the field improved the cane yield on an average by 10% as compared to without residue (Fig. 2.17 & 2.18).

RT with residue (mungbean + trash)



RT without residue

CT with residue (mungbean + trash)

CT without residue

Fig. 2.18. Effect of crop residues (mungbean + trash) on performance of sugarcane

Moreover, growing of mungbean with sugarcane as live mulch not only served the purpose of soil surface cover but also provided the economic seed yield and crop residues. The maximum seed yield of mungbean was recorded under M3 treatment

(RT+RDF applied with SORF (40%) & fertigation (50%)) which was 4 and 8% higher than M1 and M2 treatments, respectively . However, stover yield did not influence much due to different tillage and nutrient management practices.

Brood Stock Management, Breeding and Seed Production of Important Fin Fishes in Abiotic Stressed Farms (IXX09673)

Neeraj Kumar

The study has been conducted to delineate role of dietary Riboflavin (RF, Vitamin B-2) alone and in combined selenium nanoparticles (Se-NPs) on mitigation of concurrent exposure to arsenic and high temperature on *Pangasianodon hypophthalmus*. Fishes were fed with seven diets containing graded level of RF @ 0, 5, 10 and 15 mg/kg and RF @ 5, 10 and 15 mg/kg with Se-NPs @ 0.5 mg/kg diet for 90 days. The fishes were reader under arsenic (1/10th of LC50, 2.7 mg/L) and high temperature (34°C) throughout the experiment. The growth performance such as final weight gain percentage, feed conversion ratio, protein efficiency ratio and specific growth rate has been determined at the end of the experiment.

The weight gain (%) has been remarkably improved (P<0.01) with application of Vit B-2 @ 10 mg/kg diet, but the growth performance drastically reduced (P<0.05) in fish treated with arsenic and high temperature group and fed with control diet. The anti-oxidative status such as catalase, superoxide dismutase, glutathione-s-transferase, and glutathione peroxidase has been noticeably (P<0.01) improved with application of dietary RF @ 10 mg/kg diet.

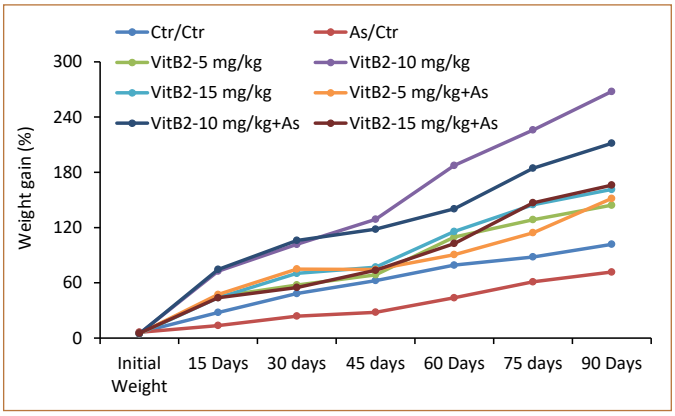


Fig. 2.19. Effect of dietary Riboflavin weight gain (%) of *P. hypophthalmus* reared under arsenic and high temperature for 90 days

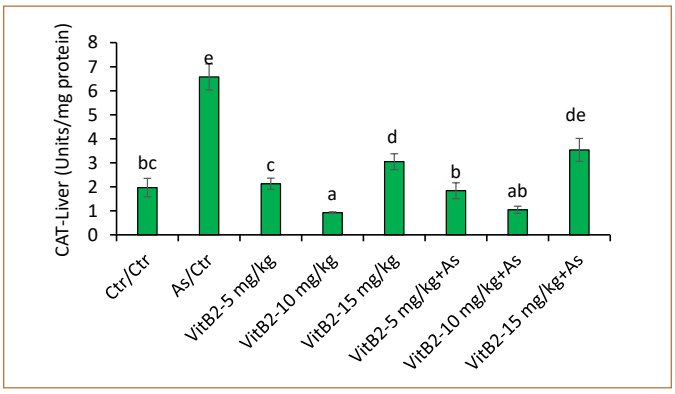


Fig. 2.20. Effect of dietary Riboflavin on catalase liver of *P. hypophthalmus* reared under arsenic and high temperature for 90 days

The dietary RF (vitamin B2) has been significantly reduced the ($p<0.01$) the catalase activities in liver tissue in comparing to other experimental group. The immunological status such as total protein, albumin, globulin, A:G ratio, NBT, myeloperoxidase and total immunoglobulin has been also significantly improved with dietary vitamin B2.

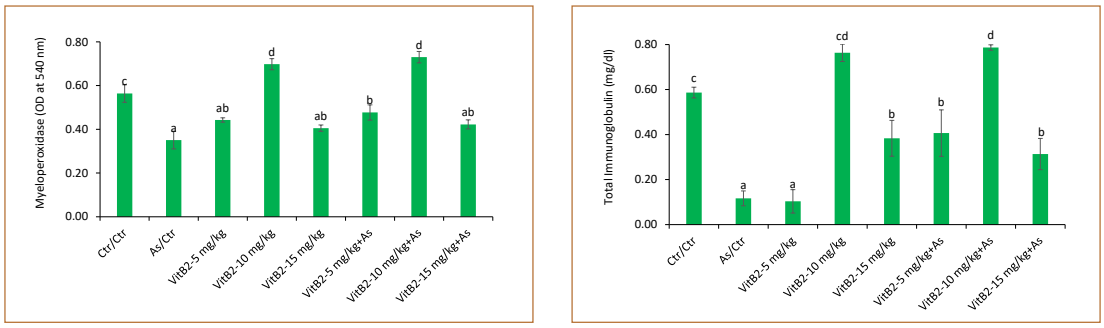


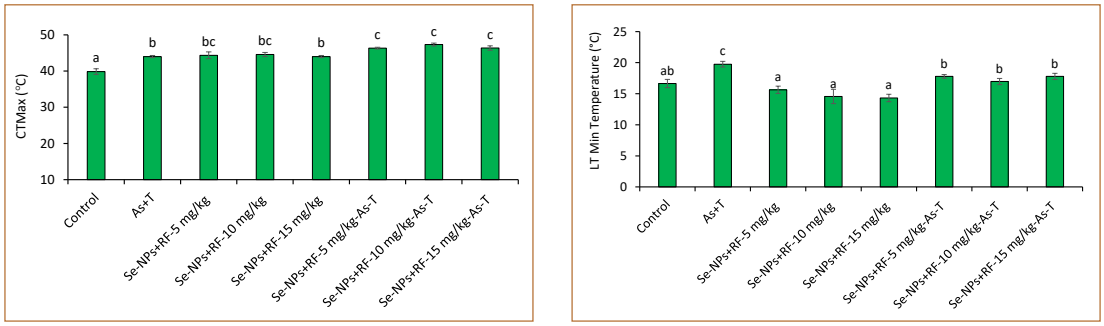
Fig. 2.21. Effect of dietary Riboflavin on myeloperoxidase and total immunoglobulin of *P. hypophthalmus* reared under arsenic and high temperature for 90 days

The bioaccumulation of arsenic in different fish tissue and experiment water has been determined as shown in the Table 2.12

Table 2.12. Effect of dietary vitamin B2 on bioaccumulation of arsenic in experimental water and different fish tissue such as liver, muscle, gill and kidney tissues of *P. hypophthalmus* reared under arsenic and high temperature for 90 days

Treatments	Water	Liver	Muscle	Gill	Kidney
Control	12.51±1.01	0.21±0.02	0.10±0.01	0.21±0.04	0.25±0.01
As+T	714.98±21.21	1.67±0.06	1.25±0.11	1.34±0.16	0.68±0.49
Vit-B2-5 mg/kg diet	11.11±1.35	0.23±0.03	0.11±0.02	0.12±0.01	0.21±0.01
Vit-B2-10 mg/kg diet	10.92±0.85	0.14±0.001	0.12±0.02	0.11±0.01	0.12±0.02
Vit-B2-15 mg/kg diet	16.29±1.75	0.21±0.01	0.15±0.01	0.13±0.02	0.19±0.03
Vit-B2-5 mg/kg diet+As+T	578.28±50.49	0.58±0.02	0.49±0.05	0.34±0.03	0.65±0.02
Vit-B2-10 mg/kg diet-AS+T	259.92±27.72	0.26±0.03	0.15±0.02	0.40±0.01	0.23±0.05
Vit-B2-15 mg/kg diet-As+T	471.89±28.26	0.52±0.01	0.48±0.01	0.42±0.02	0.47±0.03

The thermal tolerance study has been also conducted at the end of the 95 days of experimental trial as RF was remarkably improved ($p<0.01$) the CTMin, LTMin and CTMax, LTmax.



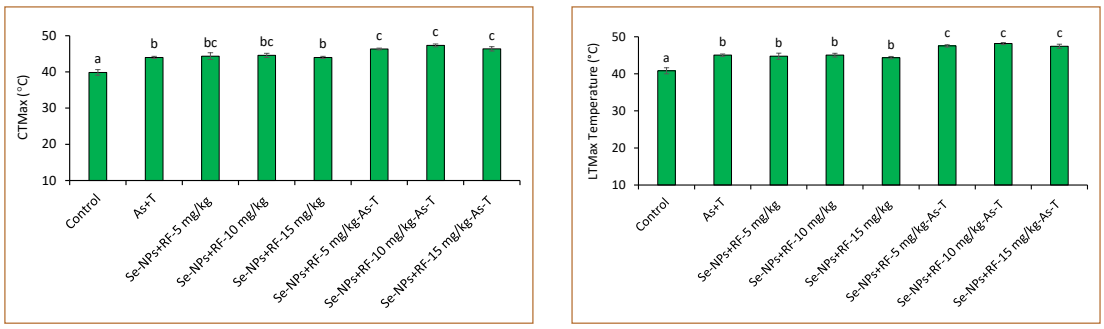


Fig. 2.22. Effect of combitorial mixture of dietary selenium-nanoparticles (Se-NPs) and Riboflavin on critical thermal minima (CTmin), lethal thermal minima (LTmin), critical thermal maxima (CTmax), lethal thermal maxima (LTmax) of *P. hypophthalmus* under concurrent exposure to arsenic and elevated temperature for 95 days

Hence, based on results it was concluded that dietary Vit B-2 @ 10 mg/kg diet have potential role in overall development of fish against the multiple stressors.

Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX09673)

Neeraj Kumar and Paritosh Kumar

The Kolkata wetlands/sewage fed system receives wastage from cities such as industrial establishments in the form of rubber industries, electroplating industries, pigment manufacturing units, potteries, and battery manufacturing plants and bring various kinds of metals throughout the year. This area comes under Ramsar site and utilized for fish culture since last several decade. However, the present study was carried out to delineate the health risk assessment and metals (Vanadium, Chromium, Manganese, Cobalt, Nickel, Copper, Zinc, Molybdenum, Silver, Arsenic, Selenium,

Table 2.13. Estimated daily intake (EDI), reference dose (RfD), Target Hazard Quotient (THQ), slope factor and cancer risk of Cr, Mn, Co, Ni, Cu, Zn, As, Se, Cd, Pb and Hg from fish muscle sample collected from 13 different sites of East Kolkata Wetland/ Sewage Fed system

Heavy Metals	EDI	RfD	THQ	Slope Factor	Cancer risk
Cr	0.0008	0.003	0.266		
Mn	0.0002	0.14	0.00174		
Co	0.000014	0.1	0.00014		
Ni	0.00052	0.02	0.026		
Cu	0.0029	0.04	0.072		
Zn	0.005	0.3	0.017		
As	0.00016	0.0003	0.525	1.5	0.00024
Se	0.0044	0.005	0.876		
Cd	0.0034	0.001	3.377		
Pb	0.000054	0.004	0.014		
Hg	0.000186	0.006	0.031		

Strontium, Tin, Cadmium, Lead and Mercury) distribution in different fish tissue, soil sediments and water sample from 13 sampling sites of Kolkata Wetland/Sewage fed system. The metals status in soil sediments, water sample and fish tissues viz. muscle, gill, liver, kidney and brain has been well within safe level in reference to recommendation of different national and international agencies excel few metal in few sampling sites like Cd, As and Pb. The relation between environment and heavy metal contamination in soil has been determined in the form of Geoaccumulation index (Igeo) and Based on Igeo status As, Se and Hg indicted that moderately to strongly contaminate of few sampling sites. The contamination index in water and target hazard quotient (THQ) and cancer risk assessment in human thorough consumption of fish is safe. The overall results concluded that, metal status in muscle tissue well within the consumption safety tolerance recommended by WHO/FAO, hence, these metal are concerned, this Wetland/Sewage fed system cultured fish are safe for human consumption.

Effect of nutritional and salinity stresses on physiological, biochemical traits and yield of turmeric (*Curcuma longa* L.) (IXX13858)

CB Harisha and KK Meena

Different turmeric varieties collected from various cultivating zones of India are tested for tolerance to nutrient stress and performance in poor structured soils based on physiological and biochemical characters were attempted. It was found that performance of Megha turmeric, NDH-98, Lakdong, Roma was good in terms of total chlorophyll content in leaves non fertilized plots since being higher biomass yielding variety and leaf having more leaf area leads to perform better in stressed condition. It

Table 2.14. Effect of nutrient stress on chlorophyll, leaf area and canopy temperature of various turmeric varieties

Varieties	Non Nutrient Stress			Nutrient Stress			Canopy Temperature (°C)		Total Leaf Area (cm^2)	
	Chl a	Chl b	Total Chl	Chl a	Chl b	Total Chl	Non Nutrient Stress	Nutrient Stress	Non Nutrient Stress	Nutrient Stress
CO -2	2.3	2.5	4.7	2.5	2.4	4.9	25.7	30.5	1158	1260
NDH -98	2.6	2.4	5.0	2.0	2.2	4.2	27.6	31.8	1548	992
Waygaon	2.1	2.2	4.3	2.2	2.3	4.5	28.8	30.4	810	1141
Pratibha	2.7	2.5	5.2	2.6	2.5	5.0	28.4	31.6	1670	720
Lakdong	2.3	2.3	4.6	2.0	2.2	4.2	27.9	28.5	1860	2154
BSR -2	2.6	2.3	4.9	2.8	2.3	5.0	29.2	30.9	1716	1242
Megha turmeric	1.8	2.2	4.0	3.5	2.8	6.3	25.2	27.9	2070	1914
Roma	2.5	2.4	4.9	3.6	2.8	6.4	28.8	28.2	894	915
Alleppey supreme	2.6	3.0	5.7	2.1	2.3	4.3	28.3	30.8	1610	2097
Kedarm	2.1	2.2	4.3	3.0	2.7	5.8	28.8	31.2	1182	1467

was also found that canopy temperature was lesser in mega turmeric (27°C) followed by Roma (28.2°C) and Lakdong (28.5°C). It is may be due to higher leaf area in the variety lakdong followed by Alleppey supreme, Megha turmeric. It can also be interpreted that suitability of soil for growing the turmeric is also one of the important factor. Small sized rhizome in other varieties leads to poor growth and also poor physiological response due to poor nutrient uptake.

Leaf volatile oil content is one of the important parameter to assess the stress level in leaf. It is found that leaf volatile oil content was increased in stressed plants in the varieties lakdong (0.69%), Megha turmeric (0.78%) and Alleppey supreme(0.73%), this indicates that higher volatile oil content in leaf improves the stress tolerance in these three turmeric varieties there by better performance in the stressed condition also. Similarly in case of % DPPH inhibition in various varieties was found to be higher in nutrient stressed plants. But in case of Mega turmeric, Alleppey supreme, and Roma the activity is high as compared to other varieties.

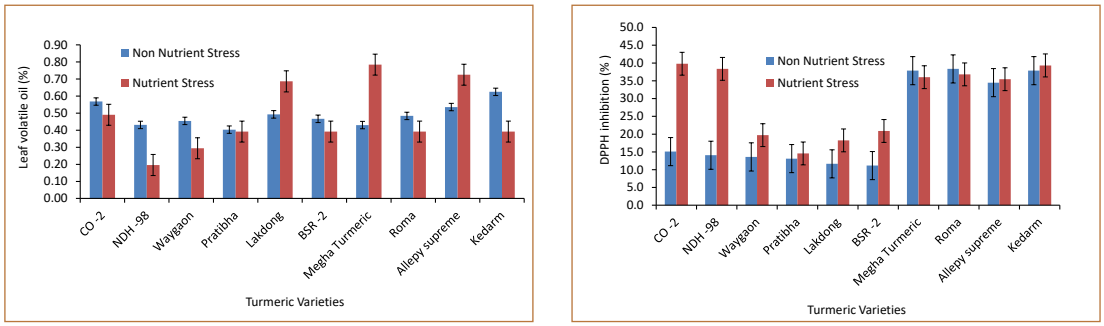


Fig. 2.23. Leaf volatile oil content and DPPH activity of turmeric varieties in nutrient stress condition

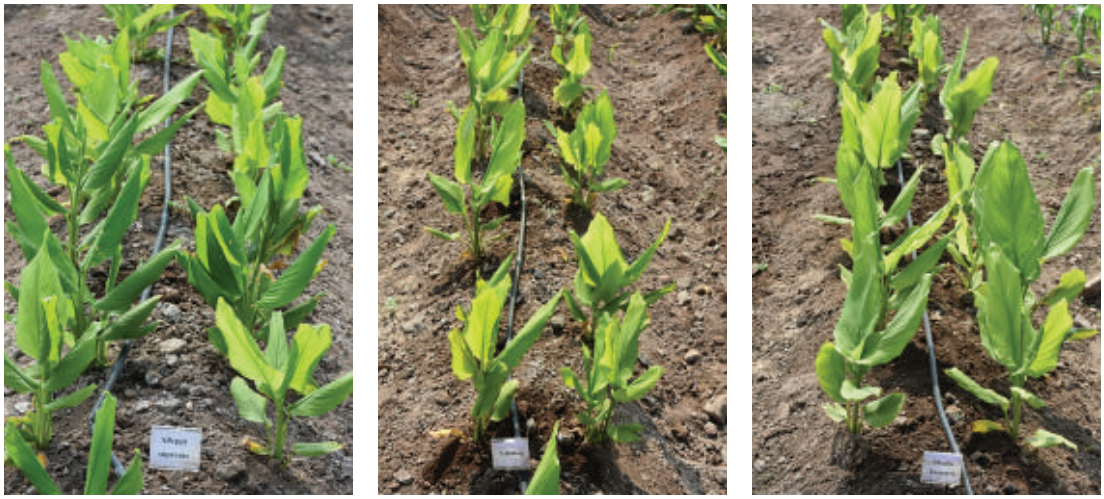


Fig. 2.24. Performance of Turmeric varieties in nutrient stressed soil

Effect of water stress on morpho-physiological parameters of fenugreek varieties

Experiment was conducted with fifteen commercial varieties of fenugreek to find the effect of moisture deficit at flowering- pod formation stage (30 days) on morpho-physiological parameters. The results revealed that moisture deficit at this stage causes huge crop loss with poor biomass yield, higher canopy temperature, lower Relative water content and faster excised leaf water loss as compared to adequate moisture plots.

Table 2.15. Morphological parameters of fenugreek varieties under moisture stress condition in murrum soils

Varieties	Plant height(cm)		No. of Pods/plant		Biomass per plant (g)		Seed Yield per plant (g)	
	RI	FI	RI	FI	RI	FI	RI	FI
Hisar Suvarna	27.6	31.2	16	16.6	17.8	20.83	7.43	8.64
Hisar Madhavi	27.4	29.2	14.2	22.6	25.9	35.27	10.97	13.28
Hisar Sonali	25.8	29.2	9.2	12.2	14.3	17.7	5.59	6.32
Hisar Mukta	31.6	33.6	16.6	21.2	22.5	29.63	9.69	11.65
Lamselan-1	26.8	29.8	25.2	26.8	34.4	42.87	15.2	16.94
Co-2	29.6	30.4	26.4	26.4	27.9	38.64	14.23	15.83
Rajendra Kanthi	18.2	30.2	12.8	13.2	13.4	17.19	2.74	3.97
Azad Methi	27.2	35.1	12.8	30.2	21.6	49.04	9.61	19.07
Pant Ragini	27.6	29.6	15	28.6	22.2	32.65	10.26	14.12
RMT-305	27.6	32.2	18.4	28.8	28.1	52.7	11.24	22.18
GM-1	29.6	30.6	21.2	22.8	22.5	29.82	10.17	10.45
GM-2	20.6	30.8	10.8	22.8	18.9	29.57	9.14	12.36
AFG-1	25.8	27.2	12.4	19.5	12.4	16.1	5.02	6.78
AFG-2	26.8	29.8	10.4	16.8	13.4	28.3	5.34	9.21
AFG-3	26.6	31.4	16.8	21.2	18.3	28.86	7.7	9.38

RI-Restricted irrigation; FI- Full irrigation

Among morphological parameters in both irrigation conditions Rmt-305, Co-2, Lam selection recorded higher growth and number of branches. In case of yield attributing characters Lam selection-1 (34.4 and 42.8 respectively) recorded higher pods per plant in both Restricted irrigation and full irrigation conditions which is followed by Rmt-305 (28.1 and 52.7 respectively) and CO-2 (27.9 and 38.6 respectively). Similar results were recorded in case of seed yield per plant also. Lowest seed yield was obtained from Rjendra kanthi followed by Hissar Sonali and Ajmer fenugreek varieties which is herb type variety was affected more to moisture deficit and being long duration yield potential reduced due to prolonged drought.

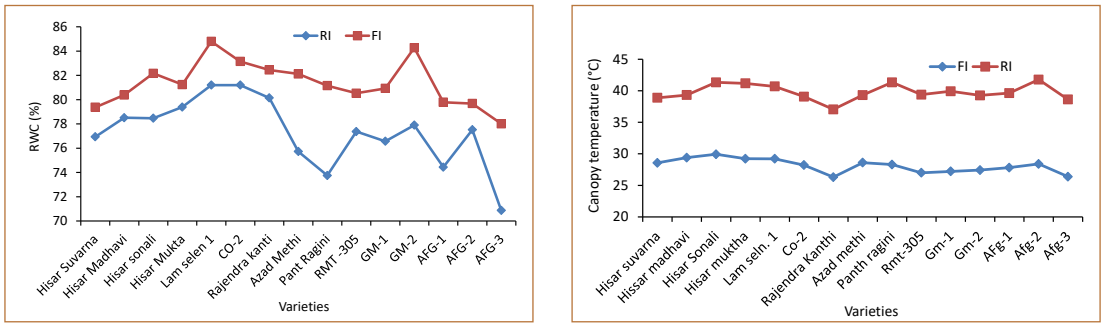


Fig. 2.25. Canopy temperature and relative water content of leaves of fenugreek varieties influenced by moisture stress in murrum soil

Canopy temperature of fenugreek varieties was varied significantly and it was cooler in Rajendra Kanthi (26.3°C in FI and 37.05 °C in RI respectively) and Afg-3 (26.37°C in FI and 38.6°C in RI respectively) which is having more green leaf content as compared to other varieties. Even then Rmt-305, GM-2, Co-2 is having lower canopy temperature in restricted irrigation condition. Therefore it is concluded that canopy temperature and Relative water content can be used as selection criteria of fenugreek for the moisture stress tolerance.

Establishment of model herbal garden for medicinal and aromatic plants (0XX04255)

CB Harisha, DD Nangare, PB Taware

Medicinal and aromatic plants garden is established under the financial assistance of National Medicinal Plants Board, department of AYUSH, New Delhi in an area of 5.0 acres comprises of 65 species of trees, shrubs, and climbers. The land is having hard rock below having shallow depth with Less than 0.5 ft of soil. The pits of size 1.5 m^3 for bigger trees, 1m^3 for shrubs, climbers, small perennial herbs and grass were made and filled with mixture of black and murrum soil in 50:50 ratio. All the plants are well established in this system of planting.

Fig. 2.26. Original site before (Left) and pit opening for planting (right)

Fig. 2.27. Plantation of different species (left) and present view of garden (right)

General observations were made on the establishment and growth of plants including canopy temperature, SPAD reading to find the tolerance of plants to moisture and high temperature stress. Among many species planted few species such as Neem, Simaruba, Soap nut, Wood apple, Terminalia speies, Putranjeeva, Bonduc, Henna, Skikakayi, Guggal, Eucalyptus, Red Sanders, Parijatha, jasmine, gunj plants showed 100% establishment. Other species such as *Mapia foetida*, Nagkesar, Surangi are showed very poor establishment rate. Establishment of aromatic grasses such as

lemon grass, citronella and vetiver is 100% and very well suited to murrum type of soils. Initial growth rate of plants were found that many species such as neem, saopnut, Eucalyptus, Parijatha, Sesbania, Terminalia sp. Jamun, putranjeeva found better and in case of climbers, gunj, jasmine, giloe, and madhunadhini is having faster growth as compared to other climbers.

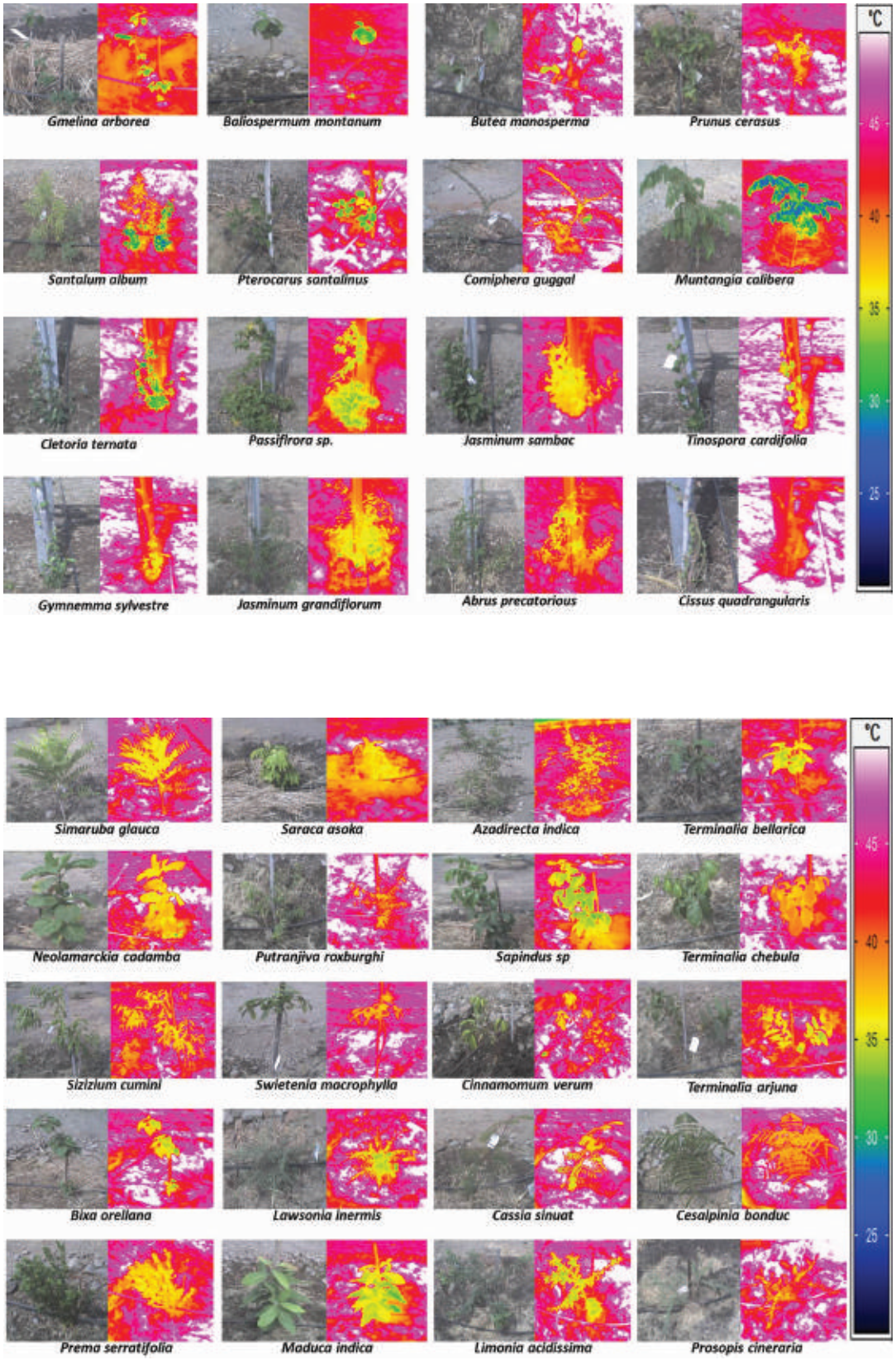


Fig. 2.28. IR image showing variability in canopy temperature of various medicinal plant species

Table 2.16. Survival, growth and physiology of medicinal species grown in shallow soils

Plant species	Sur-vival (%)	Plant height (cm)	SPAD value	Canopy Temp (°C)	Plant species	Sur-vival (%)	Plant height (cm)	SPAD value	Canopy Temp (°C)
Ashoka	89	38	26.1	36.0	Fever nut	100	53	61.3	38.2
Neem	100	126	50.8	35.1	Agnimantha	100	75	49.7	37.0
Palash	89	47	60.2	34.7	Bakul	78	25	32.5	37.3
Kadamb	83	81	60.7	36.6	Guggal	100	68	54.5	36.3
Simaruba	100	89	61.1	35.4	Red Sanders	100	56	48.1	33.0
Shami	100	61	NA	36.4	Sandalwood	100	56	39.0	36.6
Wood apple	100	67	57.0	34.3	Madhukamini	100	63	46.7	36.8
Soap nut	100	98	71.5	33.8	Curry leaf	100	51	38.1	35.6
Shivan	100	45	58.4	33.0	Parijatak	100	78	44.1	34.1
Coral tree	100	37	37.5	30.9	Eucalyptus*	100	168	44.6	35.8
T. chebula	100	50	28.7	37.9	Nilgiri	94	115	38.5	35.4
T. bellarica	100	43	59.4	34.6	Champaka	72	103	43.0	37.6
T. arjun	100	72	53.5	35.1	Sesbania	94	56	35.2	35.1
Beal	100	27	41.2	37.8	Kutaj	100	39	53.2	28.9
Jamun	100	108	45.3	36.6	Danti	100	69	50.5	31.5
Wax Apple	100	72	50.3	35.0	Nirgudi	100	59	41.1	36.6
Mahuva	100	54	44.9	34.2	Pongemia	100	76	43.8	32.6
Putranjeeva	100	32	66.4	37.6	Royal Jasmine	100	63	51.6	35.3
Mahagony	100	82	40.0	37.5	Choti Gunj	94	76	48.4	35.3
Annato	72	42	32.4	34.7	French Jasmine	100	56	59.6	35.5
Henna	100	99	57.5	33.8	Madhunasini	89	60	69.9	34.6
Khair	100	39	NA	33.8	Giloy	94	81	50.6	33.7
Shikakai	100	95	NA	35.4	Bone setter	100	50	82.5	38.3

Note: * Eucalyptus is known as lemon scented gum (lemon scented nilgiri)

Plant species usch as neem, wood apple, mahuva, *Terminalia arjuna*, *T. chebul*a and *T. bellarica*, annatto, white teak, guggal, curry leaf, red sanders, Kutaj, Singapore cherry, danti are having cooler canopy temperature even in drought and hot climatic conditions. It clearly indicates that survivability and performance of these plant species is good in the shallow soils filled with black and murrum in 1:1 ratio. It was confirmed that plant growth is faster in these species having greater survival percentage also.

Waste water treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)

Paritosh Kumar, CB Harisha, Neeraj Kumar, KK Meena

NIASM septic tank wastewater was treated through a pilot scale constructed wetland system with the aim to test the potential of Agricultural by-products incorporated multimedia based constructed wetland system for wastewater treatment (especially for removal of microbes), integration of wastewater treatment with floriculture industry and mainly to identify the floricultural crops suitable for constructed wetland system and Use of treated water for integrated horticulture and fish cultivation as aquaponics during treated water storage before its further use as irrigation water in field.

Fig. 2.29. Experimental vertical sub-surface flow constructed wetland system (HSSF-CWs)

The unit comprised of two parallel units (i) Vertical sub-surface flow based constructed wetland system (VSSF-CWs; Fig.2.29) filled with different layers of gravel and grown with typha (TW), vetiver (VW) along with unplanted (Control; CW) system in triplicate and (ii) Horizontal sub-surface flow based constructed wetland system (HSSF-CWs; Fig.2.30) filled with different growing cum filtration media viz. Gravel + Spent mushroom compost (GMW), Gravel + Coco peat (GPW), Gravel + Charcoal (GCW), Gravel (GW) and grown each with six different flowering crops viz. marigold,

Fig. 2.30. Experimental horizontal sub-surface flow constructed wetland system (HSSF-CWs)

chrysanthemum, aster, tuberose, gladiolas and sweet basil with six replications. The treated water is collected from both systems and passed through a 25 Watt UV sterilization unit and used for growing aquaponics.

The physico-chemical and microbial characteristics of septic tank waste water was analysed and their result is listed in Table 2.17.

Table 2.17. Physico-chemical and microbial characteristics of NIASM septic tank waste water

S.No.	Parameters	Value	S.No.	Parameters	Value
1	pH	7.16 ± 0.05	16	Phosphate (mg/l)	5.36 ± 0.31
2	EC (µS/cm)	419.40 ± 4.45	17	Fluoride (mg/l)	1.04 ± 0.13
3	Turbidity (NTU)	6.27 ± 0.06	18	Fe (ppb)	24.79 ± 12.48
4	Dissolved Oxygen (mg/l)	1.67 ± 0.29	19	Mn (ppb)	119.67 ± 54.10
5	Temperature (°C)	25.13 ± 0.21	20	Zn (ppb)	8.70 ± 11.21
6	TDS (ppm)	210.17 ± 2.71	21	Cu (ppb)	16.78 ± 11.63
7	Salinity (ppm)	207.97 ± 1.37	22	Ni (ppb)	20.59 ± 14.03
8	ORP (mV)	-23.60 ± 0.00	23	Cr (ppb)	104.08 ± 35.19
9	Carbonate (me/l)	0.00 ± 0.00	24	Pb (ppb)	12.66 ± 16.23
10	Bicarbonate (me/l)	6.07 ± 0.42	25	As (ppb)	62.74 ± 34.84
11	Chloride (me/l)	2.13 ± 0.61	26	Hg (ppb)	60.50 ± 48.69
12	Calcium +Magnesium (me/l)	1.87 ± 0.31	27	BOD (mg/l)	210 ± 10
13	Sodium (me/l)	1.86 ± 0.01	28	Total Coliform (MPN/100 ml)	>1600
14	Potassium (me/l)	0.29 ± 0.01	29	Fecal Coliform (MPN/100 ml)	>1600
15	Sulphate (mg/l)	183.38 ± 8.43	30	Escherichia coli (MPN/ 100ml)	>1600

Pollutant removal

As per the analysis results, in NIASM Septic tank waste water is loaded with microbial contaminants mainly coliform bacteria (Fecal coliform and Escherichia coli etc.) and their population represented at 95% confidence level as most probable number (MPN) in 100 ml of water was >1600. Among different VSSF-CWs Vetiver (VW) and unplanted (CW) system is able to remove these total and fecal coliform bacterial population from >1600 to 500 while Escherichia coli from >1600 to 9 and <2 in fifteen days interval, respectively. Typha (TW) grown system was found the best for

removal from >1600 to 300 for both total coliform and fecal coliform while <2 for Escherichia coli. Among different HSSF-CWs gravel + spent mushroom compost (GMW) and gravel filled microcosm system (GW) are able to reduce the total coliform population from >1600 to 1600 while Gravel +Coco peat (GPW) and Gravel + Charcoal (GCW) filled system to 910 in seven days. However, after integration with UV treatment the microbial population of these treatment system reduced to <2 for total coliform and Escherichia coli in both HSSF-CWs and VSSF-CWs while <2 - 12 for fecal coliform in HSSF-CWs and < 80 in VSSF-CWs irrespective of different treatments and which is within the safe limit (<100) for irrigation. Due to microbial contamination dissolved oxygen content of septic tank wastewater was found very low (1.67±0.29 mg/L) and Biological Oxygen Demand (BOD) was high (210±10 mg/L). After treatment in both VSSF-CWs and HSSF-CWs their dissolved oxygen content was increased significantly to >6 mg/L (safe limit) in all the treatments in seven days.

Apart from microbial other physicochemical parameters viz. pH, EC (S/cm),Turbidity (NTU), Dissolved Oxygen (mg/l), Temperature (°C), TDS (ppm), Salinity (ppm), ORP (mV), Carbonate (me/l), Bicarbonate (me/l), Chloride (me/l), Calcium +Magnesium (me/l), Sodium (me/l), Potassium (me/l), Sulphate (mg/L), Phosphate (mg/L), Fluoride (mg/L) as well as metals like Fe, Mn, Zn, Cu, As, Cd, Ni, Cr, Pb was found within safe limit.

Plant growth and economic yield

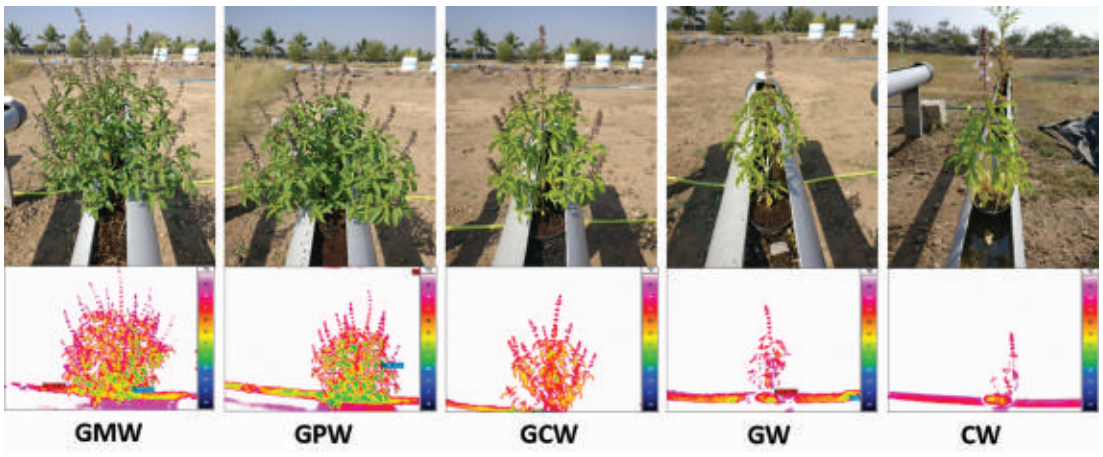
In the first crop season of HSSF-CWs among different flowering crops grown on different growing media the average yield was found in the order:

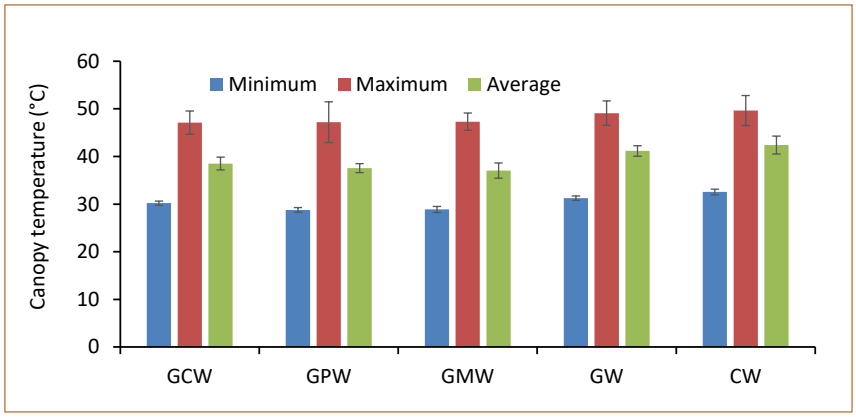
Sweet basil > Marigold > Aster > Chrysanthemum > Tuberose > Gladiolas

Fig. 2.31. Experimental flower grown in treated waste water

This indicates sweet basil and marigold are more hardy and suitable for growing on different media applied with wastewater while tuberose and gladiolas are more sensitive. Among different growing media the plant canopy growth, leaf chlorophyll content as well as average yield of flowering crops was found in the order: GMW > GPW > GCW > GW > CW

This indicates for growing these flowering crops media plays important role in supplying nutrients as well as accumulating pollutants. Among different treatments flowers yield was found significantly higher than media less (Control; CW) for all the flowering crops. This also indicates the importance of growing media in flower production and harmful effect of waterlogging as well as direct contact of pollutant dissolved in wastewater to the plant roots.





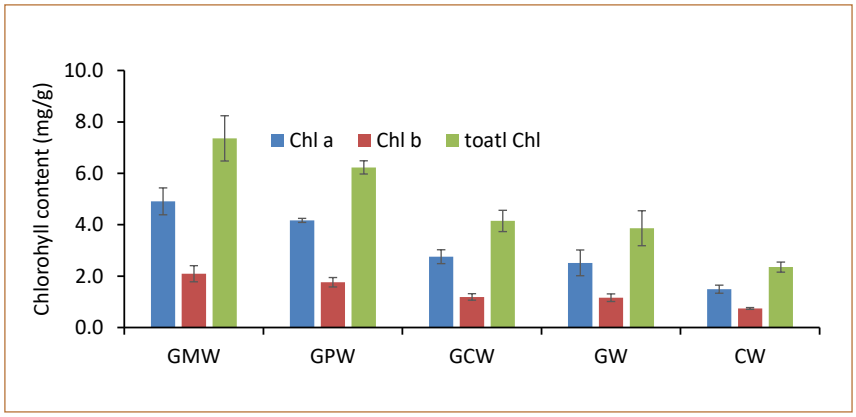


Fig. 2.32. Effect of different growth media on canopy temperature and chlorophyll content in sweet Basil

Among different flowering crops sweet basil was shown the highest flower yield of 85.50 ± 12.89 floral spikes per plant and marigold the second (5.47 ± 4.63 flowers/plant) while tuberose and gladiolas was the least. Among different growing media flower yield was found maximum for marigold on Gravel + Spent mushroom compost (GMW; 13.83 ± 9.09 and up to 27 flower per plant) while for sweet basil on Gravel +Spent mushroom compost (GMW) and Gravel +Coco peat (GPW) with average spike yield per plant of 136.00±17.93 and 127.00±11.71, respectively.

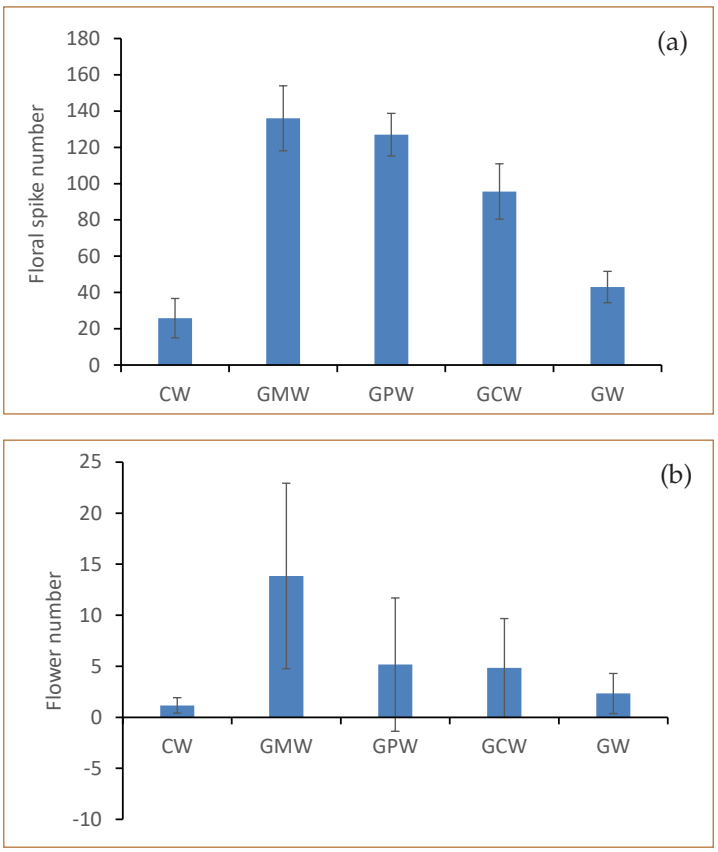


Fig. 2.33. Effect of different growth media on spike number in sweet basil (a) and flower number in Marigold (b)

Fish mortality

In the aquaponics experiment untreated septic tank wastewater (UW), typha treated water (TW), vetiver treated water (VW), and unplanted control treated water (CW) along with fresh water (FW) was used to reared *Pangasianodon hypophthalmus* with 12 number per tank kept in the open field without any external airflow with four replications. Among different fish grown aquatic system, in untreated water (UW) all the fish were died within 9-15th day due to regular depletion of dissolved oxygen (initial DO 5.18±0.31 mg/L) by fecal and microbial load while within 13-18th day in fresh water (FW) due to depletion of nutrients. However, in wetland treated waters due to balance in nutrient load and dissolved oxygen content fish mortality were extended to 16-24th day in Typha (TW), 18-23rd day in Vetiver (VW) and 23rd day in unplanted (CW) systems and their average DO content was recorded as 6.83±0.49, 9.40±0.36 and CW 7.93±1.59 mg/L, respectively.

School of Drought Stress Management

School of Drought Stress Management

Assessment of Quinoa (*Chenopodium quinoa*) as an alternate crop for water scarcity zone (IXX14286)

Jagadish Rane, Aliza Pradhan, Narendra Pratap Singh

The Quinoa crop was grown on native murrum soil of NIASM during Rabi 2016-17 and 2017-18 and in black soil during 2018-19 to test its suitability as an alternative crop for the drought prone regions. The black soils have better organic matter and water retention capacity as compared to porous, shallow native murrum soil. Hence, there was significant difference in grain yield per unit area obtained during 2016-17 and 2018-19 with almost same level of water supply. However, the marginal difference between 2017-18 and 2018-19 was mainly due to only three irrigations during the crop season though the crop was grown on black soil. Measurement of various yield related attributes indicated that there were an average of 10-12 no. of panicles per plant with panicle length of 17 to 22 cm and seed yield of 16 to 40 g per plant. Three years field demonstration trials at NIASM indicated that it is possible to get a yield ranging between 3 to 6 q ha^{-1} depending on the climate and moisture availability during the crop growing period. Also there was no major incidence of disease and pest during the crop growth period which suggests that it can also be grown organically at the region. Ability of the crop to produce yield in degraded soil also indicates that it can be grown in fields where no other crop can be grown and will provide good return to the farmer.

Fig. 2.34. Quinoa experimental trial at ICAR-NIASM

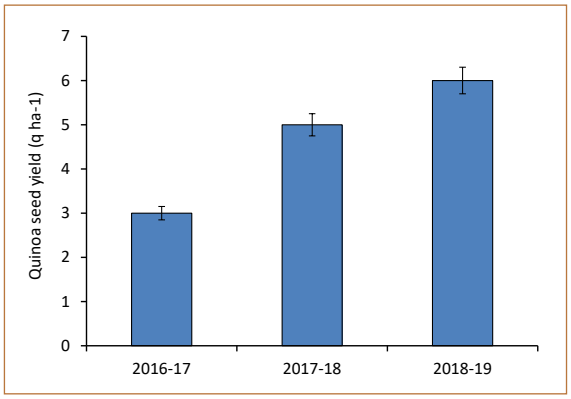


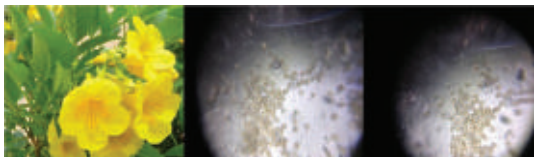
Fig. 2.35. Year wise Quinoa seed yield (q ha^{-1})

On field *in vivo* monitoring of pollen tube growth of dry land agricultural crops to identify the genotypic resilience to drought (0XX04232)

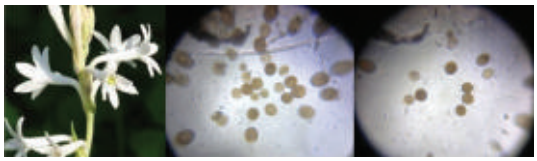
Jagadish Rane

Studies on diversity of pollen

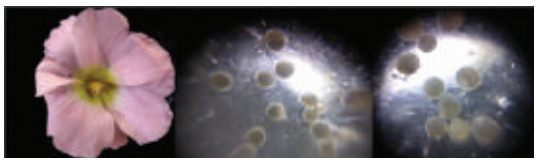
Pollen viability, germination and pollen tube growth are highly critical for reproductive success in plants and hence productivity of crop plants. These processes are often affected by drought and heat and hence result in reduction in crop productivity. For optimising the Foldscope methods for investigations on the pollens we selected both food and non-food crop prevalent in water scarcity area. The first experiment was carried out to check if the foldscope can capture these differences. Pollen grains were collected from flowers of different crops and garden flowers and brought to the laboratory. Pollen grains were dusted in a drop of water on the glass slides and observed through the Foldscope. Foldscope can efficiently capture the differences in colour, size and shape of the pollens (Fig. 2.36).



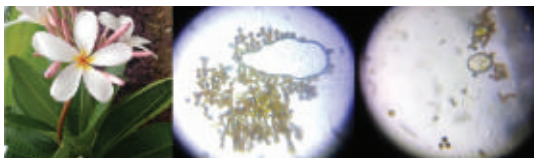
Pollen grains of Bell flower



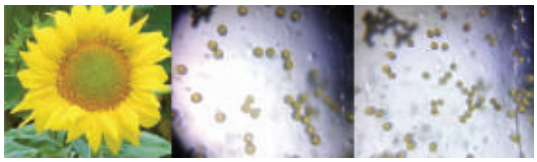
Pollen grains of Tube rose



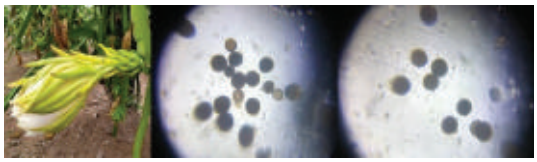
Pollen grains of holly hock



Pollen grains of Plumeria



Pollen grains of sunflower



Pollen grains of dragon fruit

Fig. 2.36. Foldscope images of pollen grains of different crops and garden flowers

Optimization of studies on pollen viability using Foldscope

Pollen viability is the ability of pollens to perform its function of delivering male gametes to the embryo sac. Pollen viability is an index of its quality and vigour. The viable pollens were appeared as red in colour whereas non viable pollens were appeared as colourless after the staining procedure. Per cent pollen viability was standardized in *Vinca rosea* (Fig. 2.37) and determined in different crops like soybean,

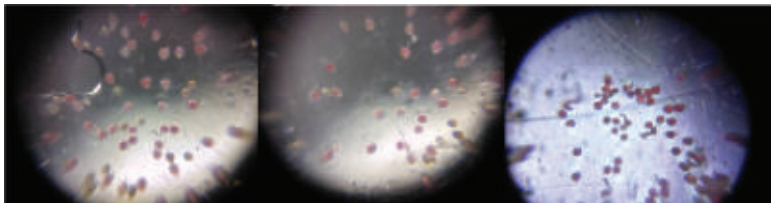


Fig. 2.37. Viability staining of *Vinca rosea* pollens

sorghum, wheat and pomegranate (Fig. 2.38). Temporal variation and effect of drought on pollen viability was studied.

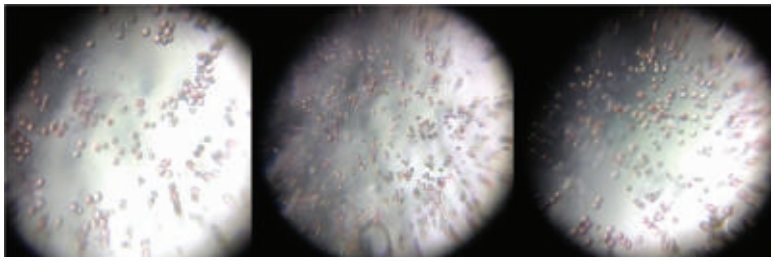


Fig. 2.38. Viability staining of Pomegranate pollens

Temporal variation of pollen viability

There was drastic reduction in pollen viability of *Vinca rosea* after 30 minutes even at room temperature. This was more conspicuous under elevated temperature (Fig. 2.39).

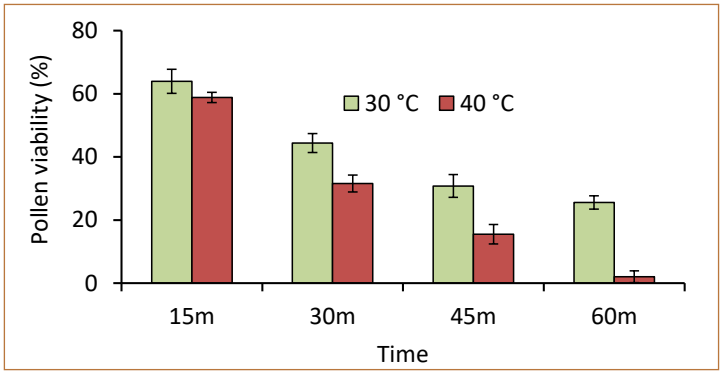


Fig. 2.39. Percent viability of *Vinca rosea* pollens at 30°C and at 40°C

Effect of drought stress on pollen viability in Sorghum (*Sorghum bicolor*)

Drought stress is a detrimental abiotic factor that affects pollen viability, thus it limits crop productivity and quality. We used Foldscope to identify better performing sorghum genotype based on its pollen viability among selected genotypes under drought condition. Five genotypes of sorghum were grown in pots in green house and drought was imposed at growth stage 2 (38 Days after sowing (DAS)). There was a complete withdrawal of water for one week and thereafter 100% FC was maintained for irrigated and 50% of FC for drought treatments for remaining days. The details of experiment are depicted in table 2.18. Pollen viability was determined at different time intervals viz., 10 AM, 12 PM and 4 PM and results are given in Fig. 2.40

Table 2.18. Details of the Sorghum experiment for pollen viability

Genotypes	CRS-19, M35-1, Phule Mauli, R-16 and Phule Chitra
Drought imposed	38 DAS
Flowering initiated in irrigated plants	64 DAS
Flowering initiated in drought plants	73 DAS

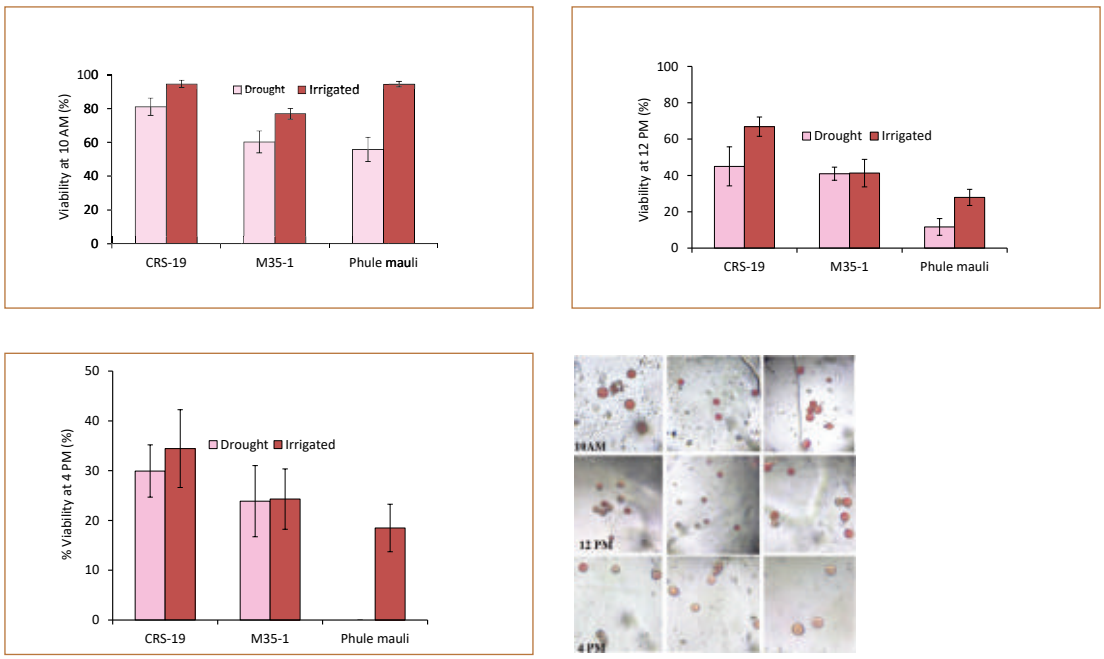


Fig. 2.40. Genetic variation in viability of sorghum pollen at different time intervals (10 AM, 12 PM & 4 PM) under irrigated and drought conditions

Optimization of methods on *in vitro* pollen germination using Foldscope

Knowledge of pollen germination is important for the study of reproductive physiology and crop improvement. Pollen grains are considered germinated only when they have tube length equal to or greater than the diameter of the pollen grain and this could be efficiently determined using Foldscope. Protocol was standardized for temporal variation in pollen germination of vinca rosea using Foldscope (Fig. 2.41). Genotypic variation in per cent pollen germination of chickpea was studied under irrigated and drought conditions. The genotype ICE-15654B showed highest percentage pollen germination as compared to other genotypes under both well watered (78.71%) and drought (60.53%) conditions (Fig. 2.42).

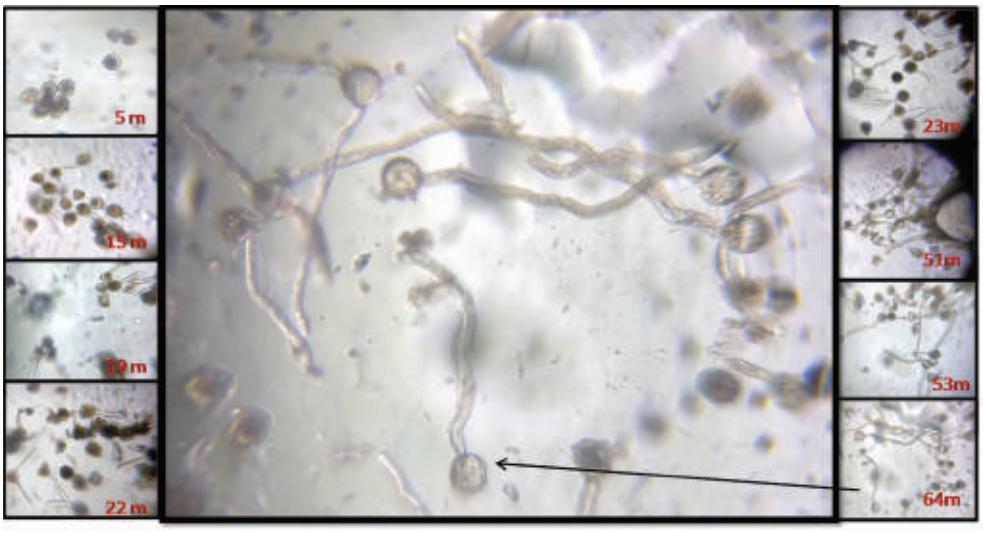


Fig. 2.41. Temporal variation of pollen tube growth of periwinkle

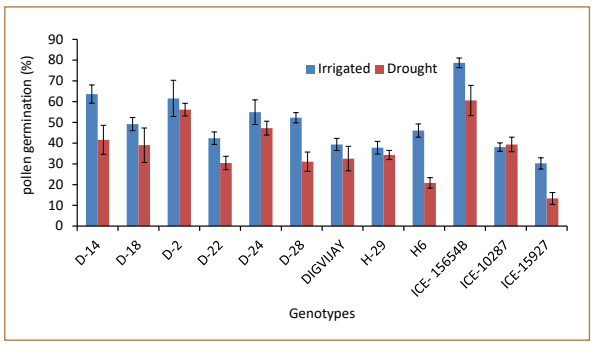


Fig. 2.42. Genetic variation in per cent pollen germination of chickpea under irrigated and drought conditions

Phenotyping of pulses for enhanced tolerance to drought and heat (0XX01737)

Jagadish Rane, Mahesh Kumar, Narendra Pratap Singh

Excised Leaf Water Loss in Chickpea

Excised Leaf Water Loss (ELWL) has been often cited as one of the traits of drought tolerant genotypes of crop plants. This trait is associated with water stress tolerance and was considered for assessing genetic variation in crop plant. Traditionally this trait is measured based on the initial and final weight of excised leaves. In this study an attempt has been made to explore NIR image based non-destructive and rapid method for assessing genetic variation in ELWL of crop like chickpea and wheat genotypes. Six chickpea were tested using NIR camera of LemnaTec HTS Scanalyzer and actual ELWL was also estimated by recording weight of excised leaf immediately after imaging at different time interval. Results indicated that NIR intensity sensed by camera can explain the tissue water content in crops.

Chlorophyll fluorescence in promising Chickpea genotypes

Chlorophyll fluorescence imaging provides information on photosynthetic performance without destruction or contact with the living plant. Experiment was conducted to evaluate the photosynthetic efficiency in promising chickpea genotypes. Promising genotypes were identified based on previous performance and Digvijay was used as local checks. The sampling was done at 10 days interval during reproductive phase and images were taken using fluorescence imaging system. It was noticed that genotypes, D-25, D-30 had better photosynthetic efficiency than Digvijay even under moisture stress conditions.

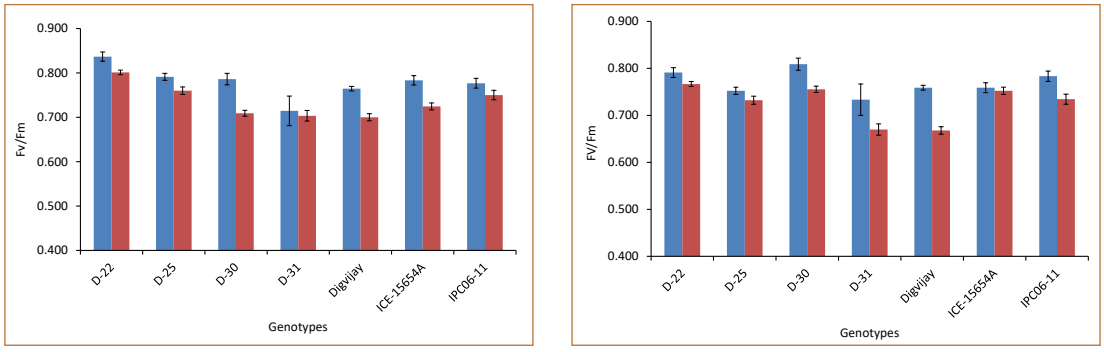


Fig. 2.43. Photosynthetic efficiency in chickpea genotypes under normal and soil moisture stress conditions at 55 and 66 days after sowing

Phenotyping of Chickpea for leaf senescence in response to water stress

Leaf senescence is the response of leaf cells to the regular ageing process and unfavourable environmental conditions. The different physiological and biochemical studies of leaf senescence have revealed that during senescence, leaf cells undergo highly coordinated changes in cell structure, metabolism and gene expression. The earliest and most significant change in leaf cells is the degradation of chloroplasts Leaf senescence leads to the degradation of photosynthetic pigments such as chlorophyll, in leaf colour changes from the usual deep green to pale green, pale green to yellow and finally to brown. Given our ability to observe these visual cues, it would be natural to consider the use of image processing techniques for a high-throughput plant leaf senescence analysis.

The present experiment carried out with twelve Chickpea germplasm in three replications with two treatments viz. well watered and water stress. The Image Analysis Configuration (IAC) was designed using LemnaGrid Software for color image segmentation and classification of images captured using LemnaTec HTS-Scanalyzer 3D platform for five days. In image analysis, plant visible area was classified into three colour classes : green, yellow and brown. The experimental results revealed that local check Digvijay had highest green area followed by C-2010 under well water condition after 73 DAS. While under water stress conditions germplasm C-2015, C-2019 had higher green area compared to the check Digvijay. The check variety Digvijay had low senescence under well watered condition followed by C-2010, C-2011. However, under water stress condition germplasm C-2015 and C-2019 showed delayed leaf senescence as compare to other genotype. The early senescence was observed in C-2014, C-2024 and C-2021 under both well watered and water stress condition.

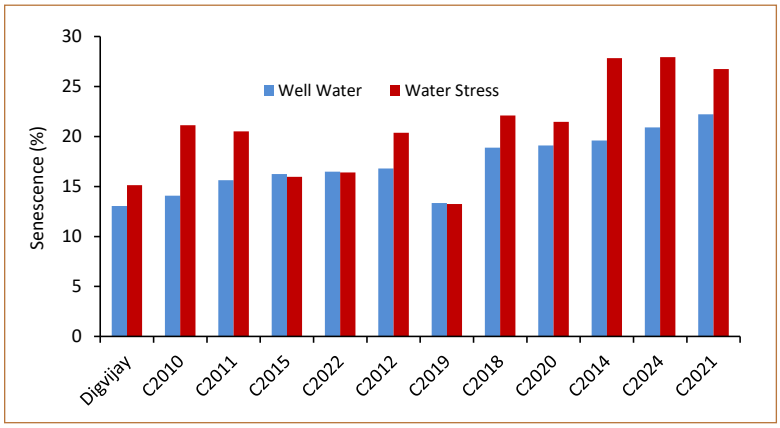


Fig. 2.44. Genetic variation in senescence in chickpea genotypes under moisture stress

High-throughput phenomics tool to assess the response of different crops to water-stress

Visible (VIS)/Near Infra Red (NIR) image based phenomics tools are non destructive and rapid method for quantifying genetic variation in phenotypic traits of different crops. Plant phenomics facility at ICAR-NIASM was used to capture the VIS/NIR images of the crops. Intensity of NIR perceived by camera are inversely proportional with water content in leaf tissues as NIR in the selected wavelength range absorbed by water molecules. The method could differentiate the responses of

genotypes to desiccation. Genetic variation was observed for all crops studied for these parameters. A positive correlation exists between weight reduction of the excised leaves and NIR intensity (R^2 for chickpea 0.711; mungbean 0.6; sugarcane 0.5 and wheat 0.7). This reveals that it is possible to differentiate crop genotypes for excised leaf water loss by employing NIR imaging technology.

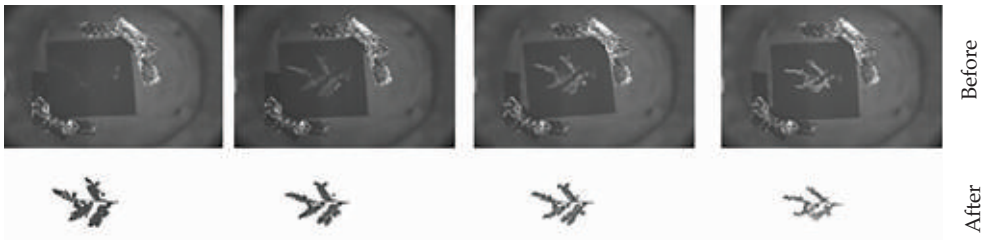


Fig. 2.45. NIR Image of chickpea genotype-D18 before and after analysis

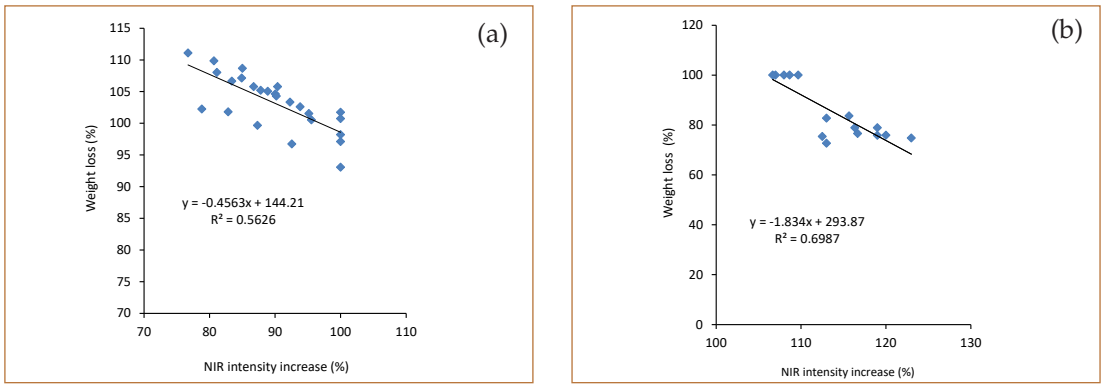


Fig. 2.46. Correlation between Excised Leaf Weight Loss and NIR Intensity of excised Mungbean leaves (a) and excised wheat leaves (b)

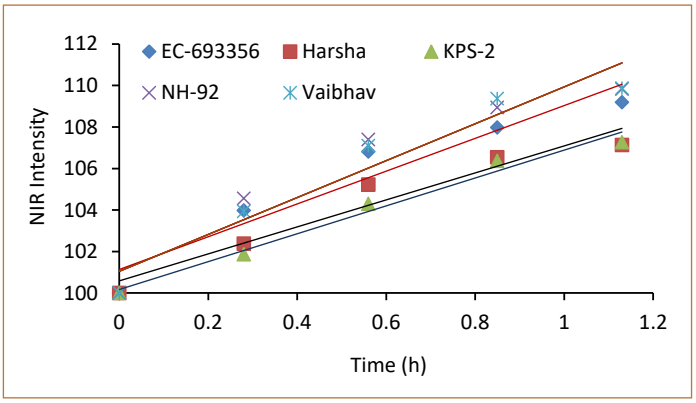


Fig. 2.47. NIR intensity in excised leaves of Mungbean genotypes

High-throughput plant leaf senescence analysis is also possible with VIS image processing techniques. Leaf senescence leads to the degradation of photosynthetic pigments such as chlorophyll, in leaf colour changes from the usual deep green to pale green, pale green to yellow and finally to brown. The experiments in Chickpea revealed that local check Digvijay had highest green area followed by C-2010 under well water condition after 73 days sowing. While under water stress conditions germplasm C-2015 and C-2019 had higher green area compared to the check Digvijay.

Likewise, germplasm C-2015 and C-2019 showed delayed leaf senescence as compare to other genotypes under water stress conditions.

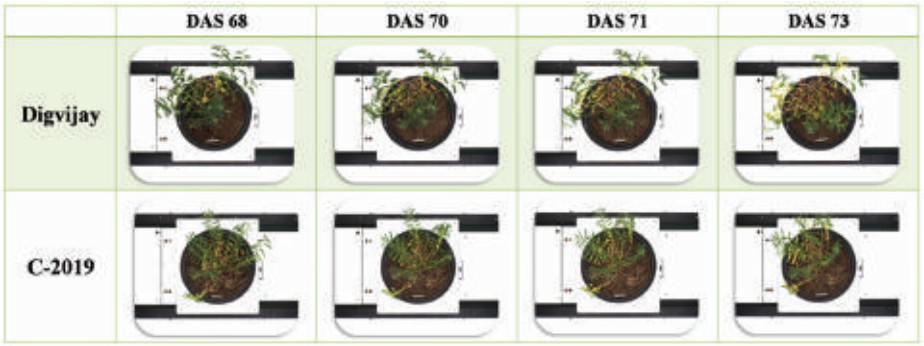


Fig. 2.48. Top view images of chickpea genotypes Digvijay and C-2019 with water stress treatment

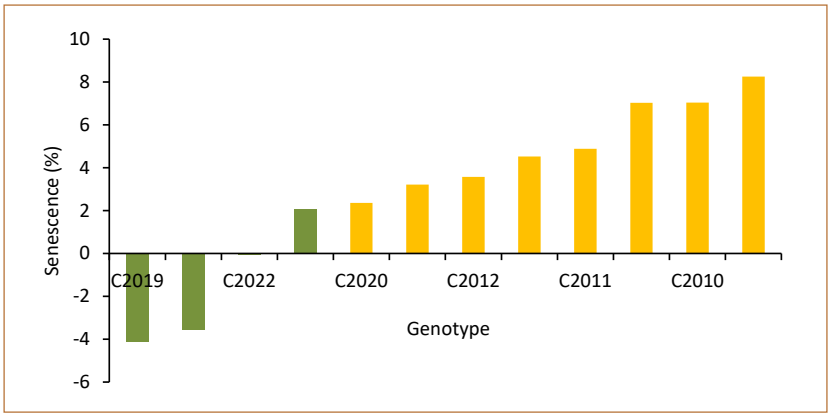


Fig. 2.49. Delayed senescence in Chickpea genotypes

Convex hull area is another trait obtained by the VIS image analysis. It is a polygonal structure which adjoins the peripheral points of plant parts by keeping all the plant parts inside the convex shape. Pigeonpea genotypes exhibited higher convex hull area under well-watered condition than under the water stressed condition. There was significant variation in per cent change in convex hull area among different pigeonpea genotypes. Genotype BPG 5-12 was least influenced by water stress than other genotypes and genotype WRP 1 showed very high response to water availability.

Cow urine-based formulations supports cell membrane water channels called aquaporins

Aquaporins are membrane proteins that serve as channels in the transfer of water across the cell membranes. They can also allow small solutes across the membrane. They are present in bacteria, plants, and animals. Structural analyses of the molecules have revealed the presence of a pore in the center of each aquaporin molecule. Several aquaporin-type water channels are expressed in mammalian kidney. In one of the experiments with mungbean plant, an hypothesis that cow-urine based formulations can influence drought responses of plant through aquaporin was tested. In addition to promotion of plant growth, the bioformulation was also found to enhance the level of expression of genes coding for aquaporin in plants and improve plant growth and development under depleting soil moisture conditions.

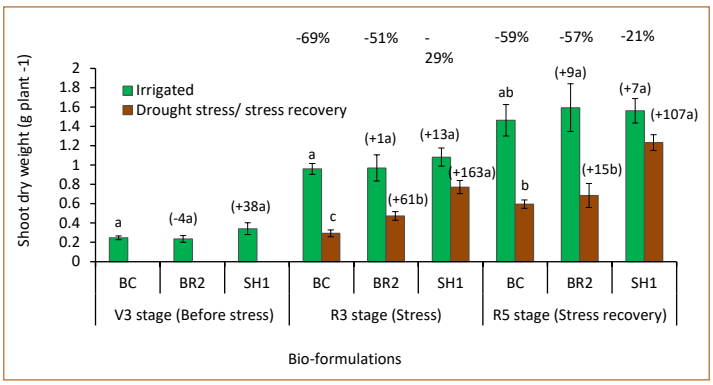


Fig. 2.50a. Effect of cow urine-based different bio-formulations on shoot growth in mungbean

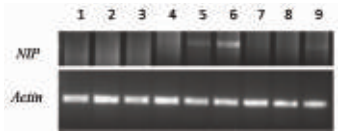


Fig. 2.50b. Expression of NIP gene and Actin gene (as a reference gene) at different growth stages [V3 (before drought stress), R3 (drought stress) and R5 (stress recovery)]. V3 stage: BC (1), BR2 (2), SH1 (3), R3 stage: BC (4), BR2 (5), SH1 (6), and R5 stage: BC (7), BR2 (8), SH1 (9) (lane details of 1–9)

Evaluation of water saving techniques for fruits and vegetables in shallow soils of semi-arid region (IXX10721)

DD Nangare, Mahesh Kumar, Yogeshwar Singh, PB Taware

The RWC, Chlorophyll and lipid peroxidation assays were conducted in grape at bloom and shatter stage and berry growth development stage under control and water stress condition. In control treatment, irrigation is applied as per package of practice i.e 0.6 Ep and under stress condition irrigation applied 0.4 Ep. The effect of control and stress treatments on RWC, Chlorophyll and lipid peroxidation is given in Fig. 2.51.

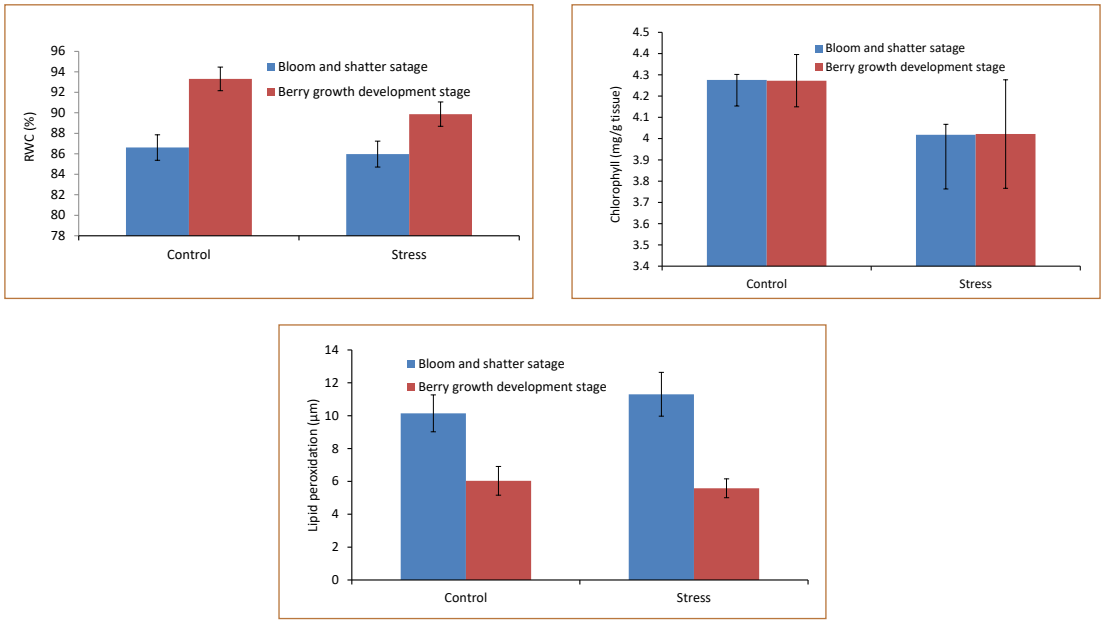


Fig. 2.51. RWC, Chlorophyll and lipid peroxidation assay under given treatments

RWC and chlorophyll content were found to be higher in control than stress condition. Whereas lipid peroxidation assay was found stable under both control and stress condition. At berry development stage, RWC was found less in stressed plants

compared to control. But at bloom and shatter stage, it was stable. Under stress condition, chlorophyll content was reduced at both growth stages compared to its respective control. At berry development stage, lipid peroxidation was found less as compared to bloom development stage.

Investigation on traits and genes associated with adaptation of wheat genotypes to local drought environments (IIX09675)

AK Singh, Mahesh Kumar, Jagadish Rane

Evaluation of traits such as Canopy temperature depression (CTD), photosynthetic efficiency and yield related traits in promising wheat genotypes along with local checks.

Twnty two wheat genotypes were evaluated for traits and genes associated with water stress tolerance under post-anthesis drought stress condition under timely sown and late sown conditions. Wheat genotypes along with check varieties were evaluated for traits such as canopy temperature, chlorophyll content, water status of plant (RWC) and yield related attributes under irrigated and water stress conditions. Promising wheat genotypes, i.e, EC-573623, IC-549394, IC-112051, IC-543366, IC-549526 and IC-549520 revealed water stress tolerant related physiology with yield stability. Promising wheat genotypes along with local check varieties were sown in the field as timely and late sown conditions. Under timely and late sown conditions, these promising wheat genotypes showed lower canopy temperature, higher SPAD value, higher chlorophyll content compared to check varieties HD-2189 and Netrawati (Figs. 2.52a & b, 2.53a & B, 2.54a & b, 2.55, 2.56a & b, 2.57a & b). These promising wheat genotypes also showed higher functional tiller and grain yield compared to check varieties HD-2189 and Netrawati.

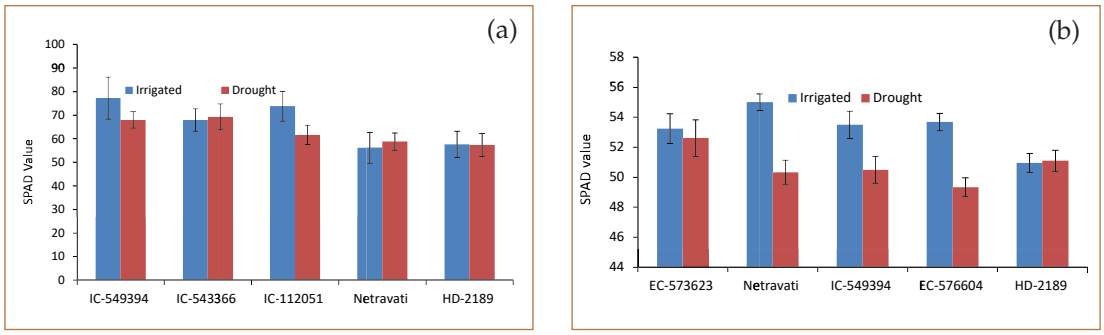


Fig. 2.52. Genetic variation in chlorophyll content under timely sown (a) and late sown conditions (b) in wheat genotypes

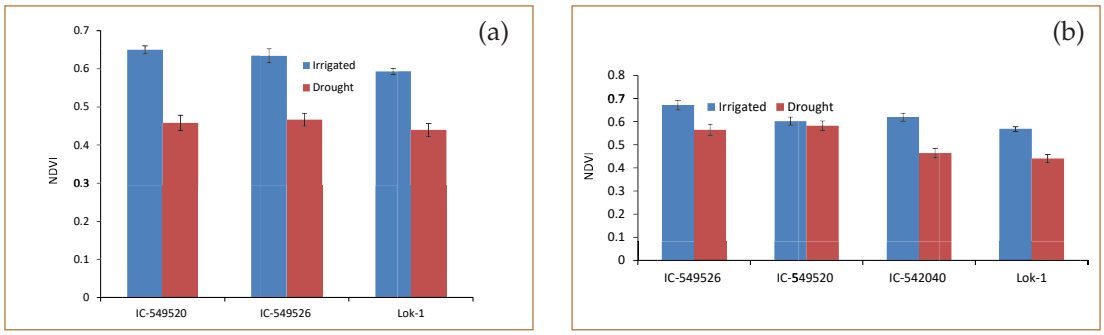


Fig. 2.53. Genetic variation in NDVI value under timely sown (a) and late sown conditions (b) in wheat genotypes

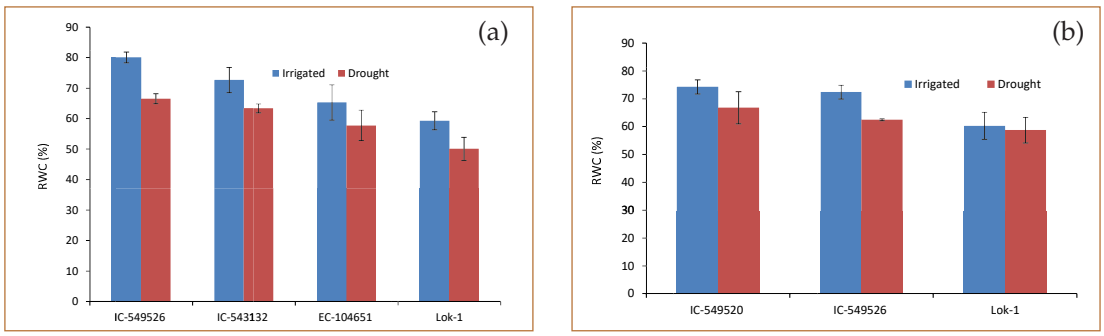


Fig. 2.54. Genetic variation in RWC under timely sown (a) and late sown conditions (b) in wheat genotypes

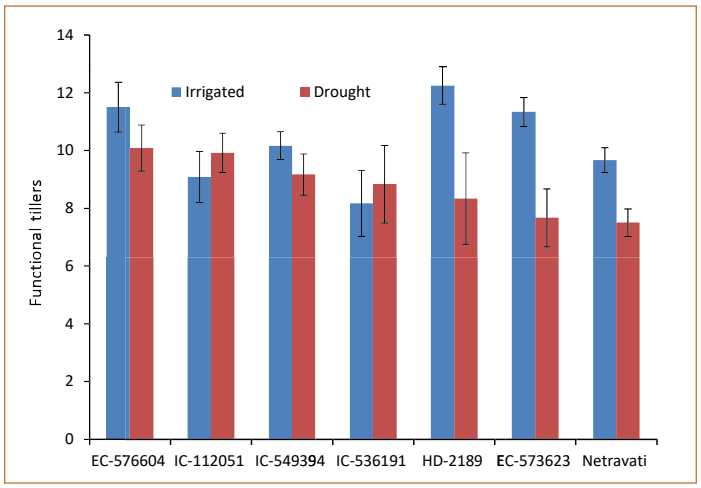


Fig. 2.55. Genetic variation in functional tillers wheat genotypes under late sown conditions

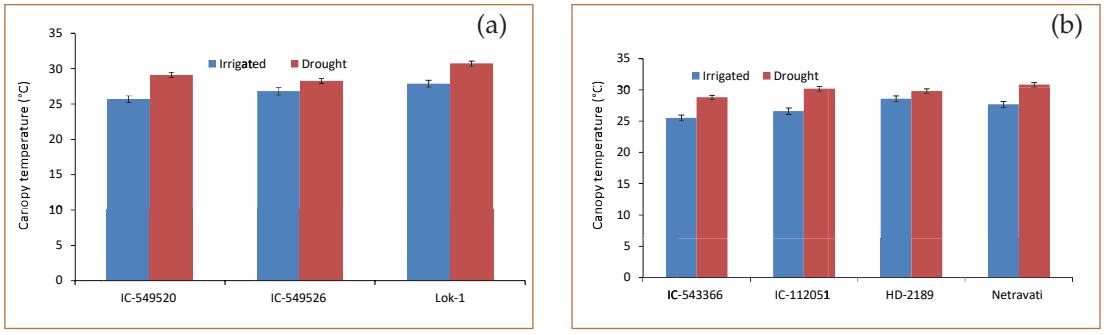


Fig. 2.56. a, b: Genetic variation in Canopy temperature in wheat genotypes

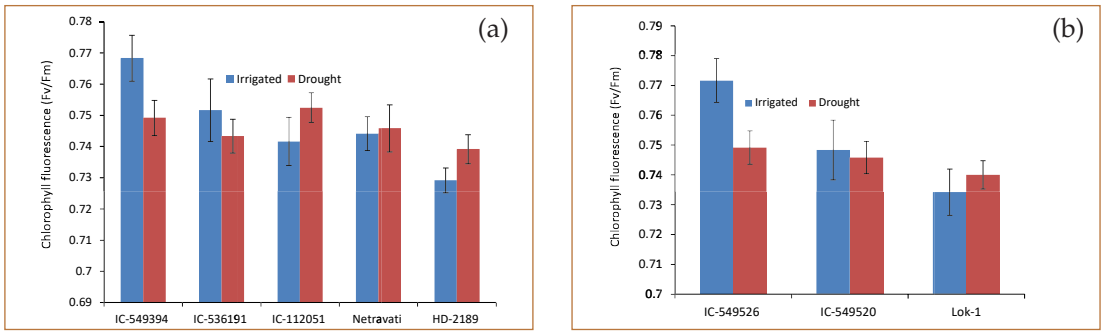


Fig. 2.57. a, b: Genetic variation in Chlorophyll fluorescence (Fv/Fm) in wheat genotypes under late sown conditions

Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean (0XX04449)

AK Singh, Yogeshwar Singh, Mahesh Kumar, Jagadish Rane

500 soybean germplasms were procured from ICAR-Indian Institute of Soybean Research, Indore. These soybean genotypes were evaluated for traits associated with adaptation to water stress tolerance. Physiological parameter, viz chlorophyll content (SPAD), chlorophyll fluorescence and Canopy temperature depression were studied. Soybean genotypes EC-245988 and TGX-849-207 showed higher chlorophyll content compared to check variety JS-335 (Fig. 2.58). Soybean genotypes were also evaluated for Root System Architecture (RSA) under in vivo by growing in PVC pipes (Length X Width) (4 feet X 5 Inch) and also under in vitro conditions by culturing soybean seeds on to ½-MS media. Root length, Root number, frequency and distribution of root hairs, root biomass, and root angle were studied under *in vitro* conditions. RSA of soybean genotypes JS-9752, IC-4882, TGX-863-26F, JS-9552 were comparable with drought tolerant check variety JS-335 (Fig. 2.59).

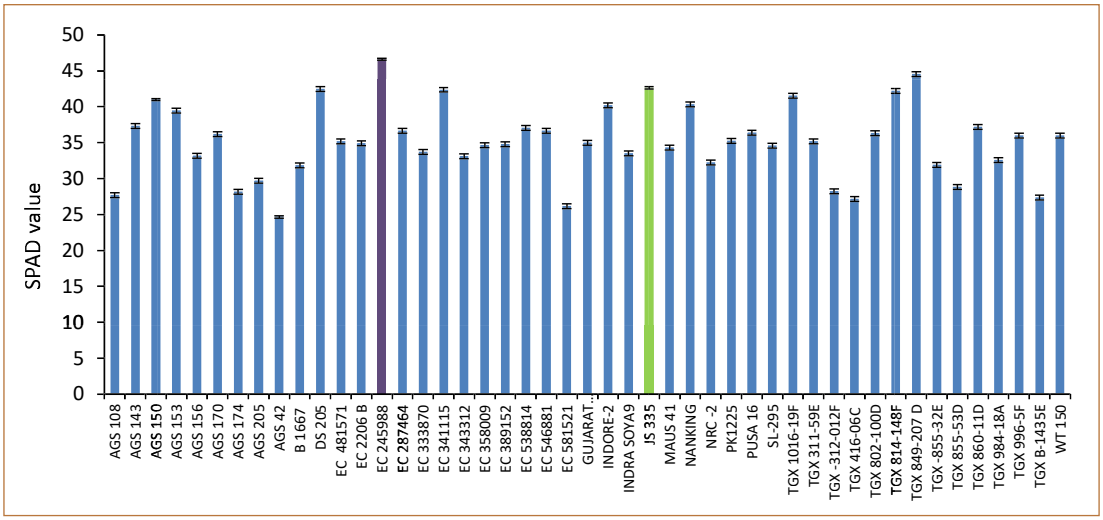


Fig. 2.58. Genetic variability in chlorophyll content (SPAD) in soybean genotypes

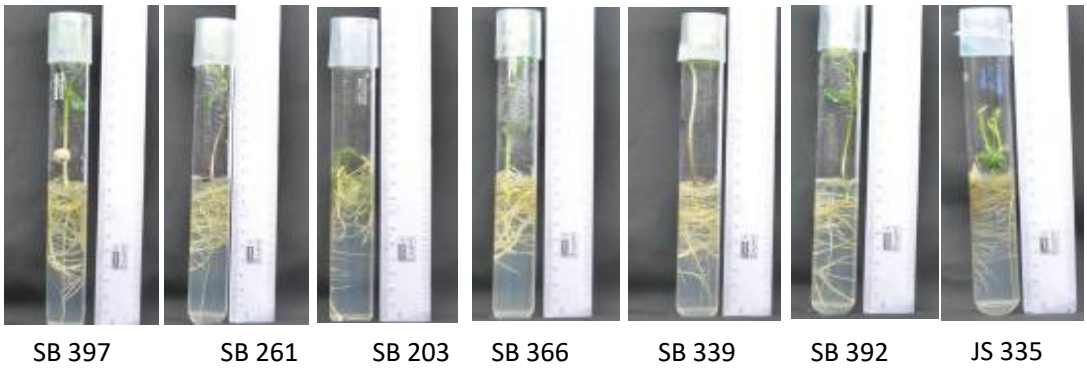


Fig. 2.59. Root system architecture studies in soybean genotypes. SB397:WT-150, SB-261:TGX722-155F, SB203:EC380522, SB366:SQL-5, SB339:JS-9552, SB392:GP493

Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (0XX03111)

Jagadish Rane, AK Singh

Though much of the wheat sown in India has access to irrigation, restricted soil moisture situation arise due to suboptimal level of water supply. Hence, efforts are being made to develop water use efficient wheat genotypes suitable for restricted soil moisture conditions. In one of the network project supported by DBT for collaboration with Universities of United Kingdom, efforts are being made to use advanced technologies to identify traits contributing to drought tolerance. NIASM has been assigned with phenotyping component of the project entitled "Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat". At NIASM, a set of 220 genotypes including cultivars released for locally adapted cultivars were evaluated for three years and a set of 50 diverse genotypes derived from 220 were tested in the fourth year for growth, yield and physiological parameters. AMMI-Biplot Analysis of four years of data could differentiate drought (D) and irrigated (I) environments (Fig. 2.60 a and b). Analysis also revealed that genotypes such as C306 could perform better in drought environments. In addition to this already known genotype, there were some genotypes

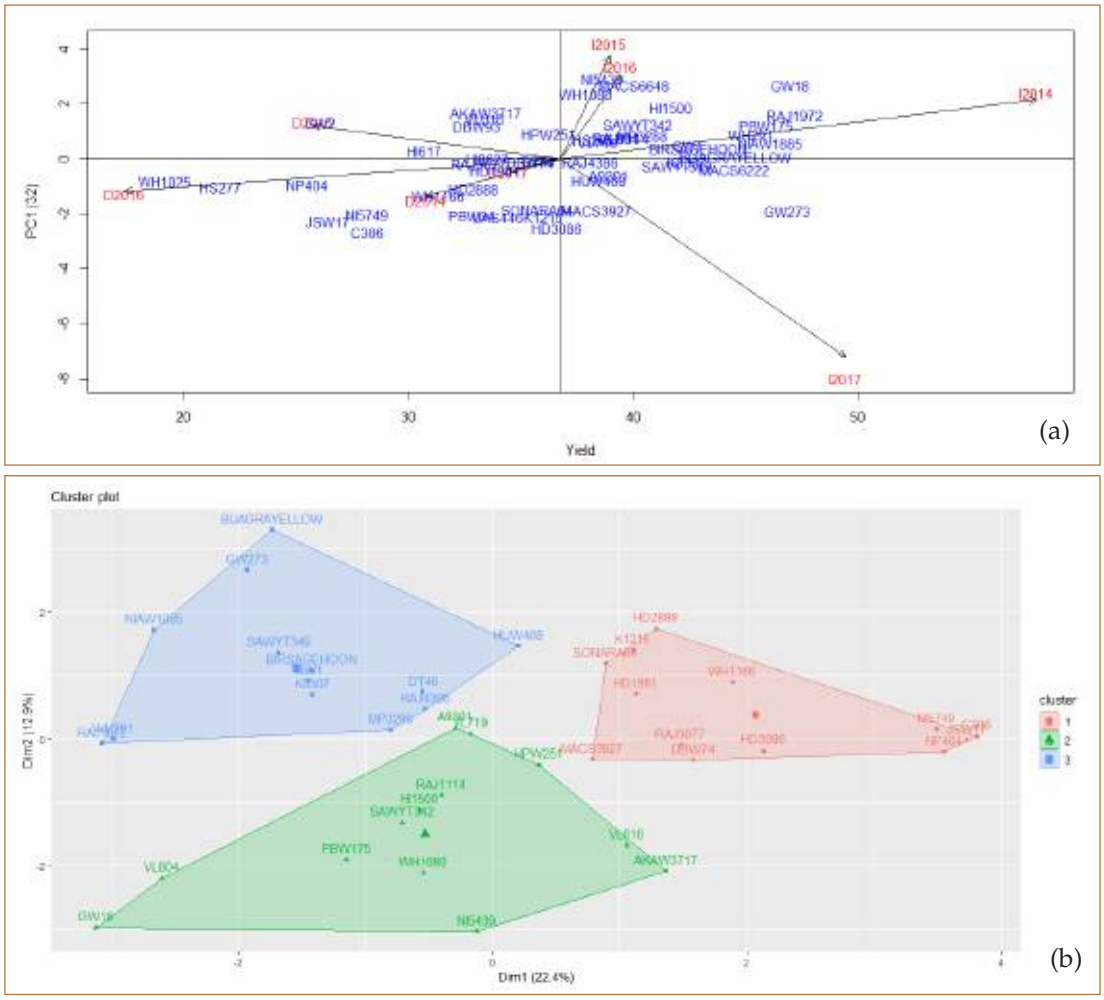


Fig. 2.60. Biplots that differentiate irrigated and water stressed environments and the genotypes adapted to these conditions(a); Cluster plot that differentiate 50 genotypes tested in three groups(b)

such as JSW17, NI5749 and NP404 that showed similar yield responses under drought conditions. This was further supported by K-cluster analysis which grouped the genotypes into three different groups (Fig. 2.60) based on grain yield performance in 8 different environments that included drought and irrigated conditions for 4 years. Both the analysis provided an hint that genotypes JSW17, NI5749 and NP404 can be as good as C306 in imparting traits responsible for drought tolerance in new cultivars.

Promising wheat genotypes superior to locally adapted cultivar

In order to search for new variation in drought responses of wheat genotypes, germplasm set containing more than two thousand genotypes were obtained from CIMMYT. During the initial crop seasons the seeds were multiplied and germplasm were compared with the locally adapted genotypes such as Lok-1 one of the most popular but old and disease sensitive cultivar. The objective was to search for better genotypes with almost same phenology. Experiments conducted under irrigated and water stressed conditions could help in identifying the genotypes which could yield more grains than the Lok-1. Values for different parameters including canopy temperature indicated that these promising cultivars keep their canopy cooler and maintain the physiology of plants even under depleting soil moisture stress conditions in a better way than Lok-1.

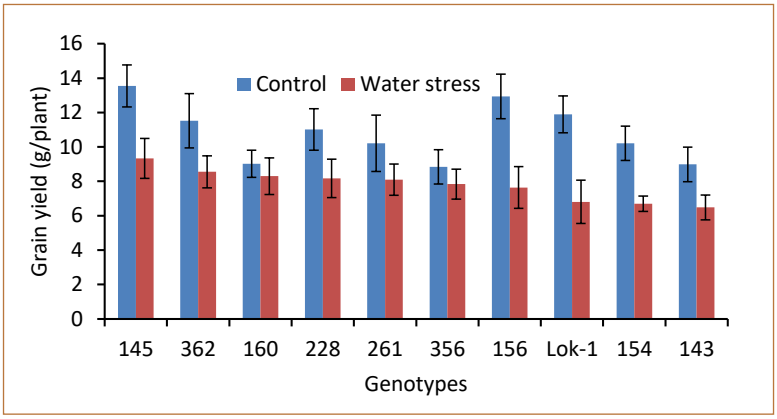


Fig. 2.61. Promising genotypes of wheat identified for terminal drought conditions

Investigation on traits and genes associated with resilience to moisture stress in soybean (IXX09675)

Mahesh Kumar, AK Singh, Jagadish Rane

Image-based method for estimation of chlorophyll content in soybean

Leaf colour has been commonly used as an index for crop stress diagnosis. Greenness assessment using wet chemical method is laborious and time consuming. We therefore developed an alternative method for non-destructive assessment of genetic variation in leaf greenness. The method is based on images of leaves captured by digital camera and quantification of colour pixels through image analysis. To assess the efficacy of the method a series of RGB images of detached leaves of soybean varying in their greenness were processed and analysed in programme developed in visual basic. Average pixel values of Red (R), Green (G) and blue (B) bands in each of the images were extracted. The values and derived parameters were compared with SPAD values and actual chlorophyll content in leaves estimated by spectrophoto-

metric method. RGB colour indices such as G/RGB, R/RGB were found to be significantly correlated with chlorophyll content and SPAD values suggesting that the method can be used for assessing the variation in greenness of leaves in soybean. The RGB-based digital image analysis has the advantage over conventional subjective methods for being fast, non-invasive, and inexpensive.

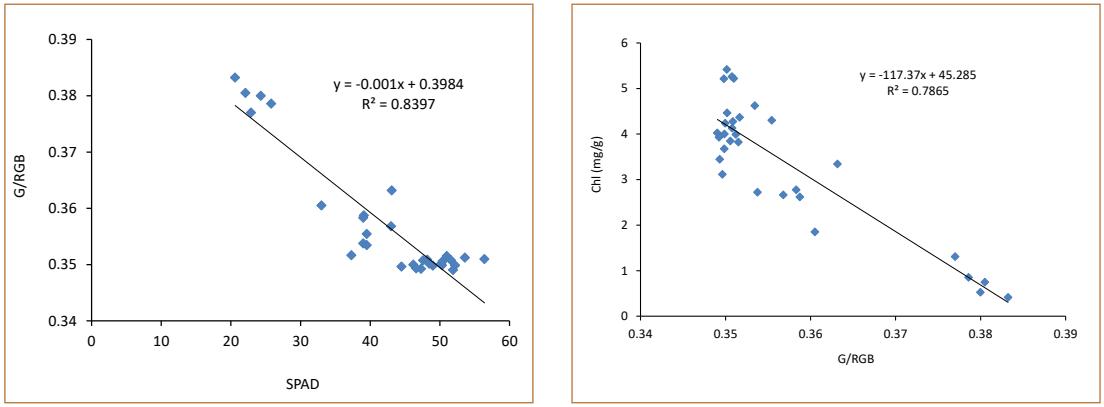


Fig. 2.62. Quantifying senescence soybean through digital images

Moisture stress particularly at the later phase of the life cycle is a major constraint for production and yield stability of chickpea and soybean in dry area. Plants show a lot of morpho-physiological changes in response to moisture stress. Leaf senescence is an important phenotypic trait for the assessment of a plant's response to stress. This is also an indicator of plant age and health. Manual quantification of senescence is time consuming and subjective. The experiment was conducted with chickpea and soybean genotypes to evaluate plant senescence by image analysis using LemnaTec HTS-Scanalyzer and indigenous tools developed at ICAR-NIASM. Using high throughput LemnaTec HTS-Scanalyzer we could observe the early senescence in C-2014, C-2024 and C-2021. In contrast, genotypes there were genotypes that exhibited delayed senescence (C-2022, C-2015, and C-2019) under both well water and water stress conditions. Experiment was also conducted with soybean in field condition with the camera mounted on a hand operated trolley that could move on an iron track installed in the experimental field. Images were analysed using indigenous programme developed at this institute. Through this image acquisition and analysis tools we could identify the fast as well as slow senescing genotypes in field conditions. We demonstrated that senescence can be estimated by image based method and used to study genetic variation in different crops.

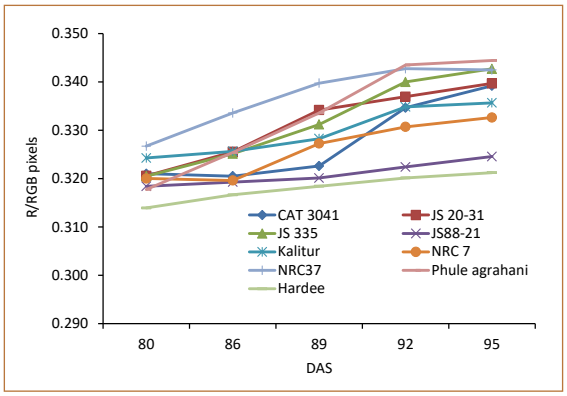


Fig. 2.63. Change in RGB pixel in different soybean genotype

Excised leaf water loss as a trait for screening soybean genotypes for drought tolerance

Soybean cultivars differ in drought tolerance, but the mechanisms controlling these differences is very complicated. Tolerance to leaf water stress is determined by a wide range of traits associated with leaf and stomata. Excised-leaf water loss (ELWL), one of the traits associated with water stress tolerance was considered for assessing genetic variation in responses of soybean cultivars. Significant differences among the genotypes were observed for this trait. ELWL was identified as a trait which can differentiate genotype based on their ability to loose moisture in environment. These differences among soybean genotypes for rate of water loss, is presumably an estimate of cuticular transpiration rate of plant. ELWL can be used as one of the drought screening traits in soybean.

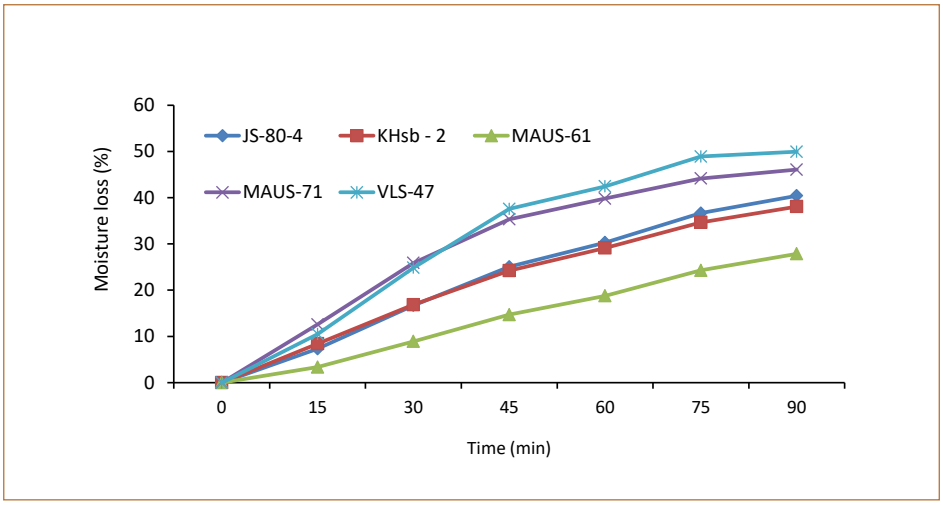
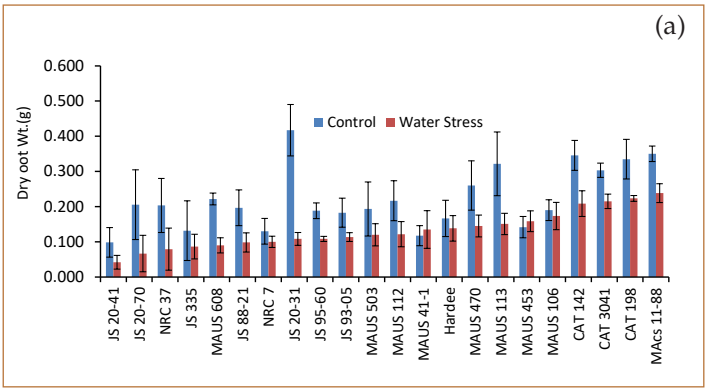


Fig. 2.64. ELWL of soybean cultivar under different time interval

Root architecture study in soybean genotypes

Pot experiments were conducted to evaluate the variation in root parameters under moisture stress conditions. The experimental setup was with two size of pots i.e., bigger poly vinyl pots (30 cm diameter x 45cm length) and with surface incorporated perforated small pots (20 cm diameter x 10 cm length with 20 mm sieve). 12 Kg soil was filled in all pot. Plant population was maintained uniform in all the pots. At flowering treatment was initiated. Root was washed in running water on a mess to avoid loss of roots. MACS 1188, CAT 142 was found promising in term of root dry weight and fresh weight.



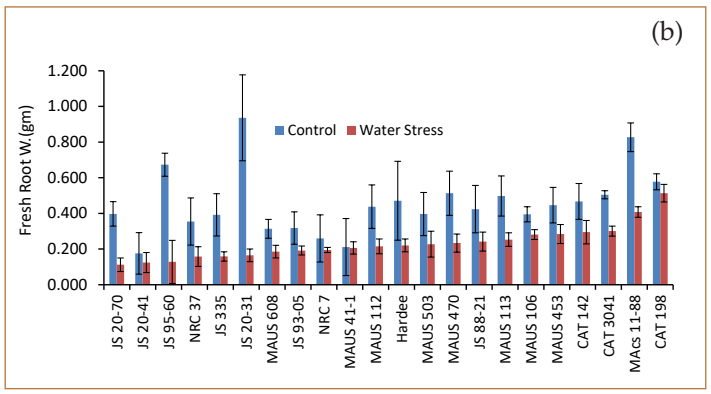


Fig. 2.65. Root dry weight (a) and fresh weight (b) of soybean genotypes

Fig. 2.66. View of root architecture and rooting system in contrasting genotype of soybean

Development of NIR based phenomics tools to assess the response of soybean to water-stress

Near Infra Red (NIR) image based phenomics tools are non destructive and rapid method for quantifying genetic variation in plant water status traits of different crops. Plant phenomics facility at ICAR-NIASM was used to capture the VIS/NIR images ofsoybean. Intensity of NIR perceived by camera are inversely proportional with water content in leaf tissues as NIR in the selected wavelength range absorbed by water molecules. In the experiments 18 soybean genotypes were evaluated under moisture stress as well as normal condition. Result indicates that Hardee, SL 525 seems capable of maintaining better tissue moisture content compared to other genotypes.

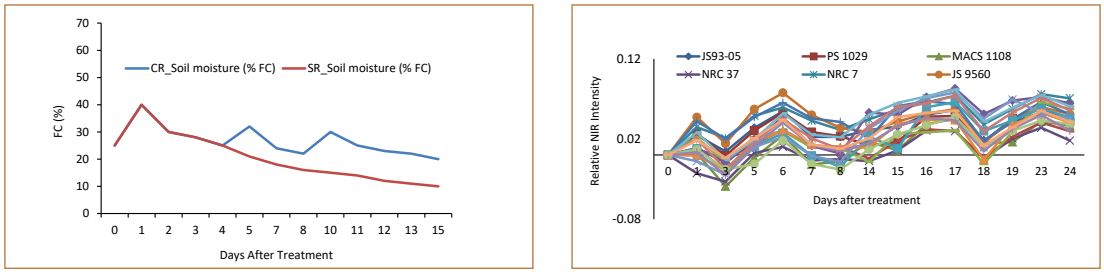


Fig. 2.67. Moisture content in pots, relative NIR intensity under stress conditions in different genotypes of soybean

Variation in pollen viability in soybean genotypes

Pollen viability, germination and pollen tube growth are highly critical for reproductive success in plants and hence productivity of crop plants. These processes are often affected by drought and heat and hence result in reduction in crop productivity. Genotypic variation in per cent pollen germination of Soybean was studied under different temperature using foldscope. Soybean genotypes tested for pollen germination. NRC-77 and Birsa Soya shows highest germination percentage at high temperature (30°C).

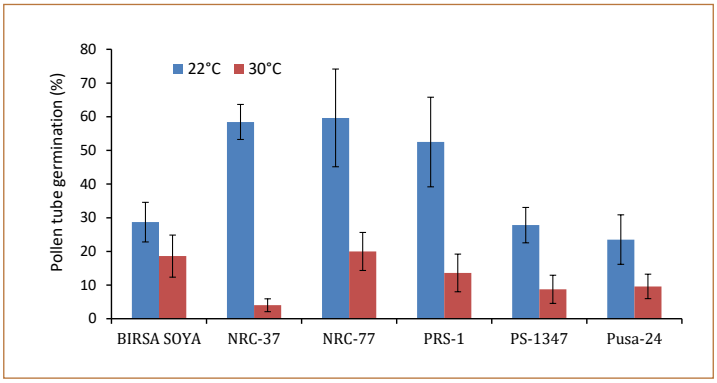


Fig. 2.68. Pollen germination in soybeangenotypes at different remperature

Expression profiling of drought responsive genes in promising soybean genotypes

Soybean genotypes, JS-9752, EC-538828 and JS-335 found to be drought tolerant and genotype JS-9560 was vulnerable to drought stress, were analysed for expression of drought responsive genes such as *FAD3* and *Farnesyltransferase* (Fnsl). Promising soybean genotypes with drought tolerance capability showed higher expression of *FAD3* gene and lower expression of *Fnsl* (*Farnesyltranserase* (ABA signalling) genes (Figs. 2.69 & 2.70). Soybean genotype JS-9560 showed higher expression of Fnsl and lower expression of FAD3. Primers sets (Forward & Reveres) used for amplification of these genes are depicted in Table 2.19. Total RNA was extracted using Qiagen RNeasy kit and cDNA synthesis was carried as per manufacturer instruction (In vitrogen) and expression profiling was done by Reverse Transcription Polymerase Chain Reaction (RT-PCR). Amplified RT-PCR products were electrophoresed on a 1% agarose gel.

Table 2.19. Primers used fort-PCR amplification

S.No.	Gene	Primer sequence
1.	*GmFAD3* (*Fatty Acid Desaturase 3*)	For:5′-CGCGGATCCATGGTTAAAGACACAAAGCCT-3′ Rev:5′- CATTCCTGGCCAGTGTCGTTGCGAGTGGAG-3′
2.	*Farnesyltransferase* (Fnsl)	For: 5′-GACTAGTTGAATGGGCGGTATT-3′ Rev:5′-TGGAGAATCTGGGTGCTTTG-3′
3.	*β-Tubulin* (As Reference gene to check level of cDNA amount)	For:5′-CAATTGGAGCGCATCAATG-3′ Rev:5′-ATACACTCATCAGCATTCTC-3′

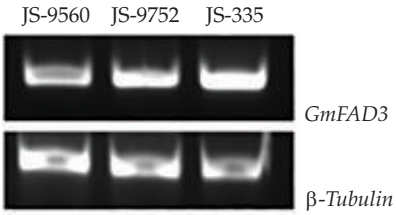


Fig. 2.69. Expression profiling of FAD3 gene in drought tolerant soybean genotypes (JS-335, JS-9752 and drought susceptible genotype (JS-9560)

Fig. 2.70. Expression profiling of *GmFarnesyltransferase* gene in drought tolerant soybean genotypes (JS-335 & JS-9752 and drought susceptible genotypes (JS-9560)

Exploring potential to obviate water and temperature stress in onion (*Allium Cepa* L.) for enhancing productivity and post–harvest storage quality (IXX14250)

GC Wakchaure and KK Meena

Onion responses to bio-regulators and waters stress for enhancing post-harvest quality of onion during long term storage

The lab experiment was conducted to investigate effect of exogenous application of bio–regulators viz., potassium nitrate (PN, 15 g L^{-1}), sodium benzoate (SB, 100 mg L^{-1}), thio–urea (TU, 450 ppm) and gibberellic acid (GA, 25 ppm) during long term storage on physiochemical and functional characteristics of onion produced under water stress conditions (Fig. 2.71). The onion bulbs stored at 25±1°C and 65±5%RH were produced under four levels of water stress i.e. no, low, medium and severe created using line source sprinkler system where irrigation water (IW) applied equalled 1.00–0.85, 0.84–0.70, 0.69–0.40 and 0.39–0.10 times the cumulative open pan evaporation (CPE), respectively. The results showed marked fall in dry matter, rehydration ratio, total soluble sugar (TSS), protein and total phenolics content (TP) of the onion bulb during initial six months and increased slightly thereafter except TSS temporally with increasing degrees of water stress. Moreover, water stress had significant increase in pyruvic acid content, superoxide dismutase (SOD) and peroxidase (POD) activity, however the trends remained irregular throughout storage. Application of bio–regulators significantly improved overall characteristics and reduced the bulb weight losses by 17.3, 23.9, 26.4 and 32.2% with SB, TU, PN and GA, respectively over the control (36.2%). Especially SB, TU and PN were identified to have better role in enhancing post–harvest storage quality of onion as evidenced by reduced weight loss and positive changes in physiochemical and functional status of

Fig. 2.71. Onion bulbs as affected by water stress and plant bio-regulators treatment

the bulbs. In conclusion, exogenous bio–regulators could substantially improve the keeping quality of onion bulbs produced under water scarce conditions in long term storage by regulating physiology and metabolic activities.

Onion cultivars responses and identification of most sensitive growth stage to water stress using drip system

The field experiment was conducted in late Rabbi Season (January to June 2018) to identify the most sensitive growth stage of onion to the water stress using drip system. The treatments were arranged in split-split plot design with four replications consisted of (i) four onion cultivars (cv. N-2-4-1, cv. Bhima Kiran, cvBhima Sweta and local) as main plot treatments (ii) four levels of irrigation water (IW) equalling, I1=1.00, I2=0.75, I3=0.50 and I4=0.25 times of the CPE (cumulative open pan evaporation) were maintained using drip system as subplot treatments and (iii) three growth stages (G1-40 to 60, G2-61 to 80 and G3-81 to 100 DAT) as sub-sub plots. The study reveals that in terms of marketable yield, local onion cultivar of the Baramati region was found to be superior over the cv. N2-4-1, B. Kiran, B. Shweta irrespective of different water stress levels applied. Further, for all onion cultivars water stress applied at 61–80 DAT was found to be most sensitive growth stage. At this stage, total marketable yield reduction of 11.28-21.50% and 18.18-25.85% in comparison to water stress applied at 30-60 DAT and 81-100 DAT, respectively (Fig. 2.72).

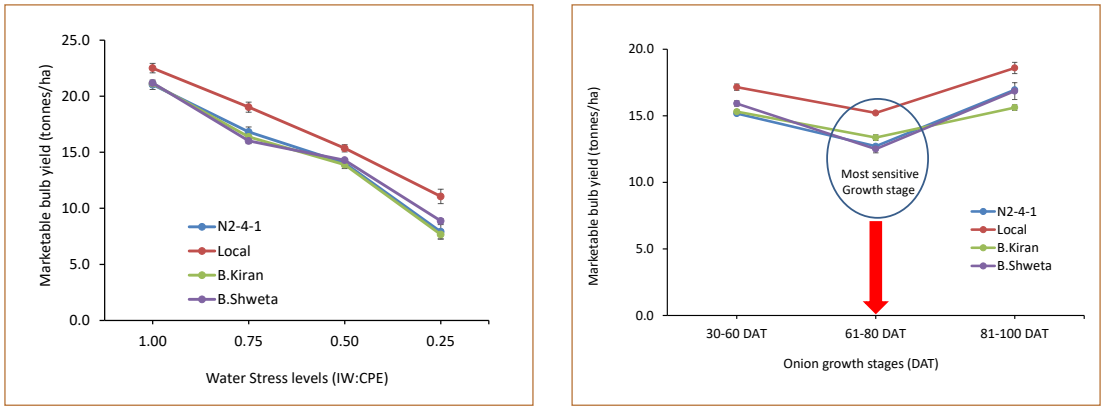


Fig. 2.72. Yield responses of onion cultivars and identification of most sensitive growth stage

Plant bio–regulators (PBRs) for alleviating water logging stress in onion

Another field experiment was conducted during the *kharif* season 2018-19, to evaluate the interactive effect of PBRs and water logging stress on growth, bulb yield and quality of onion (cv. Bhima Kiran). The treatments were arranged in RCB design consisted of (i) exogenous sprays of four PBRs viz., potassium nitrate (PN, 20 g L^{-1}), thio–urea (TU, 800 ppm), salicylic acid (SA, 15 µM) and sodium benzoate (SB, 250 mg L^{-1}) along with control (no PBRs) and (ii) three water logging stress levels maintained at 30, 60 and 90 DAT in main plots (Fig. 2.73). The foliar application of PBRs improved the bulb yields by 9.42-23.08, 14.2-31.14 and 7.2-21.9% during water logging stress occurred at 30, 60 and 90 DAT, respectively over control (Table 2.20). Potassium nitrate–KNO_3 (20g L^{-1}) and thio–urea–TU (800 ppm) showed major role for mitigating impact of water logging stress. Thus identified plants PBRs like KNO_3, TU and SA can help to boost the productions vis-a-vis profitability of onion under water logging conditions.

Table 2.20. Effect of plant bio-regulators and water logging stress on marketable bulb yield (tonne/ha)

Water logging stress	W1 (30 DAT)	W2 (60DAT)	W3 (90DAT)	Mean
Plant bio-regulators (PBRs)				
PN (20 g/L)	32.5	28.9	31.5	31.0
TU (800 ppm)	30.7	26.7	28.5	28.6
SA (15 µM)	29.2	24.5	28.2	27.3
SB (250 mg/L)	27.6	23.2	26.5	25.8
no PBR	25.0	19.9	24.6	23.2
Mean	29.0	24.6	27.9	
LSD (P=0.05), CV=7.54%	PBRs=0.66*	WL=0.40*	PBRs × WL=1.98ns	

*significant, ns=non-significant at P=0.05

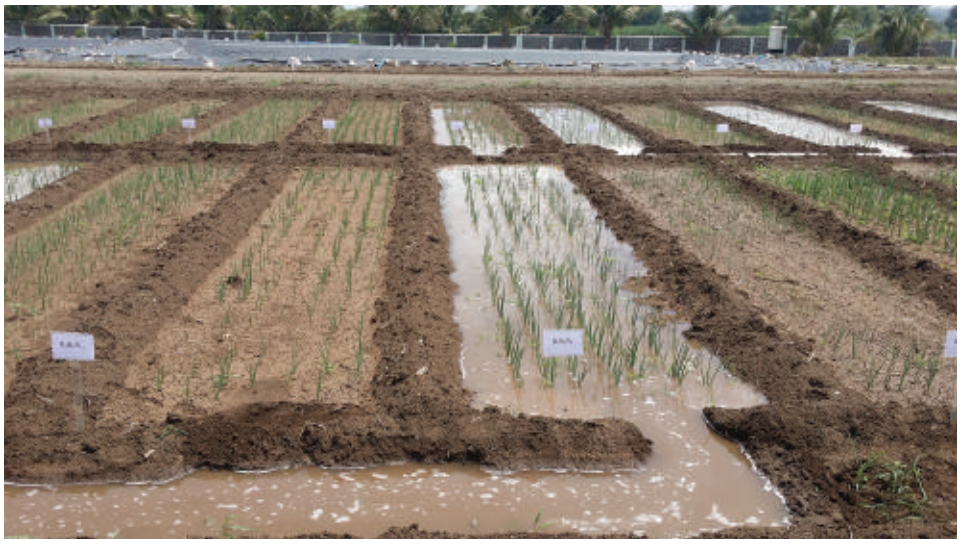


Fig. 2.73. Field view of water logging and PBRs application experiment

Identification and performance evaluation of potential water stress tolerant onion cultivars using line source sprinkler system (LSS)

The second year (2019) field experiment was repeated to evaluate the performance of the eight onion cultivars for identifying water stress tolerant onion cultivars using line source sprinkler system (*Allium cepa* L.). The onion cultivars included: Cv. Bhima Red (TFL), Bhima Shubra, Bhima Sweta, Bhima Safed, Bhima Red, Bhima Super, Bhima Raj and Control as main plot treatments. The line source sprinkler system (LSS) was used to maintain six levels of irrigation water (IW) i.e. 65.9, 57.5, 49.4, 35.3, 19.8 and 12.5 cm applied based on cumulative open pan evaporation (CPE) as subplot treatments. First year (2018) result revealed that the maximum marketable bulb yield (113.2 t ha^{-1}) was obtained at IW, 65.9 cm for control (local cultivar) and corresponding values were 99.1, 98.0, 92.2, 91.9, 89.5, 85.9 and 76.1 t ha^{-1} for cv. Bhima Shubra, Bhima Safed, Bhima Raj, Bhima Sweta, Bhima Red, Bhima Raj and Bhima Red obtained at IW 49.4–57.5 cm, respectively (Fig. 2.74). In comparison

to red onion cultivars, total 9.5–42.9, 18.6–44.6, 6.1–20.5 and 2.3–28.6% improvement in bulb yields for local (red) cultivar was reported under excess IW (65.9 cm), no stress/optimum IW (57.5 cm), moderate stress (35.3–49.4 cm) and severe water stress (12.5–19.8 cm) conditions. However, the yield performance of white onion cultivars (cv. Bhima Safed and Bhima Shubra) was found better than all red onion cultivars under moderate to severe water stress conditions. Among the red onion cultivars, maximum water productivity (WP) of 12.3–19.7 kg m^{-3} was obtained for local (control) and almost comparable, even superior than white onion cultivars like cv. Bhima Shubra (15.5–20.1 kg m^{-3}), Bhima Sweta (12.2–18.9 kg m^{-3}) and Bhima Safed (13.3–19.0 kg m^{-3}) (Fig.2.75). The post–harvest quality parameters viz., geometric mean diameter, sphericity and average bulb weight of local cultivar were found superior in comparison to all other onion cultivars tested. In conclusion, outperforming local cultivar in Baramati area could sustainably enhanced yield and quality of onion in excess/water logging and water deficits shallow basaltic soil conditions (Fig. 2.76).

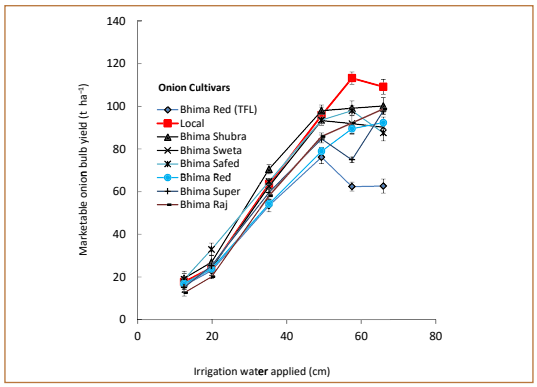


Fig. 2.74. Yield response of potential water stress tolerant onion cultivars-LSS

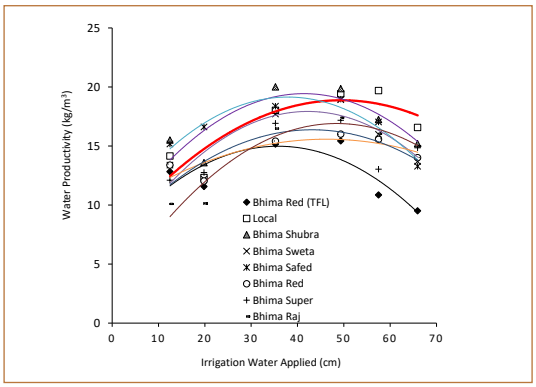


Fig. 2.75. Marketable yield and water productivity of the potential onion cultivars under varied water deficit levels

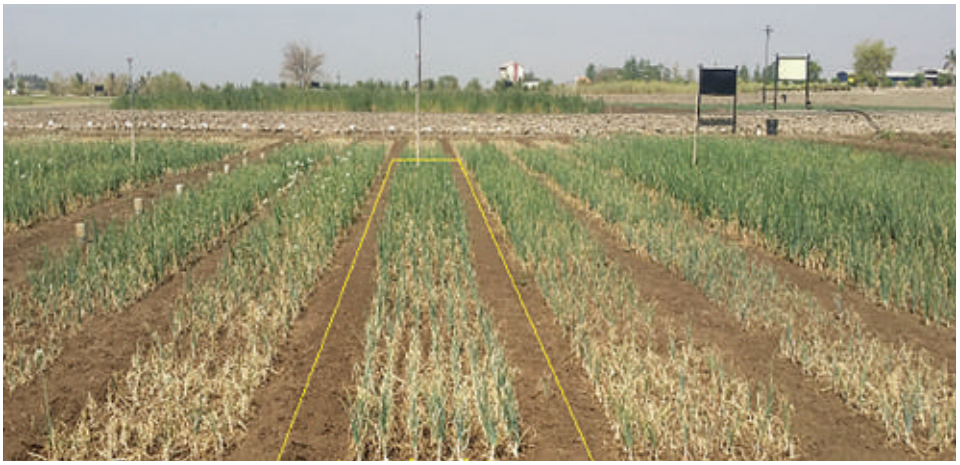


Fig. 2.76. Local identified onion cultivars (Baramati) tolerant to both excess and deficit water

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Quantifying thermal tolerance limits and genetic polymorphism to temperature stress in fishes from drought affected Bhima and Krishna rivers in Maharashtra (IXX14264)

MP Brahmane

Sampling of fishes along the Dimbhe reservoir and Bhima river was carried out. Fish species locally known as Kolas, *Cyprinus carpio, Sperata species, Wallogo attu, Chanda nama, Puntius spp., Humbdi, Gobri, Tambta, Mastacembelus armatus, Pangasius sutchi*. The fish tissues such as gill, liver, kidney, heart, fin, skin and muscle were dissected in the field at the sampling locations and preserved for DNA and RNA extraction in 70% alcohol and RNA later respectively. Experimental fishing using cast net was carried in the streams in the Sahyadri hills. Experimental fishing of small indigenous fishes and Loache fish was conducted. The fishes have been brought to the institute in live condition. The fishing activity was again commenced at Chas village on Bhima river and live fishes were collected. Samples of *Tilapia, Dhokla, Kolas, Chitala, Sandas, Salmostoma*, were sampled from the Chas Kaman reservoir Freshwater prawn, *channa* spp., *Tilapia*, *Sperata* and freshwater *Crab* were sampled at Khed, Rajgurunagar. The samples are preserved and documented and morphologically identified.

Table 2.21. List of different fishes used for sampling

S No	Scientific Name	Common Name
1	*Chanda nama*	Glass fish
2	*Hypselobarbus kolus*	Kolus
3	*Mystus cavasius*	Gangatic cat fish
4	*Systomus sarana*	Olive barb
5	*Nemacheilus troglocataractus*	Blind cave loach
6	*Channa striatus*	Striped or Banded snakehead
7	*Channa marulius*	Giant snakehead
8	*Oreochromis mossambicus*	Mozambique tilapia
9	*Cyprinus carpio*	Common carp

Spawning and larval development of Snakehead fish, *Channa* sp. and Nile Tilapia, *Oreochromis niloticus* under abiotic stress environment (IXX14249)

MP Bhendarkar

Pre-stocking management of fish pond, live feed culture and stocking of Murrel, *Channa* sp.

Pre-stocking management pond has been done and it aims at proper preparation of pond to remove the causes of poor survival, unsatisfactory growth, etc. and also to ensure ready availability of natural food in sufficient quantity and quality for spawn/fry/fingerlings to be stocked. The eradication of aquatic weed has been carried

out from the fish pond. The cow dung has been applied @ 70 kg of each pond. The main objective of manuring is to augment the production of zooplankton, the natural food of fish spawn/fry.

Eradication of aquatic weed

Plankton collection

Acclimitize of *Channa sp.*

Live feed culture unit

Fig. 2.77. Pre-stocking management of fish pond, live feed culture and stocking of Murrel, *Channa* sp.

Snakeheads are a peculiar group of freshwater fishes having accessory respiratory organ to utilize atmospheric air for respiration that enables them to thrive in oxygen depleted waters. Keeping in the view of future abiotic scenario, the major concern in freshwater aquaculture is to increase per unit area of production rather than increase area by identifying and introducing stress tolerant species in the aquaculture system. The *Channa* sp are most reliable and potential species for species diversification. On the line of objective the fry size of murrel was reared in rounded FRP tanks for conditioning with a stocking density of 1000 numbers. The partial mortality occurred due to transportation stress, feeding and cannibalism. The remaining species was transferred to fish pond no.2 for further trial. Non availability of appropriate food at the early stages of fish is major cause of larval stock losses and therefore, live feed culture unit were undertaken and initiated. The collection of rotifer from the Nira canal has been done by plankton net has mesh size 60 micron.

Exposre to multiple salinity level revels on growth response of GIFT Tilapia

Seed of Genetically Improved Farmed Tilapia (GIFT) fish having average length 2.50 ± 0.04 cm were obtained from the Rajiv Gandhi Centre for Aquaculture, Manikonda, Dist. Krishna, Andhra Pradesh and transported to the ICAR-NIASM in plastic bags of 20 liter capacity with stocking density of 150 seed per bag. The seed

were acclimatized and kept in FRP tank and Hapa for a period of 10 days before stocking in experimental tanks. Similarly the seed stocked in different tank with different stocking density in Pond no.1, FRP tank and cement tank.


Fig. 2.78. Exposure to GIFT Tilapia to multiple salinity level

Rectangular aquarium tanks having dimension 2x1x1 feet of were used for the experiment studies. Saline water having 15 ppt salinity were obtained from farmer field at Kambaleswar, and transported to the fisheries wet lab by water tanker. Experimental design were prepared with variable salinity levels maintain such as 15 ppt, 10 ppt, 05 ppt, freshwater (control) and saline water (control) designated as T1, T2, T3, T4 and T5 respectively with three replication each. Fish of an average initial weight 0.9±0.001 g were randomly assigned to each aquarium tank at the rate of 07 fishes per tank.

Aerators were provided in each tank for continuous aeration. Feeding was carried twice a daily @ 10% ABW. Important water quality parameter such as salinity, temperature, pH, were measured on twice daily basis. Twenty five per cent of water was siphon out every day and simultaneously replaced with freshwater from each aquarium tank to maintain salinity. Fishes were weighed at the 5 days interval after the stocking.

Simulation and visualisation of potential population growth in pulse beetle, *Callosobruchus chinensis* L. in Pigeonpea under changing climatic conditions and its geographic distribution (IXX14278)

Rajkumar

An Apiary unit got established at the NIASM campus comprising of five bee hives. The sunflower plot was maintained for foraging by the bees. Five colonies of *Apis mellifera*, European honey bees were being maintained for better pollination in crops. For maintenance of bee colonies sunflower during summer, coriander, fennel and ajwain during winters, maize, lucern during kharif being grown. Activities of bees is being monitored and also found that apart from cultivated crops bees are visiting coconut, babul, drumstick, opuntia, subabul flower during scarcity period.

(a) (b)

(c)

Fig. 2.79. Sunflower crop and management of honey bee: Sunflower crop as a source of pollen (a), Bee hive in sunflower plot (b) and Daily management of honey bee hive (c)

Dragon fruit: A new Host for the Mango fruit fly, Bactrocera dorsalis Hendel (Tephritidae: Diptera)

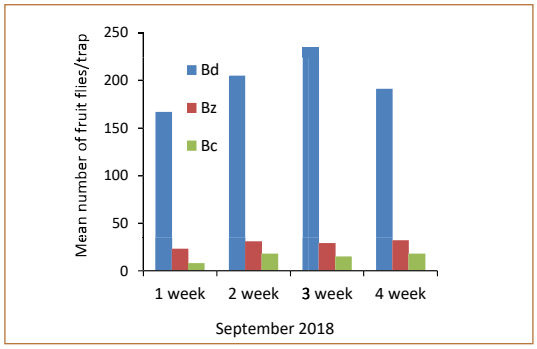
Dragon fruit (*Hylocereus* spp.) or pitaya is a climbing vine cactus species which is high-value crop and received worldwide recognition first as an ornamental plant and then has lured many farmers to its production as a fruit crop. There are four species of dragon fruit viz., red skin with white flesh (*H. undatus*), pink skin with red flesh (*H. polyrhizus*), fruit with yellow skin and white flesh (*Selenicereus megalanthus*) and dragon fruit with a very red colour of the fruit (*H. costaricensis*). Its fruit is the most attracting and beautiful in the family Cactaceae. Initial investigation revealed that the insect pests associated with dragon fruit were fruit flies which infest the fruit which is an economical part of the fruit. The dragon fruit was attacked by the three species of fruit flies viz., *Bactrocera dorsalis*, *B. zonata* and *B. correcta*. Among the three species the oriental fruit fly, Bactrocera dorsalis caused major damage.

The Oriental fruit fly, *B. dorsalis* (Hendel.) (Diptera: Tephritidae) is a polyphagous pest in tropical horticulture, causing direct damage to more than 150 species of fruits and vegetables (Christenson and Foote, 1960; Haramoto and Bess, 1970).

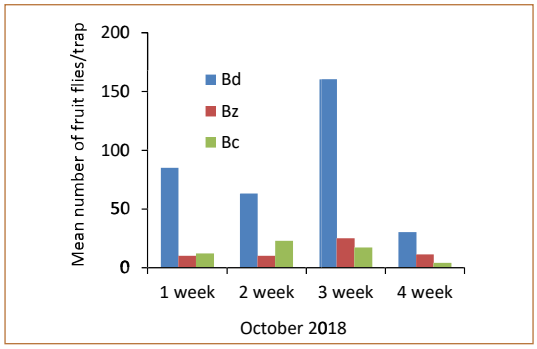
Fig. 2.80. Infestation of Dragon fruit by mango fruit flies *Bacrocera* spp.

To understand the population dynamics of fruit flies infesting dragon fruit, the initial investigations were done by monitoring of fruit flies in the mango orchard by setting up of the fruit fly traps and the different coloured sticky traps in the Dragon fruit orchard. The fruit fly trap consists of a plastic container containing a ply wood which is impregnated with the methyl eugenol to attract the male fruit flies in large numbers for their area wide management. The fruit flies were monitored at weekly interval from the month September, 2018 to December, 2018. Out of the three species reported *B. dorsalis* (Bd) found abundantly followed by the *B. zonata* (Bz) and *B. correcta* (Bc).

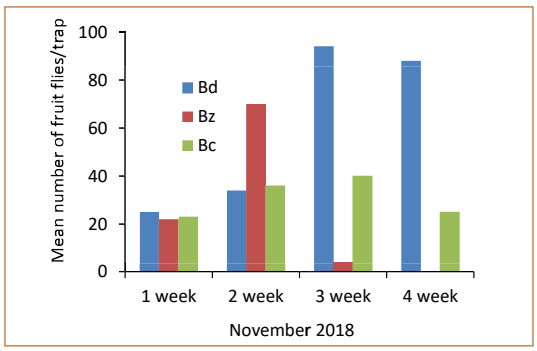
Fig. 2.81. Monthwise monitoring of fruit flies in Dragon fruit Orchard



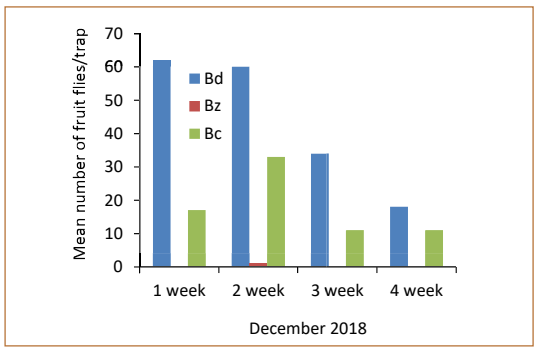
September, 2018



October, 2018



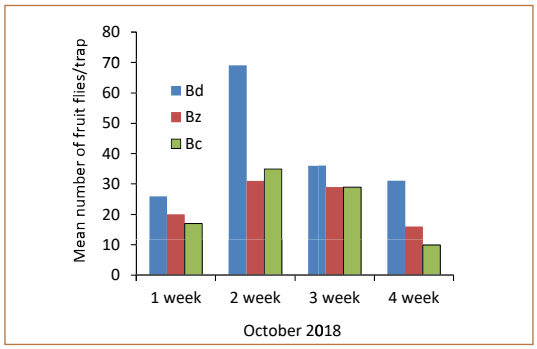
November, 2018



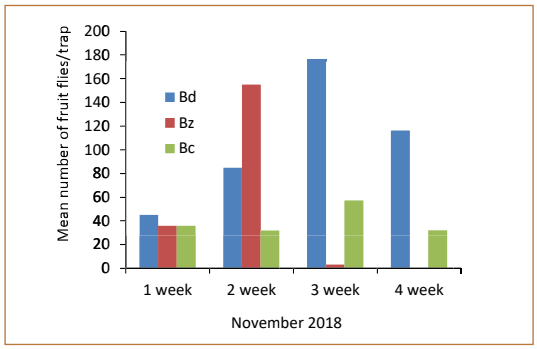
December, 2018

Fig. 2.82. Month wise monitoring of fruit flies in Dragon fruit Orchard

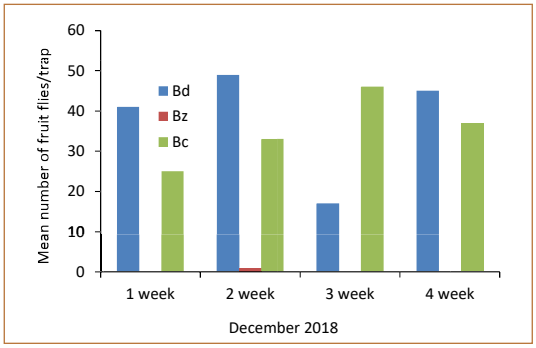
Month wise monitoring of fruit flies in Guava Orchard



October, 2018



November, 2018



December, 2018

Fig. 2.83. Month wise monitoring of fruit flies in Guava Orchard

Fruit flies were found infesting the guava and thus the fruit fly monitoring is also done at the guava orchard by setting up of methyl eugenol traps. Out of the three species reported from the guava, the abundance of *B. dorsalis* was found more followed by the *B. zonata* and then *B. correcta*.

Evaluation of Pigeonpea germplasm lines for against major insect pests:

30 germplasm lines of Pigeonpea were evaluated to understand the pest complex under varied climatic condition. The percent damage caused by the pest was reported and presented below.

Table 2.22. Evaluation of Pigeonpea germplasm lines for against major insect pests

S.No	Germplasm line	*H.armigera*	*Maruca*	*Bruchid*	Podfly	Yield (kg)
1	ICP 13270	46.25	0.00	23.99	6.52	0.53
2	ICP 12654	35.56	0.00	21.48	6.30	0.40
3	Mal	10.00	0.00	24.00	11.33	0.29
4	ICP 7366	42.86	0.00	40.00	0.00	0.50
5	Bennur Local	24.60	0.00	23.81	0.00	0.38
6	BDN 2008-12	30.09	0.00	30.97	9.73	0.45
7	BPG 7	32.52	0.00	20.25	4.91	0.38
8	BSMR 853	71.15	0.00	15.38	0.00	0.41
9	WRP 1	59.17	0.41	21.86	1.72	0.48
10	VKS 11/24-2	22.93	0.56	18.05	18.61	0.77
11	JKM 7	28.13	26.56	17.19	12.50	0.57
12	BDN 716	3.11	0.00	22.80	13.47	0.34
13	BPG 51	15.63	8.68	21.53	19.44	0.40
14	BDN 2	32.43	0.00	34.46	5.41	0.66
15	AKT 9913	45.16	14.34	18.28	12.54	0.62
16	BPG 4	41.89	7.57	11.35	23.51	0.60
17	BSMR 736	33.02	2.05	18.33	28.28	0.57
18	BDN 1	19.41	4.40	8.61	10.62	0.78
19	NA 1	21.74	1.55	30.43	8.07	0.47
20	BDN 708	22.30	0.87	54.66	0.00	0.72
21	BPG 61	45.50	0.48	85.45	2.45	0.72
22	RVK 285	28.20	5.15	65.48	6.45	0.90
23	ICP 16309	61.21	6.15	84.12	7.25	0.47
24	ICP 6668	54.15	0.45	64.48	5.65	0.55
25	BPG 5	75.00	0.65	45.73	0.00	0.72
26	PVK 275	58.59	0.64	42.48	4.48	0.72
27	Bahar	54.45	5.48	21.25	20.54	0.72
28	BDN 711	67.65	8.48	37.18	18.54	0.89
29	TJT 501	56.78	4.18	45.18	2.48	0.82
30	RVK 284	84.22	4.27	20.18	6.54	0.72

Lemon butter fly, *Papilio demoleus* in Citrus

Fig. 2.84. Lemon butter fly *Papilio demoleus* in Citrus

Culturing of lemon butterfly, *Papilio demoleus*: The culturing of lemon butterfly Papilio demoleus was carried out in the laboratory. Wherein the larvae were collected from the field regularly and maintained in the laboratory. To augment the culture more number of larvae were collected and kept for culturing. The main aim is to culture the lemon butterfly larvae in the laboratory for two to three generations so that the impact of biotic stress or feeding by the lemon butterfly on the citrus by using the hyperspectral signature. Once the sufficient number of larvae obtained then the effect of larval feeding on the plant or biotic stress will be assessed by hyperspectral signatures. During the process of culturing of lemon butterfly in the laboratory the efforts were made to feed the adult butterflies with 10% honey syrup in a cotton swab but the technique did not work. We used the marigold flowers which were impregnated with the 10% honey syrup and was observed for the feeding nature of the butterflies. The butterflies inserted the proboscis into the petals of the marigold flowers and started feeding on the honey which was impregnated. The pupas were kept separately to observe for any parasitoid infesting the pupae of lemon butterfly. It has been observed that some pupal parasitoid were parasitized the pupae and were collected and kept as repository of the insect's in the laboratory.

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3 ITMU / हिन्दी सेल

3. ITMU / हिन्दी सेल

ICAR – National Institute of Abiotic Stress Management logo as a Trademark under the class 31 was published in Trademark Journal No. 1836 dated 12.02.2018 and the copy is available online from 17th April, 2018. Institute logo has been successfully registered as TRADEMARK (Trade mark no. 3638062; trading as ICAR-NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT) under Class 31 of Trade Mark Act, 1999, Trade Mark Registry, Govt. of India on 2nd July, 2018.

Class	Goods
31	RAW AND UNPROCESSED AGRICULTURAL, AQUACULTURAL, HORTICULTURAL AND FORESTRY PRODUCTS; LIVE ANIMALS; FRESH FRUITS AND VEGETABLES, FRESH HERBS; NATURAL PLANTS AND FLOWERS; FOODSTUFFS AND BEVERAGES FOR ANIMALS; MALT; RAW AND UNPROCESSED GRAINS AND SEEDS; BULBS, SEEDLINGS AND SEEDS FOR PLANTING

One day awareness training programe on ISO 9001:2015 was conducted on June 08, 2018 at ICAR-NIASM.

A training programme was conducted for awareness on ISO 9001:2005 at ICAR for creating awareness about Indigenous traditional Knowledge, a technical folder was published in Marathi local language.

Technical Folder

अजय कुमार सिंह, आर. एल. चौधरी, प्रविण माने, बी. सज्ञनार, परितोष कुमार, एन. पी. कुराडे, के. के. कृष्णानी, जे. राणे और नरेंद्र प्रताप सिंह 2019: देशी पारंपरिक ज्ञान (आईटीके), Technical Folder: 31, ICAR-NIASM, Baramati.

हिन्दी कार्यशाला सह राजभाषा प्रशिक्षण कार्यक्रम

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान मे हिंदी भाषा को बढ़ावा देने हेतु राजभाषा कार्यान्वयन समिति ने गत वर्ष चार एक दिवसीय कार्यशालाओं का आयोजन किया। दिनांक 25 जून 2018 को एक दिवसीय कार्यशाला को तुलजाराम चतुरचंद महाविद्यालय के विभाग प्रमुख डा. प्रदीप सरोदे ने संस्थान के कर्मचारियो कों अपने विचारों से लाभान्वित किया। दिनांक 19 सितंबर 2018 को हुई एक दिवसीय कार्यशाला को मार्गदर्शन हेतु पुणे विश्वविद्यालय के सहायक अध्यापक प्रो. दवांगे मौजूद रहे। उन्होने हिंदी भाषा बेहद दिलचस्पी है तथा उसका रुझान हो इस पर विचार प्रकट किए। हिंदी भाषा राष्ट्रीय भाषा होते हुए भी इसे वैसा दर्जा नहीं मिल रहा है। हिंदी

भाषा का प्रचार –प्रसार हों इस वजह से संस्थान में कार्यशालाओं का आयोजन किया जाना आवश्यक होता है। दिनांक 24 दिसंबर 2018 को हुई एकदिवसीय कार्यशाला में मार्गदर्शक के रूप में सोमेश्वर महाविध्यालय के हिंदी विभाग प्रमुख डा. अच्युत शिंदे आए हुए थे। दिनांक 26 मार्च 2019 को हुई एक दिवसीय कार्यशाला के लिए मार्गदर्शक के रूप में डा. संदीप पवार (तुलजाराम चतुरचंद महाविद्यालय के सहायक अध्यापक के रूप में उपस्थित रहे। उन्होने मार्गदर्शन करते हुए 'लीला' एप के संदर्भ में जानकारी प्रस्तुत की। सारे संस्थान के कर्मचारियो ने इस एप के संदर्भ में जानकारी प्राप्त की। हिंदी भाषा को राष्ट्रीयत्व प्राप्त होने के बारें मे जिन समस्याओं से हमे गुजरना पड रहा है,उस समस्याओ का समाधान करते हुए डा.अच्युत शिंदे ने मार्गदर्शन किया। मार्गदर्शन देते हुए कुछ मद्दे बताए गए जैसे हिंदी भाषा मे प्रांतीय शब्द भी होना जरूरी होता है। उच्चारण अवयव भाषा को प्रभावित करने के लिए अधिक प्रभावित होते है।

एक दिवसीय कार्यशाला का दीप प्रज्वलन करते हुए डा.अच्यूत शिंदे एवं प्रधान वैज्ञानिक डा.जगदीश राणे

संस्थान के कर्मचारीयों को अपने विचारों से लाभान्वित करते हुए डा.सरोदे (हिंदी विभाग प्रमुख, टी.सी. कॉलेज)

कार्यालय व्यवहार मे जो क्लिष्ठ शब्द का इस्तेमाल होता है वह नहीं होना चाहिए। राजभाषा कार्यान्वयन समिति के सचिव सतीश कुमार ने सम्बोधन करते हुए कहा कि भाषा गतिशील होने के लिए कार्यालयीन दस्तावेज़ तथा प्रोफार्मा मे हिंदी भाषा का अनुकरण सक्रियता लाएगा। इस एक दिवसीय कार्यशाला में संस्थान के वैज्ञानिक, कर्मचारी, यंग प्रोफेशनल एवं एस आर एफ उपस्थित रहे।

एक दिवसीय कार्यशालायें –

1. जुन 25, 2018
2. सितंबर 19, 2018
3. दिसंबर 24, 2018
4. मार्च 26, 2019

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4 Meetings

4. Meetings

Network Project Meeting on Climate Resilient Crops for Maharashtra

Network Project Proposal Meeting on Climate Resilient Crops for Maharashtra was held on April 9, 2018. In this meeting, in addition to scientists from NIASM, Baramati. two scientists from MPKV, Rahuri; five scientists from VNMKV, Parbhani, two scientists from BSKKV, Dapoli and two scientists from PDKV, Akola participated. The meeting was chaired by Prof Narendra Pratap Singh, Director, ICAR- NIASM. In his introductory remark he emphasised the need to develop climate resilient crops for states like Maharashtra which often faces drought and extreme temperatures that affect both field and horticultural crops.

Fig. 4.1. Network project proposal meeting

Interface meeting between Plant Scientists of BARC, Mumbai and ICAR-NIASM, Baramati at BARC, Anushakti Nagar, Mumbai

A contingent of eight scientists from different disciplines led by Prof. Narendra Pratap Singh, Director, NIASM visited BARC, Mumbai to participate in DAE- BRNS Life Science Congress on "Frontiers of Sustainable Agriculture" on 26th - 28th of April 2018. While the Director chaired the session on "Crop Breeding for Biotic and Abiotic Stresses", other scientists used this opportunities to display the research wok being carried out at NIASM in the form of posters. Two of the scientists also delivered the talk highlighting the facilities for research on plant phenotyping and conservation agriculture. Director and scientists of NIASM had a brief interface meeting with BARC to highlight areas of common interest and future collaboration. This meeting was attended by Dr V P Venugoplan, Associated Director, and scientists working on mutation breeding and physiology of ground nut, wheat and pulse crops in the Bioscience Group at BARC. Prof Narendra Pratap Singh highlighted short-term interventions to show the impact of collaboration between the institutes by demonstrating the popular cultivars of different crops in farmers field in and around NIASM. Other areas of research discussed for collaboration included use of phenotyping platform of NIASM for characterising drought and heat tolerance in crops being improved at BARC. It was also suggested that mutation breeding should be extended to spice crop such as coriander and medicinal plants such as salvia where

seed propagation is major constraint. Dr Venugopalan suggested finalizing the MoU after reciprocal visit by BARC scientists to NIASM.

Fig. 4.2. Interaction of scientists from BARC, mumbai and ICAR-NIASM, Baramati

Institute Research Council Meeting

The 8th meeting of Institute Research Council (IRC) of ICAR-NIASM was held on May 3, 2018. The meeting was chaired by Prof. Narendra Pratap Singh, Director, NIASM. Research findings presented by scientist was reviewed during meeting. Chairman, IRC expressed gratification about research efforts made by the scientists through their projects. He also urged the scientists to demonstrate the new outcomes and institute technologies in farmer's field.

Fig. 4.3. 8th IRC meeting at NIASM

Interface meeting between ICAR Institutes and Agriculture Departments of Maharashtra

Interface meeting between ICAR institutes and Agriculture departments of Maharashtra was organised by ICAR-NIASM at ICAR-NRC on Grapes, Pune on 20th June 2018. The meeting was chaired by Mr. Sachindra Pratap Singh, Agriculture Commissioner, Pune, Govt. of Maharashtra. About 35 representatives of various departments/ institutes actively participated in this meeting. Important agenda of the programme was to introduce the ICAR institute of Maharashtra to State Department of Agriculture and to discuss the use of technologies developed by ICAR for doubling the farmer's income in Maharashtra. Various issues were discussed by State departments and ICAR institutes to increase the agricultural production and farmers income in the state.


Fig. 4.4. Interface meeting of ICAR Scientists and Sate Govt. Officials

Interaction Meeting of Agricultural Department, Pune and ICAR-NIASM, Scientists

Interaction meeting was held at ICAR NIASM, Baramati on 23rd October 2018 to discuss about contingency plans to prevent and reduce losses due to deficit rainfall particularly for orchard crops. The meeting was chaired by Shri Sachin Pratap Singh, IAS, Commissioner Agriculture, Govt. of Maharashtra. In his introductory remark, Prof Narendra Pratap Singh, Director ICAR-NIASM requested for inputs from experts representing four Agricultural Universities of the state to develop contingency plan so that Department can take immediate action to prevent losses for farmers. Shri PN Pokale, Director (Horticulture), Maharashtra observed that drought is a periodic phenomenon which can be managed and the technologies suggested by the scientists will be immensely useful. Agriculture Commissioner emphasised the need for implementing contingency plan to rescue orchards.


Fig. 4.5. Interface meeting of ICAR-NIASM Scientists and Sate Govt. Officials

Quinquennial Review Team (QRT) Meeting

QRT meetings of ICAR-NIASM, Baramati were held at ICAR-NIASM and other ICAR Institutes. The itinerary of meetings is mentioned in Table 4.1. The meeting was chaired by Dr. Gurbachan Singh, Ex Chairman, ASRB, New Delhi and panel of members were Dr Dilip Kumar, Dr KE Lawande, Dr KC Bansal, Dr RS Sidhu and Dr GGSN Rao. The chairman and members of QRT visited NIASM infrastructure, research facilities and experimental fields and appreciated the progress made during short period of time. The meetings of QRT were also attended by the Directors of ICAR Institutes in Maharashtra, Vice Chancellors, Directors of Research of SAU's of Maharashtra and emphasised the need for research on management of various kinds of abiotic stresses management in horticultural as well as field crops.

Fig. 4.6. QRT meeting and intraction with Vice Chancellor and Directors

QRT & RAC interaction meeting was also held at ICAR-NIASM, Baramati on 29th November, 2018 to discuss the recommendations of RAC to QRT for incorporation in the report. During this discussion, earlier Directors of NIASM, Dr KPR Vittal and Dr PS Minhas, Progressive farmers, Directors of ICAR institutes, State Agriculture Department officials participated and presented their views.

Fig. 4.7. QRT & RAC interaction meeting

Table 4.1. The itinerary of meetings conducted by QRT

S. No.	Meeting Theme	Date	Venue	Participants
1	Preliminary meeting	December 19, 2017	ICAR, New Delhi	Dr Gurbachan Singh, Chairman QRT; Dr K Alagusundaram, DDG, NRM, ICAR; Dr SK Chaudhari, ADG, Soil & Water Management; Dr NP Singh, Director, ICAR-NIASM
2	Review meeting	May 28-29, 2018	ICAR-NIASM, Baramati	Dr Gurbachan Singh, Dr R S Sidhu, Dr GGSN Rao, Dr K C Bansal; Dr Yogeshwar Singh; All scientific, technical and administrative staff of ICAR-NIASM
3	Meeting with stakeholders	July 08-09, 2018	ICAR-NIASM, Baramati	Dr Gurbachan Singh; Dr K E Lawande; Dr Dilip Kumar; Dr R S Sidhu; Dr GGSN Rao; Dr. Yogeshwar Singh; Directors of other ICAR-Institutes; Vice Chancellors of Agricultural Universities of Maharashtra; and NGO's, farmers, scientific, technical and administrative staff of ICAR-NIASM
4	Coastal Research Stakeholders meet at ICAR – CCARI, Goa	November 26-27, 2018	ICAR-CCARI, Goa	Dr Gurbachan Singh, Dr Dilip Kumar, Dr R S Sidhu, Dr GGSN Rao; Dr. Yogeshwar Singh; Director, ICAR-CCARI; All Scientific staff of ICAR-CCARI; State officers of Goa Agriculture Department, NGO's and Progressive farmers

S. No.	Meeting Theme	Date	Venue	Participants
5	Interaction meet with chairman and members of RAC,Directors of other ICAR-Institutes, State Officials and Farmers	November 29-30, 2018	ICAR-NIASM, Baramati	Dr Gurbachan Singh, Dr Dilip Kumar, Dr R S Sidhu, Dr GGSN Rao; Dr Yogeshwar Singh; Members of RAC of ICAR-NIASM; Dr. P. C. Sharma, Director, ICAR-CSSRI; Dr O P Yadav, Director, ICAR-CAZRI; Dr. P S Minhas and KPR Vittal, Former Directors of NIASM; All Scientific staff of ICAR-NIASM; State officials of Maharashtra Agriculture Department and Progressive farmers
6	Interaction meeting for preparation of QRT report	March 7-9, 2019	ICAR-CSSRI, Karnal	Dr Gurbachan Singh, Dr Dilip Kumar, Dr R S Sidhu, Dr GGSN Rao, Dr K C Bansal and Dr Yogeshwar Singh

7th Research Advisory Committee Meeting

7th RAC meeting was held at ICAR-NAISM, Baramati on 30th November 2018 under the chairmanship of Dr. Alok Kumar Sikka and member of RAC reviewed the research accomplishments of ICAR-NIASM. Dr Gurbachan Singh, QRT chairman and member of QRT were also present in the RAC meeting to review the work and to include important research needs in the upcoming plans.


Fig. 4.8. 7th RAC meeting

Meeting for inter-institutional collaboration to map abiotic stresses by employing GIS and remote sensing tools

A meeting between ICAR-NIASM, Baramati and ICAR-NBSS & LUP, Nagpur for "Inter-institutional collaboration to map abiotic stresses by employing GIS and remote sensing tools" was held on January 3, 2019. Dr. Alok Kumar Sikka, Ex DDG NRM chaired the meeting and detailed discussion was made to distribute the work components among participating institutes.


Fig. 4.9. Inter-institutional meeting for collaboration to map abiotic stresses

5. Awards and Recognition

- Prof. Narendra Pratap Singh was awarded as Fellow of **National Academy of Biological Science**, Chennai, Tamilnadu, India. 16th June 2018.
- Neeraj Kumar Scientist was awarded as Associate of National Academy of Agricultural Sciences (NAAS), India from January 01, 2019.
- ICAR-NIASM, Baramati exhibition stall arranged by Dr KK Meena, Sr Scientist (Microbiology), Dr GC Wakchaure, Scientist SS (AS&PE), Dr Paristosh Kumar, Scientist (Environmental Sciences) and Mr PR Chahande, STA Farm) was awarded third best stall in State Level Kisan Mela and Farmers Innovation Day organised by ICAR-CAZRI, Jodhpur during 13–15 September 2018
- KK Meena, Senior Scientist was awarded as "Adarshvidya Saraswati Rashtriya Purskar" National Award of excellence by Global Management Council of Glacier Journal Research Foundation, Ahmedabad on 22nd July 2018.
- Mahesh Kumar was awarded best oral presentation in West zone Plant Physiology conference for the paper "Image based method for estimation of chlorophyll content in soybean held on 2nd August 2018 at MPKV Rahuri.
- Mukesh P. Bhendarkar, Scientist was awarded best Poster Award during International Conference on Doubling Farmers Income through innovative Approaches" Organized by Agriculture Development Trust, Baramati During 9-11 April 2018 held at KVK, Baramati
- Yogeshwar Singh, Senior Scientist received Best poster award for the paper 'Identification of Hyperspectral Vegetation Indices for Estimating Chlorophyll and Relative Water Content with Respect to Moisture Stress in Sweet Orange' In: ISPP West Zonal Seminar on "Emerging Trends in Plant Physiology for Crop Production under Climate Change Scenario" organized by MPKV, Rahuri and Indian Society for Plant Physiology, New Delhi at Rahuri during 2nd August, 2018.
- Priya George was awarded best poster award in West zone Plant Physiology conference held at MPKV Rahuri on 2nd August 2018. In: ISPP West Zonal Seminar on "Emerging Trends in Plant Physiology for Crop Production under Climate Change Scenario" organized by MPKV, Rahuri and Indian Society for Plant Physiology, New Delhi at Rahuri during 2nd August, 2018.
- KK Meena was nominated as Member of Editorial Board of Glacier Journal of Scientific Research on 22nd July 2018.
- KK Meena received best Presentation Award in 1st International conference on climate change and adaptive crops protection for sustainable agri-horticulture land scape at ICAR-NRCSS, Ajmer Rajasthan, during December 20-22, 2018.
- Jagadish Rane, Principal Scientist (Plant Physiology), Yogeshwar Singh, Senior Scientist (Agronomy) and Goraksh Wakchaure, Scientist (Agricultural Structure

and Process Engineering) were awarded best Performance award by Director General, ICAR on 11th Foundation Day held at ICAR-NIASM on February 22, 2019.

- Pravin Taware, Senior Technical officer (Farm), Mr. Pravin More, Senior Technical Assistant (Computer Science), Mr. Lalit Aher, Senior Technical Assistant (Bio-Technology) and Mrs Purnima Ghadge, Assistant Administrative Officer were awarded best Performance award by Director General, ICAR on 11th Foundation Day held at ICAR-NIASM on February 22, 2019.
- Patel, DP, Meena, RL, Rajagopal, V and Choudhary, RL received the Best Poster Award for their research paper entitled "Screening of soybean for waterlogging tolerance" in the ISMPP 39th Annual Conference & National symposium on "Plant and soil health management: new challenges and opportunities" held at ICAR-Indian Institute of Pulses Research, Kanpur, UP, India during 16-18th November, 2018.

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6. Linkages and Collaborations

Research institute	Areas identified for research collaboration
ICAR-NBPGR, New Delhi	Screening wheat, common bean and mungbean germplasm for drought and high temperature stress tolerance
ICRISAT, Hyderbad	Genomics in soyabean for improvement of yield under drought condition
ICAR-CRIDA, Hyderabad	Phenotyping pulses for tolerance to soil moisture stress
ICAR-IARI, New Delhi	Identification of micro-organisms for drought tolerance
ICAR-NRCG, Pune	Studies on tolerance to abiotic stress in grapes
ICAR-CAZRI, Jodhpur	Plant phenotyping and evaluation of CAZRI products
ICAR-NRCP, Solapur	Fruit cracking in and aril browning in Pomegranate Screening of Pomegranate genotypes against blight and other stresses using Phenomics facility
ICAR-CIFE, Mumbai	Abiotic and biotic stress management in fishes
ICAR-NBAIM, Mau Nath Bhanjan	Functional characterization of salt tolerant bacteria using multi omics approaches & their exploitation for alleviation of salt stress in crop plants
ICAR-IIPR, Kanpur, PAU, Ludhiana	Exchange of germplasm of pulse crops and evaluation for drought tolerance
ICAR-IISR, Indore	Screening soybean germplasm for drought tolerance
ICAR-IIW& BR, Karnal	Screening wheat germplasm for drought and high temperature stress tolerance
MPKV, Rahuri	Conservation agriculture Collaboration in academic program and post graduate research Genetic enhancement of crop productivity by using modern tools
VNMKV, Parbhani SKUAST, Kashmir UAS, Bengaluru GKVV, Raipur	Collaboration in academic program and post graduate research Studies on abiotic stress tolerance in crop plants and exchange of students and faculties for post graduate studies
University of Delhi, N. Delhi	RNAi and VIGS for drought and heat stress tolerance in Soybean crop
MRDBS, Pune	Joint research activities for abiotic stress in grapes Participation in seminars and academic meetings Special, short-term academic/training programs for grape growers
Banaras Hindu University, Varanasi	Collaborative research with focus on drought/ water quality/salinity tolerance in plants
CRP on CA, ICAR-IISS, Bhopal	Conservation agriculture in sugarcane based cropping system

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7 Publications

7. Publications

Research Papers

Kumar N, Krishnani KK, Kumar P, Sharma R, Baitha R, Singh DK, Singh NP (2018) Dietary nano-silver: Does support or discourage thermal tolerance and biochemical status in air-breathing fish reared under multiple stressors? **Journal of Thermal Biology**. 77: 111-121.

Kumar N, Krishnani KK, Gupta SK, Sharma R, Baitha R, Singh DK, Singh NP (2018) Immuno-protective role of biologically synthesized dietary selenium nanoparticles against multiple stressors in Pangasianodon hypophthalmus. **Fish and Shellfish Immunology**. 78:289-298.

Kumar N, Krishnani KK, Singh NP (2019) Oxidative and Cellular Metabolic Stress of Fish: An Appealing Tool for Biomonitoring of Metal Contamination in the Kolkata Wetland, a Ramsar Site. **Archives of Environmental Contamination and Toxicology**. 76:469-482.

Kumar N, Singh NP (2019) Effect of dietary selenium on immuno-biochemical plasticity and resistance against Aeromonas veronii biovar sobria in fish reared under multiple stressors. **Fish and Shellfish Immunology**. 84: 38-47.

Rane J, Singh AK, George P, Govindasamy V, Cukkemane A, Raina SK, Chavan MP, Aher L, Sunoj VJ, Singh NP (2019) Effect of Cow Urine-Based Bio-formulations on Growth and Physiological Responses in Mungbean Under Soil Moisture Stress Conditions. **Proceedings of the National Academy of Sciences, India Section B: Biological Sciences**. https://doi.org/10.1007/s40011-019-01088-8.

Research papers in association with other institutes

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8 Participation in Meetings/Conferences/ Workshops/Trainings

8. Participation in Meetings/Conferences/ Workshops/Trainings

Participation in Seminar/Symposia/Conferences/Meetings

Name	Event	Organized by	Place	Date
Narendra Pratap Singh	International Conference on "Doubling the Farmers Income through Innovative Approaches	Agricultural Development Trust, Baramati	KVK, Baramati	Apr. 09 – 11 2018
	DAE-BRNS Life Science symposium on Frontiers in Sustainable Agriculture.	Organized by Bioscience group, BARC, Mumbai	BARC, Mumbai	Apr.26-28, 2018
	Annual Zonal Workshop of KVKs working under Zone VIII	ATARI, Pune	MPKV, Rahuri	May 05-07, 2018
	International Mango Conference, 2018	BSKKV, Dapoli, ISASaT, Dapoli	RFRS. Vengurla, Maharashtra	May 8-11, 2018
	Steering Indian Agriculture Through Valagro's Sustainable Solutions	Valagro India	Park Hyatt Hotel, Hyderabad	May 26-27, 2018.
	Summer Instituttional training on 'Soil Water Conservation and Watershed Management'	ICAR-IISWC	ICAR-ISWC, Udhagamandalam, Ooty	01, June 2018
	International Conference on Recent Advances in Food Processing Technology, ICRAFPT 18	India Institute of Food Processing Technology,	Thanjavur, Tamil Nadu	Aug. 17-19, 2018.
	Foundation Day & Workshop on Addressing farmers' issues in pomegranate production , protection & marketing	ICAR-NRCP, Solapur	ICAR-NRCP, Solapur	Sept. 25, 2018.
	National Symposia on Coastal Agriculture: Boosting Production Potential under Stresses Environment,	Indian Society of Coastal Agricultural Research and ISASAT, Dapoli	Dr BSKKV, Dapoli	Sept. 28-Oct.01, 2018
	5th International Rice Research Conference- Transformative Science for Food and Nutrition Security	International Rice Research Institute, Philippines	Marina Bay Sands, Singapore	Octo.14-17, 2018
	National Conference on Arid Horticulture for Enhancing Productivity and Economics Empowerment	Indian Society for Arid Horticulture & ICAR-CIAH, Bikaner	Bikaner Rajasthan	Octo. 27-29, 2018
	National Seminar on theme Smart Technologies to Boost Farm Profitability and Socio-Economic Status of Rural India	Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu	SKUAST-J, J&K,	Nov. 19-20, 2018

Name	Event	Organized by	Place	Date
Narendra Pratap Singh	31st All India Congress of Zoology (31st AICZ) & National Seminar on Climate-Smart Aquaculture & Fisheries	North East Society for Fisheries and Aquaculture Lembucherra & Zoological Society of India (ZSI) Gaya, Bihar	College of Fisheries, CAU Lembucherra, Tripura	Jan. 12-16, 2019
	International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities"	ICAR-CSSRI and Indian Society of Soil Salinity and Water Quality, Karnal	ICAR-CSSRI, Karnal, Haryana	Feb. 07-09, 2019
	Agri Summit 2019	Indian Chamber of Commerce (ICC)	Motihari, Bihar	09 - 11 Feb. , 2019
	International Symposium in Edible Alliums: Challenges and Opportunities	Indian Society of Alliums and ICAR-DOGR	ICAR-DOGR Pune	Feb. 9-12, 2019
	Coastal Agri Expo - 2019	CCARI, and Association of Coastal Agricultural Research, Goa	CCARI, Goa	02-04 March , 2019
Jagadish Rane	Valagro India Conference (For Future Farming)	Valagro India	Hyderabad	May 26-27, 2018
	National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development	ASM Foundation and DRPCAU, Pusa	DRPCAU, Pusa (Samastipur) Bihar	May 28-31, 2018
	West Zone Symposium of Indian Society for Plant Physiology	ISPP, New Delhi,	MPKV, Rahuri	Aug. 4, 2018
	Annual Group Meet of All India Coordinated Research Project on Chickpea	AICRP on Chick pea	RARI, Durgapura, Jaipur	Aug. 27-29, 2018
	4th International Plant Physiology Congress	Indian Society for Plant Physiology, Lucknow	CSIR-NBRI, Lucknow	Dec. 2-5, 2018
	Asia Pacific Federation for Information Technology in Agriculture (AFITA)	IIT, Mumbai	Mumbai	Oct. 24 - 26, 2018
	National Seminar on Abiotic stress management challenges and opportunities	TNAU, ICAR-SBI and ICAR -CICR	Coimbatore	Oct. 25-26, 2018
	International Symposium in Edible Alliums: Challenges and Opportunities	Indian Society of Alliums and ICAR-DOGR	ICAR-DOGR Pune	Feb. 9-12, 2019
DD Nangare	International Mango Conference, 2018	BSKKV, Dapoli, ISASaT, Dapoli	Regional Fruit Research Station. Vengurla, Maharashtra	May 8-11, 2018

Name	Event	Organized by	Place	Date
DD Nangare	Inception workshop on Climate smart agriculture and water management	MPKV, Rahuri	MPKV, Rahuri	Jul. 15-17, 2018
	Global Water Security conference for Agriculture and Natural Resources	ASABE and ISAE India	Hyderabad	Oct. 3-6, 2018
	Inception Workshop of Centre for Advanced Agricultural Science and Technology (CAAST) for Climate Smart Agriculture on Water Management (CSAWM)	National Agricultural Higher Education Project (NAHEP) MPKV, Rahuri	MPKV, Rahuri	Jul. 15-17, 2018
KK Meena	1st International Conference on Climate Change and adap-tive protection for sustainable agri-horticulture land scape	Indian society for seed spices, Ajmer	ICAR-NRCSS Ajmer	Dec. 20-22, 2018
	International Salinity Conference on "Resilient Agriculture in Saline Environments under Changing Climate: Challenges & Opportunities"	ICAR-CSSRI and Indian Society of Soil Salinity and Water Quality, Karnal	ICAR-CSSRI, Karnal, Haryana	Feb. 07-09, 2019
	International conference on empowering the society with microbial technology	Association of microbiologist south zone, Pune	TC College, Baramati	Jan. 30, 2019
Yogeshwar Singh	BSG and DAE-BRNS Life Science Symposium 2018 (LSS-2018)	Bio-Science Group (BSG), BARC	Mumbai	Apr. 26-28, 2018
	International Mango Conference, 2018	BSKKV, Dapoli, ISASaT, Dapoli	RFRS, Vengurla	May 8-11, 2018
	National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development	ASM Foundation and DRPCAU, Pusa	DRPCAU, Pusa (Samastipur) Bihar	May 28-31, 2018.
	Workshop-cum-meeting on Weed Management in Conservation Agriculture	ICAR-DWR, Jabalpur	ICAR-DWR, Jabalpur (MP)	Sept. 11-12, 2018.
AK Singh	National Conference on Enhancing Productivity Of Oilseeds in Changing Climate Scenario	Indian Society of Oil Seed Research and ICAR-DGR, Junagadh	ICAR-DGR, Junagadh, Gujarat	Apr. 07-09, 2018
	State Level Biosafety, Capacity Building Workshop	MPKV, Rahuri and Biotech Consortium India Ltd , New Delhi	MPKV, Rahuri	Apr.13, 2018
	BSG and DAE-BRNS Life Science Symposium 2018 (LSS-2018)	Bio-Science Group (BSG), BARC	Mumbai	Apr. 26-28, 2018
Mahesh Kumar	Workshop on Hospitality Management	ICAR-NAARM, Hyderabad	ICAR-NAARM, Hyderabad	Apr. 20-25, 2018
	DAE-BRNS Life Science symposium on Frontiers in Sustainable Agriculture	Bioscience group, BARC, Mumbai	BARC, Mumbai	Apr. 26-28, 2018
	West Zone Plant Physiology conference	ISPP New Delhi and MPKV Rahuri	MPKV Rahuri	Aug 2, 2018

Name	Event	Organized by	Place	Date
Mahesh Kumar	National seminar on abiotic Stress management	Department of Crop Physiology, TNAU	TNAU, Coimbatore, Tamil Nadu	Oct. 25-26, 2018
	4th International Plant Physiology Congress	Indian Society for Plant Physiology, Lucknow	CSIR-NBRI, Lucknow	Dec. 2-5, 2018
GC Wackchaure	DAE-BRNS Life Science symposium on Frontiers in Sustainable Agriculture.	Bioscience group, BARC, Mumbai	BARC, Mumbai	Apr. 26-28, 2018
	International Conference on Recent Advances in Food Processing Technology, ICRAFPT'18 (Doubling Farmers Income through Food Processing)	India Institute of Food Processing Technology,	Thanjavur, Tamil Nadu	Aug. 17-19, 2018.
	Global Water Security Conference for Agriculture and Natural Resources,	ISAE, New Delhi and ASABE, USA	Hotel Taj Krishna Hyderabad	Octo. 3-6, 2018
	International Symposium in Edible Alliums: Challenges and Opportunities	Indian Society of Alliums and ICAR-DOGR	Pune	Feb. 9-12, 2019
BB Gaikwad	First Workshop of the Centre for the Fourth Industrial Revolution India (Agricultural Drones and Data Utility Platform)	World Economic Forum	Sahyadri Guest House, Mumbai	Nov. 29, 2018
	Inception Workshop of Centre for Advanced Agricultural Science and Technology (CAAST) for Climate Smart Agriculture on Water Management (CSAWM)	National Agricultural Higher Education Project (NAHEP) MPKV, Rahuri	MPKV, Rahuri	Jul. 15-17, 2018
	3rd National Workshop of Officer In-charge, Data Management, Krishi Portal	ICAR-IASRI, New Delhi	ICAR-IASRI, New Delhi	Dec. 4-5, 2018
CB Harisha	DAE-BRNS Life Science symposium on Frontiers in Sustainable Agriculture.	Bioscience group, BARC, Mumbai	BARC, Mumbai	Apr. 26-28, 2018
	International Mango Conference, 2018	BSKKV, Dapoli, ISASaT, Dapoli	Regional Fruit Res. Station. Vengurla, Maharashtra	May 8-11, 2018
	National workshop on Digital Field Book	IIMR, Hyderabad and ICAR-DOGR, Pune	ICAR-DOGR, Pune	Sept. 29 2018
Satish Kumar	National workshop on Digital Field Book	IIMR, Hyderabad and ICAR-DOGR, Pune	ICAR-DOGR Pune	Sept. 29, 2018
MP Bhendarkar	International Conference on Doubling the Farmers Income through Innovative Approaches	Agricultural Development Trust, Baramati	KVK, Baramati	Apr. 09 – 11, 2018.
RL Choudhary	BSG and DAE-BRNS Life Science Symposium 2018 (LSS-2018)	Bio-Science Group (BSG), BARC	BARC, Mumbai	Apr. 26-28, 2018

Participation in Trainings/Winter school/Summer school/short course

Name	Training programme	Venue	Date
AK Singh	Intellectual Property Valuation and Technology Management	ICAR-NAARM, Hyderabad	Aug. 24- 29, 2018
CB Harisha Satish Kumar	Summer school on climate change and abiotic stress management strategies for doubling farmer's income	ICAR-NIASM, Baramati	Sept.7-27 2018
MP Bhendarkar	Recent advance in fisheries biology techniques for biodiver-sity evaluation and conservation	ICAR-CMFRI, Kochi	Dec. 01- 21, 2018
Sunil Potekar	Familiarization Training Program for Part Time Observers	Regional Meteoro-logical Centre, IMD, Mumbai	Mar. 26-27, 2019
Neeraj Kumar	Technique on Molecular Biology	College of Fisheries, Lembuchera	Sept.15-Oct.11, 2018
BB Gaikwad	Workshop on "Imaging Spectroscopy for Smart Agriculture (ISSA)"	IITB, Powai	Nov. 26, 2018
	ICAR KRISHI Geoportal - A Digital Platform for Sustainable Agriculture	ICAR NBSS&LUP, Nagpur	Mar. 7-8, 2019
Rajkumar	Analysis of Experimental Data	ICAR-NAARM, Hyderabad	Sept. 6-11, 2018.

Organization of Teaching/ Training Programme/Workshop/Seminar

Name of co-ordinators	Event	Title	Sponsors	Date
ICAR-NIASM	Farmers fair	Pomegranate Production Technology for Doubling Farmers Income	ICAR-NIASM	May 19, 2018
RL Choudhary	Training cum Workshop	Scope and prospects of organic farming in sugarcane cultivation		Jun. 26, 2018
Narendra Pratap Singh Yogeshwar Singh Mahesh Kumar	Summer School	Climate change and abiotic stress manage-ment strategies for doubling farmer's income	ICAR	Sept. 7-27, 2018
MP Bhendarkar	Training	Entrepreneurship Development in Inland Fisheries	MFEDB	Nov. 28, 2018
NP Kurade MP Brahmane BB Gaikwad Neeraj Kumar MP Bhendarkar	Farmers Training	Krishi Kalyan Abhiyan	TSP Govt. of India	Jul. 20, 2018

Partcipation in Exhibitions/ Kisan Mela/Field visits

Participants	Programme	Place	Date
KK Meena GC Wakchaure Parithosh Kumar PR Chahande	State Level Kisan Mela and Farmers Innovation Day	ICAR-CAZRI, Jodhpur	13–15 Sept. 2018
NP Kurade MP Brahmane BB Gaikwad Neeraj Kumar MP Bhendarkar	Tribal Farmers Training Programme "Krishi Kalyan Abhiyan"	Visarwadi, Nandurbar	Jul. 19, 2018
DD Nangare GC Wakchaure BB Gaikwad	Kisan Adhar Sammelan 2018	MPKV, Rahuri	Oct. 15-18, 2018
Rajkumar Sunil Potekar Rushikesh Gophane	Bharatiy Kisan Sangh Adhiveshan	Aurangabad, Maharashtra	Nov. 28-29 2018
MP Brahmane Rajkumar	Krushik 2019	KVK, Baramati	Jan. 17-20 2019
Narendra Pratap Singh Yogeshwar Singh Mahesh Kumar	AGRI-SUMMIT 2019 & Exhibition	Gandhi Maidan, Motihari, Bihar	Feb. 9-11 2019.
Narendra Pratap Singh Yogeshwar Singh Pravin Taware	Coastal Agri Expo 2019	ICAR-CCARI, Goa	Mar. 2-4, 2019.

9 Major Events

9. Major Events

Farmers fair on pomegranate production technology for doubling farmers income

Farmers fair was organized at Shri Chatrapati Mangal Karyalaya, Bhavaninagar, Indapur on May 19, 2018 on "Pomegranate Production Technology for Doubling Farmers Income" by ICAR-NIASM, Baramati & ICAR-NRCP, Sholapur. The programme was inaugurated by Shri Girish Bapat, Minister of Food, Civil Supplies and Consumer Protection, Govt. of Maharashtra. During this event Shri Sadabhau Khot, Minister of Agriculture, Horticulture and Marketing, Govt. of Maharashtra addressed the gathering and urged the scientists to support farmers to get better production and higher returns by improved technology and timely advice. In this programme more than 900 farmers participated and discussions made on pomegranate cultivation, plant protection, post-harvest technologies and marketing etc.


Fig. 9.1. Inaugration and gathering in farmers fair on pomegranate

One day awareness training program on ISO 9001:2015

Awareness programme on ISO certification was held on June 08, 2018 at ICAR-NIASM. During which quality standards to be maintained in scientific institutes were explained by Shri D.P. Singh, Quality Consultants, New Delhi during which all the staff including scientific, technical, administrative were present and this institute was continued with an ISO9001:2015 Certification. In the programme, details of protocols and procedures to be maintained to make the working environment more systematic and efficient. Director ICAR-NIASM urged with the staff to follow discipline so that work will be faster and can be completed with definite success.


Fig. 9.2. ISO awareness and training programme

International Yoga Day

The 4th International Yoga Day was celebrated on June 21, 2018 by following the Common Protocol published by Ministry of AYUSH, Govt. of India. All staff members including Scientist, Technical, Administration, Contractual staff and Students participated in the event. The program started with recorded message of Hon'ble Prime Minister Shri Narendra Modi, Hon'ble Minister for External Affairs and Hon'ble State Minister for AYUSH, Govt. of India. This was followed by an introduction to Yoga and the Prayer. All the attendee performed Yoga practices like Asanas, Pranayama, Dhyana, etc. with overwhelmed enthusiasm.

Fig. 9.3. International Yoga Day celebrations

हिंदी सप्ताह

संस्थान में राजभाषा हिंदी के प्रयोग को बढ़ावा देने हेतु हिंदी सप्ताह (14– सितंबर से 20 सितंबर 2019) का आयोजन किया गया । हिंदी दिवस और हिंदी सप्ताह कार्यक्रम का उद्घाटन दिनांक 14 सितंबर 2018 को राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान, मालेगाव, बारामती के निदेशक तथा राजभाषा कार्यान्वयन समिति अध्यक्ष डा. नरेंद्र प्रताप सिंह की उपस्थिति में संपन्न हुआ । राजभाषा कार्यान्वयन समिति सदस्य/ सचिव डा. सतीश कुमार ने अथितियों का स्वागत करते हुए हिंदी भाषा के रुझान के लिए तथा हिंदी के प्रयोग को बढ़ावा देने हेतु संस्थान में किए जा रहे प्रयासों व काम–काज का ब्योरा प्रस्तुत किया । प्रमुख अतिथि प्रो. नरेंद्र प्रताप सिंह ने संस्थान के कर्मचारियों को सम्बोधन करते हुए संस्थान के दैनिक कार्यों में राजभाषा हिंदी के प्रयोग को बढ़ावा देने का अवाहन किया ।

हिंदी सप्ताह–2018 के दौरान ,कार्यालय में कम्पुटर पर हिंदी टंकलेखन,अग्रेजी से हिंदी में अनुवाद, हिंदी

चित्र 9.4. हिंदी दिवस एवं हिंदी सप्ताह कार्यक्रम में .नरेंद्र प्रताप सिंह दीप प्रज्वलन करते हुए

चित्र 9.5. श्री सुरजीत कुमार साह संस्थान के कर्मचारियों को संबोधित करते हुए

निबंध, काव्यवाचन, हिंदी गायन प्रतियोगिता, वाद –विवाद प्रतियोगिता, आदि प्रतियोगिताओं का आयोजन किया गया। इस दौरान हिंदी के प्रयोग को बढ़ावा देने के लिए 19 सितंबर 2018 को एक दिवसीय हिंदी कार्यशाला का आयोजन भी किया गया जिसमें मुख्य अतिथि डा महेश दवांगे,सहायक प्राध्यापक सावित्री बाई फुले, विश्वविद्यालय पुणे, ने संस्थान के कर्मचारियों को संबोधित किया । हिंदी सप्ताह का समापन एवं प्रतियोगिता पुरस्कार वितरण समारोह दिनांक 20 सितंबर 2019 को मुख्य अतिथि श्री सुरजीत कुमार साह मुख्य प्रबन्धक, भारतीय स्टेट बँक, बारामती, की उपस्थिति में संपन्न हुआ। निदेशक महोदय ने अपने सम्बोधन में संस्थान के राजभाषा कार्यान्वयन समिति के सदस्य एवं सभी कर्मचारियों को हिंदी सप्ताह तथा हिंदी दिवस के सफल आयोजन एवं उनके सक्रिय सहभाग के लिए बधाई देते हुए भविष्य में राजभाषा हिंदी के प्रयोग में और अधिक योगदान देने का आग्रह किया। हिंदी सप्ताह कार्यक्रम का समापन डा जगदीश राणे, प्रधान वैज्ञानिक तथा राजभाषा कार्यान्वयन समिति सदस्य के धन्यवाद ज्ञापन के साथ संपन्न हुआ।

Workshop cum Training Program on Scope and Prospects of Organic Farming in Sugarcane Cultivation

The workshop cum training programme was inaugurated on June 26, 2018 by Shri Rajan Kumar Taware, Chairman, Malegaon and Cooperative Sugar Factory in presence of Prof. Narendra Pratap Singh, Director, ICAR–NIASM. Other dignitaries Shri P Jagtap, Chairman, Someshwar, Cooperative Sugar Factory; Dr Anil Deshmukh, Deputy Project Manager, ATMA, Pune; Dr S S Ali, Project Coordinator, KVK, Baramati and Shri D Padwal, Tahsil Agriculture Officer, Baramati were present during the programme. The two technical sessions (i) organic sugarcane production technologies and (ii) cultivation technologies for increasing productivity of sugarcane and soil health management were organised. The sugarcane expert from KVK Baramati and Central Sugarcane Research Station, MPKV, Padegaon were also invited. About 100 sugarcane farmers and ICAR-NIASM staff were participated in the workshop.

Fig. 9.6. Workshop on sugarcane organic farming

Independence Day Celebration

72nd Independence Day was celebrated at NIASM Campus. The national flag was hoisted by Director NIASM followed by Independence Day speech. All the staff member, security personal, RA SRF and other field workers were present on the occasion.

Fig. 9.7. Flag hoisting by Director, ICAR-NIASM

Summer school on climate change and abiotic stress management strategies for doubling farmer's income

ICAR sponsored summer school was inaugurated by Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati on September 07, 2018. Twenty three scientists, teachers and researchers from six states including Tamil Nadu, Telangana, Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra were participated in this programme. Lectures related to abiotic stress management and doubling farmers income in abiotic stressed areas were delivered and also hands on training on use of equipment related to abiotic stress assessment such as Hyper Spectral Remote Sensing, Plant Phonemic facility, orchard management and gene silencing etc. were demonstrated to the trainees. Various eminent researchers and speakers from various ICAR Institutes and agriculture universities were also delivered lectures on climate change and abiotic stress management. The Summer school programme was concluded on September 27, 2018 which was graced by the Dr AK Singh, Ex-DDG (NRM).

Fig. 9.8. Summer school programme at ICAR-NIASM

Inauguration of School of Drought Stress Management

Shri Chhabilendra Roul, Special Secretary (DARE) & Secretary (ICAR) visited ICAR-NIASM, on October 20, 2018 and appreciated the research achievements. He visited all the research facilities, field, laboratory and new residential complex at MIDC, Baramati. He inaugurated the Type-VI quarters and also School of Drought Stress Management.

Fig. 9.9. Inauguration of school buiding (School Drought Stress Management)

Inauguration of staff residential quarter at MIDC, Baramati

The "Godavari Residency" (Type V Quarter – Six nos.) at ICAR-NIASM residential complex MIDC, Baramati was inaugurated by Dr Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR) in presence of Prof. Narendra Pratap Singh, Director, ICAR-NIASM; Er. M K Tilak, Chief Engineer WZ-II; Er. C B Upadhayay, SE Civil; Er. M V Chalpatirao, SE Electrical; Er S K Prasad, EE (C), Er S Bishwas, EE (E); Shri Mahak Pal Singh, Dy Director, Horticulture; Shri NPC Kaushik, Assistant Director Horticulture and D D Nangare, OIC (works) & Works committee members ICAR-NIASM on the 22nd Feb. 2019. The Chief Engineer, CPWD briefed the details and features of quarters. On this occasion, tree plantation was done by the Dr. Trilochan Mohapatra, Er M K Tilak, and Dr Narendra Pratap Singh in the ICAR-NIASM residential complex premises.

Fig. 9.10. Inauguration of Type-V staff quarters at MIDC, Baramati

The "Indrayani Residency" (Type-VI Quarter – Four nos.) at ICAR-NIASM residential complex, MIDC, Baramati and School of Drought Stress Management

Fig. 9.11. Inauguration of Type-VI staff quarter at MIDC, Baramati

(SDSM) at Gat-35, Malegaon (Khurd was inaugurated by Shri Chabilendra Roul (IAS) Special Secretary (DARE) & Secretary (ICAR) in presence of Prof. Narendra Pratap Singh, Director, ICAR-NIASM; Er. C B Upadhayay, SE Civil; Er M. V. Chalpatirao, SE Electrical and D. D. Nangare OIC (works) & Works committee members ICAR-NIASM on the 20th Oct. 2018. The supertending engineer Civil CPWD briefed the details and features of Type VI quarters and development works.

Celebration of Rashtriya Ekta Diwas

Rashtriya Ekta Diwas was celebrated on the occasion of Birth Anniversary of Sardar Vallabhbhai Patel at ICAR-NIASM on October 31, 2018. During this Ekta oath was taken by all the staff and unity run was performed.

Fig. 9.12. Rashtriya Ekta Diwas celebration at ICAR-NIASM

Training programme on Entrepreneurship Development in Inland Fisheries

One day farmers training programme on "Entrepreneurship Development in Inland Fisheries" on November 28, 2018. Dr M M Shiradhankar, Professor and Head, College of Fisheries, Ratnagiri was the Chief Guest of the programme. Other dignitaries on this occasion were Shri Avinash Nakawa, Assistant Commissioner of Fisheries, Pune division and Dr Jagadish Rane, Principal Scientist, ICAR-NIASM. A total 40 progressive fish farmers from six districts were participated the training. The programme covered interactive discussion on various aspects of like Modern carp culture, RAS technology, Soil and water Quality Management in Aquaculture, feed management, farm pond based aquaculture and governmental scheme in carp polyculture.

Fig. 9.13. Training programme on Entrepreneurship Development in Inland Fisheries at ICAR-NIASM

World Soil Day

World Soil Day was celebrated on the December 05, 2018, jointly with KVK, Baramati, at ICAR-NIASM, Baramati. More than 250 farmers attended the world soil day programme. Mr Rajendra Pawar, Chairman, Agricultural Development Trust, addressed the farmers emphasized on the theme of "Be the Solution to Soil Pollution". He also highlighted the need of soil health card based fertilizers recommendations after distribution of soil health cards to the farmers.


Fig. 9.14. World soil day celebration

Refresher Course on Administration & Finance Management for Section Officers, AAOs, AFAOs & Assistants of ICAR HQ & Institutes

Refresher course on Administration & Finance Management for Section Officers, AAOs, AFAOs & Assistants of ICAR HQ & Institutes was held during December 10-14, 2018 at ICAR-NIASM, Baramati which was organized by ICAR-NAARM, Hyderabad. In this training programme 25 officers and staff from different ICAR institutes were participated. Various aspects of administration, finance and office management were deliberated by experts from ICAR HQ and other ICAR institutes.


Fig. 9.15. Refresher Course on Administration & Finance Management

Workshop on 'Application of Foldscope for pollen studies' for high school students

In a two days workshop held during January 11-12, 2019, NIASM scientists demonstrated the use of portable microscope called 'Foldscope' for studies on pollens of crop plants. This was carried out under the project funded by DBT. There were 21 students and 3 teachers from Shardabai Pawar Vidyaniketan, Saradanagar attended the workshop. On the first day of the training all were acquainted with pollen

germination studies. The results were observed and recorded in the observation sheets provided. A good interactive session was there in continuation with the presentation about 'Foldscope- as an economical feasible research tool'. All the doubts in the young minds regarding these studies were clarified. On the second day, students studied temporal variation in viability of pollens of crops in field.

Fig. 9.16. High school students participating in workshop on 'Application of Foldscope for pollen studies'

Scientific talk by Prof. Pushpendra Kumar Gupta, Emeritus Professor

In lieu of celebration of 150 years of Mahatma, the guest lecture was arranged at ICAR-NIASM, Baramati on January 04, 2019. Prof. Pushpendra Kumar Gupta, Emeritus Professor, Meerut University, Meerut has delivered a lecture on "Abiotic stress tolerance in post genomics era". All the staff of ICAR-NIASM including scientists, RA, SRF, JRF and Young Professionals attended the lecture. He highlighted the use of genomics and traditional breeding techniques to develop abiotic stress tolerant genotypes so that climate resilient varieties may be developed.

Fig. 9.17. Scientific talk by Prof. Pushpendra Kumar Gupta, Emeritus Professor, Meerut University, Meerut

Republic Day Celebration

ICAR-NIASM celebrated 70th Republic Day on January 26, 2019. All the staff including scientific, technical, administrative, SRF, JRF, YPs and contractual were present for the event. On this occasion Prof Narendra Pratap Singh, Director, ICAR-NIASM hoisted the national flag and addressed to the staff of ICAR-NIASM. In his address he highlighted that effectors made by the institute for developing technologies and also he urged with that staff to be sincere and discipline din work as well as in personal life to make work smoother, easier and effective.

Fig. 9.18. Republic Day celebration at ICAR-NIASM

National Productivity Week

ICAR-NIASM, Baramati observed National Productivity Week-2019 from 12-February 18, 2019. The programme was inaugurated by the chief guest Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati and addressed the gathering about the importance of productivity in every sector like agriculture, machinery, IT etc. and its importance in the national economy. The students and teachers from the schools and colleges of Baramati were invited for the inaugural function to aware them about the event. As a part of the event the various healthy competitions like drawing, essay writing and poster presentations were conducted for the school and college students at the institute on various themes. Nearly about 80 students from various schools and colleges participated in the events.


Fig. 9.19. National Productivity Week-2019

Foundation Day Celebration of ICAR-NIASM

ICAR-NIASM, Baramati, celebrated 11th Foundation day on February 22, 2019. Dr. Trilochan Mohapatra, Secretary (DARE) & DG (ICAR), New Delhi graced the occasion and addressed the gathered of foundation day. He appreciated the efforts made by the staff and director for making institute more visible among scientific community and farmers by developing rocky area into arable land. During this occasion Shri Rajan Taware, Chairman, Malegaon Sahakari Sakhar Karkhana, Malegoan; Mr Shinde, Chairman and MD, Tiruati Balaji Agro Industires; Shri Rajendra Pawar, Chairman, Agriculture Development Trust, Baramati and Jaydeep Taware, Sarpunch, Malegaon were also present. Outstanding scientific, technical, administrative staff and contractual workers were awarded along with farmers for their contributions. During this occasion DG (ICAR) inaugurated the Godavari residential quarter (Type V) and School of Edaphic Stress Management

Fig. 9.20. Foundation Day celebration at ICAR-NIASM : Inauguration of School of Edaphic Stress Management by Dr. Trilochan Mohapatra Secretary (DARE) & Director General (ICAR)

Webcasting of PM-KISAN Sanman Nidhi Yojana

ICAR-NIASM arranged for webcast of PM-Kisan Sanman Nidhi Yojana held on February 24, 2019. In the event 263 farmers and 30 officials of ICAR-NIASM, KVK, Baramati & State Agriculture and Revenue Department participated. Prime Minister highlighted the key features of the scheme. The scheme is highly useful for small and marginal farmers having land less than 2.5 acres will get financial assistance for purchase of seeds, fertilizers and other agriculture inputs.

Fig. 9.21. Webcasting of PM- Kisan Sanman Nidhi Yojana

International Women's Day Celebration

International Women's Day was celebrated at ICAR-NIASM, Baramati on March 08, 2019 on the theme "Think Equal, Build Smart, Innovate for Change". All the staff members including contractual staff of office and field, YPs, RA's, SRF's and JRF's participated in the function. The function was chaired by Director, ICAR-NIASM and Dr A N Rai, Ex Vice Chancellor, NEHU, Shillong also graced the function. The address of Hon'ble Prime Minister Shri Narendra Modiji's to nation from National Women

Livelihood Meet, Varanasi was live telecasted. Mrs. Priya George, Senior Technical Assistant conducted the programme in which 150 participants including 90 women working in various capacities participated in the celebration.


Fig. 9.22. Celebration of International Women's Day

Swachh Bharat Mission

Under Swachh Bharat Abhiyan more than 100 persons including scientific, administrative, technical, young professionals, research fellows and contractual labours contributed more than 50 hours in different Swachhata Action Plan (SAP) approved activities. Different activities such as cleaning the toilets, office building premises, doing weeding and plantation of flowering plants in front of the office building regularly. To make the institute campus plastic waste and Parthenium free cleaning and eradication drive conducted every month. For the implementation of Swachh Bharat Mission, Ministry of Drinking Water & Sanitation has launched a campaign 'Swachhata Hi Sewa-2018' from September 15 to October 02, 2018 as part of the 150th Birth year celebration of Mahatma Gandhi. In this campaign cleaning and construction of toilets, awareness campaign in schools, village and school level rally


Fig. 9.23. Collection of plastic waste in campus

Fig. 9.24. Cleaning of office premises

was performed and also waste segregation, vermicomposting unit, sewage water treatment unit was constructed. All the staff and school children around the institute is participated in various activities. Apart from all these activities cleaning of office premises, residential quarters, farm and guest house was also performed.

Fig. 9.25. Waste management by vermi-composting

Fig. 9.26. Swachata Hi Seva rally by school children

Visit of Dr Peter Carberry, DG, ICRISAT, Hyderabad to ICAR-NIASM, Baramati on January 17, 2019

Dr Peter Carberry, Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad and Dr Anupama Hingane, Plant Breeder, ICRISAT visited ICAR-National Institute of Abiotic Stress Management, Baramati, Pune on January 17, 2019. They visited the research facilities and interacted with scientists and staff of ICAR-NIASM. They emphasized for possible collaboration to carry out research for management of various kinds of abiotic stresses by employing genomics and phenomics approaches. Detailed discussions were also made taking into consideration of possible strategies for mitigation/management of various kinds of abiotic stresses.

Fig. 9.27. Dr Peter Carberry, DG, ICRISAT addressing ICAR-NIASM scientists, staff and researchers

Fig. 9.28. Interaction meeting between ICAR-NIASM scientists and DG, ICRISAT for collaboration to manage various abiotic stresses

10 *Rights of Person with Disability (RPwD)*

11 *New Staff, Promotion, Transfer and Probation*

10. Rights of Person with Disability (RPwD)

Rights of Person with Disability (RPwD) Act, 2016: Action taken by the Institute

The Rights of Persons with Disabilities (RPwD) Act, 2016 is the disability legislation passed by the Indian Parliament to fulfil its obligation to the United Nations Convention on the Rights of Persons with Disabilities. Rights and Entitlement of Persons with Disabilities include right to equality, life with dignity and respect for his or her integrity equally with others, no discrimination on the ground of disability (Equality and Non-discrimination); rights to live in community (Community life); Protection of disabled person from being subjected to torture, cruel, inhuman or degrading treatment (Protection from cruelty and inhuman treatment); Protection of disabled person from incidence of abuse, violence and exploitation (Protection from abuse, violence and exploitation); rights of equal protection and safety in situations of risk, armed conflict, humanitarian emergencies and natural disasters (Protection and safety); rights to access any court, tribunal, authority, commission or any other body having judicial or quasi-judicial or investigative powers without discrimination on the basis of disability (Access to justice); No child with disability shall be separated from his or her parents on the ground of disability except on an order of competent court, if required, in the best interest of the child (Home and family) etc.

ICAR-NIASM complies with RPwD Act, 2016 and various activities and the decisions have been taken for implementation of RPwD Act, 2016 during financial year 2017-18:

- Special provisions like ramps and lift have been installed /made for facilitating ease of mobility of disabled persons in the Institute.
- Decisions have been made to accommodate disabled staff preferably at the ground floor for their convenience and provision has been made for special washroom for disabled persons in the newly constructed buildings.
- Offices of the Heads of the Schools, Administrative officer and Accounts officer have been located in the ground floor to facilitate the transaction/interaction of disabled persons.
- Visitors with disability can use the lift for attending meetings in different seminar halls and committee rooms.
- Each of the building has been provided with more than one entry point to facilitate the mobility of disabled persons from the nearest and convenient entry point.
- The library which was placed in the first floor has now been extended to the ground floor. Institutes Grievances cell has been specially instructed to attend the grievances from disable persons on priority and comply with the RPwD Act, 2016.
- No separate record has been maintained with regard to number of beneficiaries with disabilities and their percentage in relation to the total number of beneficiaries, however, the persons/farmers benefitted from Institutes programme conducted in its campus or different villages in Navapur districts of Maharashtra under TSP included Persons with Disabilities who availed equal opportunity to improve their livelihood through adoption of improved agricultural technologies.

11. New Staff, Promotion, Transfer and Probation

New Staff

- Shri Anil Kumar Sidharth, Finance & Accounts Officer transferred from ICAR-DWR, Karnal and joined at ICAR-NIASM, on July 23, 2018
- Dr Aliza Pradhan, Scientist (Agronomy) joined ICAR-NIASM on October 09, 2018.
- Mr Amresh Choudhary Scientist (Soil Science) joined ICAR-NIASM on October 09, 2018

Promotion

- Dr D D Nangare promoted as Senior Scientist Grade pay 9000 w.e.f. 09.10.2015.

Transfer

- Dr KK Krishnani Principal Scientist, transferred to ICAR-CIFE Mumbai on June 30, 2018
- Dr RL Choudhary, Scientist (Agronomy) transferred to ICAR-DRMR, Bharatpur on June 30, 2018

Probation

- Harisha CB, Scientist (Spices, Plantation, Medicinal and Aromatic Plants) has cleared probation w.e.f 01.01.2016
- MP Bhendarkar, Scientist (Fisheries Resource Management) has cleared probation w.e.f 01.01.2018
- Rajkumar, Scientist (Agricultural Entomology) has cleared probation w.e.f 01.01.2019

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12 Budget Utilisation

13 Research Projects

14 Personnel

12. Budget Utilisation

(₹ lakhs)

Head/Sub Head	Allocation	Expenditure
Grants in aid –Capital	345.21	
Works		300.00
Equipment		2.46
Information Technology		18.13
Library		16.45
Furniture and fixures		7.17
Vehicles and Vessels		0.00
Livestock		1.00
Sub Total - 1	**345.21**	**345.21**
Grants in aid –Salary		
a) Establishment Charges	587.00	587.00
Sub Total – 2	**587.00**	**587.00**
Grants in Aid - General		
Pension & Other retirement Benefits	106.14	106.14
Travelling Allowance	450.00	20.00
Research & Operational Expenses		237.79
Administrative Expenses		122.52
Miscellaneous Expenses		69.69
Total Grants in Aid-General	556.14	556.14
Tribal Sub Plan	0.00	0.00
Scheduled Castes Sub Plan		
Grants in aid –Capital	77.75	77.75
Grants in aid –General	38.57	38.57
SCSP Total	116.32	116.32
Grand Total	**1604.67**	**1604.67**

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13. Research Projects

S. No	Project Name	PI	Co-PI
School of Atmospheric Stress Management			
1.	Identification, cloning and expression analysis of temperature, salinity and hypoxia responsive genes in fish (IXX09672)	MP Brahmane	Satish Kumar
2.	Quantifying thermal tolerance limits and genetic polymorphism to temperature stress in fishes from drought affected Bhima, Krishna rivers (IXX14264)	MP Brahmane	MP Bendharkar Neeraj Kumar
3.	Simulation and visualisation of potential population growth in pulse beetle, *callosobruchus chinensis* L. (Bruchidae: Coleoptera) in pigeonpea (*Cajanus cajan* L. Millsp) under changing climatic conditions and its geographic distribution. (IXX14278)	Rajkumar	AK Singh
3.	Spawning and larval development of snakehead, Channa spp, and Nile Tilapia (*Oreochromis nilolicus)* under abiotic stress environment (IXX14249)	MP Bhendarkar	MP Brahmane Neeraj Kumar
School of Drought Stress Management			
1.	Assessment of Quinoa (*Chenopodium quinoa*) as an alternate crop for water scarcity zone (IXX14286)	Jagadish Rane	NP Singh Aliza Pradhan
2.	Evaluation of nutritional stressors and their indicators in cattle population in different drought prone areas (IXX11259)	NP Kurade	Neeraj Kumar AV Nirmale
3.	Investigation on traits and genes associated with adaptation of wheat genotypes to local drought stress environments (IXX09675)	AK Singh	Jagadish Rane M Kumar
4.	Evaluation of water saving techniques for fruits and vegetables in shallow soils of semi-arid region (IXX10721)	DD Nangare	Yogeshwar Singh Mahesh Kumar PB Taware
5.	Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivar (IXX11584)	GC Wakchaure	RL Choudhary KK Meena
6.	Exploring potential to obviate water and high temperature stress in onion (*Allium Cepa* L.) for enhancing productivity and post-harvest storage quality (IXX14250)	GC Wakchaure	BB Gaikwad KK Meena

S. No	Project Name	PI	Co-PI
School of Drought Stress Management			
7.	Investigation of traits and genes associated with resilience to moisture stress in soybean (IXX09645)	Mahesh Kumar	AK Singh RL Choudhary Jagadish Rane
8.	Spectral delineation of moisture and nutrient stresses in vineyards through hyperspectral spectroscopy (IXX14265)	BB Gaikwad	DD Nangare GC Wakchaure
School of Edaphic Stress Management			
1.	Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils (IXX09671)	Yogeshwar Singh	DD Nangare Mahesh Kumar Jagadish Rane PB Taware
2.	Isolation and characterization of biomolecule producing bacteria for salt stress alleviation in major crops (IXX10378)	KK Meena	KK Krishnani RL Choudhary CB Harisha
3.	Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (IXX09673)	Neeraj Kumar	MP Brahmane KK Krishnani
4.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	KK Krishnani Paritosh Kumar
5.	Waste water treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)	Paritosh Kumar	KK Meena Neeraj Kumar CB Harisha
6.	Effect of nutritional and salinity stress on physiological, biochemical traits and yield of turmeric (*Curcuma longa* L.) (IXX13858)	CB Harisha	KK Meena

Externally Funded Projects (on going)

S. No	Project Name	PI	Co-PI	Funded by
1.	Phenotyping of pulses for enhanced tolerance to drought and heat (OXX01737)	Jagadish Rane	Mahesh Kumar Narendra Pratap Singh	NICRA, CRIDA, Hyderabad
2.	Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (OXX03111)	Jagadish Rane	AK Singh	DBT, GoI-BBSRC, UK

S. No	Project Name	PI	Co-PI	Funded by
3.	Abiotic stress detection from field to landscape scale in different crops using remote sensing tools (OXX04474)	Jagadish Rane	-	ISRO-SAC
4.	On field *in vivo* monitoring of pollen tube growth of dry land agricultural crops to identify the genotypic resilience to drought (OXX04232)	Jagadish Rane	-	DBT
5.	Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (OXX03595)	Yogeshwar Singh	BB Gaikwad DD Nangare Mahesh Kumar Rajkumar	(BDA-HSRS) DST
6.	Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean (OXX04449)	AK Singh	Mahesh Kumar Yogeshwar Singh Jagadish Rane	ICAR-NASF
7.	Raising rice productivity through drought tolerant rice varieties and their matching management practices in Maharashtra (OXX03978)	Yogeshwar Singh	NP Singh DD Nangare Mahesh Kumar	IRRI, Phillipines
8.	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (OXX03355)	Yogehswar Singh	RL Choudhary NP Singh KK Meena Mahesh Kumar Paritosh Kumar	CA Platform ICAR
9.	Evaluation of halotolerant *Rhizobium* and PGPB based biomolecules for alleviation of drought and salt stress (OXX04473)	KK Meena	GC Wakchaure CB Harisha NP Singh	AMAAS, NBAIM, Mau.
10.	Establishment of model herbal garden for medicinal and aromatic plants (OXX04255)	CB Harisha	DD Nangare	NMPB, New Delhi

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14. Personnel

Research Management Position (RMP)	
Prof. Narendra Pratap Singh	Director
Scientific Staff	
School of Atmospheric Stress Management	
Dr Jagadish Rane	Head (I/c)
Dr M.P. Brahmane	Principal Scientist (Biotechnology – Animal Science)
Dr Sachinkumar S Pawar	Scientist (Animal Biotechnology)
Mr Gopalakrishnan B.	Scientist (Environmental Science)- On study leave
Mr Rajkumar	Scientist (Agricultural Entomology)
Mr Mukesh Bhendarkar	Scientist (Fisheries Resource Management)
School of Drought Stress Management	
Dr Jagadish Rane	Head (I/c)
Dr NP Kurade	Principal Scientist (Veterinary Pathology)
Dr Ajay Kumar Singh	Senior Scientist (Agricultural Biotechnology)
Dr DD Nangare	Senior Scientist (Soil & Water Conservation Engineering)
Dr GC Wakchaure	Scientist (Agricultural Structure & Process Engineering)
Dr Bhaskar B Gaikwad	Scientist (Farm Machinery)
Dr Mahesh Kumar	Scientist (Plant Physiology)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Dr (Mrs) Aliza Pradhan	Scientist (Agronomy)
School of Edaphic Stress Management	
Dr Kamlesh K Meena	Head (I/c), Senior Scientist (Agricultural Microbiology)
Dr Yogeshwar Singh	Senior Scientist (Agronomy)
Mr V Rajagopal	Scientist (Soil Chem./Fert./Microbiology) – On study leave
Dr Neeraj Kumar	Scientist (Fish Nutrition)

Dr Paritosh Kumar	Scientist (Environmental Science)
Mr CB Harisha	Scientist (Spices, Plantation, Medicinal and Aromatic Plants)
Mr Amresh Chaudhary	Scientist (Soil Science)
School of Policy Support Research	
Dr Kamlesh K Meena	Head (I/c)
Administrative Staff	
Shri Babul Kumar Sinha	Senior Administrative Officer
Shri Anil Kumar Sidharth	Finance & Accounts Officer
Smt Purnima S Ghadge	Assistant Administrative Officer
Mr Dayanand Kharat	Assistant
Mr Girish V Kulkarni	Assistant
Technical Staff	
Dr AV Nirmale	Chief Technical Officer (Animal Science)
Dr Pravin B Taware	Senior Technical Officer (Farm)
Mrs Noshin Shaikh	Senior Technical Assistant (Civil)
Mr Santosh Pawar	Senior Technical Assistant (Electrical)
Mr Pravin More	Senior Technical Assistant (Computer)
Mr Madhukar Gubbala	Senior Technical Assistant (Information Technology)
Mr Rushikesh Gophane	Senior Technical Assistant (Horticulture)
Dr (Mrs) Priya George	Senior Technical Assistant (Microbiology)
Mr Lalitkumar Aher	Senior Technical Assistant (Biotechnology)
Mr Sunil V Potekar	Senior Technical Assistant (Agro-Meteorology)
Mr Patwaru R Chahande	Senior Technical Assistant (Agriculture)
Mr Rupesh K Amarghade	Senior Technician Assistant (Mechanical)
Mr Aniket T More	Senior Technician (Farm)

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15 Distinguished Visitors

15. Distinguished Visitors

1. Dr Gurbachan Singh, QRT Chairman, Ex-Chairman, ASRB, New Delhi, Nov. 29, 8 July and 28 May 2018.
2. Dr Rajinder Singh Sidhu, Registrar, Punjab Agriculture University, Ludhiyana, Nov. 29, 8 July and 28 May 2018.
3. Prof Dilip Kumar, Ex Director, ICAR-CIFE, Mumbai, Nov. 29, 8 July 2018.
4. Prof KE Lawande, Ex Vice Chancellor, Dr BSKKV Dapoli, 8 July 2018.
5. Dr KC Bansal, Ex Director, ICAR-NBPGR, New Delhi, 28 May 2018.
6. Dr GGSN Rao, Ex Project Coordinator, AICRP Agromet, ICAR-CRIDA, Hyderabad, Nov. 29, 8 July and 28 May 2018.
7. Dr AS Dhawan, Vice Chancellor, NMKV, Parbhani, 8 July 2018.
8. Dr KP Vishwanatha, Vice Chancellor, MPKV, Rahuri 8 July 2018.
9. Dr PM Haldankar, Director Research, Dr. BSKKV, Dapoli, 8 July 2018.
10. Dr Sammi Reddy, Director (Acting), ICAR-CRIDA, Hyderabad, 8 July 2018.
11. Dr SD Sawant, Director, ICAR-NRC on Grapes, Pune, 8 July 2018.
12. Dr Jyotsana Sharma, Director (Acting), ICAR-NRC on Pomegranate, Solapur, 8 July 2018.
13. Dr KV Prasad, Director, ICAR-DFR, Pune, 8 July 2018.
14. Dr Major Singh, Director, ICAR-DOGR, Pune, 8 July 2018 and 19 September 2018.
15. Dr Subodh Gupta, Principal Scientist, ICAR-CIFE, Mumbai, 8 July 2018.
16. Dr P S Paithankar, Principal Scientist, PDKV, Akola, 8 July 2018.
17. Dr (Mrs) Nandini Nimbakar, NARI, Phaltan, 8 July 2018.
18. Dr SM Paul Khurana, Ex Vice Chancellor, Rani Durgavati University, Jabalpur and QRT Chairman NIBSM, Raipur, 9-10 July 2018.
19. Dr RH Lakshman, Principal Scientist (Plant Physiology), ICAR-IIHR Bangalore, 14 September 2018.
20. Dr M Prabhakar, Principal Scientist, (Entomology), ICAR-CRIDA, Hyderabad, 15 September 2018.
21. Dr Ajay Kumar Upadhyay, Principal Scientist, ICAR-NRC Grapes, Pune, 15 September 2018.
22. Dr M Maheshwari, Head (Crop Sciences), ICAR-CRIDA, Hyderabad, 15 September 2018.

23. Dr AK Singh, Principal Scientist, ICAR-IISR, Lucknow, 19 September, 2018.

24. Dr RN Sahoo, Principal Scientist (Agril. Physics) ICAR-IARI, New Delhi, 22 September 2018.

25. Dr SK Bal, Principal Scientist (Agro. Met.) ICAR-CRIDA, Hyderabad, 22 September 2018.

26. Dr VK Singh, Head (Agronomy), ICAR-IARI, New Delhi, 25 September 2018.

27. Dr Sanjeev Gupta, Principal Scientist (Plant Breeding), ICAR-IIPR, Kanpur, 25 September 2018.

28. Shri Chilabendra Roul, Special Secretary (DARE) & Secretary (ICAR), October 20, 2018.

29. Dr Alok Kumar Sikka, Ex DDG (NRM), ICAR & IWMI Representative-India & Principal Researcher, International Water Management Institute, Delhi Office, Pusa, New Delhi, November 30, 2018.

30. Dr DP Waskar, RAC Member, ICAR-NIASM, Baramati and Director of Research, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, November 30, 2018.

31. Dr JS Parihar, Member RAC, ICAR-NIASM, Baramati and Ex-Deputy Director, Satish Dhawan Professor ISRO-Space Application Centre, Ahmedabad, November 30, 2018.

32. Dr AG Ponnaiah, Member RAC, Anna Nagar West, Channai, November 30, 2018.

33. Dr OP Yadav, Director, ICAR- CAZRI, Jodhpur, November 29, 2018.

34. Dr PS Minhas Ex-Director, ICAR-NIASM, Baramati, November 29, 2018.

35. Dr K R Vittal, Former Director, ICAR-NIASM, Baramati, November 29, 2018.

36. Dr PC Sharma, Director, ICAR-CSSRI, Karnal, November 29, 2018.

37. Dr AK Singh, Former DDG (NRM), ICAR and Ex VC RVSKVV, Gwalior, September 27, 2018.

38. Prof Pushpendra Kumar Gupta, Emeritus Professor, Meerut University, Meerut, January 04, 2019.

39. Shri Rajendra Pawar, Chairman, Agricultural Development Trust, Baramati, February 22, 2019.

40. Dr Peter Carberry, Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), January 17, 2019.

41. Dr Anupama Hingane, Plant Breeder, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), January 17, 2019.

42. Shri Sachindra Pratap Singh, Commissioner of Agriculture, Maharashtra, January 20, 2019 and October 23, 2018.

43. Dr Trilochan Mahapotra, Secretary (DARE) and Director General (ICAR), New Delhi, 22 February 2019.

44. Mr RN Shinde, Chairman, Tirupati Balaji Agro Products Pvt. Ltd. Baramati, February 22, 2019 and September 27, 2018.

45. Shri Ranjan Taware, Chairman, Malegaon Sahakari Sakhar Karkhana, Malegaon, Baramati, 22 February 2019.

47. Dr Tapas Bhattacharya, Ex Vice Chancellor, Dr. BSKKV, Dapoli, 25 February 2019.

48. Dr HP Singh, Former DDG (Horticulture), ICAR, New Delhi, March 11, 2019 and May 24, 2018.

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Appendix

Institute Management Committee

1 Prof Narendra Pratap Singh, Director, ICAR-NIASM, Baramati

2 Dr Shrikant Kakde, Director (Education), Maharashtra Council of Agricultural Education and Research, Bhosale Nagar, Pune

3 Dr Naveen P Singh, Principal Scientist, ICAR-National Institute of Agricultural Economics and Policy Research(NIAP), New Delhi

4 Dr Vijay Mahajan, Principal Scientist, ICAR-Directorate of Onion and Garlic, Rajgurunagar, Pune-410505, Maharashtra, India

5 Dr Ajay Kumar Upadhyaya, Principal Scientist, ICAR-National Research Centre on Grapes, Pune

6 Dr Eaknath B Chakurkar, Director, ICAR-Central Coastal Agricultural Research Institute, Ela, Old Goa, Distt North Goa, Goa

7 Dr Pawan L Kulwal, Associate Professor (Genetics and Plant Breeding) State Level Biotechnology Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra

8 Shri Ramchandra V Nimbalkar At/Po- Bhawani Nagar, Indapur Taluka , Pune

9 Shri Shyam Appa Chakor At/Po- Mandhawagan Farta, Shirur Taluka, Pune

10 Shri O P Nagar, Deputy Director (Account) II, ICAR, Krishi Bhavan, New Delhi

11 Senior Administrative Officer, NIASM, Malegaon, Baramati

Research Advisory Committee

1 Dr Alok K Sikka, Chairman, RAC and Ex DDG (NRM), ICAR & IWMI Representative-India & Principal Researcher, International Water Management Institute, Delhi Office, DPS Shastri Marg, Pusa, New Delhi-110012

2 Dr D P Waskar, Director of Research, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani 431 402 Maharashtra India

3 Dr (Mrs) Vidya Gupta, Fellow National Academy of Science, Biochemical Science Division, CSIR-National Chemical Laboratory, Dr Homi Bhabha Road, Pune- 411 008, India

4 Dr J S Parihar, Ex-Deputy Director, Satish Dhawan Professor ISRO-Space Application Centre, Ahmedabad, 100, ISCON Greens, near Hari Om Villa, Ghuma, Post Office: Bopal, Ahmedabad

5 Dr Arun Varma , Former ADG (AN and P), ICAR, Uttar Pradesh

6 Dr A G Ponaiah, Former Director, ICAR-CIBA, Chennai

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7 Prof Narendra Pratap Singh, Director, NIASM, Baramati, Pune 413115

8 Dr Jagadish Rane, Head, SDSM, NIASM, Baramati (Member Secretary)

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1 Dr Gurbachan Singh, Ex-Chairman, ASRB, New Delhi & Chairman QRT

2 Dr Rajinder Singh Sidhu, Registrar, PAU, Ludhiana & Member QRT

3 Prof Dilip Kumar, Ex-Director, ICAR-CIFE, Mumbai & Member QRT

4 Prof KE Lawande, Ex-Vice Chancellor, Dr BSKKV, Dapoli & Member QRT

5 Dr KC Bansal, Ex-Director, ICAR-NBPGR, New Delhi & Member QRT

6 Dr GGSN Rao, Ex-PC, AICRP-Agromet, ICAR-CRIDA, Hyderabad & Member QRT

7 Dr Yogeshwar Singh, Senior Scientist, ICAR-NIASM & Member Secretary QRT

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Institute Biosafety Committee

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RTI Cell

Dr K K Meena (CPIO) and Dr N P Kurade (Transparency Officer)

Women Cell

Mr B K Sinha (Chairman), Dr Mahesh Kumar, Mrs Noshin Shaikh, Dr (Smt) Priya George and Mrs Purnima S Ghadge (Member Secretary)

Security Incharge

Dr G C Wakchaure

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Abbreviations

CD	Critical Difference
CT	Conventional Tillage
CTD	Canopy Temperature Depression
CTMax	Critical Temperature Maximum
CTMin	Critical Temperature Minimum
DAS	Days After Sowing
ELWL	Excised Leaf Water Loss
FAD3	Fatty Acid Desaturase 3
FP	Farmers Practice
GA	Gibberellic Acid
GST	Glutathione-S-Transferase
HSP	Heat Shock Protein
ICAR	Indian Council of Agricultural Research
IISR	Indian Institute of Soybean Research
IIHR	Indian Institute of Horticulture Research
IIPR	Indian Institute of Pulse Research
IRC	Institute Research Council
ITMU	Institute Technology Management Unit
KVK	Krishi Vigyan Kendra
MDH	Malate Dehydrogenase
MGMG	Mera Gaon Mera Gaurav
LDH	Lactate Dehydrogenase
LLL	Laser Land Levelling
MMR	Maximum Metabolic Rate
MPKV	Mahatma Phule Krishi Vidyapeeth
NARS	National Agricultural Research System
NIR	Near Infra Red
NBPGR	National Bureau of Plant Genetic Resources
NIASM	National Institute of Abiotic Stress Management
NRC	National Research Center
NRM	Natural Resource Management
PBRs	Plant Bio Regulators
PK	Pyruvate Kinase
OBC	Other Backward Cast
PME	Priority setting, monitoring and evaluation
RAC	Research Advisory Committee
RWC	Relative Water Content
SA	Salicylic Acid
RNAi	RNA interference
SAUs	State Agriculture Universities
SDI	Surface Drip Irrigation
SW	Spent Wash
SOD	Superoxide Dismutase
SMR	Standard Metabolic Rate
STC	Schedule Tribe Component
TKW	Thousand Kernel Weight
TSP	Tribal Sub Plan
VIGS	Virus Induced Gene Silencing
WP	Water Productivity
WUE	Water Use Efficiency