वार्षिक प्रतिवेदन ♦ Annual Report

2016-17



राअस्ट्रैप्रसं
NIASM

भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

(भारतीय कृषि अनुसंधान परिषद)

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

ICAR-National Institute of Abiotic Stress Management

(Indian Council of Agricultural Research)

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

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Correct citation : Annual Report (2016-17). ICAR-National Institute of Abiotic Stress Management, Malegaon, Baramati - 413 115, Pune, Maharashtra, India.

June 2017	जुन 2017
Published by Director, ICAR-NIASM	**प्रकाशक** निदेशक, भाकृअनुप–राअस्ट्रैप्रसं
Edited and Compiled by Narendra Pratap Singh Santanu Kumar Bal Yogeshwar Singh Neeraj Kumar Ajay Kumar Singh Gopalakrishnan B. Manoj P. Brahmane Dharmendra Prasad Patel Basavaraj Sajjanar	**संपादन एवं संकलन** नरेन्द्र प्रताप सिंह सांतनु कुमार बल योगेश्वर सिंह नीरज कुमार अजय कुमार सिंह गोपालाकृष्णन बी. मनोज पी. ब्राम्हणे धरमेंद्र प्रसाद पटेल बसवराज सज्जनार
Photography & Art Sunil V. Potekar Pravin More	**छायाचित्र एवं रेखांकन** सुनिल वी. पोतेकर प्रविण मोरे

Cover
General view of activities of field experimentation

भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
ICAR-NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT
(समतुल्य विश्वविद्यालय)(Deemed to University)
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
Ministry of Agriculture & Farmers Welfare, Government of India
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Prof. Narendra Pratap Singh
Director

Preface

The institute aims to provide dynamic mechanisms and robust tools for managing abiotic stresses in present or amplified version in the future in various agro-ecosystems. Recurrent drought, unprecedented hailstorm events, micro irrigation induced salinization are some of the major concerns to be dealt with. To accomplish this, institute has accelerated its efforts with a focus on basic researches on abiotic stresses in crops, animals and fish.

In the last few years efforts were made for development of infrastructural facilities in terms of farm development, construction activities and procurement of equipments for strengthening the state of the art laboratories. In fact, the foremost achievement of the year has been operationalization of the state of the art Phenomics facility for identifying genotypes for optimizing water use. The major research endeavours during this year have been confirmation of results for determination of light saturation points in soybean, identification of bioregulators to minimize the impact of drought, testing of large number of genotypes for drought tolerant traits, identified critical thermal limits for abiotic stress tolerant fishes and dragon fruit as potential crop for water scarce and rocky land areas; developed microbial consortium for alleviation of nutritional stress in wheat crop. In addition the scientists and technical staff actively participated in the tribal subplan and interactions with farmers under Mera Gaon Mera Gaurav.

For encouraging networks, MoUs' have been signed with national and international centres and sincere efforts are being made to initiate the academic program which is on top priority.The institute successfully conducted a brain storming event on "Abiotic Stress Management" to prepare the roadmap for future researches on abiotic stress management and appreciated by all. I extend my sincere thanks to Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Chhabilendra Roul, Additional Secretary (DARE) and Secretary (ICAR); Shri Sunil Kumar Singh, Addl. Secretary & Financial Advisor (DARE/ICAR); DDG (NRM, ICAR); ADG (Soil & Water Management), and 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 on time.

Dated: June 28, 2017
ICAR-NIASM, Baramati

(Narendra Pratap Singh)
Director

Contents

कार्यकारी सारांश

वर्ष के दौरान बुनियादी एवं अनुसंधान सुविधाओं के विकास के लिए सार्थक प्रयास किया गया। स्कूल भवन, छात्रावास और एमआईडीसी, बारामती में आवासीय परिसर के निर्माण की प्रगति संतोषजनक रही। नियंत्रित जलवायु वाले उच्च तकनीक ग्रीनहाउस का निर्माण प्रगति पर है, जबकि पशुधन प्रयोग से संबन्धित सुविधा दक्षिण तरफ वाले फार्म में विकसित किया गया है। बड़ी संख्या में आधुनिक अनुसंधान उपकरणों की भी खरीद की गई। समीक्षाधीन अवधि के दौरान की मुख्य उपलब्धियों का वर्णन संक्षेप में नीचे दिया गया है:

- चार वर्ष के प्रयोग समाप्त होने पर मुर्रम में विघटन/अवखण्डन की घटती प्रवृत्ति इस क्रम में देखी गई – सोयाबीन – गेहूं – स्पेंट वाश > गन्ना + स्पेंट वाश > नेपियर घास > सोयाबीन – गेहूं > गन्ना > सुबाबुल लूसर्न > मक्का – चारा ज्वार > सुबाबुल (वर्षा आधारित) > कंट्रोल + स्पेंट वाश > अंजन (वर्षा आधारित) > चारा ज्वार (वर्षा आधारित) > कंट्रोल। स्पेंट वाश प्राप्त प्रयोग में 1.9 से 3.6 प्रतिशत ज्यादा विघटन पाया गया।

- चौथे वर्ष में गन्ना + स्पेंट वाश उपचार में अधिकतम गन्ना उपज दर्ज की गई जो अन्य सभी उपचारों से काफी बेहतर थी। सिंचित स्थिति में गन्ना उपज घटती प्रवृत्ति में इस क्रम में देखी गई: गन्ना + स्पेंट वाश नेपियर घास > गन्ना > सोयाबीन – गेहूं – स्पेंट वाश > लूसर्न > सोयाबीन + गेहूं मक्का – चारा ज्वार जब कि वर्षा आधारित स्थितियों में अंजन > चारा ज्वार में।

- उथले बेसाल्टीक क्षेत्र में औगर रोपण की अपेक्षा गड्डों या खंदकों में रोपित सपोटा, अमरूद और अनार के बागानों का निष्पादन बेहतर पाया गया। सूक्ष्म विस्फोटन ने इन बगीचों की स्थापना में बिना सूक्ष्म विस्फोट उपचार की तुलना में अपनी श्रेष्ठता को साबित किया है। पौधे की वृध्दि और इसकी कार्यिकी एवं पादप प्रजनन क्रियाएँ 50% स्थानीय मुर्रम और 50% काली मिट्टी से भरे गड्डों और खंदकों में 100% काली मिट्टी की तुलना में काफी अच्छी पायीं गईं।

- ड्रैगन फल को पानी की दुर्लभ और उथले बेसाल्टिक भूमि के लिए एक संभावित फसल के रूप में पहचान की गई है। इसकी खेती प्रौद्योगिकी और एक्सपोजर विज़िट के माध्यम से इसे वैकल्पिक पीक के रूप में बढ़ावा देने के प्रयास किए गए।

- लाइन स्रोत सिंचन प्रणाली का उपयोग करके ज्वार, प्याज और बैंगन के पौधों में जैव नियामक (बायोरेगुलेटर्स) की प्रतिक्रिया और फसल उत्पादन में जल की खपत (क्रॉप वाटर प्रोडक्शन फंसन) का मूल्यांकन किया गया। शोध में यह पाया गया कि पीबीआर की सापेक्ष प्रतिक्रिया पर्यावरण की अवस्था पर निर्भर थी और सभी फसल के लिए अलग थी। पीबीआर जैसे सोडियम बेंजोएट (100 मिलीग्राम प्रति लीटर), पोटैशियम नाइट्रेट (1.5 प्रतिशत) और थायो – यूरिया (500 पार्ट पर मिलियन) ने ज्वार, प्याज और बैंगन में पानी के कमी (वाटर स्ट्रेस) को सहने में मदद की। इस प्रकार पीबीआर का उपयोग पानी की कमी की स्थिति में फसलों के उत्पादन को बढ़ावा देने में मदद कर सकता है। इसी तरह ज्वार के लिए विभिन्न प्लास्टिक मल्च उपचारों में पारंपरिक अभ्यास के सापेक्ष प्लास्टिक मल्च उपचारित सपाट एवं उभरा बेड (60÷15 सेंटीमीटर) 15–27% तक बेहतर उपज के साथ सर्वोत्तम पाया गया।

- एचडी–2189 की तुलना में गेहूं की आईसी–549394, इसी–573623 और आईसी–112051 प्ररूपों में कार्यात्मक टिलर और प्रकाश संश्लेषण दक्षता अधिक पायी गयी है। गेहूं की आईसी–549394, इसी–573623 और आईसी–112051 प्रारूप सूखा क्षेत्र मे उतपादन के लिए उपयुक्त पाये गए हैं।

- गेहूं की आईसी–549394, इसी–573623 और आईसी–112051 प्ररूपों में जल तनाव रोधक क्षमता सीडीपीके और सीबीएफ जीन की उच्च अभिव्यक्ति से सहसंबध्द पाये गए।

- सूखे और गर्मी तनाव रोधक क्षमता को सोयबीन में बढ़ाने के लिए 20 उपयुकत जीन के कार्य को स्पष्ट करने हेतु वायरस प्रेरित जीन सायलेंसिंग तथा आरएनए हस्तक्षेप (आरएनएआई) तकनीक का उपयोग किया गया है।

- सर्व प्रथम हमने क्षेत्र के सोयबीन की एक लोकप्रिय प्रजाति जेएस–335 की पृष्ठभूमि में एथीलीन असंवेदनशील 2, एआरएफ, डब्लूआरकेवाई–49 और फ़ारनेसिल ट्रान्सफेरेज़ जीन की अल्प अभिव्यक्ति युक्त सोयाबीन पौधा विकसित किया है। इन पौधों में तनाव संबन्धित जीन के कार्य का आकलन किया गया है, जो कि अरबिडोप्सिस जैसे मॉडल पौधों में पहले पता लगाया गया था। तनाव संबन्धित जीन के कार्य के आकलन हेतु 15 अन्य जीन का सायलेंसिंग किया जा रहा है।

- डीबीटी–बीबीएसआरसी परियोजना के अंतर्गत गेहूं की 220 जीनोटाइप पर बाली निकलने के बाद सूखे के प्रभाव का अध्ययन किया गया और पांच जीनोटाइप– डीबीडब्ल्यू–74, बीजागरा येलो, एचडी–4672, एचपीडब्ल्यू–155 और एसएवाईयूआईटी 342, स्थानीय प्रजाति की तुलना में बेहतर पाये गए।

- सोयाबीन के पत्तों में क्लोरोफिल को मापने के लिए सामान्य छवि आधारित पध्दति को विकसित किया गया। वास्तविक क्लोरोफिल एवं दृश्यमान छवियों के औसत आर (R) और जी (G) पिक्सेल में नकारात्मक संबंध पाया गया। यह दर्शाता है कि छवि विश्लेषण आधारित रंगीन पिक्सल का उपयोग सोयाबीन के पत्तो में क्लोरोफिल का अनुमान लगाने के लिए किया जा सकता है। सामान्यइमेजिंग को क्लोरोफिल आकलन के लिए पौधों को नुकसान पहुंचाए बिना इस्तेमाल किया जा सकता है।

- पानी के विभिन्न स्तरों और पोषण संबंधी तनाव से जुड़े फसलों के महत्वपूर्ण चरणों की पहचान करने के लिए गन्ना और नींबू वर्गीय फसलों के बगीचों में हाइपर स्पेक्ट्रल जानकारी एकत्र की गई।

- प्रकाश की तीव्रता और अवधि के साथ जेएस – 335 और कालितूर के पीएस–II (PSII) के क्वांटम यील्ड (एफवी / एफएम) को प्रभावित करती है। कालितूर की तुलना में जेएस–335 में पीएस–2 की क्षतिपूर्ति में सुधार पाया गया।

- पानी की कमी की स्थिति के लिए आम अति संवेदनशील पाया गया। नमी तनाव की स्थिति मे विभिन्न बागवानी फसलों में क्वांटम दक्षता में कमी की दर का क्रम अनार < करौंदा < नींबू < संतरा < अंगूर < सापोटा < आम पाया गया।

- तापमान में वृध्दि के साथ क्वांटम दक्षता में कमी की दर का क्रम ड्रैगन फ्रूट > नींबू > शरीफा > करौंदा > संतरा > अनार > अमरूद > अंगूर > जामुन > आम > सपोटा में पाई गई। ड्रैगन फल अन्य फसलों की तुलना में तापमान में वृध्दि के लिए अधिक सहिष्णु पाया गया।

- सोयाबीन की विभिन्न किस्मों का खेत में जल–जमाव के प्रति सहिष्णुता के लिए जांच की गई। सामान्य जल प्रबंधन की तुलना में जल–जमाव के उपचार के तहत आरकेएस –24 और आरवीएस–2001–4 प्रजातियाँ फसल विकास के अधिकांश मापदंडों में न्यूनतम कमी के साथ रोधी पाई गई। जल–जमाव के प्रति सहिष्णुता की जांच के लिए प्रजनन अवस्था के मुकाबले वनस्पतिक अवस्था अधिक उपयुक्त पाई गई।

- लवणीय तनाव के तहत एण्डोलीथिक और एपिथैथिक बायोमोलेक्लस निर्माण करने वाले मेथिलोट्रॉफिक बैक्टीरिया गेहूं के बीज में अंकुरण, विकास और स्थापना को बढ़ाता है।

- सीमित पोषक तत्व शर्तों के तहत गेहूं की पैदावार में वध्दि के लिए मृदुसंयोगी कंसोर्टियम को विकसित किया गया।

- लवणीय मिट्टी के नमूनों से प्राप्त पौधों की वध्दि को बढ़ावा देने वाले हेलोलोटेरेंट बैक्टीरिया पौधों के विकास व बीज अंकुरण को सुविधाजनक बनाने के द्वारा गेहूं में लवणता के तनाव को कम करने में मदद करता है।
- फसल अवशेष का सतह पर आच्छादन तथा इसके साथ सोर्फ मशीन का प्रयोग (स्टबल शेविंग, ऑफ–बेरिंग, रूट प्रुनिंग और उर्वरक प्लेसमेंट) के संयोजन ने पारंपरिक पेड़ी गन्ने के प्रबंधन की अपेक्षा 13.3–27.6 और 28.3–44.4% तक गन्ना उपज और पानी की उत्पादकता में वध्दि पाया गया। इन पध्दतियों ने जड़ विकास में सुधार के साथ– साथ गन्ने में अल्पकालिक सूखा प्रभावों को कम करने में भी लाभकारी पाया गया।
- सेलेनियम–नैनो कण और जिंक– नैनो कण में वध्दि संबर्धन को बढ़ाने की क्षमता है और इसके साथ साथ प्रथम, व्दितीय और तृतीय तनाव को पंगासियस हाइपोथैलेमस में कम करने की क्षमता है ।
- प्रदूषित जलीय वातावरण में अल्प तत्वों के प्रदूषण के लिए बायोमार्कर के रूप में इस्तेमाल करने वाले ऑक्सीडेटिव तनाव, सेलुलर तनाव, न्यूरोट्रांसमीटर, लिपिड पेरोक्साइड और कुछ रूपात्मक मापदंडों के तर्कसंगत अनुप्रयोग है ।
- तिलापिया मछली में शरीर की वध्दि को मापने के लिए शरीर का वजन, सफेद मांसपेशी, फाइबर आवृत्ति के माध्यम से तथा qRT-PCR के मायोस्टेटिन जीन की अभिव्यक्ति 34 डिग्री सेल्सियस 25 डिग्री सेल्सियस और 30 डिग्री सेल्सियस से काफी अधिक थी।
- नेनोटेक्नोलॉजिकल हस्तक्षेप के माध्यम से जेओलिट्स में मूल्य सवर्धन की गयी है। मछली में तनावों के निवारण के लिए नैनोसिल्वर आधारित फ़ीड तैयार करने का मानकीकरण किया गया है।

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Executive Summary

A major effort during the year was made on the development of infrastructure facilities as well as research facilities. The construction of School Buildings, Hostel and Residential complex at MIDC, Baramati are progressing satisfactorily. Livestock experimentation facility has been developed in south-side farm whereas a Hi-tech Greenhouse construction in progress has provision for controlled climate. A large number of sophisticated research equipment was also procured. Salient achievements during the reporting period have been summarized below:

- Disintegration of murrum has followed the decreasing trend in the order of Soybean-Wheat-Spent wash > Sugarcane-spent wash> Napier grass > Soybean-Wheat > Sugarcane > Subabul > Lucerne > Maize-Fodder sorghum > Subabul (R) > Control + Spent wash > Anjan (R)> Fodder Sorghum (R). Treatment comprising spent wash resulted in 1.9 to 3.6 per cent higher disintegration of murrum as compared to respective cropping system alone.

- After the completion of four years experimentation, sugarcane equivalent yield was recorded maximum in Sugarcane + spent wash which was significantly superior to all other treatments and followed the decreasing trend in the order of Sugarcane + spent wash > Napier grass > Sugarcane > Soybean- Wheat *fb* wheat residue incorporation + Spent wash > Lucerne > Soybean+ Wheat > Maize-Fodder sorghum in irrigated condition and Anjan > Fodder Sorghum in rainfed condition

- Trench and pit planted Sapota, Guava and Pomegranate orchards are performing better compared to farmers' practice and Auger planting in shallow basaltic region. Micro-blasting also proved its superiority over without micro-blast treatments in establishment of these orchards. Mixtures of black soil and native murrum are performing better than 100% Black soil in terms of growth and its physiological activities under limited moisture availability.

- Dragon fruit has been identified as a potential crop for water scarce and shallow basaltic lands with shallow soil. Efforts were made to promote it as alternative crop through transferring its cultivation technology and conducting exposure visits for farmers.

- Crop water production functions and relative response of plant bioregulators (PBRs) for sorghum, onion and brinjal were evaluated using line source sprinkler system. The relative response of PBRs was highly specific to environment conditions and varied with crop to crop. PBRs like sodium benzoate (100 mg L^{-1}), KNO_3 (1.5%) and thiourea (500 pmm) helped to mitigate water stress for sorghum, onion and brinjal, respectively. Thus use of PBRs can help to boost the productions of crops under water scarcity conditions. Similarly among different plastic mulch treatments tested for sorghum, raised bed and flat bed with plastic mulch (60 × 15 cm) was found be the best with increase in grain yield by 15–27% over traditional practice.

- Wheat genotypes, i.e, IC-112051, IC-549394 and EC-573623 showed higher functional tillers and photosynthetic efficiency compared to local check HD-2189. Wheat genotypes viz. IC-549394, EC-573623 and IC-112051 were found suitable for cultivation under limited soil moisture conditions.
- Water stress tolerance in promising genotypes viz. IC-549394, EC-573623 and IC-112051 was correlated with higher expression of *CDPKs* and *CBFs* genes.
- 20 candidate genes were identified from soybean and Arabidopsis data base for elucidation of their function using Virus Induced Gene Silencing (VIGS) and RNA interference (RNAi) approaches to enhance drought and heat stress tolerance.
- BPMV based VIGS gene constructs were developed to silence *EIN2*, *EIN3*, *FAD3*, *CAM4*, *ARF*, *WRKY-49*, *Farnesyltransferase*, *ABI Glyma*, *MCERA*, *ORE1*, *NAC053* and *PRAP* genes in soybean.
- The institute has developed the Ethylene insensitive 2, ARF, WRKY-49 and Farnesyltransferase silenced soybean plants in the background of JS-335, a popular cultivar of the region. In these plants genes have been silenced to assess functions of stress tolerant genes reported in model plants like Arabidopsis. Silencing of 15 more genes for elucidating of their function is in progress.
- The post heading imposed drought on the 220 wheat germplasms received through DBT-BBSRC project revealed the five superior genotypes viz., DBW-74, BIJAGRA YELLOW, HD-4672, HPW-155 and SAWYT 342 as compared to local checks.
- RGB Image based method has been developed to quantify chlorophyll content in soybean leaves. Significant negative association was found in actual chlorophyll content to average R and G pixels in visible images. This indicates that image analysis based colour pixels can be used to estimate the chlorophyll content in the leaf of soybean. Visible imaging in plant phenotyping is the simplest method and can be used for non-destructive estimation of chlorophyll content.
- Hyper-spectral information was generated in sugarcane and citrus orchards for characterizing and identifying critical stages of crops afflicated by various levels of water and nutritional related stresses.
- Reduction in quantum yield (Fv/Fm) with light intensity and duration of exposure affects PS-II of JS335 and Kalitur. Recovery of PS-II from photo-damage was improved in JS335 than in Kalitur.
- High sensitivity to desiccation was observed in mango during water scarcity conditions. The rate of decrease in quantum efficiency with moisture stress for various orchards was in order of pomegranate <karvonda< acid lime< sweet orange<grape< sapota <mango.
- The rate of decrease in quantum efficiency with rise in temperature was in the order of Dragon fruit > acid lime > custard apple > karvanda > sweet orange > pomegranate > guava> grape> Jamun> mango> Sapota indicating that dragon fruit is more tolerant to rise in temperature than other crops.

- Soybean varieties were screened for their tolerance to waterlogging under field condition. RKS-24 and RVS-2001-4 were found to be tolerant with minimum reduction in most of the crop growth parameters under flood treatment compared to normal water management. Vegetative stage was found to be more suitable compared to reproductive stage for screening of waterlogging tolerance under field condition.
- Endolithic and epiphytic biomolecules producing methylotrophic bacteria enhances wheat seed germination, growth and establishment under salinity stress.
- Microbial consortium has been developed for enhancing in-situ growth, and yield of wheat under nutrient limiting conditions.
- Plant growth promoting Halotolerant bacteria obtained from saline soil samples attenuate salinity stress in wheat by facilitating seed germination and seedlings growth.
- Surface retention of chopped trash and adoption of individual or combination of SORF (stubble shaving, off-barring, root pruning and fertilizer placement) techniques improved the cane yield and water productivity by 13.3-27.6 and 28.3-44.4 % over conventional sugarcane ratoon management practices. These practices also improved the root growth and found beneficial in mitigating the short-term drought impacts in sugarcane.
- Se-NPs and Zn-NPs have potential novel compound to enhanced growth performance, reduced primary, secondary and tertiary stress level in Pangasius hypophthalmus.
- Rational application of oxidative stress, cellular stress, neurotransmitter, lipid peroxide and some morphological parameters to be used as biomarkers for biomonitoring the contamination of trace elements in polluted open aquatic environment.
- Tilapia fish growth was measured in terms of body weight, white muscle fibre frequency through HE staining and qRT-PCR based expression of myoD and myostatin gene. It was found that MyoD gene expression was significantly higher at 34°C than 25°C and 30°C.
- Value addition in zeolites have been done through nano-technological interventions. Nano-silver based feed formulation has been standardized for mitigation of multiple stresses in fish.

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1. 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, there 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 ismore challengedwith 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-Adm 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 24, 12 and 3, respectively. Thus, the filled up cadre strength is 39 against 104 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, 2017

Cadre	Sanctioned	Filled	Vacant
Scientific	51*	24	27
Technical	33	12	21
Administrative	20	03	17
Grand total	104	39	65
*Including Director			

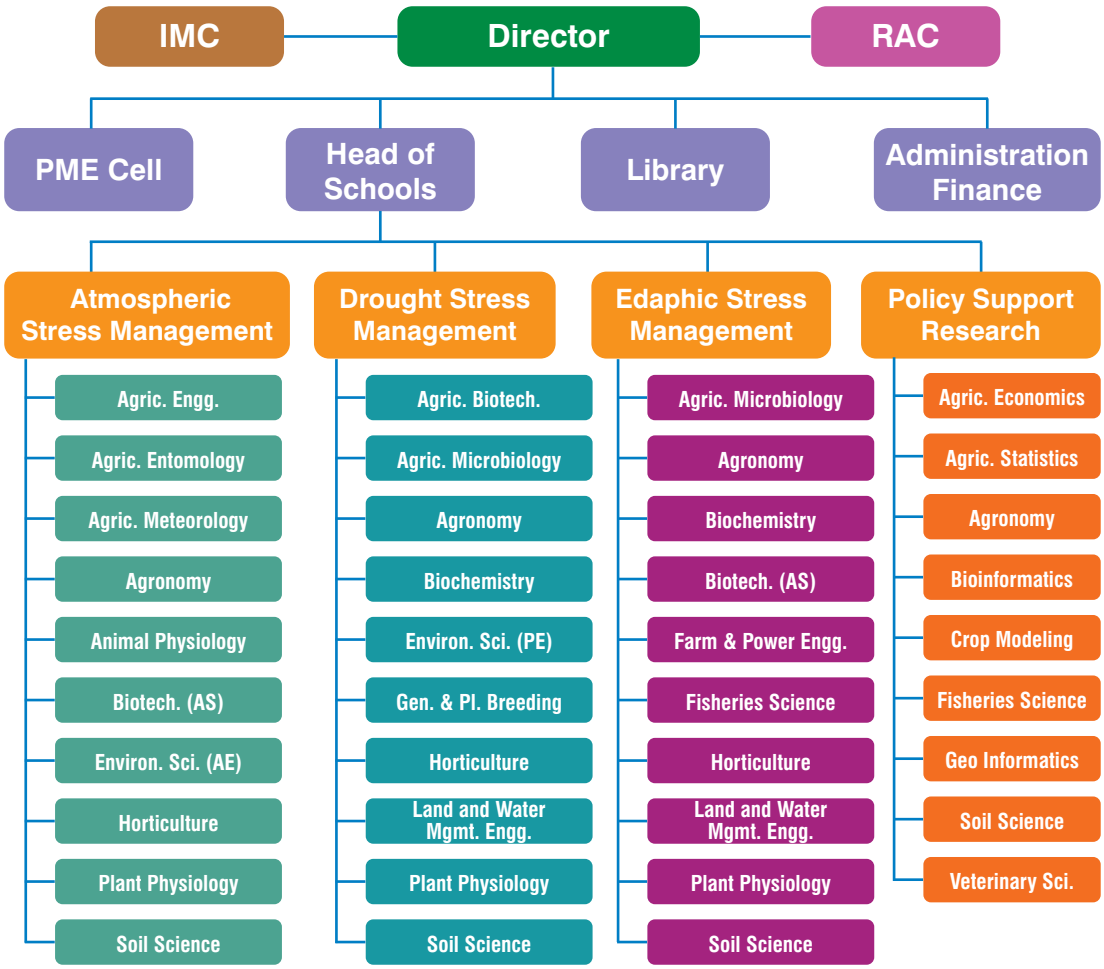


Fig. 1.2. Organogram of the institute

Research Programmes of the Institute

School of Atmospheric Stress Management

- Quantifying the impact of elevated CO_2, heat/cold etc. on food and horticultural crops, livestock and fisheries
- Adaptive and mitigation strategies for Atmopsheric Brown Cloud
- Eludicitating molecular basis of adaptation using "omics" approach
- Developing Decision Support System (DSS) for managing the extreme weather events

School of Drought Stress Management

- Investigations on physiological manifestations, signal transduction and regulation of Stress responsive genes
- Development of screening protocols for traits and genes relevant to stress tolerance
- Use of genomics, phenomics, proteomics and metabolomics tools
- Plant-endo/rhizo bacteria interactions for alleviating stress

School of Edaphic Stress Management

- Genetic and molecular basis of tolerance and ion homeostasis under salinity, nutrient deficiencies, pollutants, anoxia etc
- Application of soil meta-genomics, nanotechnology and system biology
- Assessing soil as a sink for greenhouse gases
- Conservation/precision agriculture as adaptive tools for stress environments

School of Policy Support Research

- Policy research to promote adoption of techniques for adaptations to abiotic stress
- Designing novel management options that provide opportunity for stress mitigation and carbon trading

Infrastructural Development Activities

Office-cum Administrative Building

Office Cum Administrative Building is now fully furnished and divided into 5 sections i.e. Director Cell, Admin section, Atmospheric, Edapic, Drought and Policy schools. It has fully equipped central lab divided in three sections, well equipped auditorium with seating capacity of 225 persons and amphitheatre equipped with public address system.The administrative building also equipped with fire detection and alarm system. Total area of Office cum Admin building is 5756 Sq m.

Guest House

The NIRA guest house is having fully furnished three VIP suits and 18 regular suits with WiFi connection. The guest house was inaugurated by Hon'ble Secretary, Department of Agriculture Research & Education (DARE), Director General, ICAR on 23rd October 2016.The Guest house is having facilities of canteen with seatting capacity of 44 persons and well-furnished recreation/meeting room.

Boys Hostel, Girls Hostel and Dining Block

Boys and girls hostels and dining block are on the verge of completion. Completed work includes flooring, internal and external plastering and painting, fixing of doors, windows including fittings, wall tiling, flooring, water supply, sanitary installations in all toilets and kitchen. The hostels have 72 rooms with attached bathrooms and provision of solar water heater. The common dining block of these hostels is equipped with advanced cooking system with a seating capacity of 70 persons. These buildings are yet to be furnished and other related works are in progress to make these buildings fully functional. Hostels will be used by the students coming under various exchange programmes and academic activities, research scholars working under various projects, visiting farmers coming for exposure, and trainees coming during various training programmes. There is provision of solar water heater system in hostels.

School Building (2 Nos.)

The portions completed during the current year include: flooring, internal plumbing, sanitary installations in toilets, fixing of aluminum and toughened glass doors, SS railing, planters, internal and external painting and false ceiling work, wiring for electrical and installation of air conditioning system. Other works are in progress.

ICAR-NIASM Residential Complex, MIDC, Baramati

The construction of Type VI - 04, Type V - 06, Type IV - 08 and Type III - 08 quarters was started on 17th March 2016. During the current financial year, the RCC work of floor slab was completed and brick and other works are in progress.

Power Sub-station and External lighting scheme at NIASM

RCC and brick work was completed. Completed work also includes flooring, internal and external plastering. The wiring for electrical work and other works are in progress.

(a)

(b)

(c)

(d)

(e)

(f)

Fig. 1.3. School Building (a), Hostel Building (b), Type IV residential complex (c), Type VI Residential Complex (d), Type V Residential Complex at MIDC, Baramati, under construction (e) and Review of work progress by Director (f)

Research Farm Development

Livestock experimentation facility

A low cost livestock experimentation facility has been developed at ICAR-NIASM. The facility consists of cattle, goat and poultry sheds which will be used for housing the animals for carrying out studies related to abiotic stresses in large and small ruminants and poultry birds. At present four murrah buffaloes, 10 Konkan kanya and six Osmanabadi goats, and 50 Grampriya as well as Srinidhi backyard poultry parent birds are available for research and demonstration. Gramapriya is a layer type variety developed for free range farming in rural and tribal areas. Srinidhi variety has optimum body weight and better egg production. Konkan Kanya goat is meat type breed adapted to high rainfall and hot and humid climate of Konkan region of Maharasthra. Animals have typical white bands on black face and black ear with white margin. Osmanabadi goat breed is from Latur and Osmanabad district of Maharashtra generally reared for its tender meat, good reproductive ability and adaptability to different climatic conditions due to better disease resistance ability. Murrah buffaloes are originally from Punjab and Haryana states of India and have been used to improve the milk production of dairy buffalo. They are known for disease resistance ability also.

Fig. 1.4. Livestock Experimentation Facility at ICAR-NIASM

Development of Malad Research Farm

Prosopis juliflora bushes removed from 6.57 ha area of Malad farm was auctioned for clearing of the field for ploughing. A small temporary shade was established at Farm for providing shelter to the staff and workers. Entire farm (16 Acre) was ploughed by Mouldboard plough, Rotavator and Cultivator on hiring basis for development of the farm. Marking of plots and internal roads was done as per planned layout and bunding was completed. Plots were made ready for sowing of crops. Initially, to see the homogeneity of plots, green manure crop (Dhaincha) was grown in 15.5 Acre area at Malad Research Farm. Green manure crop was incorporated into the field by Mouldboard plough and thereafter field was prepared using Rotavator and Cultivator on hiring basis. Five (5) research experiments on various aspects in *Rabi*- jowar under rainfed condition was conducted in an area about 6 Acres. However, due to lack of fencing remaining area was left fallow. The performance of rainfed *rabi*-jowar was found highly encouraging in all the experiments.

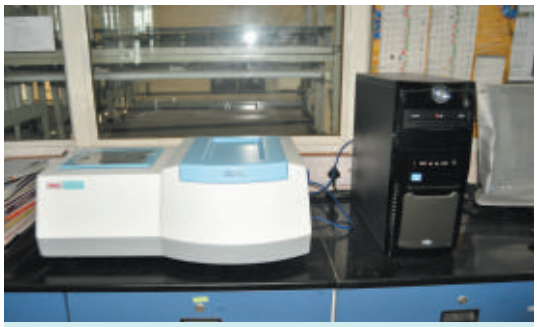
Fig. 1.5. Malad Research Farm developmental activities

Research Laboratory

During this year, the institute procured Real-Time PCR Machine, Plant growth chamber, Automated autoclave, Refregrated incubator shaker, Spectrophotometer, Ice flaking machine, Refrigerated centrifuges, Biosafety cabinet, CO_2 incubator, Electronic weighing balance, Hot air oven, and DSLR camera. These are in addition to existing equipment like Real-Time PCR, Refrigerated Centrifuge, Chemiluminescence Imaging System and Freeze Drier Lyophilizer. Hyper Spectroradiometer, Atomic Absorption Spectrophotometer, Plant Stress Device, Kjeldahl Digestion and Distillation unit, Guelph Permeameter Kit, GLC System, Flame Photometer, Motorized Sampling Auger, Advanced Photosynthesis System, IR Thermometer, Line Quantum Sensor & Leaf Area Meter, Eddy Covariance System, Bowen Ratio System, Infrared Thermal

Imaging System, Real Time Chlorophyll Fluorescence System etc. Thus, the laboratories have now capacity to analyse biomolecules, plant photosystem parameters, and soil characteristics and to quantify gene expression at transcript and protein level.

(a)



(b)

(c)

(d)

Fig. 1.6. Central Laboratory (a), UV-vis Spectrophotometer (b), Walk-in Growth Chamber (outside view) (c) and Plants growing in Growth chamber (inside view) (d)

Plant Phenomics facility

Plant phenomics facility established under NICRA program is now fully functional. It was inaugareted on 23rd October 2016. The Plant Phenomics facility with a capacity to house 225 pots is equipped with three imaging systems viz., Infra-Red (IR), Visible (VIS) and Near-Infra Red (NIR) for knowledge the plants in different wavelength region. The facility is also equipped with automated weighing and watering stations. The system utilizes a conveyor belt system to move the plants within the facility to and fro from growth chambers to imaging cabinet. The entire facility is computer operated through Lemna Control Software.

(a)

(b)

(c)

(d)

Fig. 1.7. Plant phenomics (a), Plant phenomics (Imaging chamber) (b), Plants growing in Plant Phenomics facility (c) and Inauguration of Plant Phenomics facility (d)

Greenhouse facility

Hi-tech Greenhouse (4 Nos.) with area of 240 m^2 each are being constructed. Each Grenhouse is having three chambers of 10 m x 8 m (L × W) = 80 m^2 area. Greenhouse will be equipped with cooling pad system and axial exhaust fan system with a platform for growing plants. These greenhouses will have provision for controlling temperature, photoperiod, humidity and light intensity.

Fig. 1.8. Greenhouse facility

Library

Library plays a crucial role in supporting the research and other programmes of the Institute. The Institute library is now being scaled up to host repository of information in the form of recent books and online access to relevant research and review articles related to abiotic stress and its management research. NIASM library has a good collection of books with areas related to agriculture, animal husbandry and basic science subjects to achieve the mandate of the Institute. Scientists, technical personnel, research associates, students and trainees are regular users of the library. Library maintained its designated services and activities of acquisition of books, exchange of literature, circulation, reference services and documentation. The library mails Institute's publications including annual report to all ICAR Institutes/ SAU of NARS system. Present library acquisitions has been raised to 1829 in addition to other documents like newsletters of NAAS/ ICAR institutes and other open source articles and documents. Library has received more than 100 publications including annual reports as gratis from various organizations. ICAR-NIASM Library is one of the

members of ICAR-CeRA Consortium. Hence all scientists and technical personnel have facilities of accessing the on-line journals. Library transactions are being implemented online to cater the needs of institute's staff. Institute has access of 1174 e-books along with 17 e-book series, India agristat data base through CeRA.

ICAR-NIASM library organised book exhibition (Fig. 1.9.) two times during currect financial year. Latest books on abiotic stress research in agriculture and allied sciences were displayed in the exhibition.

Fig. 1.9. Book exhibition

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2. Research Highlights

School of Atmospheric Stress Management

Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing

Two experiments were conducted with an aim to distinguish crop conditions under non limiting growth environment and environment where crop growth potential has been limited by abiotic and biotic factors through hyper-spectral remote sensing. The sugarcane field experiment was conducted in split plot design with three replications having two varieties (Viz., Co-10001 and Co-86032), three irrigation levels (I1: 0.75, 0.75 and 0.50 IW/CPE, I2: 0.50, 0.75 and 0.50 IW/CPE, I3: 0.75, 0.50 and 0.50 IW/CPE at tillering, grand growth period and maturity) and three nitrogen levels (N1: 100% RDN, N2: 75% RDN, N3: 50% RDN). Field data collection were done by using the Asd hyper-spectral spectroradiometer with an FOV of 25 degree at before 2 days of irrigation and after 4 days of irrigation and simultaneously biochemical analysis was also done for sugarcane. The result show that variety Co-10001 showed better morpho-physiological character than Co-86032. The irrigation and nitrogen levels also showed varietal differences through hyper-spectral analysis (Fig. 2.1).

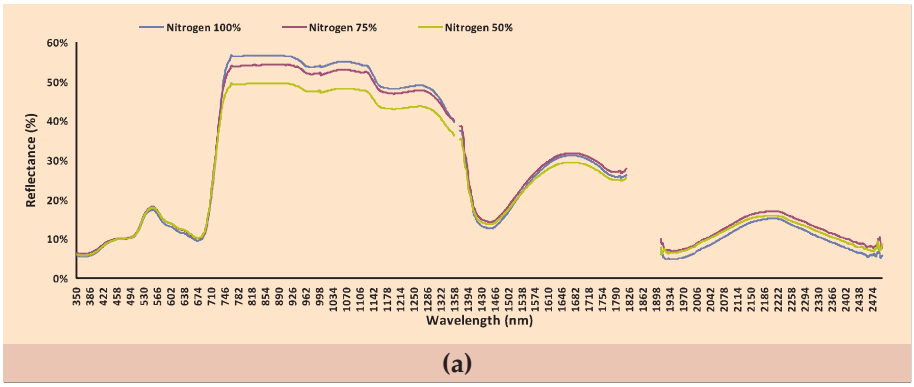


Fig. 2.1. Spectra of different levels of nitrogen in Sugarcane varitiey Co-10001 (a) and Hyperspectral data collection using ASD spectro-radiometer (b)

The citrus field experiment was designed in four replications with eight irrigation levels I1-Full irrigation 100%, I2-Full irrigation 100% + Subsurface irrigation I3-Deficit

irrigation 75%, I4-Deficit irrigation 75% + Subsurface irrigation, I5-Partial root-zone drying (PRD) 75% I6-Deficit irrigation 50%, I7-Deficit irrigation 50% + Subsurface irrigation and I8-Partial root-zone drying (PRD) 50%. Initial observations showed significant variation in irrigation treatments (Fig. 2.2)

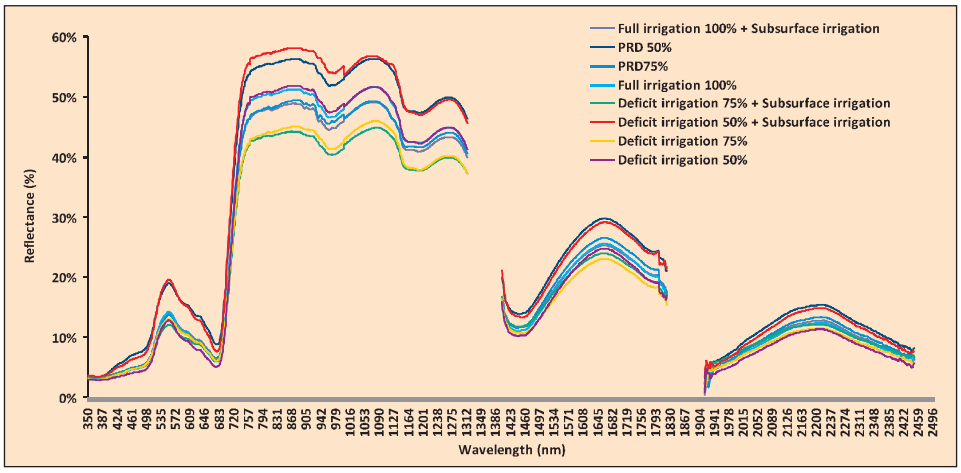


Fig. 2.2. Spectra of Sweet Orange under different irrigation treatment

Impact of radiation levels on physio biochemical behaviour, yield and yield attributes in soybean and *rabi* sorghum

Soybean is physiologically photosensitive in nature and therefore will be highly affected by the increasing intensity of aerosols, commonly known as "surface dimming", and moisture stress condition, which may prevail in near future. An experiment was conducted to understand the response of determinate, semi-determinate and indeterminate soybean genotypes under moisture stress condition. Irrigation was with held at 60 DAS and per cent reduction in terms of grain yield and dry biomass yield was recorded. Due to moisture stress (at 60 DAS), per cent reduction in terms of grain yield (q ha^{-1}) was recorded minimum in semi-determinate genotypes

Table 2.1. Yield and yield attributes under normal irrigation (NI) and moisture stress (MS) at 60 DAS in soybean genotypes

Yield Parameters	Grain yield (q ha^{-1})			Dry biomass (q ha^{-1})		
	NI	MS	% Reduction	NI	MS	% Reduction
JS-93-05	17.4	15.7	9.9	14.4	13.5	6.7
JS-335	20.7	19.0	8.7	15.2	13.9	8.5
Kalitur	15.8	14.4	8.7	24.9	22.6	9.5
Phule Agrani	20.2	19.2	5.0	40.5	37.8	6.2
MACS-1188	14.6	13.3	9.4	23.2	20.4	12.3
NRC-37	18.5	16.9	8.4	28.5	26.8	6.5
JS-88-21	17.7	16.5	6.5	26.2	23.7	9.2
NRC-7	14.6	13.5	7.6	18.7	16.1	15.0
MAUS-453	18.6	17.1	7.8	21.7	18.3	16.1

Phule Agrani (5.0%) and JS-88-21 (6.5%) followed by determinate NRC-7 (7.6%), where Phule Agrani (19.2 q ha^{-1}) and JS-335 (19.0 q ha^{-1}) performed better in terms of number of grain yield (q ha^{-1}) as compared to other genotypes. Over all, the semi-determinate performed better both under normal irrigated and under moisture stress condition (60 DAS) in terms of grain yield as compared to determinate and indeterminate soybean types.

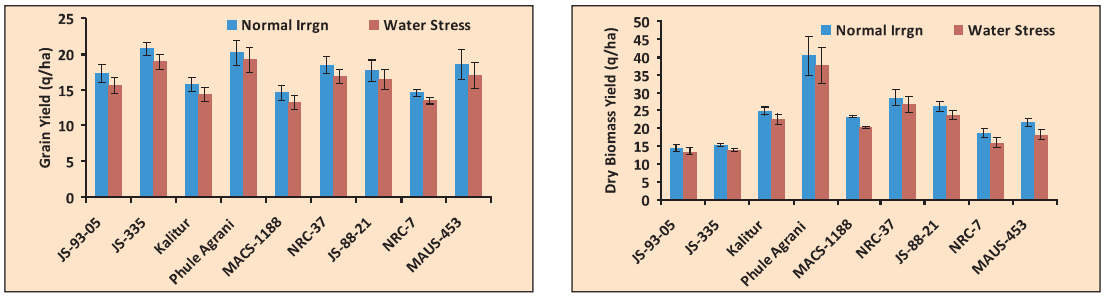


Fig. 2.3. Effect of moisture stress at stage of 60 DAS on grain yield and dry biomass yield of various determinate, semi-determinate and indeterminate soybean genotypes.

Identification, cloning and expression analysis of temperature, salinity and hypoxia responsive genes in fish

The critical thermal methodology for thermal tolerance was used to determine CTMax and CTMin for Tilapia, *Oreochromis mossambicus* collected from Ujani reservoir on river Bhima (Fig. 2.4a). The fishes of average weight 0.29 g acclimated to 25, 30 and 34°C exhibited CTMax at 41.5, 43.5 and 44.08°C respectively. The CTMin values for 25, 30 and 34°C acclimation was 10.9, 11.0, 11.5°C. The lethal thermal maximum and lethal thermal minimum for tilapia acclimated at 25, 30 and 34°C was 43, 43.7, 44.3 and 8.8, 9.45, 9.8°C.

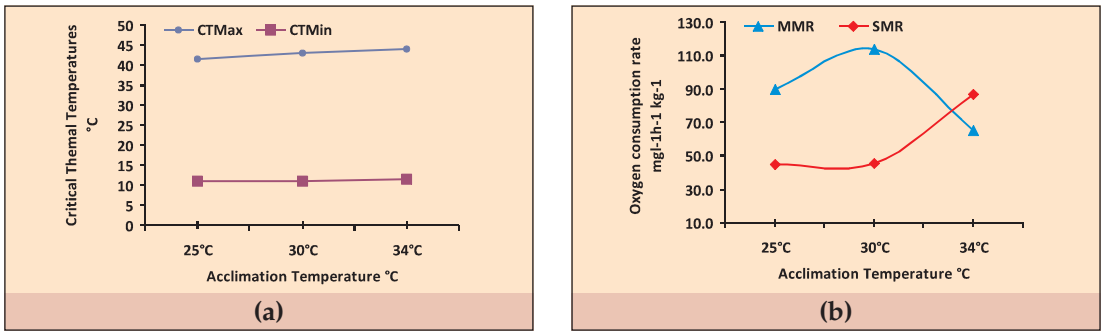


Fig. 2.4. Critical Thermal Maxima and Minima of *Oreochromis mossambicus* (a) and Standard metabolic rate (SMR) and Maximum metabolic rate (MMR) of *Oreochromis mossambicus* fry (b) acclimated to 25, 30 and 34°C

Oxygen Consumption rate of *Oreochromis mossambicus* fry acclimated to 25, 30 and 34°C was measured. Standard metabolic rate, maximum metabolic rate and aerobic scope was analyzed in respirometer, oxygen concentration was measured using Winkler's method. The SMR for fishes acclimated to 25, 30 and 34°C were 44.99, 45.57 and 86.85 mg $l^{-1}h^{-1}kg^{-1}$ and MMR 89.97, 113.93 and 65.14 mg $l^{-1}h^{-1}kg^{-1}$, respectively (Fig. 2.4b).

SMR increased with increase in acclimation temperature. MMR increased with increase in acclimation temperature but at 34°C acclimation the fish exhibits limitation in consuming available dissolved oxygen. It suggests that the 34°C is the limit of the fish capacity to consume oxygen from water. It results in decrease in the aerobic scope of fish at higher temperature suggesting vulnerability of oxygen consumption capacity to thermal stress. A study was conducted to understand the effect of rearing temperatures on tilapia growth, muscle cellularity and expression of myoD and myostatin genes. Tilapia larvae were reared at 25°C, 30°C and 34°C for 60 days. Fish growth was measured in terms of body weight, white muscle fibre frequency through HE staining and qRT-PCR based expression of myoD and myostatin gene. At 60 day, tilapia juveniles reared at 30°C grew significantly higher than 25°C and 34°C, the frequency distribution of white muscle fibres in diameter class <25 µm was similar at 25°C and 30°C, but was significantly higher for fish reared at 34°C and of white muscle fibre of diameter 25-50 µm was significantly higher at 30°C in comparison to 25°C and 34°C (Table 2.2). MyoD gene expression was significantly higher at 34°C than 25°C and 30°C . Whereas, myostatin expression was similar at all three rearing temperature (Fig. 2.5a). The investigation suggests that rearing temperature affects fish growth, muscle cellularity and gene expression in juvenile tilapia. Increase in water temperature to 30°C is beneficial for achieving maximum body growth and hypertrophic muscle growth in *O. mossambicus*.

Table 2.2. Histological characterstics of white muscle fibres of fish reared at varying temperatures

White muscle diameter class (µm)	Rearing Temperatures (°C)		
	25°C	30°C	34°C
<25	15.29[a]	13.76[a]	32.52[b]
25-50	62.60[a]	81.60[b]	50.93[c]
>50	22.11[a]	4.64[b]	16.55[c]

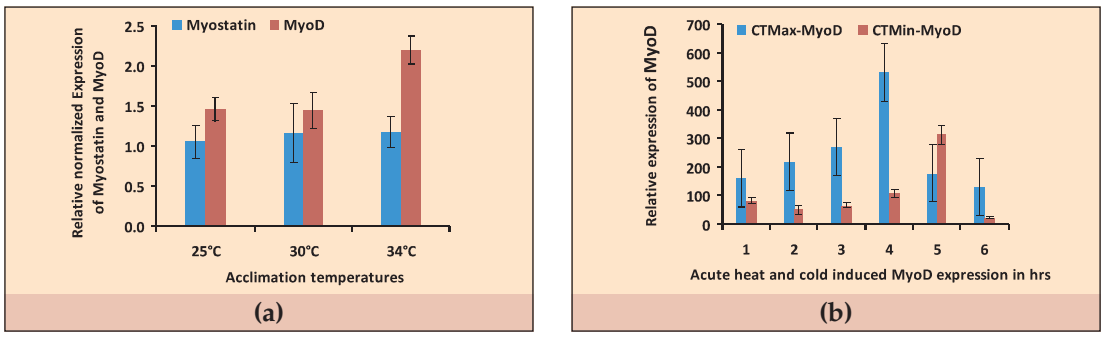


Fig. 2.5. Quantitative RT-PCR of myoD and myostatin mRNA expression in white muscle of *Oreochromis mossambicus* reared at 25, 30 and 34°C (a) and acute heat and cold exposed expression of MyoD gene (b)

Tilapia fish was exposed to acute change in temperatures such that the temperatures rise to their CTMax and CTMin values in a very short period @ 0.3°C min^{-1}. The fishes were then sampled at 0, 2, 4, 6, 24, 48 hrs and analyzed for impact of acute thermal stress on the expression of MyoD. The results indicate that MyoD expression is induced and peaks at 6 hours. In Acute cold stress, MyoD achieves maximum expression at 24 hours with decrease at 48 hours (Fig. 2.5b). Differential response time and quantity of expression of MyoD was observed during the two types of acute thermal stress conditions.

Impact of cropping systems and spentwash on soil development under irrigated and rainfed conditions

Large areas of barren and uncultivable terrain as developed from superficially subdued basalt igneous rocks exist in peninsular India. These lands are porous, shallow in soil depth, gravelly, low in organic matter, high in bulk density and poor water retention capacity. There is general lack of techniques for the quicker disintegration of the murrum so that the soil can be put into cultivation. Spent wash, a by-product from sugar factory with high organic load and acidic in nature has potential to soften and disintegrate murrum. Keeping above in view, a long term experiment was initiated at ICAR-NIASM farm in October 2012. The pH of raw spent wash and post methaneted spent wash was 3.8 and 6.7, respectively and the former was having higher EC, TSS, TDS, OC, total P and total K. The spent wash was initially applied @ 0.4 million L ha^{-1}. Initial analysis of the soil samples collected from the experimental field revealed that the soil fraction (< 2 mm) of the land was only about 23% and rest was gravels of different size. The fertility status of the land was very low with organic carbon ~0.07% and available N, P and K was only 14.7, 0.47, and 18.2 kg ha^{-1}, respectively.

The experiments involved 13 treatments viz., sugarcane and soybean-wheat cropping sequence with and without spent wash, maize-sorghum fodder, subabul and napier grass under irrigated conditions and subabul, anjan grass and sorghum fodder under rainfed conditions. Treatment comprising spent wash resulted in 1.9 to 3.6 per cent higher disintegration of *murrum* as compared to their respective cropping system alone. After completion of four year of experimentation it has been monitored that disintegration of murrum has followed the decreasing trend in the order of Soybean-Wheat-Spent wash > Sugarcane-spent wash > Napier grass > Soybean-Wheat> Sugarcane> Subabul > Lucerne > Maize-Fodder sorghum > Subabul > Control + Spent wash > Anjan > Fodder Sorghum (Table 2.3 and Fig. 2.6). Sugarcane equivalent yield was determined for comparing the system productivity and it was observed maximum in Sugarcane + spent wash which was significantly superior to all other treatments and has followed the decreasing trend in the order of Sugarcane + spent wash > Napier grass > Sugarcane > Soybean – Wheat followed by wheat residue incorporation + Spent wash > Lucerne > Soybean+ Wheat > Maize - Fodder sorghum in irrigated condition and Anjan > Fodder Sorghum in rainfed condition.

Table 2.3. Effect of cropping systems and spent wash on soil development, soil properties and system productivity

Treatment	< 2 mm (%) 0-15 cm	< 2 mm (%) 15-30 cm	EC (dS m^{-1})	OC (%)	Sugarcane equivalent yield (q ha^{-1} yr^{-1})
Control	28.4	28.1	0.15	0.08	-
Control + Spent wash	32.0	31.4	0.21	0.09	-
Sugarcane	35.7	31.8	0.13	0.09	677.9
Sugarcane+ Spent wash	38.3	34.8	0.17	0.11	912.6
Soybean-Wheat	36.4	32.9	0.11	0.90	484.7
Soybean– Wheat-Spent wash	40.5	35.8	0.16	0.12	619.7
Lucerne	33.2	30.3	0.10	0.10	508.1
Maize- Fodder sorghum	33.0	30.6	0.13	0.09	410.9
Subabul	34.9	31.4	0.14	0.13	-
Napier grass	37.9	33.7	0.10	0.11	607.2
Subabul	32.7	29.4	0.15	0.11	-
Anjan	31.8	28.2	0.15	0.09	72.4
Sorghum	30.5	27.2	0.15	0.09	37.1
CD (P=0.05)	3.18	3.05	0.04	0.013	32.04

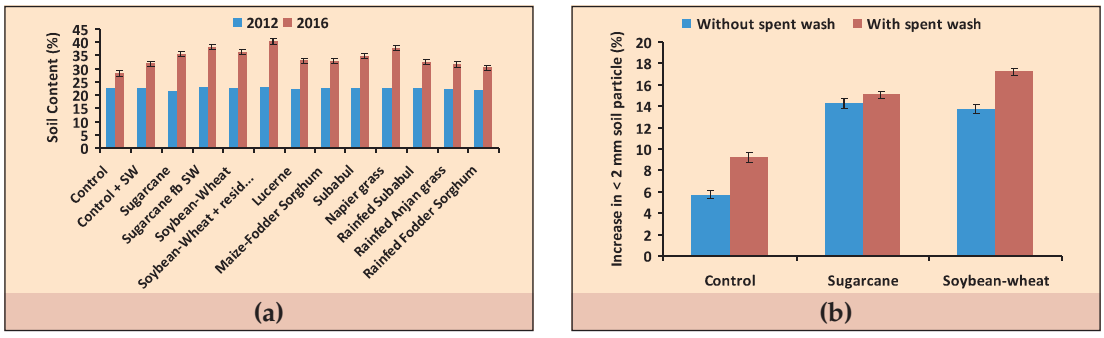


Fig. 2.6. Change in soil content as influenced by cropping systems (a) and spent wash (b)

Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils

Large areas of barren and uncultivable terrain as developed from superficially subdued basalt igneous rocks exist in peninsular India. 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 shallow basaltic soils of Maharashtra. Therefore an experiment entitled "Innovative Techniques to obviate edaphic & drought stresses on pomegranate grown in shallow basaltic soils" has been initiated in the year 2013 at ICAR-NIASM, Baramati on Pomegranate (shallow rooted), Guava (medium rooted) and Sapota (deep rooted) crops to increase economic longevity of theses orchards and to address the issues of edaphic and drought stress. Observation revealed that there is significant influence of various treatments on pomegranate and guava orchard in terms of growth, physiological, hyperspectral responses and yield. The tallest plant height, diameter and canopy spread in pomegranate were monitored with pit and trench planting filled up with mixture of native *murrum* and black soil. Pomegranate yield was also higher in these treatments as compared to other treatments as well as farmer's practice and was recorded maximum (24.3 kg per plant) under micro blasted trench planted pit filled up with mixtures of black soil and native soil treatment (Table 2.4). Similarly, net photosynthetic rate and stomatal conductance measured through IRGA, revealed that highest values were obtained under treatments planted by pit and trench methods having mixture of soils with additional 1 m soil depth by micro-blasting. Mixtures of black soil and native *murrum* are performing better than 100% Black soil in terms of plant growth and its physiological activities under limited moisture availability. The activity of enzymes like nitrate reductase, catalase and superoxide dismutase (SOD) activities were also lower under treatment having mixture of soils and planted in pit and trench methods with additional 1 m soil depth by micro-blasting.

Better soil moisture regimes were maintained with rainwater conservation with blasting as soil moisture observation revealed that moisture content was more with blasting (20.8%) than without blasting (16.8%). Auger planting with 100% black soil recorded more soil moisture in deeper layer (60 cm) – 22.6% than mid layer (40 cm) – 15.2%. Auger planting filled with black soil recorded more soil moisture in deeper soil. Trench or pit planted Guava and Pomegranate orchards are performing better than Auger planting under shallow basaltic region. Micro-blasting proved its superiority over without micro-blast treatments in establishment of these orchards. These cracked rocks could further facilitate the root penetration and water conservation.

An experiment has been initiated to introduce dragon fruit (*Hylocerus undatus*) as a new crop to adopt in low rainfall zone for rocky barren land. The results of experiments are very encouraging which has resulted in gaining rapid popularity amongst farmers. In this experiment dragon fruit crop is planted under three different soil mixtures viz. 100%native *murrum* soil; 50% Native *murrum* soil + 50% black soil and 100% black soil. There were total seven harvesting from each plant in one year. Dragon fruit yield varies from 14.2 to 19.7 kg per plant in three different soil mixtures (Fig 2.7). The maximum yield was obtained in native *murrum* soil. Average fruit weight of dragon fruit was recorded maximum in treatment having 50 % black soil and 50 % native soil. The average fruit weight varies from 182.2 to 372 g in seven harvesting. Maximum fruit weight was observed up to 618 g with diameter of 94.41 mm and

length of 102.3 mm. While in small sized fruits, minimum fruit weight was observed 125 g with diameter of 60.8 mm and length of 72.4 mm. The experiment was also conducted to study storage life/shelf life of dragon fruit. The shelf life of dragon fruit was observed 5-7 days at ambient room temperature, 10-12 days and 20-21 days in cold storage at of 18°C and 8°C temperature, respectively.

Table 2.4. Effect of various treatments on pomegranate yield (kg plant^{-1})

Planting method	Without blasting				With blasting			
	Native	Native + spent wash	Native + black	Black	Native	Native + spent wash	Native + black	Black
Auger	13.3	13.6	15.6	10.9	13.9	14.3	16.5	11.7
Pit	15.5	16.5	19.9	-	18.2	-	22.3	-
Trench (2*1)	16.0	-	21.1	-	18.7	-	24.3	-
Trench	15.6	-	20.6	-	18.2	-	23.1	-
FP	12.9	13.4	-	-	-	-	-	-
CD (P=0.05)	2.97							

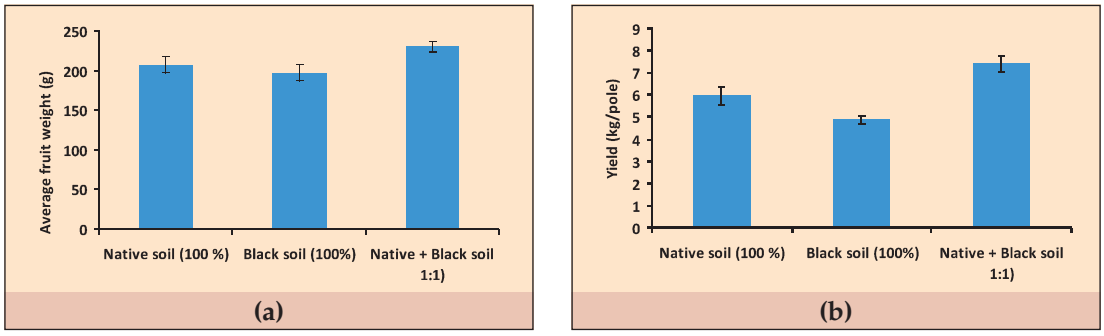


Fig. 2.7. Performance of dragon fruit under different filling mixtures: average fruit weight (a) and fruit yield (b)

Study of immune response and HSP genes polymorphism in relation to heat stress in poultry

In sub-tropical country like India where summer is severe and with recent increase in extreme heat wave events, enhancing poultry productivity remains a major challenge. Furthermore, earlier development of modern poultry genotypes for higher production at optimal temperature is becoming a major concern for poultry production during summer. A study was carried out to evaluate thermal stress risk in poultry birds during summer season. The experimental birds were reared in Californian cage system. The environmental parameters namely, temperature and relative humidity were recorded in morning, afternoon and evening during the experimental period and temperature humidity index (THI) was calculated (Fig. 2.8) weekly for evaluation of heat stress in poultry birds reared during summer. The stress

threshold was determined at ≤70. The THI of 70-75 is considered as mild, 76-81 as moderate and ≥82 was determined as severe stress. In conclusion, it was observed that during summer months the thermal stress risk in experimental poultry varied from moderate to severe.

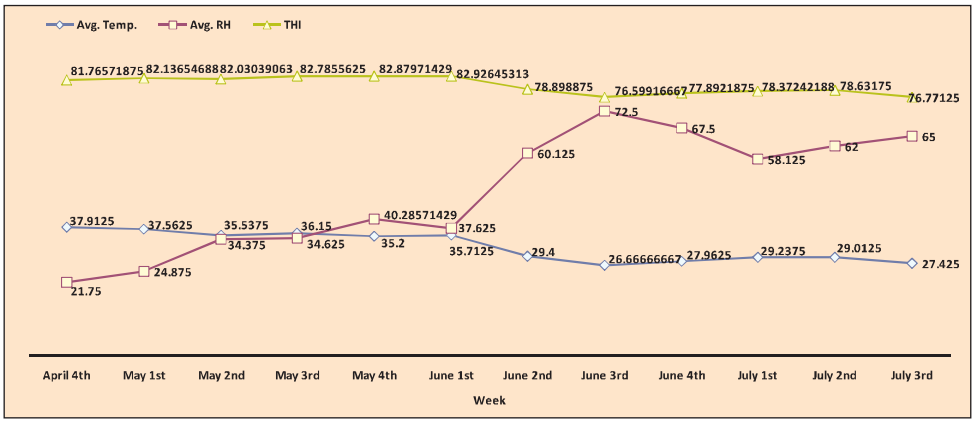


Fig. 2.8. Determination of temperature humidity index (THI) during summer

Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivars

During year 2016–17, four field trials (i) sorghum (Phule Suchitra) (ii) Onion (cv. Bhima Kiran), (ii) Brinjal (cv. Panchganga) with PBRs and (iii) Sorghum (cv. Phule Suchitra) with plastic mulch were conducted using LSS. The interactive effect of plant bioregulators (PBRs) and supplemental irrigation on growth and grain yield of sorghum [*Sorghum bicolor* (L.) Moench] was evaluated. The exogenous application included four PBRs viz., 10 µM salicylic acid (SA), 100 mg L^{-1} sodium benzoate (SB), 500 ppm thiourea (TU), 1.5% potassium nitrate (KNO_3) at seedling elongation (20 DAS), reproductive (50 DAS) and panicle emergence (75 DAS) stages and control (no spray of PBR). Two years (2015–16) results showed that maximum grain yield (3.60–3.88 Mg ha^{-1}) was obtained at IW: CPE 0.80 and declined @ 0.43–0.49 Mg ha^{-1} for every 0.1 IW: CPE for PBRs and the corresponding values were 3.49 and 0.53 Mg ha^{-1} without PBR. Also application of PBRs mitigated water stress and improved grain

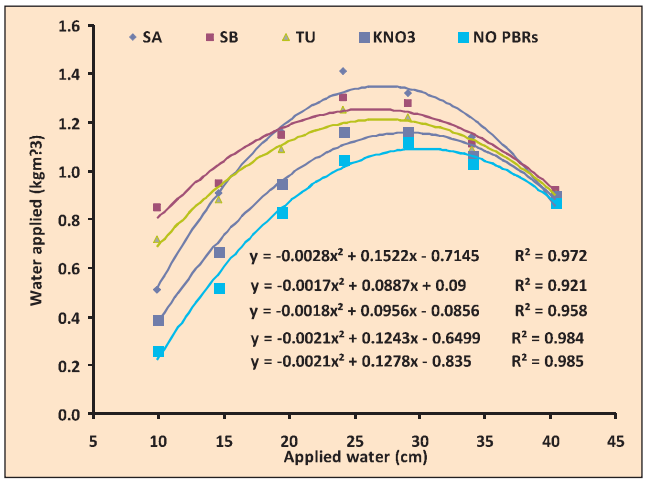


Fig. 2.9. Water productivity as expressed as the function of PBRs at various quantities of applied water (AW)

yield, straw yield and water productivity by 6.8–18.5%, 5.7–14.7% and 1.16–1.41 kg m^{-3}, respectively (Fig. 2.9). Overall SA was found more effective under moderate (IW: CPE 0.79–0.50) while SB and TU were better under severe water deficits (IW: CPE 0.49–0.05). Thus SB and TU present useful option to reduce water use by 25–50% under water stress condition.

In another field experiment the interactive effect of exogenous application plant bioregulators on onion (cv. Bhima Kiran) under supplemental irrigation was studied. Foliar application of KNO_3 (1.5%) and thiourea at vegetative, bulb formation, bulb development and before maturity stages significantly improved bulb yield (4–20%) and above ground biomass (3–12%). Thus PBRs has efficacy in alleviation of water stress by efficient water use, modulating canopy temperatures and enhanced total soluble sugars and sink partition are essential for enhancing yield and water productivity. PBRs also enhanced nutritional quality (TSS, protein contents and antioxidant enzymes activities) of onion significantly under water deficits over control. The two years (2015–17) field trials of sorghum (cv. Phule Suchitra) with plastic mulch (PM) was carried to study the interactive responses of plastic mulch and irrigation levels using the LSS. The split plot design with four replications included: flat bed (45 cm × 15 cm) with and without plastic mulch, raised bed (60 cm × 15 cm) with and without plastic mulch and raised bed (45 cm × 15 cm) with and without plastic mulch as main plots and seven levels of irrigation IW: CPE 0.95, 0.80, 0.65, 0.50, 0.35, 0.20 and 0.05 as subplots treatments (Fig. 2.10). This study recommended that among different plastic mulch treatments tested for sorghum, raised bed and flat bed with plastic mulch (60 cm × 15 cm) was found be best and improved grain yield by 15–27% over traditional practice.

Fig. 2.10. Experimental layout of plastic mulch for sorghum

The preliminary experiment to study the interactive effect of microbial biopolymer and water stress on yield and post–harvest quality of onion (*Allium cepa* L.) was performed to evaluated as an alternative option for chemical plant bioregulators (PBRs). The application of application of PBRs and biopolymer significantly improved marketable yield and water productivity over control. Thus identified plants PBRs like KNO_3, SA help to mitigate water stress and can help to boost the productions and profitability of onion under water scarcity conditions. Similarly use of microbial biopolymer can be better alternative for chemical PBRs for enhancing yield.

Study of genetic polymorphism of heat shock protein genes among indigenous and cross breed cattle

Higher temperatures of summer months and impending climate change scenario have increased the risk of heat stress in dairy cattle. Heat stress severely impacts productive performance and immune potential of animals making them more susceptible to diseases. The present study aims to analyze heat stress mediated changes genes expression patterns involved in innate immune mechanisms against invading microbes. Blood samples were collected from the indigenous breed (Sahiwal) and cross-bred (Frieswal) dairy cattle. The peripheral blood mononuclear cells (PBMC) isolated and were subjected to in vitro thermal stress. The heat stress was given to the PBMC sample groups at 42°C for one hour followed by incubation at 37°C for one hour followed by recovery time. The kinetics of gene expression of innate immune system (TLR2, TLR4, IL4 and IFN gamma) (Fig. 2.11) were analyzed at different recovery intervals of 0, 2, 4, 6 and 8 h. acute inflammatory cytokines, IL2 and IFN gamma increased in both indigenous and cross bred cattle. However the expression was more pronounced in Sahiwal cattle compared to the Frieswal. The innate immunity protein TLR2 did not show much variation whereas TLR4 was induced by heat stress. These preliminary studies indicated that the immune-related genes differentially expressed during thermal stress among native and crossbred cattle. Enhanced expression of immune genes may provide evidence for the adaptability status of indigenous cattle breeds in higher temperatures of tropical climate.

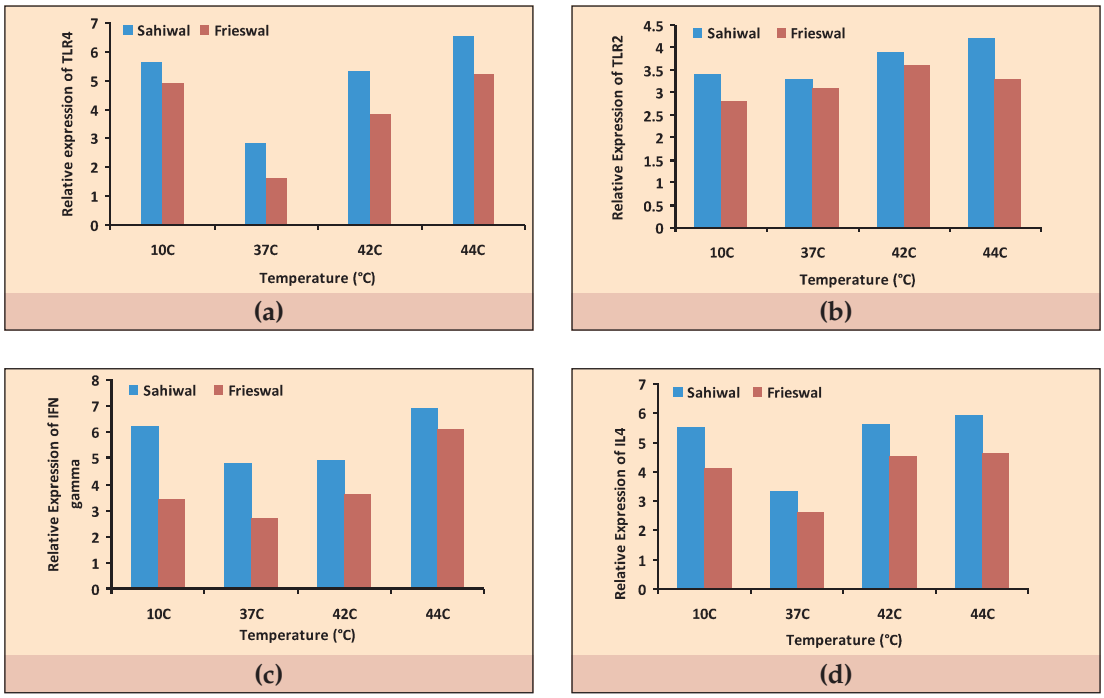


Fig. 2.11. Relative expression of TLR4 (a), TLR2 (b), IFN gamma (c) and IL4 (d) in Sahiwal and Frieswal at varying temperature levels

School of Drought Stress Management

Investigation on traits and genes associated with adaptation of wheat genotypes to local drought stress environments

Water stress tolerance capability among diverse bread wheat genotypes was determined using traits associated with adaptation to water stress in order to select promising wheat genotypes for use in breeding programme. 120 wheat genotypes were evaluated with three replications and two treatments, i.e, well-watered and post-anthesis water stress for traits associated with adaptation to limited soil moisture. The following traits were analyzed after stress imposed during the heading to anthesis period: the number of days to heading (DTH), days to maturity (DTM), productive tiller number (TN), plant height (PH), spike length (SL), spikelet per spike (SPS), kernels per spike (KPS), thousand kernel weight (TKW) and grain yield (GY). Wheat genotypes along with check varieties were also evaluated for Relative Water Content (RWC), CO_2 assimilation rate, transpiration rate, canopy temperature under well-watered and water stressed condition. Genetic variability was studied for canopy temperature depression, functional tillers and grain yield in wheat genotypes IC-112051, IC-549394 and EC-573623. Promissing wheat genotypes mentioned above showed lower canoy temperature, higher functional tillers and grain yield compared to local check HD-2189 (Figs 2.12, 2.13).

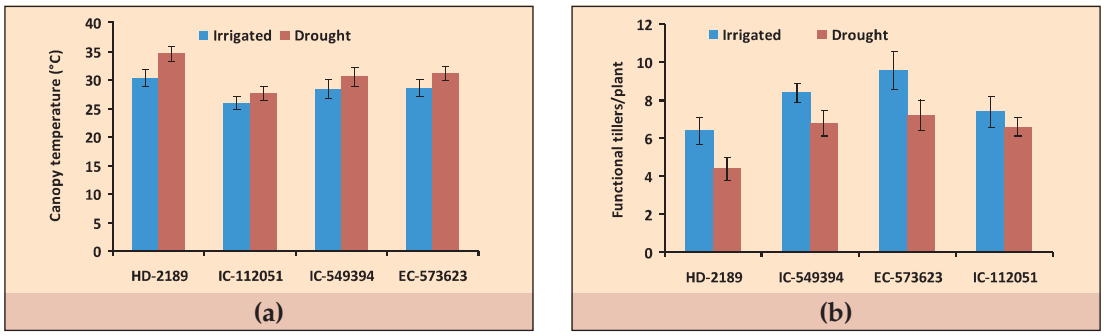


Fig. 2.12. Genetic variability in canopy temperature (a) and functional tillers (b) in promising wheat genotypes under irrigated and drought conditions

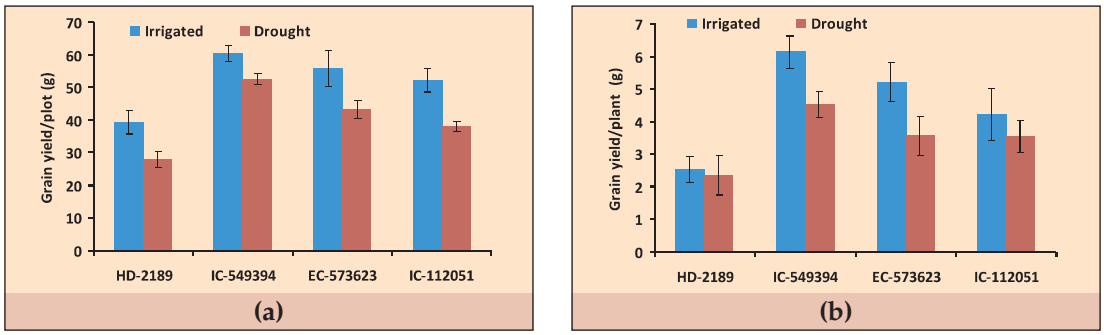


Fig. 2.13. Genetic variability in grain yield/plot (a) and grain yield/plant (b) in promising wheat genotypes under irrigated and drought conditions

RNA interference and virus induced gene silencing approaches to enhance drought and heat stress tolerance in soybean

20 candidate genes were identified from Soybean and Arabidopsis data base for

elucidation of their function using Virus Induced Gene Silencing (VIGS) and RNA interference (RNAi) approaches to enhance drought and heat stress tolerance. BPMV-based VIGS constructs were developed to silence genes such as *ARF* and *WRKY-49* genes (Fig. 2.14a). Soybean plants infected with recombinant BPMV having WRKY and ARF target fragments showed efficient silencing. The WRKY-49 and ARF silenced plants were analyzed for expression of *DELLA* protein genes and *PR1* and *PR3* genes. The ARF silenced plants were evaluated for water stress tolerance and RWC was measured. These plants showed enhanced water stress tolerance and also showed higher RWC compared to wild type plants and empty vector control plants (Fig. 2.14b).

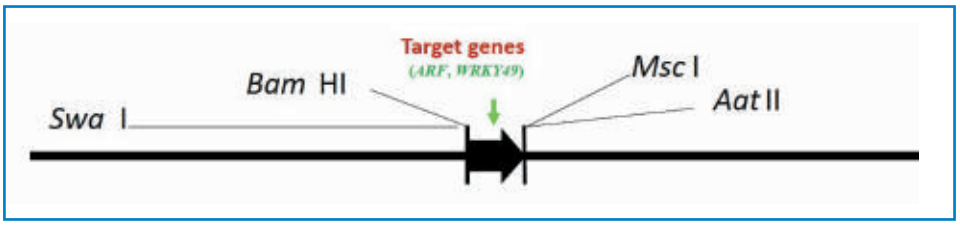


Fig. 2.14a. VIGS vector construction for down regulation of *ARF* and *WRKY49* genes in soybean plants

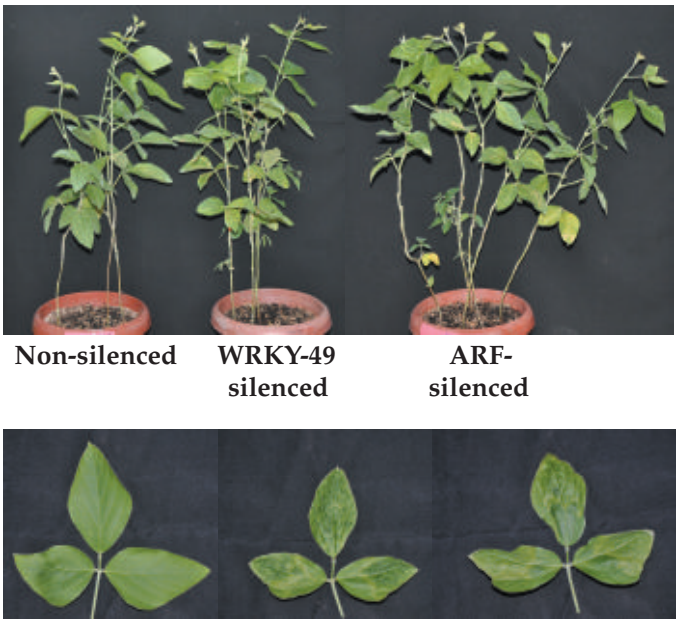


Fig. 2.14b. Phenotype of vector alone, WRKY-49 and ARF-silenced soybean plants

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

High temperature and moisture stress are important constraints that limit the productivity of fruit crop in dry and hot ecosystem. Chlorophyll fluorescence imaging phenotyping tool was used to assess the photosynthetic efficiency of plants. High sensitivity to desiccation was observed in mango and pomogranate was found to be tolerant towater stress. The rate of decrease in quantum efficiency with moisture stress was in order of pomegranate < karvanda < acid lime < sweet orange < grape < sapota < mango (Fig. 2.15).

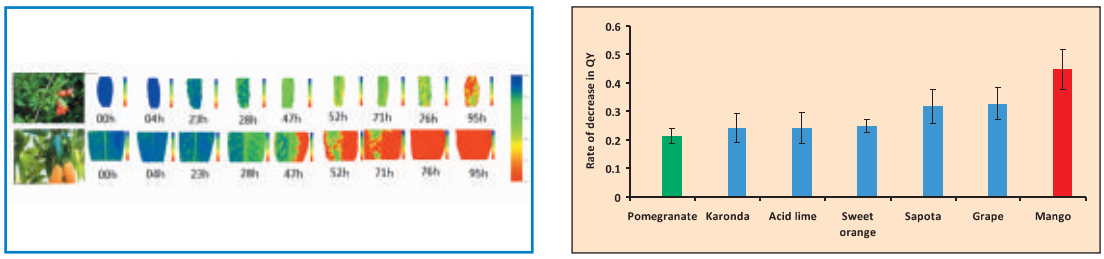


Fig. 2.15. Reduction in QY(Fv/Fm) per unit water loss

The sensitivity to rise in temperature was lesser in dragon fruit and acid lime than other fruit crop. The rate of decrease in quantum efficiency with rise in temperature was in the order of dragon fruit > acid lime > custard apple > karvanda > sweet orange > pomegranate > guava > grape > jamun > mango > sapota indicating that dragon fruit is more tolerant to rise in temperature than other crops (Fig. 2.16).

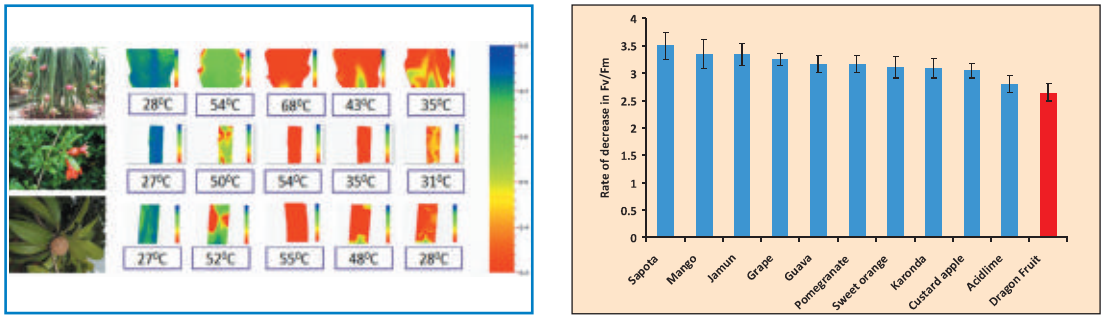


Fig. 2.16. Reduction in Fv/Fm per unit increase in temperature

In grape, the average stem girth in grapevine under different irrigation and soil treatments varies from 33.83 mm to 35.89 mm. The amount of irrigation water applied in 2016-17 in Thomson seedless varies from 28.3 to 42.7 cm. The plant yield under different deficit irrigation strategies and soil mixtures varies from 6.10 to 10.14 kg per plant. The yield and WUE was found more in mix soil (native and black soil 50:50) followed by black soil andwas noticed lowest in native soil. The grape yield undermix soil (50%native and 50% black soil) was at par with black soil and significantly higher as compared to native soil. The mixed soil i.e., 1:1 native murrum and black soil was found to be suitable for growing grape to overcome the edaphic and drought stress in grape. In grape (cv. Thompson Seedless), chlorophyll and proline content in Salicylic acid (SA) treated plant was found at par with the control during moisture stress. Activities of anti-oxidative enzymes (e.g., superoxide dismutase (SOD), peroxidase and catalase activity in fruit were also assayed. Activities of SOD, peroxidase and catalase activity were increased by the application of SA as compared to control. This suggests that exogenous SA (0.5 mM) application can alleviate drought stress by enhancing the net photosynthetic rate and antioxidative enzyme activities while decreasing lipid peroxidation as compared to the controls.

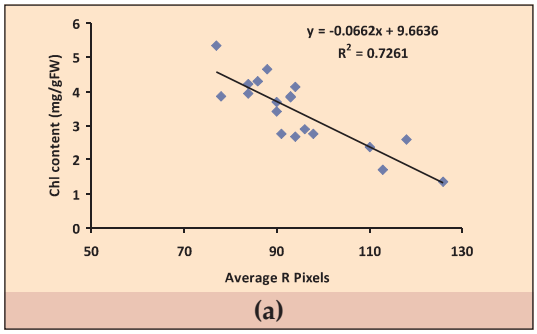
In pomegranate, the average stemgirth ranged from 34.8-39.5 mm in response to different water saving irrigation treatments with and without mulch. The PRD 60 strategy along with mulch increased fruit yields by 9.3% and water productivity by

34% as compared with RDI 0.8 ET without mulch. This might be due to higher enzymatic activity like SOD, peroxidase, catalase by water deficit under PRD as compared to RDI. The PRD-treated plants exhibited lower stomatal conductance and higher RWC compared to those with RDI. SA application can be used for alleviating moisture/drought stress in fruit crops i.e., pomegranate and grapes.

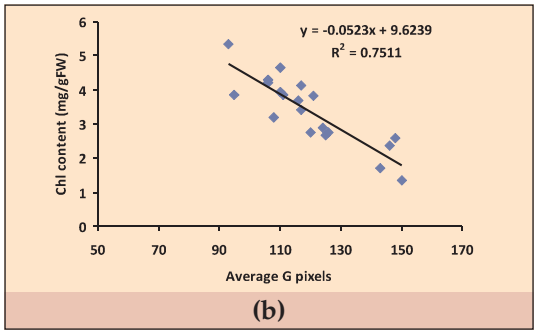
The average increase in tomato yield through drip irrigationwithoutmulch over the normal furrow irrigation was 38.4%. The average increase in yield was 3.9% in furrow irrigation with PRD over without PRD with average water saving of 63.8%. The increase in yield in furrow irrigation with PRD was as high as 12.1% at 0.75 ET irrigation level with water saving of 62.5% as compared to without PRD. In RDI, the percent increase in yield of 19.2 and 17.6 were found with plastic mulch over without mulch at 0.5 ET and 0.75 ET, respectively. The tomato yield gets reduced 5.2% under drip irrigation with mulch as compared to without mulch at 1.0 ET. The maximum water use efficiency (WUE) to an extent of 270.4 kg ha-1mm-1 was found at 0.75 ET under PRD.

Investigation of traits and genes associated with resilience to moisture stress in soybean

RGB Image basedmethod has been developed to quantify chlorophyll content in soybean leaves. Chlorophyll content measured in soybean canopy was in the range of 0.41 to 5.71 mg g-1 FW. When regress it with different pixels obtained after image analysis (Fig 2.17), significant negative association was found in actual chlorophyll content to average R and G pixels in visible images. Soybean plot images were captured frequently to understand the distribution of chlorophyll content among the soybean groups. Results indicate that in all the three groups at pixel values of R and G reached its peak atmid growth stage (R4-R6 stage) and became lower and at further later stage these pixel count increases. It shows less chlorophyll content at initial and later growth stage and more chlorophyll content at mid/reproductive stages. This kind of trend in changes in different colour pixels during the crop growth cycle was common for all the three groups however; there were significant variations in mean values of chlorophyll content across the groups at different phenological stages of growth. Chlorophyll content in leaves was higher in Group 1 than in Group 2 and 3. This indicates that image analysis based colour pixels can be used to estimate the chlorophyll content in the leaf of soybean. Visible imaging in plant phenotyping is the simplest method and can be used for non-destructive estimation of chlorophyll content.



(a)



(b)

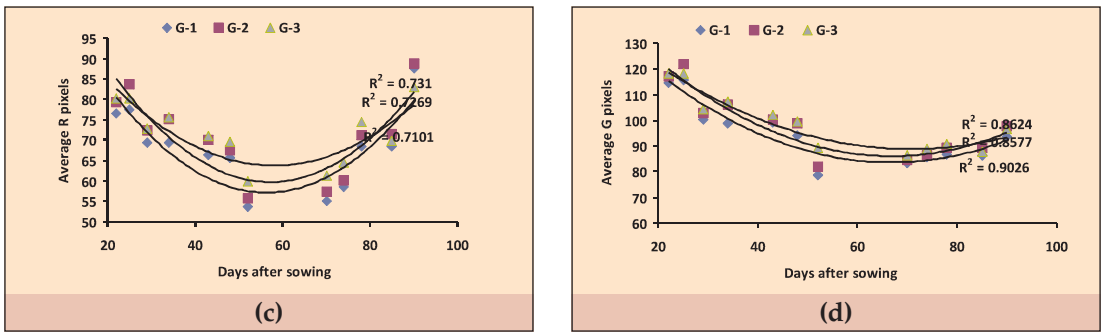


Fig. 2.17. Relationship between chlorophyll content and average R (a) and G (b) pixels in soybean leaves and variations in R and G (c, d) pixels at different days after sowing (DAS)

Effect of light intensity (600-1100 µmol m^{-2} s^{-1}) and its duration (1, 2, 3 hrs) on photosystem-II the two soybean cultivars namely JS335 and Kalitur were studied (Fig.2.18a and b). Reduction in quantum yield (Fv/Fm) with both increase in light intensity and duration of exposure confirmed the sensitivity of PS-II in both the cultivars. No significant difference was observed in chlorophyll fluorescence at 600 µmol m^{-2} s^{-1} in both the cultivars but there was significant reduction in quantum yield beyond 900 µmol m^{-2} s^{-1}. However the recovery of PS-II fromphoto-damage was better in JS335 than in Kalitur.

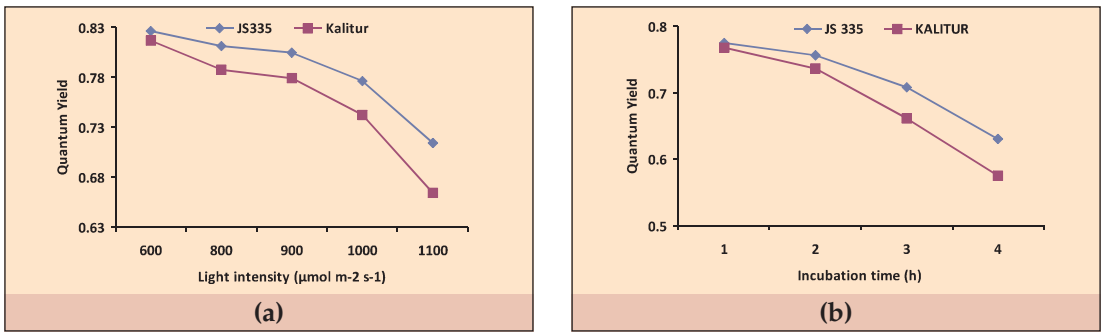


Fig. 2.18. Effect of different light intensities (a) and duration (b) on quantum efficiency of two soybean cultivars

Maximizing rainfed *rabi* Sorghum yield by optimizing sowing dates, plant spacing and cultivars for deep black soils of Deccan Plateau

A field experiment was conducted during the rabi season (Sept-March) of year 2016-17 at Malad Research Farmof the ICAR-NIASM, to optimize sowing dates plant spacing and cultivars for deep black soils of Deccan Plateau to maximizing yield of rainfed *rabi* sorghum. The treatments comprising three sowing dates (S1-Sowing date 18th September, S2- 28th September and S3- 9th October) were allocated in horizontal strip, four plant spacing (P1- 15 x 60 cm, P2- 15 x 45 cm, P3-10 x 45 cm and P4-10 x 45 cm (Every 3rd row removed at early heading stage) were allocated in vertical strip and two cultivars (V1-Phule Suchitra and V2- M-35-1) were allocated in sub plot under strip-split plot design with three replication. The result revealed that stover and grain yield of rabi sorghum was significantly affected by sowing dates, plant spacing and cultivars in deep black soil under rainfed conditions. Stover and grain yield of *rabi*

sorghum were higher under S1 as compared to S2 and S3 sowing dates (Table 2.5 and 2.6). Among plant spacing, plant spacing P2 resulted the significantly highest stover and grain yield of rabi sorghum, In case of crop cultivars Phule Suchitra resulted higher stover and grain yield in deep black soils under rainfed conditions.

Interaction effect of sowing dates and cultivar on stover and grain yield of rabi sorghum was found significant. Sowing of Phule Suchitra (V1) *rabi* sorghum on deep black soils in mid september (S1-Sowing date 18th September) resulted significantly the higher stover and grain yield than other combination of sowing dates and cultivars. Over all the sowing date, plant spacing and cultivars combination S1 P2V1 is more beneficial in terms of productivity of *rabi* sorghum in deep black soils under rainfed conditions of Deccan Plateau.

Table 2.5. Stover and grain yield of rainfed *rabi* sorghum as influenced by sowing dates, plant spacing and cultivars

Treatment	Stover yield (t ha^{-1})	Grain yield (t ha^{-1})
Sowing dates		
S1 (18 September)	6.5	3.8
S2 (28 September)	6.1	3.5
S3 (09 October)	5.9	3.3
SEM±	0.16	0.11
CD (P=0.05)	NS	NS
Plant spacing		
P1 (15 x 60 cm)	6.1	3.6
P2 (15 x 45 cm)	6.8	3.9
P3 (10 x 45 cm)	6.0	3.4
P4 (10 x 45 cm)	5.9	3.2
SEM±	0.09	0.04
CD (P=0.05)	0.31	0.15
Cultivars		
V1 (Phule Suchitra)	6.3	3.6
V2 (M-35-1)	6.1	3.5
SEM±	0.03	0.02
CD (P=0.05)	0.10	0.05

Table 2.6. Stover and grain yield of rainfed *rabi* sorghum as influenced by interaction of sowing dates and cultivars

Treatments	Stover yield (t ha^{-1})				Grain yield (t ha^{-1})			
	S1	S2	S3	Mean	S1	S2	S3	Mean
V1	6.70	6.21	5.84	6.25	3.86	3.54	3.28	3.56
V2	6.34	6.08	5.98	6.13	3.66	3.46	3.35	3.49
Mean	6.52	6.14	5.91	6.19	3.76	3.50	3.31	3.52
SEM±		0.058				0.032		
CD (P=0.05)		0.169				0.092		

Phenotyping for tolerance to drought and salinity in pulse crops

Association between image parameter and biomasswas established. The protocol knowledge with parameters of image in visible wavelength of electromagnetic radiation can help in identification of genotypes with more biomass and less water relative to well adapted cultivar. The study lead to identification of mungbean genotypes that could maintain cooler canopy (VC-6173-C) and better photo-system health (DMG 1050, SML 1150, and VC 6173-8-10) as revealed by canopy temperature measurements and chlorophyll fluorescence kinetics. Grain yield per plant of SML 1168, SML 832 and IC 32578 were better than locally adapted mungbean variety Vaibhav under depleting soil moisture conditions in field. Canopy of chickpea genotypes D5 and D24 obtained from IIPR were cooler than locally adapted variety Digvijay (Fig. 2.19). Genotypes D21, D18 and D24 had higher seed yield relative to locally adapted variety despite almost same phenology. Superiority of genotypes of chickpea in field could be attributed partially to differences in root systemarchitecture (Fig. 2.19).

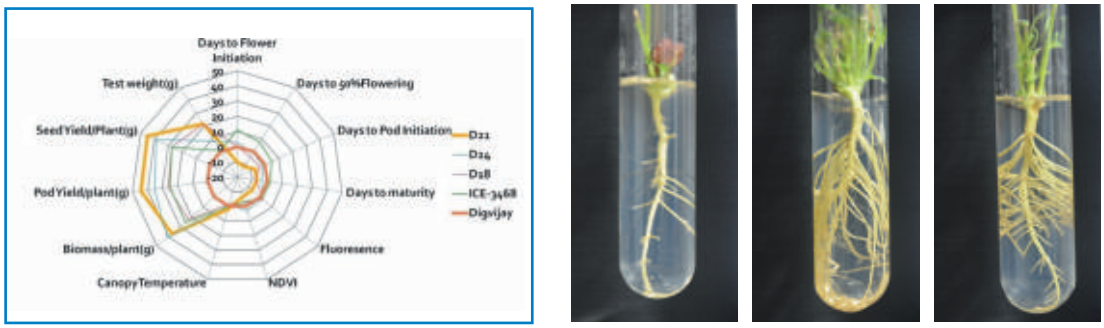


Fig. 2.19. Evaluation of chickpea genotypes for cooler cooler canopy, better photo-system and root system architecture and higher grain yield

96 chickpea diverse genotypes were evaluated for soil moisture stress tolerance in the research farm of ICAR-NIASM during the rabi season 2016-17 under rainfed conditions. Genetic variation in phenology, canopy temperature and chlorophyll fluorescence were studied in these genotypes. Genotypes were identified which were performing better compared to check varieties for individual traits and few genotypes

had a better trait combination that imparted tolerance to soil moisture stress. Early flowered genotypes identified were D30 (32 DAS), D31 (33 DAS), D21 (33 DAS) and D13 (34 DAS) compared to the check varieties Digvijay (37 DAS) and ICCV 92944 (41 DAS). D5, D21, D24 genotypes maintained cooler canopy and higher photosynthetic efficiency, also had higher pod yield than two check varieties Digvijay and ICCV 92944 (Fig. 2.20).

Table 2.7. Genetic variation of phenology in chickpea genotypes

Phenology	Genotypes
Days to flower initiation	D_{30} (32 DAS), D_{31}(33 DAS), D_{21}(33DAS) & D_{13}(34 DAS) flowered earlier than the check varieties Digvijay (37 DAS) & D_{32}(41 DAS)
Days to 50% flowering	Genotype D_{21}(37 DAS), D_{31}(37 DAS), D_{13}(39 DAS) & D_{25}(39 DAS) recorded 50% flowering early than the check varieties Digvijay (42 DAS) & D_{32}(45 DAS)
Days to Pod initiation	D_{31}(41 DAS), D_{30}(44 DAS), D_{13}(44 DAS) & D_5(45 DAS)registered early pod initiation than the checks Digvijay (47 DAS) & D_{32}(49 DAS)

Table 2.8. Genetic variation in canopy temperature and chlorophyll fluorescence in chickpea genotypes

Parameters	44 DAS	65 DAS	80 DAS
Canopy Temperature (°C)	D22(26.47), D24(26.5), D5(26.77), D26(27.03), ICE 6565 (27.18), D12 (27.48) and ICE 7594(27.62) has cooler canopy than Digvijay (27.74) and D32 (27.7)	D1 (25.81), D24 (26.10), D5 (26.71) ICE 7594 (27.29), ICE 7474(27.96), ICE 6565 (27.88), has cooler canopy than Digvijay (28.28) and D32 (27.86)	D32(31.34), ICE 7474(31.49), D12(32.14), ICE 7594 (32.58) and ICE 6565 (32.78) has cooler canopy than Digvijay (33.02)
Chlorophyll Fluorescence	D24 (0.83), ICE 7594 (0.82), D1 (0.8) ICE 7474 (0.79) ICE 6565 (0.79), D12 (0.787) and D5 (0.786) has high photo-synthetic efficiency than Digvijay (0.78) and D32 (0.75)	D5 (0.76), D12 (0.76), D24 (0.75) ICE 16015 (0.75) ICE 6565 (0.75), and ICE 7474 (0.74) revealed high photo-synthetic efficiency than Digvijay (0.74) and D32 (0.71)	ICE 7474 (0.728), ICE 7594 (0.715), ICE 6565 (0.707) and D32 (0.669) revealed high photosynthetic efficiency than Digvijay (0.640)

(a)

(b)

Fig. 2.20. Canopy temperature mesurement through IR thermal imaging system (a) and chickpea germplasm evaluation for traits associated with water stress tolerance (b)

156 mungbean genotypes were studied for genetic variation in canopy temperature, chlorophyll fluorescence and stomatal conductance (Table 2.9). VC-6173-C was identified as promising genotype compared to check for canopy temperature trait. For stomatal conductance trait, SML 1168, SML 931, VC 6173-8-10, VC 6369-53-97 were identified as promising genotypes compared to check (Table 2.9).

Table 2.9. Genetic variation in canopy temperature, chlorophyll fluorescence, yield and stomatal conductance in mungbean genotypes

Physiological Traits	Promising genotypes identified
Canopy temperature	VC-6173-C
Quantum yield (Fv/Fm)	DMG 1050,SML 1150, VC 6173-8-10
Yield/plant	SML 1168, SML 832, IC 325787
Stomatal conductance	SML 1168, SML 931, VC 6173-8-10, VC 6369-53-97
Novel trait combinations (High quantum yield at higher canopy temperature)	VC-6369-53-97, VC-6370-30-65, SML-1309

The application of bioformulations lead to an increase of total dry weight and number of nodules, especially in the plants treatedwith cattle and agriculture product based bioformulations (BK and SH) at different growth stages andmoisture conditions as compared to the control plants (Fig. 2.21). Least decrease or no change in photochemical efficiency of PS II (Fv/Fm) and decrease in stomatal conductance at drought stress indicates the acquired tolerance on mungbean to drought stress with help of bioformulations by increasing water use efficiency and stable photosynthesis. It was also supported with higher expression of NIP gene under drought stress and recovery conditions (Fig. 2.21).

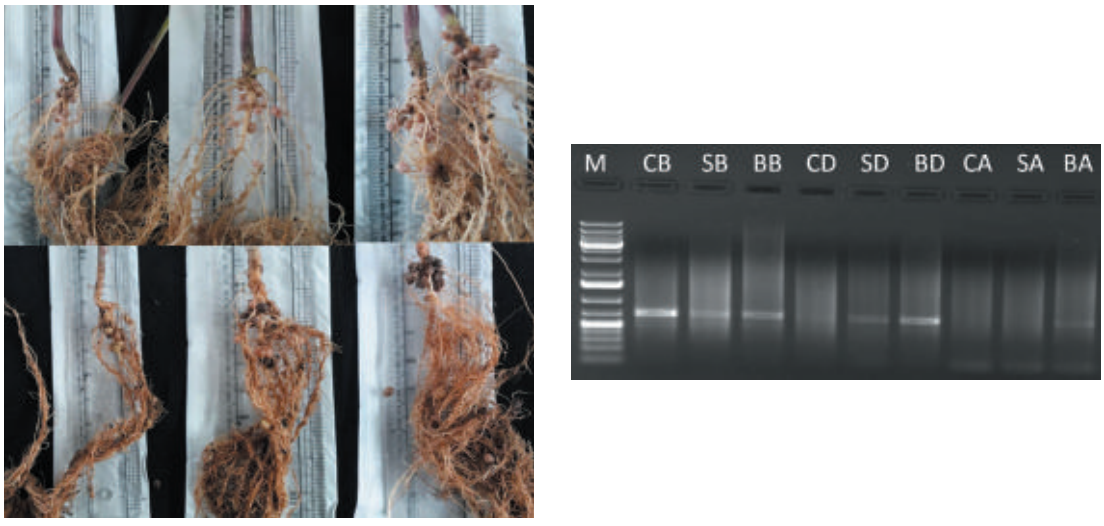


Fig. 2.21. Effects of bioformulations on root system architecture and expression profiling of *NIP* gene under drought stress and recovery conditions

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

Phenotyping of 220 diverse genotypes for *Rabi* 2016-17 has revealed wide diversity in 15 traits associated with drought tolerance. Under drought treatment, we applied only two irrigations (1st at sowing and 2nd at 24 DAS). Canopy temperature (CT) recorded with the help of IR camera at different time intervals. CT 7 DAA was found to vary between 25.7°C (HI-240) to 39.1°C (DBW-74) for drought treatment and 23.6°C (WH-1025) to 33.4°C (SONARA-64) for irrigated treatment. The study could lead to identification of genotypes that couldmaintain cooler canopy and better photosystem health as revealed by canopy temperature measurements and chlorophyll fluorescence kinetics. Genotypes distinct in their responses in terms of grain weight, canopy temperature, chlorophyll fluorescence,maturity etc. have been identified (Fig. 2.22). These phenotyping efforts will contribute to identification of useful genes.

Fig. 2.22. Field phenotyping of diverse wheat genotypes for cooler canopy, better photosystem and grain yield

Evaluation of nutritional stressors and their indicators in cattle population in different drought prone areas

Survey was conducted of 5 cattle camps organized in Latur and Osmanbad districts. (Fig. 2.23) More than 80% farmers were within five kilometer radius from the location of camp. Farmers in the camp were mainly having either small land holding or landless and their educational status mostly below matriculation. Maximum livestock holding was with small farmers followed by large and landless farmers. Analysis of feed samples revealed deficit status of nutrients in respect to forages and feed used in animal camps. Effect of nutritional stress observed in cattle was anorexia, dullness, stunted growth, emaciation, poor productivity, infertility problems such as repeat breeding and anoestrus and skin problems.

Agriculture production was drastically hampered due to drought situation in most of the areas studied and livestock farming was the only alternative to majority of farmers. Milk production of animals in cattle camp was reduced by 30% as compared to its original production at home. Hence research/management is required to improve nutritional status of animals in cattle camp. More research on TMR feed blocks, Silage and hydroponics is required to improve nutritional status of livestock during scarcity conditions, besides improved fodder varieties.

(a)

(b)

(c)

Fig. 2.23. Cattle camps survey in Osmanabad and Latur districts (a), Providing health services in cattle camp along with ICAR-IVRI,TEC Pune (b), Sample collection for analysis of stress indicators (c)

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

For the first time suitability of Quinoa as alternative crop for degraded soils of water scarcity zone was tested at NIASM during rabi and it was demonstrated that it is possible to get as high as 3 q ha^{-1} of seeds from as small as 1 kg seed. The seeds of genotypes EC-507740, EC-507744, EC-507748 received from NBPGR were multiplied and assessed for various physiological traits including stomatal density (Fig. 2.24). There was no significant differences in seed yield among the genotypes though there were some differences in growth and development. Preliminary studies on stomatal conductance revealed that the *C. quinoa* transpires less water per unit leaf area per unit time relative to wild chenopodium species and also found to be almost free of diseases and pest suggesting the possibilities of growing them organically.

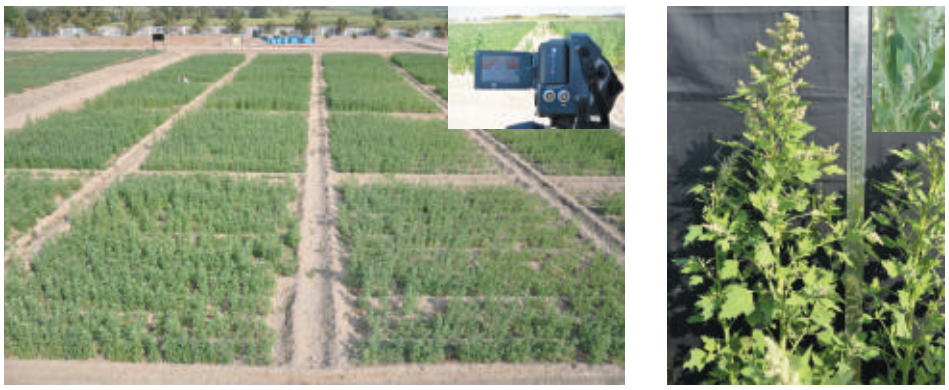


Fig. 2.24. Assessment of Quinoa (*Chenopodium quinoa*) as an alternate crop for water scarcity zone

School of Edaphic Stress Management

Nano (bio) remediation of nitrogenous contaminants using silver-ion exchanged zeolites

Nano (bio) technological interventions based on trapping of biologically synthesized Ag and Zn nanoparticles have been applied for the development of zeolite based nanocomposites. Stilbite is abundantly available in quarries of Maharashtra; hence a method for trapping of nanosilver in stilbite has been standardized by modifying the published protocol (Krishnani et al, 2012). Water quality and fish growth were monitored in the farm/aquaculture pond stocked with IMC. Bactericidal activity of silver nanoparticles and zeolite based nano-composite has also been evaluated against *Pseudomonas* sp. (GenBank NCBI database accession No LC027455) using agar well diffusion method. Ammonia was reduced in a farm pond treated with Ag-stilbite, leading to higher fish production. Application of nanosilver stilbite helped in alleviation of multiple stresses in the pond with the result of higher fish production. Cost economics of trapping of silver nanoparticles in stilbite has also been evaluated. Metals, micronutrients and nanosilver in zeolites samples were determined using ICP-MS.

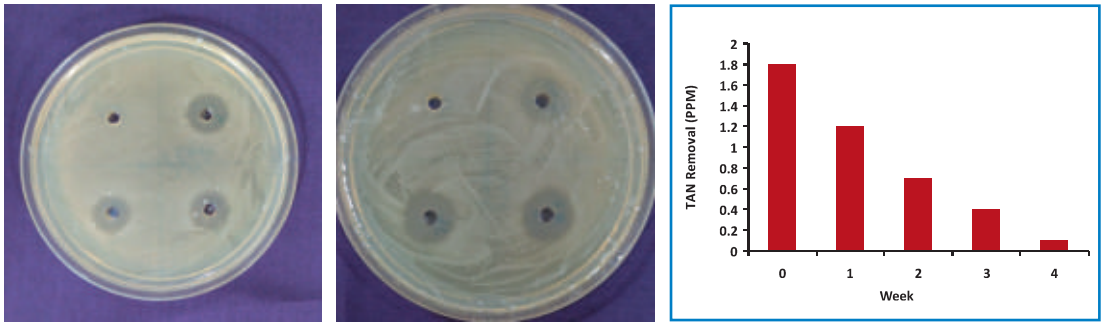


Fig. 2.25. Bactericidal activity and Ammonia removal in aquaculture pond using zeolite based nanocomposite

In addition, preparation of nanosilver (Ag-NPs) based feed formulations (0-1 mg kg^{-1}) has been standardized and were used for alleviation of lead and high temperature in *Channa striatus*. Results indicated that supplementation of Ag-NPs with

concentration of 0.5 mg kg^{-1} in the diet has a definitive role in the mitigation of multiple stresses in *C. striatus* with the result of improved growth performance, immunity, survival and maintained stress biomarker. Feeding with higher concentration of Ag-NPs (1 mg kg^{-1} diet) had reduced growth performance.The present work on value addition of naturally and abundantly available stilbite using nanotechnological interventions has a potential application in alleviation of multiple stressors in aquaculture system. The application of zeolite based nanocomposites may be explored for input use efficiency in major plant crops.

Enhancement of waterlogging tolerance in soybean (*Glycine max* L.)

Important high yielding varieties (92) and germplasm lines (100) of soybean was collected from IISR, Indore for their screening to waterlogging tolerance. Collected seed material was in small quantity, therefore a seed multiplication trial was conducted. Multiplication trial was conducted in two separate sets; one set for 92 varieties and another for 100 germplasm line. Observations on growth parameters, yield and yield attributes were recorded for all the varieties and germplasm lines. From mean data of 92 varieties it was observed that performance of CO-1 was better followed by Tans-98-21, MAUS-2, MACS-13, MAUS-158, RKS-24, MAUS-81, MAUS-1, PK-472, JS-20-29, VLS-63, JS-71-05, SL-295, HARDEE, Tans-38, VLS-59 and JS-335 in terms of higher biomass $plant^{-1}$, pod $plant^{-1}$, pod wt. $plant^{-1}$, seed yield $plant^{-1}$ and seed index (100 seed wt.) compared to other varieties. These varieties will be further used for screening for waterlogging tolerance. 100 germplasm lines mean data on growth parameter, yield and yield attributes indicated that performance of Cat 1077 was found better followed by Cat 1171 A, Cat 2097 A, Cat 1508 A, AGS 31, Cat 1157, Cat 1135, Cat 872 B, Cat 2086 B, Cat 661, Cat 1109, Cat 2898, Cat 1708, Cat 945 B, Cat 1191, Cat 1524, Cat 941 B, Cat 2127 B and Cat 734 in terms of biomass/plant, pod/plant, pod wt./plant, seed yield/plant, and seed index (100 seed wt.) compared to other germplasm lines. These germplasm lines will be further used for screening for waterlogging tolerance.

A field experiment was conducted with 16 varieties which consists of two waterlogging treatments (Normal and Flooded) imposed at two growth stages (Vegetative & Reproductive) independently in four replications in a Randomized Block Design. Treatment was imposed at vegetative stage and flooding was continued for a period of 15 days in all the varieties uniformly. However, at reproductive stage flooding treatment was continued for 20 days. All the important observations such as days to 50% flowering, 100% flowering and maturity, crop growth parameters, yield and yield attributes were recorded in all the treatments. Sampling was done at regular interval for study of biomass accumulation, periodical depletion and recovery of chlorophyll (a, b and total) content and changes in root anatomy. Rooting pattern was also studied in all the varieties under experiment. In general, yellowing symptoms was observed in almost all the varieties including check variety (JS- 97- 52) after 4 days of flood treatment. However, variation in yellowing intensity was observed among the varieties. A significant reduction in biomass accumulation (15-62%), yield attributing characters and seed yield (26-80%) was observed in almost all the varieties due to waterlogging treatment at vegetative stage. Similar trend in crop performance

was also observed due to waterlogging at reproductive stage. Among the 16 varieties screened, Hardee, JS 335, NRC 37, RAUS-5, PK- 471, RVS-2001-4 and RKS-24 performed better compared to other varieties under normal conditions. However, RVS-2001-4 and RKS-24 showed minimum reduction in most of the parameters under flood treatment compared to normal condition at vegetative stage. Whereas, after flood treatment at reproductive stage, performance of RVS- 2001-4 and RAUS-5 was found better compared to other varieties. Performance of RVS-2001-4 was found better under flood treatment at both the growth stages, vegetative as well as reproductive stage compared to all other varieties under test. Wide range of variation in yield related traits was observed after waterlogging at vegetative stage compared to reproductive stage. Therefore, vegetative stage was found more suitable compared to reproductive stage for screening of waterlogging tolerance under field condition.

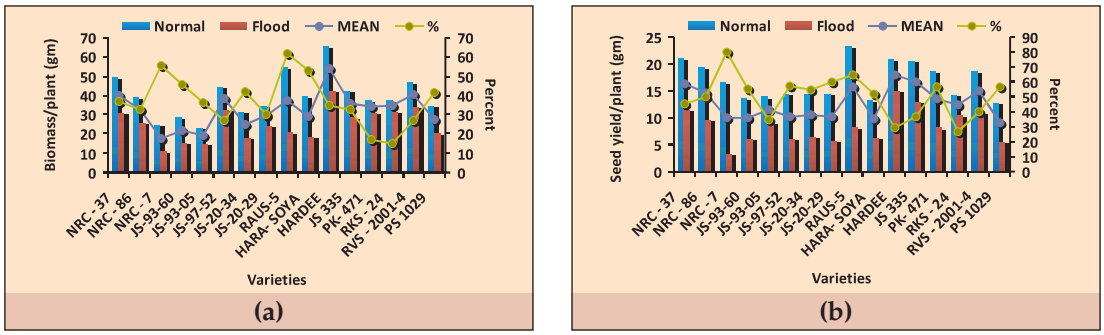


Fig. 2.26. Biomass (a) and Seed yield (b) of soybean varieties as influenced by normal and flood water management at vegetative stage

Fig. 2.27. Waterlogging treatment at vegetative stage

Functional characterization of salt tolerant bacteria using multi-omic approaches and their exploitation for alleviation of salt stress in crop plants

Microbial consortium was developed using the bacterial strains isolated from the phyllosphere of crop plants and halophytic *Psoralea corylifolia* L. The strains exhibited high degree of metabolic diversity and stress tolerance capacity. The PGP traits included solubilization of phosphate, plant growth regulating hormones production, siderophore production, exopolysaccharides production, nitrogen fixation, etc. The microbial consortium was tested for its on-field PGP ability with sorghum and wheat crops.

Screening (*in-vitro* PGP traits, and BIOLOG) of candidate PGP bacterial strains was done to develop the microbial consortium for plant growth promotion under nutrient limiting conditions. The consortium included eight bacterial strains having major PGP traits siderophore producers, nitrogen fixers, phosphate solubilizers, EPS

producers and plant growth hormone producers, etc. The BIOLOG Gen-III assay allowed insights to the metabolic knowledge of the isolates in presence of different carbon substrates. PGP potential of microbial consortium in sorghum under simulated drought conditions using line-source sprinkler system was determined. The microbial consortium (T1) was seed-primed in sorghum and evaluated for mitigation of drought stress under field conditions. In another experiment, the same consortium was seed-primed in wheat and assessed *in situ* for PGP performance under nutrient limiting conditions, other treatments included were seed priming with microbial carbohydrate-metabolite AMAAS IXX (T2), and a PGP bacterium (T3). The fertility gradient was generated on-field by applying reducing concentrations of N, P and K fertilizers (Fig. 2.28).

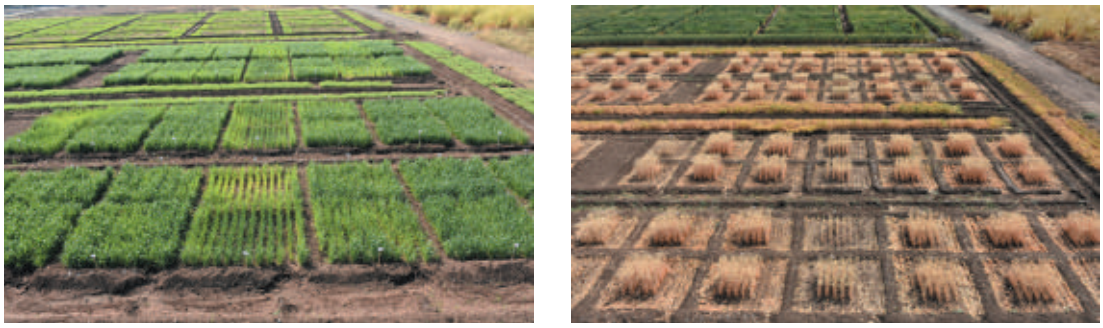


Fig. 2.28. Experimental wheat crop at ICAR-NIASM farm

The relative performance of the treatments under nutrient limiting conditions in wheat was evaluated in terms of physiochemical status of the crop (Fig. 2.29). Where, the performance of microbial consortium was found superior over the rest of the treatments. Overall the results highlight the need of possible improvements and validation of the product prior to recommending for the farming practice.

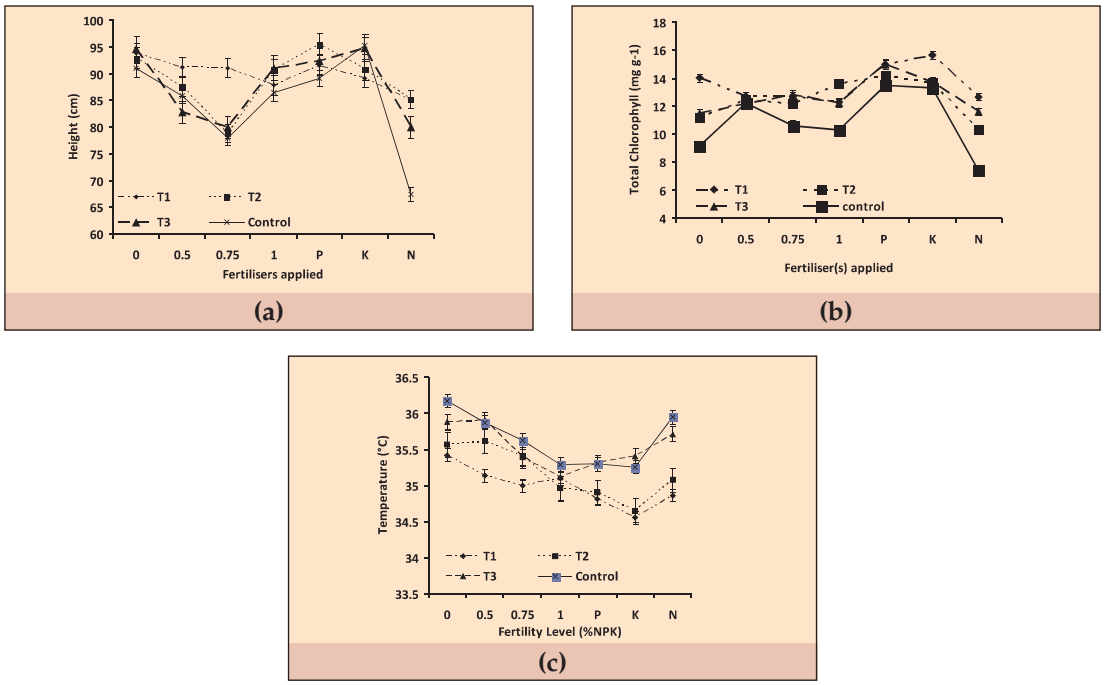


Fig. 2.29. Height of the crop (a); total chlorophylls content (b) and canopy temperature of the crop at 90 DAS (c)

Development of likelihood model of microbes mediated salt and drought stress alleviation in wheat crop using omics approaches

Halotolerant bacterial strains obtained from different salinity affected habitats were further characterized for their PGP performance under *in-vitro* condition. The isolates exhibited interesting PGP ability under saline conditions. The isolates when seed-primed in wheat, efficiently facilitated the germination and growth of the crop under elevated levels of salinity. The effectiveness of strains-inoculation was assessed in terms of physicochemical status of the seedlings. The results underlined the salinity stress mitigation potential of the strains at a threshold of moderate stress conditions, beyond which the performance of the strains declined progressively. In order to investigate the metabolic fluctuations shown by the strains under salinity stress, the *in-vitro* induced metabolites of the isolates were analysed using UHPLC. The results showed remarkable variations in both the concentration and abundance of the unidentified metabolites, thus highlighting the needful studies of salinity stress management with the help of harvested metabolites produced by the strains.

Dry shoot weight found significantly higher under the influence of treatment with PGP bacteria. Root dry weight on the other hand, though differed slightly, it hardly exhibited any significant increase (Fig. 2.30). The strain-I showed better PGP performance up to 10 dS m^{-1}, however the same failed even to induce the germination of wheat at 15 dS m^{-1}. The strain-II found performing better even at highly saline conditions (dS m^{-1}).

Both the strains significantly influenced the levels of antioxidant enzymes in the seedlings (Fig. 2.30c). This indicated successful mounting of enzymatic machinery to combat the increasing oxidative stress under increasing saline conditions. This could

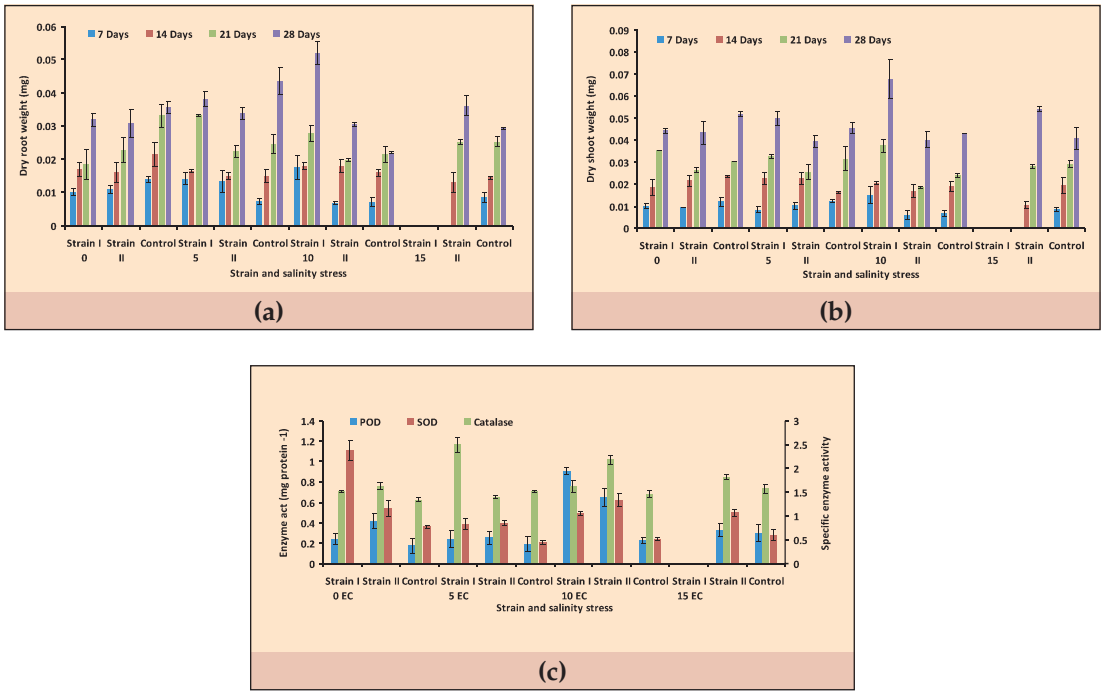


Fig. 2.30. Physicochemical characters of wheat seedlings influenced by the treatments with PGP bacterial strains under saline conditions. Failure of the strain to induce germination of wheat under highly saline conditions

help the plant to survive and establish under the elevated levels of salinity stress. These results signify the importance of halotolerant, plant growth promoting bacteria in mitigation of abiotic stressor(s) in crop plants. Moreover, following the keen evaluation and identification of stress-responsive, bioactive metabolites from these bacterial strains, the metabolic potential of these bacteria could also be utilized in the area of abiotic stress mitigation in crop plants.

Isolation and charecterization of biomolecules producing bacteria for salt stress alleviation in major crops

Methylotrophic bacteria are well known phyllosphere inhabitants that characteristically utilize the C1 compounds as carbon source. The unique ability of these organisms to produce plant growth regulating biomolecules, e.g. IAA, IBA, GA etc. have been well demonstrated. We isolated halotolerant strains of methylotrophic bacteria having PGP traits from the rocks and phyllosphere of crop plants. The metabolic diversity of the strains was analysed using BIOLOG Gen III assay, where majority of the isolates successfully utilized variety of carbon substrates.

Considering the exceptional metabolic potential of these isolates, the candidate isolates were cultivated *in-vitro* to produce biomolecules. The biomolecules were harvested using XAD 16 resin, and were seed-primed in wheat and evaluated for PGP performance *in-vitro* on agarized water substrate having different levels of salt stress (0, 5 and 10 dS m^{-1}). The efficiency of biomolecules treatment was evaluated in terms of physicochemical status of the seedlings.

The biomolecules successfully increased the levels of important parameters including average biomass, protein content and peroxidase enzyme activity in the seedlings (Fig. 2.31), indicating appropriate establishment of the seedlings under stress conditions.

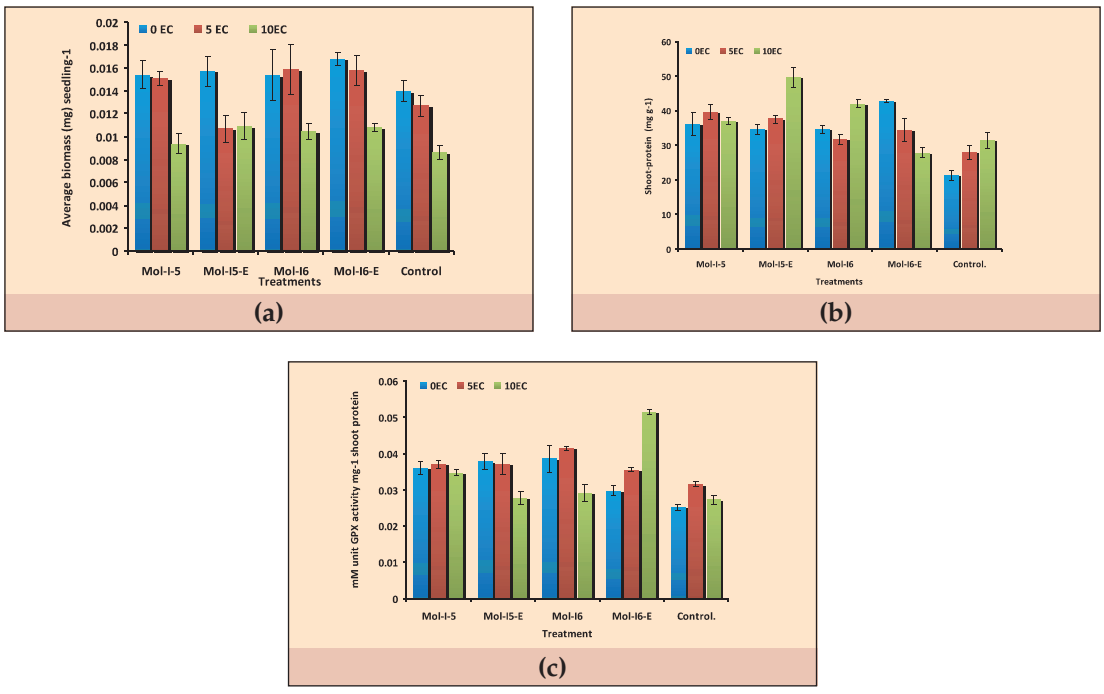


Fig. 2.31. Physicochemical characters of seedlings under the influence of metabolites produced by the methylotrophic bacteria

The overall results underlined the positive performance of biomolecules towards alleviation of salinity stress in wheat. The results also encourage efforts for development of new strategy involving bacterial biomolecules as bio-inoculants for mitigation of abiotic stresses.

Impact of trash and other ratoon management practices on yield and water productivity of sugarcane

A stubble shaver, off bar cum fertilizer applicator developed by ICAR-IISR, Lucknow was further up-graded successfully with the inclusion of robust power transmission system, larger capacity fertilizer box and root pruning mechanisms into a multi-purpose stubble shaver, off bar, root pruner cum fertilizer drill (SORF) machine. The machine was found to improve cane productivity significantly over farmers' practices. Therefore, to determine the individual and combined effects of stubble shaving, off-barring, root pruning and placement of fertilizers in soil on productivity, profitability and resource-use efficiency of sugarcane ratoon crop, a field experiment was conducted with eight treatment combinations including 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: NT; burnt trash: BT and spreading the trash uniformly in the field after chopping with a trash cutter: CT) and two absolute control with no nitrogen and un-chopped trash (UCT+No-N) and without trash (NT+No-N). 50 and 75 % of recommended dose of fert-N was applied as basal under broadcast and placement of N treatments, respectively.

The maximum numbers of millable cane, cane length, cane weight and juice yield were recorded under CT+NP+RP+OB+SS which were significantly ($P \leq 0.05$) higher over others except in case of millable cane which was at par with CT+NP+RP and CT+NP+OB treatments. In-situ retention of chopped trash and placement of fert-N (CT+NP) in soil improved cane yield by 13.3-69.7% over control (UCT+No-N) and other broadcast application of fert-N treatments, while pruning of older roots (CT+NP+RP) further improved the cane yield over CT+NP by 7.4%. There was no significant improvement in the cane yield due to root pruning and off-barring practices over the placement of fert-N (CT+NP). However, when stubble shaving, off-barring and root pruning practices were employed together, cane yield improved significantly by 11.3-12.7% than that of individual practices of off-barring and placement of ferti-

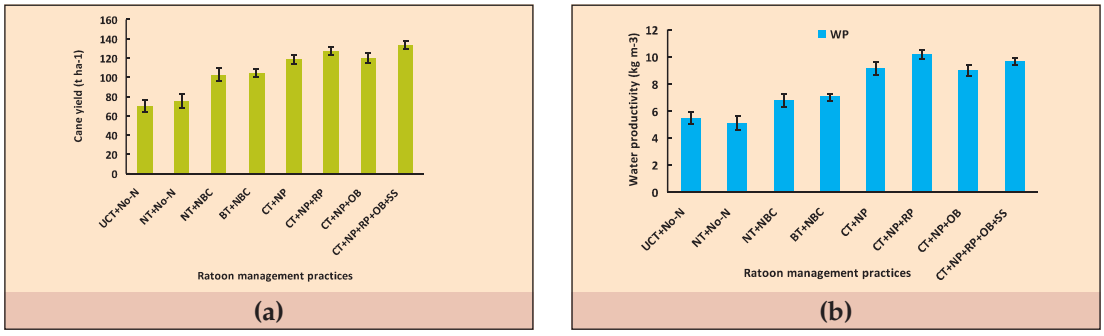


Fig. 2.32. Effect of ratoon management practices on cane yield and water productivity of ratoon sugarcane

N (Fig. 2.32). The maximum water productivity (10.1 kg m-3) was recorded under CT+NP+RP treatment which was significantly higher (44.4%) than the conventional trash burnt and broadcast application of fert-N treatment (BT+NBC), but remained statistically similar with surface retention of chopped trash and other SORF treatments. Surface retention of chopped trash and employing of individual or in combination of SORF techniques also improved the water productivity by 28.2-36.9% over BT+NBC (Fig. 2.32).

Conservation agriculture for improving root growth and mitigation of short term water stress in ratoon sugarcane

The minirhizotron technique for in-situ root architectural monitoring during entire crop growing season was standardized for sugarcane crop. Standard access tubes of 1.8 m length were installed in the field and in-situ root images representing 0.2 m soil depth were captured using a Root Scanner CI-600. The images were knowledge for root length (L) with the RootSnap! Software. The maximum root density (LA) was monitored in surface 0.4 m soil having 75-85% roots. The growth rate of roots varied during the crop cycle and the maximum was recorded between 26 to 55 days after ratoon initiation (DARI) (Fig. 2.33). The LA in surface 0.2 m soil was comparatively higher with conservation agriculture (CA) treatments (T3: retention of chopped trash on soil surface and drilling of basal fertiliser doses with machine and T4: surface retention of chopped trash and use of SORF machine for stubble shaving, off-barring, root pruning and placement of basal doses of fertilisers) than the other ratoon management treatments.

Severe water stress conditions after 55 DARI caused stagnation in LA or even decline due to root decay in the surface 0.2 m soil until 101 DARI especially in control (T1: no-trash without fertilizer nitrogen) and conventional practices (T2: burning of left over trash and broadcasting of basal fertiliser doses), though root density substantially improved in deeper layers. On the contrary, the roots continued to grow in CA treatments as indicated by substantial improvement in LA from 55 to 101 DARI.

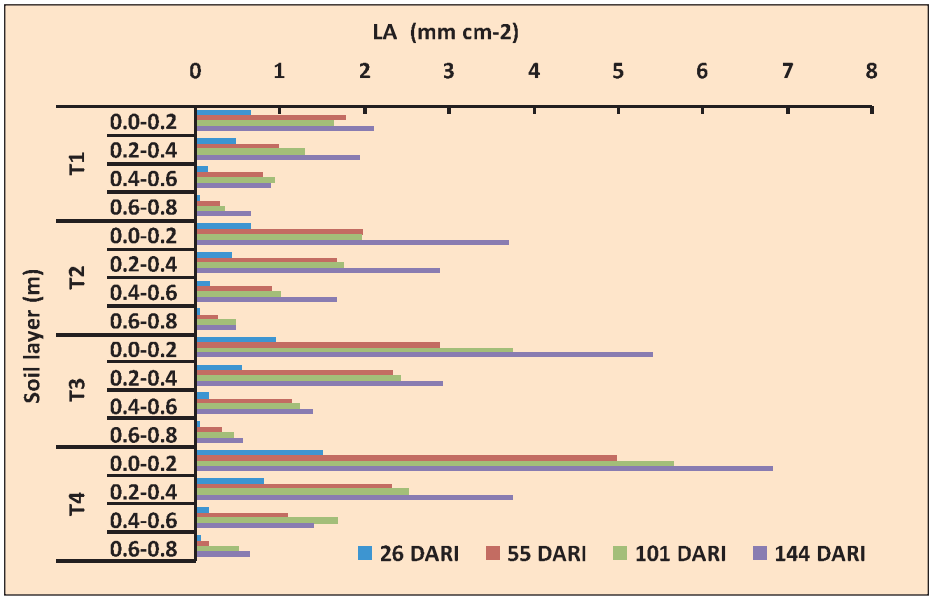


Fig. 2.33. Effect of ratoon management practices on cumulative root density (L_A) of sugarcane

This was obviously the impact of better maintenance of hydro-thermal regimes with surface retention of trash. Thus, surface retention of chopped trash mitigated the short term water stress effect through sustained root growth. Drilling of the 75% dose of N as basal along with adoption of SORF techniques of ratoon management led to substantial improvements in the root growth of sugarcane.

On-farm demonstration of best-bet CA technologies

To enhance resource-use efficiency, environmental quality and profitability of sugarcane ratoon crop, six live demonstrations of stubble shaver, off-bar, root pruner cum fertilizer drill (SORF) machine were conducted at the farmers' fields in and around Baramati (Fig. 2.34).

Fig. 2.34. Demonstration of stubble shaver, off-bar, root pruner cum fertilizer drill (SORF) machine at farmer's fields

Effect of biochar application on properties of sandy and black clayey soils and growth and development of wheat crop in the central Deccan plateau region

The biochar, partially decomposed organic product contains more stable carbon has recently got a wider application in western agriculture due to its importance in climate change mitigation for the large size carbon sequestration upon amendments in agriculture. It has been no much of supporting data for biochar use in Indian agriculture that the preliminary study, pot culture experiment was conducted to test the hypothesis that the amount of biochar application may differed for soil types due to its varied interaction with soils. To account the size effect for soil biochar interaction and its influence on plant growth parameters and yield attributes the study was conducted with application of biochar at the rate of 0, 10, 20, 30 and 40 g kg^{-1} in both sandy and clayey soils. The rabi wheat was taken as test crop. The wood residues collected from the fly wood industries of the Baramati city used for biochar production. The biochar conversion efficiency, pH, CEC, organic carbon content, available nitrogen, phosphorous and potassium and water holding capacity of the biochar were 450 g kg^{-1}, 8.03, 36.1 cmol (p+) kg^{-1}, 3.1 g kg^{-1}, 1.2 g kg^{-1} and 2.78 g kg^{-1} and 360 g kg^{-1}, respectively.

Effect of biochar application on soil properties of sandy and black clay soils

The biochar application optimized soil properties namely, soil pH, total organic carbon, water holding capacity and bulk density in both the soils. The minimum quantity of biochar required for the significant improvement of soil properties varied

for soil types and soil properties. The minimum 20 g kg^{-1} of biochar application is required to alter the bulk density of soils. There was a decrease of bulk density about 10% in the sandy soils and 8.3% in the black soils over that of control treatment. The bulk density of sandy soils is higher than sandy soils that size effect is more in the sandy soils. The biochar particles might have diffused within as well as between aggregates of different size that improved the soil water content of both the soils. The biochar is very porous in nature and low density that improved water holding capacity of the soils even at the low application of 10 g kg^{-1} biochar to soils. The sandy soils increased the water content by 45 g kg-1 while it was an increase of 15 g kg^{-1} of soils in the clayey soils. The increase of water content gets decreased with increased application of biochar.

The soil carbon content gets increased with application of biochar in the soils. As the biochar carbon stable for long time in soils, it is highly worth even at low amount of biochar application. The soil carbon content increase was not perfectly with increasing level of biochar application which indicates presence of labile carbon in the biochar. The oxidation residues normally associated with increase of mineral content that the pH of biochar usually higher than that of the residues. Because of this liming effect, the soil pH gets increased for the application of biochar. As the sandy soils are low buffering capacity in compare to clayey soils, the unit of change for the given level of biochar application was high under sandy soil type. In our study, it was found that the pH of soil increased about 0.2 units in clayey soils and 0.4 units in the sandy soils.

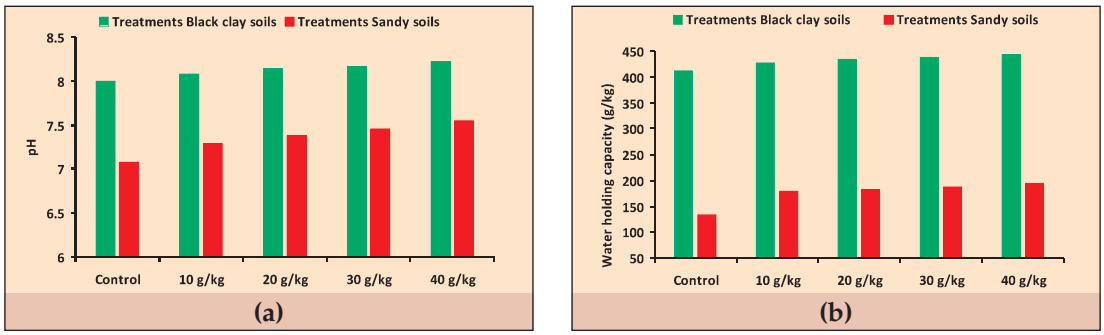


Fig. 2.35. Effect of biochar application on improvement of soil pH (a) and water holding capacity (b) on two contrasting soil types

Effect of soil biochar interaction on growth parameters and yield attributes of wheat crop

The crop response for application of biochar is highly associated with the improvement of soil properties which is varied for soil types. The absolute growth and development of crops was better in the black clayey soils due to superior soil fertility status over the sandy soils. It was found that low amount of application of biochar @ 10 g kg^{-1} gave significant yield increase over the control in sandy soil while the minimum of 30 g kg^{-1} was required for the black clayey soils. The both soil types increased the pant height even at the low rate of biochar application but the high response of increase in height observed from the sandy soils. Similarly, the length of the spike also increased with biochar application. The roots parameter such as root

length, root biomass and root volume are getting increased for biochar application and more response was observed from the sandy soils. The amount of increase for biochar application is shown in the Table 2.10. The increase in crop yield were highly associated with length of the spike and bulk density reduction in the black soils while it was by all the plant and soil parameters in sandy soils except root volume and root length density. It is concluded that as the more response of wheat crop were observed from the sandy soils, the application of low amount biochar of (1%) recommended for sandy soils while it was 3% application for black soils however, further field studies need to be conducted.

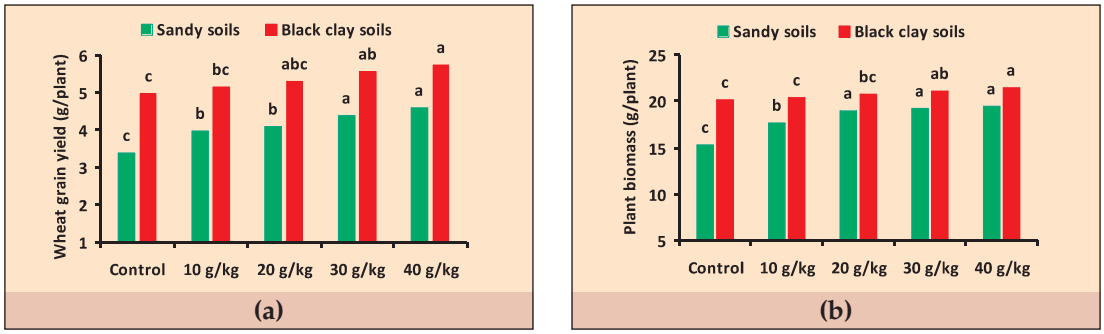


Fig. 2.36. Effect of biochar application on grain (a) and biomass (b) yield of wheat crop grown on two contrasting soils

Table 2.10. Effect of biochar application on root parameters of wheat crop grown on sandy and black clay soils

Treatments (g kg^{-1} biochar)	Black clay soils				Sandy soils			
	Root length (cm)	Root biomass (g) per plant	Root volume (cm^3)	RLD (cm cm^{-3})	Root length (cm)	Root biomass (g) per plant	Root volume (cm^3)	RLD (cm cm^{-3})
Control	24.8d	4.0d	7.9c	3.1	27.5d	2.8c	7.4d	3.7
10	27.3c	4.6c	12.2b	2.2	29.3c	3.4b	10.0c	2.9
20	28.4bc	4.7bc	13.1ab	2.2	30.7b	3.6b	10.6b	2.9
30	29.3b	4.7b	14.5a	2.0	31.6ab	3.9a	11.4a	2.8
40	30.0a	4.9a	15.0a	2.0	32.7a	3.9a	11.9a	2.7
CD (p= <0.01) (p= <0.05)	2.36 1.62	0.22 0.15	3.2 2.2	NS	1.62 1.11	0.41 0.28	0.59 0.41	NS

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

A novel feed formulation has been prepared based on Selenium and Zinc and their nanoparticles with fisheries waste. An experiment has been conducted on selenium nanoparticles (Se-NPs) and Zn-NPs for improvement in growth performance, antioxiadtive status and finally immunity of fish reared under lead (Pb)

and high temperature. Dietary Se-NPs @ 1 mg kg^{-1} and Zn-NPs @ 10 mg kg^{-1} diet showed a novel result that growth performance improved up to 150-180%, improved antioxidative status, neurotransmitter enzymes, stress marker and more importantly enhanced immunity of the fish. In addition, after bacterial infection *Aeromonas veronii biovar sobria*, the relative % survival increased and cumulative mortality has been decreased in the Se-NPs @ 1 mg kg^{-1} and Zn-NPs @ 10 mg kg^{-1} diet group. Pb and high temperature treated and fed with control diet has devastating the growth performance, antioxidative status, stress markers and immunity of the fish. Overall results indicated that, Se-NPs @ 1 mg kg^{-1} and Zn-NPs @ 10 mg kg^{-1} diet have ability to enhanced overall performance and mitigate abiotic and biotic stress in *Pangasius hypophthalmus*. Hence Se-NPs and Zn-NPs have ability to develop green chemistry in feed industry for better growth performance of fish. The Zn-NPs were also evaluated on thermal stress in *Pangasius hypophthalmus* reared under concurrent exposed to lead (Pb) and elevated temperature (34°C). Studied critical temperature minima (Ctmin), lethal temperature minima (Ltmin), and critical temperature maxima (Ctmax), lethal temperature maxima (Ltmax) and biochemical stress parameters on *P. hypophthalmus*. The results indicated that, noticeable being increased in the Ctmin, Ltmin and Ctmax, Ltmax of Zn-NPs supplemented groups and prior exposure to temperature group. Positive correlations were observed between Ctmin and Ltmin (Y= -0.495+10.08x, R^2, 0.896) and Ctmax and Ltmax (Y= -0.872+4.43x, R^2, 0.940). At the end of the thermal tolerance study, oxidative stress and lipid peroxidation (LPO) were noticeable reduced and neurotransmitter enzyme was significantly increased in the groups fed Zn-NPs 10

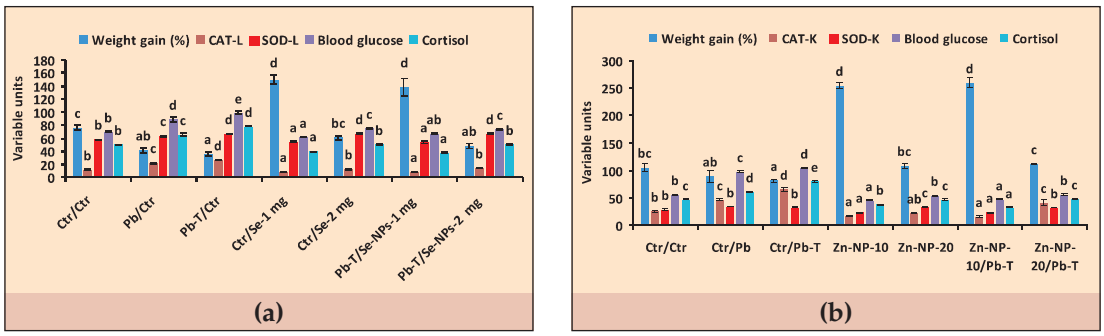


Fig. 2.37. Effect of dietary selenium nanoparticle (Se-NPs) (a) and Zn-NPs (b) on Weight gain (%), catalase and SOD in liver, blood glucose and cortisol. Catalase and SOD: units/mg protein, blood glucose: mg/dl, cortisol: ng/ml

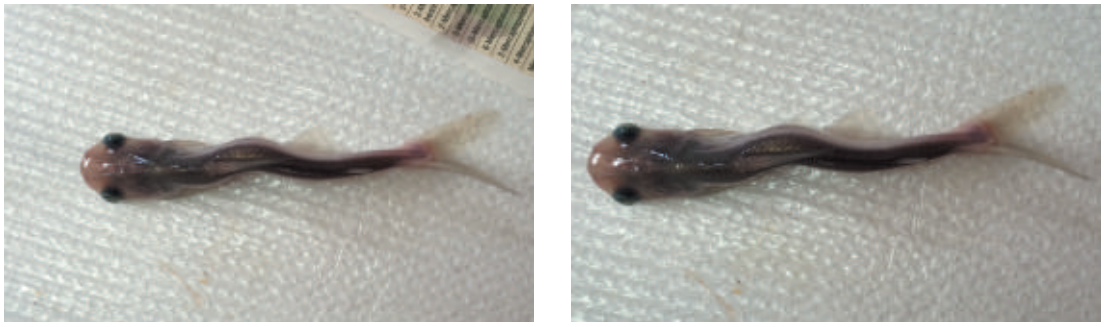


Fig. 2.38. The fish showed vertebral deformities such as scoliosis (abnormal lateral curvature) and lordosis (excessive inward curvature) in Pb and high temperature exposed and fed with Zn free diet

mg and 20 mg kg^{-1}. Overall results indicated that dietary Zn-NPs can confer protection against thermal stress in *P. hypophthalmus*.

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

Antioxidative status, cellular metabolic stress and neurotransmitter enzyme assay as a pollution biomarker in *Oreochromis mossambicus* collected from Bhima river were investigated. *O. mossambicus* was collected from 18 different sites of Bhima River, which differ in their extent and type of contamination load. The antioxidative status were determined such as catalase (CAT), superoxide dismutase (SOD) and glutathione-s-trasferase (GST) in the liver, gill, brain, gonad and kidney. The cellular stress enzymes such as lactate dehydrogenase (LDH), and malate dehydrogenase (MDH) in liver, gill, brain, gonad and muscle were remarkably ($p<0.01$) elevated in *O. mossambicus* collected from Bhima river. The brain acetylcholine esterase (AchE) was noticeably inhibited ($p<0.01$) whereas lipid peroxide (LPO) elevated in fish collected from a few sites. We also used morphological study as biomarkers indictaors such as condition factor (CF), hepatosomatic index (I) and gonadosomatic index (GSI). The results of condition factor and gonadosomatic index are significantly ($p<0.01$) poor and hepatosomatic index was significantly ($p<0.01$) elevated in *O. mossambicus*. The finding of the present investigation provides a rational application of oxidative stress, cellular stress, neurotransmitter, lipid peroxide and some morphological parameters to be used as biomarkers for biomonitoring the contamination of trace elements in polluted aquatic environment. In another study in fourteen metals namely chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), selenium (Se), arsenic (As), strontium (Sr), cadmium (Cd), tin (Sn), antimony (Sb), mercury, (Hg) and lead (Pb) has been studied in freshwater mollusk, *Lamellidens marginalis* in Dhimbe reservoir. In addition, we have also studied the cellular and anti-oxidative status to assess metals contamination as pollution biomarkers has also been studied.

The study has been conducted to delineate 96 h median lethal concentration of lead (Pb) heavy metal alone and in combined with high temperature (34°C) by conducting static non-renewable acute toxicity bio-assay in *Pangasius hypophthalmus* (average weight 3.65 ± 0.75 g). Further, the effect of different definitive doses (80, 82, 84, 86, 88 and 90 mg L^{-1}) of Pb alone and high temperature on cellular metabolic response were probed. The LC_{50} of lead was found to be 84.93 mg L^{-1} and in combination with high temperature 83.10 mg L^{-1} in *P. hypophthalmus*. In another study based on selenium (Se) and Se-NPs on toxicity at higher concentration, lethal concentration (LC_{50}) of Se, has been determined to be 5.29 and 3.97 mg L^{-1} in Se and Se-NPs respectively at 96 h in *P. hypophthalmus*. Oxidative stress, neurotransmitter enzymes and other cellular biochemical attributes at different concentration of Se and Se-NPs have also been studied. The histopathology of liver and gill were also studied which indicates several alterations such as large vacuole, cloudy swelling, focal necrosis, and interstitial oedema, necrosis in liver and thickening of primary lamellae epithelium and curling of secondary lamellae. The present study suggests that at higher concentration of trace elements in both form (inorganic and nano form) could create toxicity.

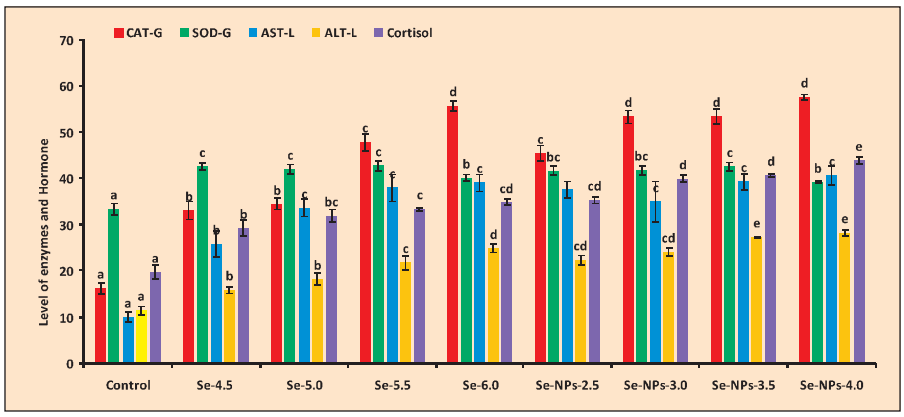


Fig. 2.39. Effect of dietary selenium and Se-NPs on catalase and SOD gill and Aspartate amino transferase and alanine amino transferees during 96 hr LC_{50} in *Pangasius hypophthalmus*

Table 2.11. Median lethal concentration (LC_{50}) and cumulative mortality (%) of *Pangasius hypophthalmus* exposed to different concentrations of lead (Pb) alone and in combination with temperature (34°C) for period of 96 h

Period of exposure (h)	R^2 Value	LC_{50} (mg L^{-1})	95 % confidence interval		S-value	Safe level	Intercept	Slope
			Lower	Higher				
24	0.78	91.70	89.29	98.22	1.04	24.48	-5.07	0.09
48	0.88	88.20	86.65	91.12			-6.53	0.12
72	0.76	86.55	85.11	88.68			-12.01	0.20
96	0.87	84.93	83.48	86.40			-15.63	0.25
Treated with 34^{0}C Temperature								
24	0.75	99.93	91.95	111.23	1.14	20.19	-0.41	0.02
48	0.85	87.59	85.78	91.35			-14.60	0.21
72	0.87	84.78	82.79	86.74			-13.26	0.21
96	0.79	83.10	80.80	84.61			-14.36	0.24

3. Tribal Sub-Plan

Activities related to improved technology interventions in field crop and horticulture crops, livestock and poultry, fisheries and integrated farming have been undertaken in various villages of Navapur Tehsil in Nandurbar District for improving the livelihood of resource poor farmers as part of Tribal Sub-Plan (TSP). Procurement of following inputs for distribution to tribal farmers have been facilitated: Planting materials (rice seeds, dragon fruit cuttings, tissue culture banana plants, baby corn seeds, onion seeds, chili seed, other vegetable seeds), fertilizers, insect net, mulching paper, poultry cages, chicks, poultry feed, waterers, feederers, vitamin mineral mixture, goats, IMC fingerlings, fish feed, feed pelletizers and grinding machines, ice boxes, aerators, power tillers with accessories, soil analysis kit, multi-purpose containers, milk cans, feeding buckets, agricultural sprayers, compost production units, and other miscellaneous items. Four training programmes, and six exposure visits were conducted. Improved technology interventions led to higher production/marketable yield of rice (6-10 tonnes ha^{-1}), Sugarcane (40-75 tonnes $acre^{-1}$), onion (25-68 tonnes ha^{-1}), banana (15,000-27,000 kg $acre^{-1}$), baby corn (4 tonnes $acre^{-1}$), milk (Av. 108–188 L $month^{-1}$), and fish (>2000 kg ha^{-1}). Improved technology interventions in goat farming as backyard enterprise and dragon fruit cultivation as kitchen gardening are also undertaken for livelihood improvement of tribal farmers.

Improved technology interventions in field crops

More than 100 tribal farmers of various villages from Navapur Taluka of Nandurbar (MS) were selected under TSP for on-farm demonstration of improved rice production technology suitable for the area. HYV seeds of rice var. Indrayani and Phule Samruddhi were distributed to the farmers. Fertilizer briquettes were supplied to all the beneficiaries.

Farmer's participatory demonstration on "water efficient crop production technology in sugarcane" was planned and discussed with the farmers. More than 100 beneficiaries were selected from 16 villages. Regular monitoring of progress in sowing and management of sugarcane crop was done through training, interaction with individual farmers and farmers group. Most of the selected farmers adopted improved method of planting along with drip system of irrigation.

Organization of farmer's field day

To showcase the Farmers Participatory demonstrations on"Four point rice production technology" to the farmers of adjoining village/area under TSP at Navapur, a "Farmers Field Day on Rice" was organised at Mugdhan village of Navapur Taluka on 2nd November 2016 where more than 150 farmers from various villages namely; Mugdhan, Gadad, Savrat, Kukran, Pimpran, Vaghalapada, Nagzhri, Bhardu and Karanji Khurd was participated in the programme and shared their views through discussions.

To showcase the Farmers Participatory demonstrations on "Water efficient crop production technology in sugarcane" to the farmers of adjoining village/area, a

"Farmers Field Day on Sugarcane" was organised at Karanji Bk village of Navapur Taluka where more than 150 farmers from various villages participated in the programme which provided enough opportunity to a large number of farmers to exchange their ideas and at the same time also helped in making awareness about efficient use of water among farmers of the project area.

(a)

(b)

Fig. 3.1. Monitoring of rice demonstration fields and Farmer's field day on sugarcane crop

Improved technology interventions in horticulture crops

Implementation of improved technology intervention in fruit and vegetable crops led to adoption of cultivation of virus free tissue culture banana (var. Grand Nain), rabi onion (var. Bhimakiran) and late kahrif onion (Bhimashakti) in Navapur villages. On the 15th February 2017, exposure visit related to precision farming and micro-irrigation systems, agro-products and cultivation of tissue culture plants were organised at Jain Irrigation Jalgaon District. Activities related to implementation of improved technology interventions in horticulture crops have been expanded. Dragon fruit cuttings/saplings were also distributed to tribal farmers for kitchen gardening / backyard farming.

(a)

(b)

Fig. 3.2. Monitoring of banana demonstration fields and exposure visit of tribal farmers

Set up of Backyard Poultry Demonstration units

Small and landless tribal farmers, particularly womens groups, were selected for this intervention. 150 fabricated poultry cages along with 20 Giriraja chicks were distributed to tribal farmers from villages of Navapur tehsil. All these farmers were provided with poultry feed, feeders and waterers. Training programme was organized on 14th February 2017 for 300 beneficiary farmers regarding scientific management of their birds.

(a)

(b)

Fig. 3.3. Training to tribal farmers regarding backyard poultry management and distribution of cages, feed and poultry birds by Hon'ble Member of Parliament, Nandurbar

Establishment of Goat Farming units

For upliftment of livelihood of tribal farmers from Navapur and Dhadgaon tribal areas goat farming units were established. 44 goat farming demonstration units consisting one male and four females were established in different villages of Navapur and Dhadgaon tehsil. Four training programme cum exposure visits were also organized for 177 tribal farmers regarding scientific management of goats at KNP college of Veterinary Science, Shivral on 6-8, 9-11, 20-22 and 23-25 March, 2017.

Fig. 3.4. Distribution of goats to tribal farmers

Fig. 3.5. Organization of goat farming training for tribal farmers

Improved technology interventions in fisheries

Six villages of Navapur Taluka namely Karanji, Bhomdipada, Borepada, Jamtalav, Chowky and Chitvi were selected for IMC aquaculture. Indian major carp (IMC) fingerlings (size 5-6 g) were stocked in farm/fisheries ponds (stocking density @ 10,000 ha^{-1}). Research on fish ponds led to the optimal water quality and plankton primary productivity. In order to control ammonia level, zeolite (stilbite) trapped with

silver nanoparticles was applied in the pond. This has helped in alleviation of multiple abiotic and biotic stresses in the pond with the result of higher fish production.


Fig. 3.6. Exposure visit and training programme related to fisheries activities

Training programmes on "Nutritional management in fisheries and livestock for livelihood improvement of tribal farmers" were conducted on 17-18 Sept 2016, where 200 Tribal farmers from Navapur villages participated and benefitted. Farmers were given training on farm pond preparation, water quality management, fertilisation of ponds, primary productivity, procurement of IMC seeds from nearby hatchery, feeding and nutrition, harvest and post-harvest technologies, fish marketing and integrated agri-aquaculture. Exposure visit on fish and prawn farming and their management was organized for 38 tribal farmers of Navapur tehsil of Nandurbar District at KVK-Navasari on March 25, 2017. In addition, a training programme on method for Fish feed formulation and preparation was conducted at Navapur tehsil on March, 26, 2017 for about 100 tribal farmers who expressed their happiness with the wide exposure received and huge beneficial impact of ongoing TSP activities related to successful implementation of integrated agri-aquaculture.

Farm Input Distribution among Tribal Farmers

Various inputs were distributed among tribal farmers alongwith conduct of exposure visits and training programmes. These inputs were distributed in the presence of Dr Heena Gavit, Hon'ble Member of Parliament, Nandurbar, Dr Vijay Kumar Gavit, Hon'ble Member of Legislative Assembly, Maharashtra and Dr N.P. Singh, Director ICAR-NIASM and Dr K.K. Krishnani, Chairman-TSP in the various programmes organized at Navapur taluka.


Fig. 3.7. Distribution of inputs by Hon'ble MP Nandurbar and Director ICAR-NIASM

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4. Mera Gaon Mera Gaurav

MGMG Programme

ICAR-NIASM, Baramati MGMG teams identified the general problems namely, water scarcity, roads, animal disease, marketing of agricultural goods, irrigation, soil quality and, information on newer technologies. Issues regarding agriculture were scanty rainfall, drought, water salinity, non availability of water storage tank, subsidy for water storage tank, sugarcane trash burning, higher tiller mortality and lower cane yields of sugarcane ratoon and excess and imbalanced use of fertilizer, problem soils, poor drainage, soil sodicity and salinity, quality seed availability, frequent and intermittent drought, post-harvest and storage of farm produce, nutrient deficiencies. Altogether 34 visits were made under Mera Gaon Mera Gaurav program in all identified villages (Khor, Kusegaon, Roti, Hinganigada, Diksal, Sonkaswadi, Kanadwadi, Waky, Jalkewadi, Sanghavi, Kambaleshwar, Pandare, Pavanewadi, Manapawadi, Belwandi, Rakshaswadi, Baradgaon dagdi, Lakdi, Nimbodi, Shindewadi, Bori and Kazad). Frequent interaction and demonstrations were conducted during the whole year in which 1393 farmers were involved and got benefited. In addition to it, 41 Goshtis/Interface meetings were also conducted in these villages which involved 701 farmers; 147 farmers were trained through 6 training programmes; 157 mobile advisories were communicated to 250 farmers.

Various awareness programmes were organized and farmers were made aware through literature support in Marathi about Pradhan Mantri Fasal Bima Yojna, Soil Health Card Scheme, dragon fruit an alternative option for water scare areas, pomegranate management during drought period, shinghi breeding, poultry and cattle management. In these programmes 1344 no. of farmers participated. Proper linkages were developed with State Agriculture Department, KVK Baramati, NGOs, Nathson Farmer Producer Company, Department of Animal Husbandry, Local Revenue department and Taluka Agriculture Officer. MGMG teams created awareness in farmers regarding diversification of crops i.e dragon fruit and drumstick under water scarcity areas; Jalyukta Shivar scheme of Government of Maharashtra; Conservation agriculture for enhancing resource-use efficiency and environmental quality; avoidance of sugarcane trash/crop residue burning; integrated farming system involving horticulture crops, livestock, poultry and fisheries for livelihood security; vaccination in livestocks; integrated nutrient management; organic farming; soil test based nutrient application; pond preparation for insitu water conservation; pest and disease management; micro-irrigation strategies for efficient water management; fish seed production and management; post-harvest quality management and Marketing.

Director, ICAR-NIASM regulary monitored the ongoing activities being undertaken under this program. He visited Shindewadi village and interacted with group of farmers mainly associated with cultivation of Grape and Pomegranate for export purpose. He also discussed about the Dragon Fruit - a potential crop fopr water scarce regions as it requires substantially less water as compared to Grape and

Pomegranate. To promote this crop one day training program cum exposure visit was organised at ICAR-NIASM in which 118 farmers from 23 villages got benifitted.

(a)

(b)

(c)

(d)

Fig. 4.1. Director, ICAR-NIASM interacting with farmers of MGMG adopted villages (a), exposure visit of dragon fruit for water scarce areas (b), Farmers' field day (c) and Farmer's meet (d)

5. Meetings

ITMU

Institute Technology Management Unit (ITMU) has been established at ICAR-National Institute of Abiotic Stress Management (ICAR-NIASM) to facilitate the management of various technologies developed by the institute and Intellectual Property Right (IPR) related issues. Institute Technology Management Committee (ITMC) is the highest decision making body at the institute which oversee the activities of ITMU. The novel tools, technologies, products, varieties and practical methods developed by the institute are being registered at National Agencies and documented at ITMU. The management, transfer of technologies and its dissemination to the farming community is co-ordinated by the ITMU.

Objectives

- To pursue all Intellectual Property (IP) protection, maintenance, transfer and commercialization related matters at the institute level following ICAR guidelines and any other administrative or policy decisions taken by ICAR from time to time.
- To create awareness about IPR's.
- To facilitate commercialization of technologies.
- To accelerate technology development and utilization by the entrepreneurs for commercialization of agricultural technologies.
- To provide prior art search/patent search to staff of the institute.
- To collect and document literature related to agricultural technologies.

Activities of the ITMU

- The Unit is working on behalf of institute for registration of technologies as Patents, Trademark, Copyright, Plant breeder rights and Geographical indication at Mumbai Registry Office.
- Actively involved in providing information, orientation related to different IPR issue and facilities to institute researchers and scientists.
- Organization of IPR awareness programmes in collaboration with other ICAR institutes.
- Collection and documentation of the literature related to IPR and Agricultural Technology.

Salient Achievements

Institute Technology Management Committee (ITMC) was constituted as per the guidelines of IP & TM unit, ICAR, New Delhi on 5th Oct, 2016. First meeting of ITMC was conducted on 7th October, 2016 at ICAR-NIASM. It was decided to register institute logo as Trademark under Class 31 & 44, which covers product and services

of the institute, at the office of Controller General of Patents, Designs & Trademarks, Mumbai.

Fig. 5.1. ITMC meeting of ICAR-NIASM held on 7th October 2016

Potential technologies developed by the ICAR/ICAR-NIASM suitable for this area were identified for commercialization given as under:

Fig. 5.2. Dragon fruit: Wonder crop for degraded and water scarce area

Enhancing profitability from ratoon sugarcane with efficient management of sugarcane waste (Trash) and improved ratoon management practices by using a multi-purpose "SORF Machine"

Fig. 5.3. Stubble shaving, Off-barring, Root pruning and Placement of basal dose of fertilisers

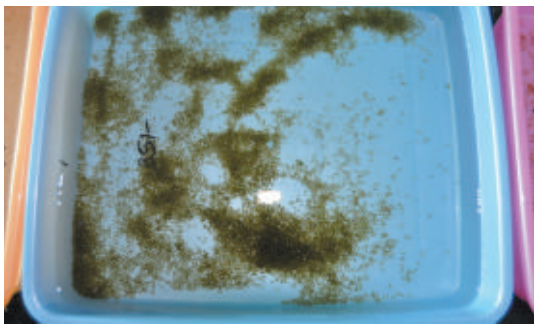

Fig. 5.4. Breeding and seed production of stinging catfish, *Heteropneustes fossilis* (Singhi)

Information on these technologies was collected, documented and published for its popularization among the farmers through various outreach programmes of institute such as Mera Gaon Mera Gaurav (MGMG) and Tribal Sub- Plan (TSP). Application for registration of Trademark of ICAR-NIASM was filed at Trademark Registry Office Mumbai. A Technical Folder on "Role and Achievements of ITMU" was published (Technical Folder No. 13). Farmer's training cum exhibition programme on "Promotion of dragon fruit cultivation as kitchen gardening in semi-arid region of Maharashtra" was organised on 25th March, 2017 at ICAR-NIASM, Baramati. More than 100 farmers from various villages of Baramati and Indapur taluka of Pune district (MH) selected under MGMG programme of ICAR participated in the training programme. This programme was conducted as follow up action of ITMC meeting on 7th October 2016 for scaling-up of dragon fruit cultivation in Maharashtra in association with other scientists of the institute.

Experts Consultation meeting

Having spent its initial seven years in developing infrastructure and research facilities, this unique institute is now ready to expand its preliminary research into full-fledged projects on abiotic stress in crops, livestock and fisheries. Since every research institute associated with agriculture is giving due priority to this aspect, it was decided to have a close interaction between the scientists and experts to develop a road map through consultation meeting. Therefore, Consultation meeting was organized at ICAR-NIASM during January 30-31st 2017, Baramati, to know about abiotic research in progress at other institutes, expectations of other institutes from ICAR-NIASM and possible opportunities for research collaboration to avoid duplication and to establish synergy in achieving the common goal of abiotic stress management for the cause of farmers in harsh environments. The theme of the meeting had a distinct relevance to the ICAR-NIASM mandate of undertaking basic and strategic research on management of abiotic stresses of crop plants, animals, fishes and microorganisms through genetic, biotechnological and nano-technological tools and through conservation agriculture methods for enhanced and sustainable productivity, food/feed quality and farm profitability through inter-disciplinary and inter-institutional approaches. The brain storming session included presentation by experts in wide range of discipline with focus on efforts to understand abiotic stress environment, options for mitigation of stress, approaches for improving adaptation to stress and policy support for adoption of technologies. There were 5 sessions including

the inaugural and plenary sessions. The other three sessions were carried out in parallel involving three groups of expertise viz. Natural Resource Management, Crop and Horticultural Sciences and Animal and Fisheries Sciences. Each session had a brief key note address followed by brief presentation and detailed discussion. About 40 participants including those from institute participated in this meeting. During meeting, the discussions were largely oriented towards the priorities in abiotic stress research, mitigation and adaptation options for management of abiotic stresses and way forward for future research and education.

Fig. 5.5. Organisation of Brainstorming session on Abiotic Stress Management

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6. Awards and recognition

- Dr K.K Krishnani has been awarded the Fellow of the National Academy of Sciences at National Academy of Sciences during 4-5, June 2016.
- Dr Prashantkumar S Hanjagi received 1 gold (200 m race) and 1 Silver medal (400m race) and 1 bronze medal (1500 m race) in ICAR Zonal sports Meet (West Zone) held at ICAR-NRCC, Bikaner, Rajasthan, during September, 24-27, 2016.
- Dr D D Nangare received the best poster award for his paper 'Influence of Plant growth regulating chemicals on recovery response to waterlogging in onion' in International meet and 7th Indian Horticulture congress 2017 held at IARI during October, 15-18, 2016.
- Dr Yogeshwar Singh received best poster award for presenting his paper "Impact of spent wash and cropping sequence in conversion of barren basaltic gravelly land into cultivation, during International Conference on "Integrated land Use Planning for Smart Agriculture – An Agenda for Sustainable Land Management" held at ICAR-NBSS&LUP, Nagpur, during November 10-13, 2016.
- Dr Yogeshwar Singh best research paper award for the oral paper 'Dragon fruit: Wonder crop for degraded and water scarce-areas' during International conference on 'Climate change adoption and biodiversity: Ecological sustainability and resource management for livelihood security' held at ICAR-CIARI, Portblair, during December 8-10, 2016.
- Dr S.K. Bal nominated as a Member of the Executive Council for Association of Agro meteorologists, Anand.
- Dr Neeraj Kumar received the best Publication of the Year award for 2015-2016 in ICAR- Central Institute of Fisheries Education (CIFE), Mumbai on June 06, 2016.
- Dr Neeraj Kumar selected as a member of Editorial Borad for – Clinical Nutrition and Dietetics, EC Nutrition, International Journal of Agricultural Science and Food Technology, International Journal of Drug Research & Technology.

(a)

(b)

Fig. 6.1. Dr K.K. Krishnani - Fellow of the National Academy of Sciences (a), Dr R.L. Choudhary - Best Oral Presentation Award (b)

- Dr R L Choudhary received the best Oral Presentation Award for the research paper entitled "Innovation and scope in summer mungbean cultivation for sustainable diversification of sugarcane cropping system in peninsular India", in National symposium on "Advances in Agriculture through Sustainable Technologies and Holistic Approaches" held at Panjim, Goa, during February 15-17, 2017.
- Mr U M Bitla received the best poster award in 5th national seminar on climate resilient saline agriculture: sustaining livelihood security-2017 held at SK Agricultural University, Bikaner during 21-23 January, 2017.

7. Linkages and Collaborations

Research institute	Areas identified for research collaboration
ICAR-IARI, New Delhi KVK, Malegaon ICAR-NBAIM, Mau ICAR-NRCG, Pune IISc, Bangalore	• Identification of micro-organisms for drought tolerance
ICAR-CIFE, Mumbai ICAR-CIFRI, Barrackpore	• Abiotic and biotic stress management in fisheries and aquaculture
MPKV, Rahuri	• Conservation agriculture • Collaboration in academic program and post graduate research • Genetic enhancement of crop productivity by using modern tools
ICAR-IISS, Bhopal	• Conservation agriculture in sugarcane based cropping system.
ICAR-CIRC, Meerut	• Study of genetic polymorphism of heat shock protein genes in indigenous and crossbreed cattle
ICAR-NBPGR, New Delhi	• Screening wheat, common bean and mungbean germplasm for drought and high temperature stress tolerance
NICRA, ICAR-CRIDA, Hyderabad	• Phenotyping pulses for tolerance to soil moisture stress
ICAR-NBAIM, Mau Nath Bhanjan	• Functional charaterisation of salt tolerant bacteria using multi omics approaches and their exploitation for alleviation of salt stress in crop plants
ICAR-IIPR, Kanpur PAU, Ludhiana	• Screening mungbean germplasm
CCSHAU, Hisar; RAU, Bikaner; MPKV, Rahuri	• Screening cluster bean germplasm for drought tolerance/ responsive traits
IISR, Indore	• Screening soybean germplasm for drought tolerance
ICAR-IIW & BR, Karnal	• Screening wheat germplasm for drought and high temperature stress tolerance
ICAR-IISR, Indore; University of Delhi, New Delhi	• RNAi and VIGS for drought and heat stress tolerance in Soybean crop
VSBT, Baramati	• Biotechnology and nanotechnology based research program
TC College, Baramati	• Collaborative research with focus on drought/ water quality/salinity tolerance mechanisms in plants/fish stress mitigation

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8. Publications

Institute Publication

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9. Participation in Meetings/Conferences/ Workshops/Trainings

Participation in winter schools/ seminars/ workshop/ lectures/ conferences/ meetings/ trainings/ exhibitions

Name	Event	Place	Date
Dr K.K. Krishnani Dr Neeraj Kumar	3rd International IUPAC Conference on Agrochemicals Protecting Crops, Health and Natural Environment: New Chemistries for phytomedicines and Crop protection Chemicals	NASC, New Delhi	April 6-9, 2016
Dr D.D. Nangare	Kisan Sabha	Grampanchayat office, Dhakale, Baramati, Maharashtra	April 22, 2016
Dr Sunayan Saha	Workshop on DST's Knowledge Network on Climate Chage and Agriculture	New Delhi	April 28-29, 2016
Mr Paritosh Kumar	Professional attachment training	ICAR-IARI, New Delhi	May 23-22 Aug 2016
Mrs S. Bandela	Professional attachment training	PJTSAY, Hyderabad, Telangana	May 28-30 Aug 2016
Dr Yogeshwar Singh	Global Conference on Perspective of Future challenges and options in Agriculture	JSIL, Jain Hills, Jalgaon, Maharashtra	May 28-31, 2016
Mr Rajkumar	Professional attachment training	ICAR-IIHR, Bangalore	June 06-05 Sep 2016
Dr K.K. Krishnani	Pre RMPManagement development programme on Leadership Development	ICAR NAARM, Hyderabad, Telangana	June 7-18, 2016
Dr K.K. Meena	AMAAS Project	NASC, New Delhi	July 07-08, 2016
Mr Pravin More Mr Pardeep Kumar Mr M.S. Bhatkar	Implementation of NIC's e-procurement solution through CPP portal	ICAR-NDRI, Karnal, Haryana	July to 21-22, 2016
Mr Sunil Potekar	Agro meteorological Data Collection, Analysis and Management	ICAR-CRIDA, Hyderabad, Telangana	July 25-August 6, 2016
Dr Mahesh Kumar	Bringing Self-sufficient in Pulses for Eastern India	Bihar Agric. University, Sabour, Bihar	August 5-6, 2016

Name	Event	Place	Date
Mr V. Rajagopal	International conference on Agriculture, Food Science, Natural Resource Management and Environmental Dynamics: The Technology, People and Sustainable Development	BCKV, Kalyani, West Bengal	August 13-14, 2016
Dr D.D. Nangare	Training on Analysis of experimental data	ICAR-NAARM, Hyderabad, Telangana	August 18-23, 2016
Dr P.B. Taware	Annual function of Maharashtra Rajya Draksha Bagaitdar Sangh	Balewadi, Pune, Maharashtra	August 26-28, 2016
Dr D.D. Nangare	Kisan Sabha	Gram Panchayat office, Loni Bhapkar, Maharashtra	September 6, 2016
Dr K.K. Meena	BISmis	CSIR-NCCS, Pune, Maharashtra	September 12-15, 2016
Mr Santosh Pawar	Project Management	National Council for Training and Social Research, New Delhi	September. 21-23, 2016
Dr Jagadish Rane Dr V. Rajagopal	Development in Soil Science: Climate change and its influence in natural resource management	BSKKV, Dapoli, Maharashtra	September 22-23, 2016
Dr Mahesh Kumar	Training & awareness workshop on J-gate@CeRA for Western region states	ICAR-DKMA; NAU, Navsari, Gujarat	October, 8 2016
Dr N.P. Singh	3rd AAHP Convention and National Symposium on Poultry Health and Welfare: Riding the wave to the future at Goa	ICAR-CCARI, Goa	October 16-21, 2016
Dr R.L. Choudhary	Mid-term review meeting of CRP on CA projects	NRM Division, ICAR, New Delhi	October 25, 2016.
Dr N.P. Singh	Agro-Ecotourism: An emerging enterperises for agriculture Diversification as the Guest of Honour	ICAR-CCARI, Goa	December 30-01 November 2016
Dr K.K. Krishnani	National Seminar on Soil health assessment with Mridaparikshak	ICAR-IISS, Bhopal, M.P	November 4-5, 2016
Dr Jagadish Rane	Horticulture crops conference	Nashik, Maharashtra	November 5-6, 2016

Name	Event	Place	Date
Dr N.P. Singh Dr G.C.Wakchaure	2nd National Symposium on Edible Alliums: Challenges and Future Strategies for sustainable production	Indian Society of Alliums, Pune at Beej Sheetal Bio–Science Foundation, Jalna, Maharashtra.	November 7–9, 2016
Dr N.P.Singh Dr Yogeshwar Singh	International conference on Integrated Land Use Planning for Smart Agriculture – An Agenda for Sustainable Land Management	ICAR-NBSS & LUP, Nagpur, Maharashtra	November 10-12, 2016
Dr Jagadish Rane Dr R.L. Choudhary	International Conference & Exhibition on Sugarcane Value Chain-Vision 2025 Sugar	Vasantdada Sugar Institute (VSI), Pune, Maharashtra	November 13-16, 2016
Dr N.P. Singh Dr D.D. Nangare	7th Horticulture Congress 2016 on An International Meet on Doubling Farmers Income through Horticulture	ICAR-IARI, New Delhi	November 15-18, 2016
Dr A.K. Singh	Review committee meeting on ICAR-Extramural Research project	Krishi Bhawan, New Delhi	November 18, 2016
Dr N.P.Singh Dr D.P. Patel Dr Yogeshwar Singh Dr R.L. Choudhary Dr R.L. Meena	4th International Agronomy Congress on Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge	Indian Society of Agronomy, New Delhi	November 22-26, 2016
Dr N.P. Singh	VII Research Advisory Committee Meeting	ICAR-CCARI, Goa	November 27-30, 2016
Dr D.P. Patel	Training programme/ workshop for the Nodal Officers of the Public Authority under DARE/ ICAR related to RTI-MIS Online Portal	CSOI, New Delhi	November 28, 2016
Mr V. Rajagopal Dr P.B. Taware	Recent Advances in Weed Management Strategies	National Institute of Plant Health Management (NIPHM), Hyderabad, Telangana	November 29-30, 2016
Dr D.D. Nangare	Winter school on Real Time Irrigation Management using Sensor Network, Decision Support System (DSS) and Electronic Controls for Precision Agriculture in Vertisols	ICAR-CIAE, Bhopal, M.P	December 1-21, 2016

Name	Event	Place	Date
Dr K.K. Krishnani	World Soil Day	KVK, Baramati, Maharashtra	December 5, 2016
Dr S.K.Bal Dr M.P. Brahmane Dr A.K. Singh Dr Yogeshwar Singh Dr R.L. Choudhary Mr V. Rajagopal Dr Neeraj Kumar	International conference on Climate Change Adapation and Biodiversity: Ecological Sustainability and Resource Management for Livelihood Security	ICAR-CIARI, Port Blair, Andaman	December 8-10, 2016
Dr K.K. Meena	National Symposium of Indian Phytopathology Society, New Delhi	College of Agriculture, Udgir, Latur, Maharashtra	December 11-12, 2016
Dr K.K. Krishnani	International Conference Clean up India 2016 on Contaminated site remediation.	TNAU, Coimbatore, Taminnadu	December 13-15, 2016
Dr S.K. Bal	AGMET-2016: National Symposium on Agrometeorology	TNAU, Coimbatore, Tamilnadu	December 20-22, 2016
Dr N.P. Singh	Plant Genome Saviour Community Award 2013-14	New Delhi	December 21-23, 2016
Dr J. Rane	24th National Childrens Science Congress, 2016 at VIIT	Vidya Pratishthans Institute of Information Technology (VIIT), Baramati, Maharashtra	December 27-31, 2016
Dr K.K. Krishnani	Participated in NAAS Get-together meeting/General Discussions.	NAAS, New Delhi	January 2, 2017
Dr N.P. Singh	Stakeholder's Consultation Meeting for doubling the farmers' income by 2022	Pune, Maharashtra	January 16, 2017
Dr N.P. Singh	ICAR Directors' conference	NASC Complex, New Delhi	February 13-16, 2017
Dr N.P. Singh Dr A.K.Singh Dr R.L. Choudhary	National Symposium on Advances in Agriculture through Sustainable technologies and Holistic Approaches	Dona Paula, Goa, India,	February 15-17, 2017
Dr D.D. Nangare	51st Annual Convention of Indian Society of Agricultural Engineers (ISAE), National Symposium on Agricultural Engineering for Sustainable and climate smart Agriculture	Collge of Agricultural Engineering and Technology, CCS HAU, Hisar	February 16-18, 2017

Name	Event	Place	Date
Dr D.D. Nangare Mr V. Rajagopal	13th National Agriculture Science Congress-2017	UAS, Bangalore	February 21-24, 2017
Dr K.K. Krishnani	Workshop "Microbiovision 2017"	ShardaBai Pawar Mahila Mahavidyalaya, Baramati, Maharashtra	February 27, 2017
Dr N.P. Singh	National conference on "Perspective ofchallenges and options in maize production and utilization	DRPCAU, Pusa, Samastipur, Bihar	March 03-05, 2017
Dr J. Rane Dr Yogeshwar Singh Dr D.D. Nanagre	National Seminar on Pomegranate	Market Yard, Pune, Maharashtra	March 18-19, 2017

Teaching/ training/ conducting programmes/ workshops/ seminars

Name	Event	Title	Date
Dr N.P. Singh Dr K.K. Krishnani Dr N P Kurade Dr Neeraj Kumar Dr A V Nirmale	Training programme	"Nutritional management in livestock and fisheries for livelihood improvement of tribal farmers" at Visarvadi and Navapur, Maharashtra	Sept 17-18, 2016
Dr N.P. Singh Dr D.P. Patel Dr Yogeshwar Singh Dr R.L. Choudhary Dr R.L. Meena Dr P.B. Taware	Exhibition	Research showcase of ICAR-NIASM at 4th International Agronomy Congress at IARI, New Delhi	November 22-26, 2016
Dr N.P. Singh Dr K.K. Krishnani Dr K.K. Meena Dr R.L. Choudhary Mr V. Rajagopal	World Soil Day	World Soil Day at NIASM (Beneficiaries 75 farmers). Also participated in KVK-Baramati on the same day, Maharashtra	December 5, 2016
Dr M.P. Brahmane Dr D.D. Nangare Dr G.C. Wakchaure	State level exhibition	Maha Agro 2016, Aurangabad, Maharashtra	December 25-27, 2016
Dr M.P. Brahmane Dr Yogeshwar Singh Dr D.D. Nangare Dr S.S. Pawar Dr G.C. Wakchaure Dr P. Hanjagi	State level agricultural exhibition	Krushik 2017 at KVK, Baramati	January 18-22, 2017

Name	Event	Title	Date
Dr N.P. Singh Dr J. Rane Dr K.K. Krishnani Dr S.K. Bal Dr D.P. Patel Dr A.K. Singh Dr Yogeshwar Singh Dr Neeraj Kumar	Experts Consultation Meeting	"Management of Abiotic Stress in Agriculture: Roadmap for Future Research and Education" held at ICAR-National Institute of Abiotic Stress Management, Baramati, Pune, India	January 30-31, 2017
Dr K.K. Krishnani Dr N.P. Kurade Dr A.V. Nirmale	Training programme	Scientific management of backyard poultry farming. Backyard poultry cages and Vanaraja birds along with other poultry inputs were distributed to Tribal farmers, Nandurbar, Maharashtra.	February 14, 2017
Dr K.K. Krishnani Dr N.P. Kurade	Exposure visit	Precision farming and micro-irrigation systems, food processing plants/agro-products and cultivation of tissue culture plants at Jain Group of Agro Industries Jalgaon, Maharashtra	February 15, 2017
Dr M.P. Brahmane Dr D.D. Nangare Dr B. Sajjanar Dr A.L. Kamble Dr V. Rajagopal Mr Rajkumar	Exhibition	13th Agricultural Science Congress and India expo 2017, Bangalore, Karnataka	February 22-26, 2017
Dr K.K. Krishnani Dr N.P. Kurade Dr R.L. Meena Dr Neeraj Kumar Dr A.V. Nirmale	Exposure visits cum training programmes	Exposure visits (04), three days each related to goat farming training campaign at KNP College of Veterinary Sciences, Shirval, Maharashtra. Farmers also visited NIASM for kitchen gardening of dragon fruit and DOGR for onion cultivation, Pune, Maharashtra	March 6-8, 9-11, 20-22, 23-25, 2017.
Dr K.K. Krishnani Dr Neeraj Kumar	Exposure Visit	Aqua-farmers at KVK-Navsari, Gujarat	March 25, 2017
Dr D.P. Patel Dr Yogeshwar Singh Dr D.D. Nangare Dr A.L. Kamble Dr Mahesh Kumar Dr B. Sajjanar	One day Training cum exhibition program	Promotion of dragon fruit cultivation as kitchen gardening in semi-arid region. Technology for successful cultivation of Dragon Fruit and its marketing strategy was demonstrated by scientists of the Institute, Baramati, Pune	March 25, 2017
Dr K.K. Krishnani Dr Neeraj Kumar	Training programme	Fish feed preparation, Navapur, Maharashtra	March 26, 2017

Lectures/ Invited talks

Name	Topic	Event	Date
Dr K.K. Krishnani	Biotechnological tools for enhancing biodegradation of persistent organic compounds	3rd International IUPAC Conference on Agrochemicals Protecting Crops, Health and Natural Environment, ICAR-IARI, New Delhi	April 5-9, 2016
Dr S.K. Bal	Future Thrusts and Strategies for Agrometeorological Research	Brainstorming meeting on Future Thrusts and Strategies for Agrometeorological Education, Research and Extension in India, ICAR-CRIDA, Hyderabad, Telangana	April 29-30, 2016
Dr J. Rane	Abiotic stress management with special emphasis on drought	Brainstorming meeting on Abiotic stresses at National Academy of Agricultural Sciences (NAAS) at NASC Complex, New Delhi NASC, New Delhi	May 23, 2016
Dr S.K. Bal	Abiotic stress management with special emphasis on hailstorm		
Dr K.K. Krishnani	Abiotic stress management with special emphasis on salinity		
Dr K.K. Krishnani	Bioremediation of chemical and microbial contaminants in aquaculture – Application of molecular and nanotechnological tools	Central Institute of Fisheries Education, Mumbai, Maharashtra	May 25, 2016
Dr K.K. Krishnani	Bioremediation of aquatic contaminants using molecular tools	National Academy of Agricultural Sciences (NAAS), New Delhi	June 4-5, 2016
Dr R.L. Choudhary	Conventional v/s. conservation agricultural	Agriculture Day Program organized by Agriculture College, MPKV, Phaltan, Maharashtra	July 01, 2016
Dr K.K. Krishnani	Agri-aquaculture Integration – yet another mode of multi-trophic aquaculture and Establishment of nitrification and denitrification through bagasse assisted bioremediation in ZWEAPS	Cochin University of Science and Technology, India, Kochi, Kerala	July 23-24, 2016

Name	Topic	Event	Date
Dr K.K. Krishnani	Recent advances and molecular perspectives of microbial bioremediation in aquatic environment	ICAR sponsored training programme on Application of nanotechnology and molecular diagnostics in Fisheries and Aquaculture at ICAR-CIFA, Bhubaneswar, Orissa	July 30, 2016
Dr K.K. Krishnani	Integrated approach for assessment and remediation of contaminants in soil, water and related aquatic environment	DST sponsored Inspire Internship Camp for 200 students of various schools of Chhatisgarh at Pt. Ravishankar Shukla University, Raipur, Chattisgadh	August 12-14, 2016
Dr R.L. Choudhary	Improved agro-techniques for higher production of soybean	Farmers Training Program organized by Dept. of Agriculture, Govt. of Maharashtra at Baramati, Pune, Maharashtra	August 13, 2016
Dr N.P. Singh	Coastal agriculture in Indian context- an overview	National symposium on advances in agriculture through sustainable technologies and holistic approaches, ICAR-CCARI, Goa	January 15-17, 2017
Dr K.K. Krishnani	Recent advances in Agricultural Applications of Environmental Biotechnology	National Conference on Recent trends and opportunities in Life Sciences, Waghire College, Saswad, Pune, Maharashtra	January 24, 2017
Dr N.P. Singh	Identifying Sugarcane Genotypes for Intermittent Drought Tolerance Through Thermal Imaging and Spectral Signature	13th Agricultural Science Congress - 2017: Climate Smart Agriculture, UAS, Bengaluru, Karnataka	February 21-24, 2017
Dr N.P. Singh	Abiotic stress management in maize crop and its future outlook	National conference on Perspective Challeneges and Options in Maize Production and Utilization, DRPCAU, Pusa, Samastipur, Bihar	March 03-04, 2017

Name	Topic	Event	Date
Dr K.K. Krishnani	Environmental and health management of aquaculture using molecular techniques	Winter school on current trends in molecular diagnosis for better health management in aquaculture at ICAR-CIFA, Bhubaneswar, Orissa	March 04, 2017
Dr D.D. Nangare	Dragon fruit cultivation and management	236th monthly seminar for farmer's, KVK, Jalna, Maharashtra	March 05, 2017
Dr. Yogeshwar Singh	Production technology of Dragon fruit – A wonder crop for water scarce area	One day training cum exhibition program on "Promotion of dragon fruit cultivation as kitchen gardening in semi-arid region of Maharashtra" at ICAr-NIASM, Baramati, Pune, Maharashtra	March 25, 2017
Dr D.D. Nangare	Water management in Dragon fruit		
Dr A.L. Kamble	Marketing management of Dragon fruit		
Dr. Mahesh Kumar	Nutritional aspects of Dragon fruit		

Patent Applied

Patent Granted

Krishnani, K.K. Molecular tool for the detection of chemolithoautotrophic bacteria (Application No.2021/CHE/2008, GRANT No 275528).

Patent Complete specification submitted

Meena, K.K., Sorty, A.M., Krishnani, K.K. and Minhas, P.S. Development of a microbially derived polymeric product for gel formation, microbial colonization, and metals binding. Patent Application No. 3127/MUM/2015

Patents under Examination

Sarkar, B., Maurya, U., Brahmane, M.P., Krishnani, K.K. and Minhas P.S. Process for one step synthesis of bactericidal silver nanoparticles from tissue extracts of *Labeo rohita.* Application No. 3255/MUM/2012.

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10. Important Events

हिन्दी दिवस 2016

संस्थान में राजभाषा हिन्दी के प्रयोग को बढ़ावा देने हेतु हिन्दी चेतना मास (01 से 30 सितम्बर 2016) का आयोजन किया गया। इस कार्यक्रम का उद्घाटन दिनांक 1 सितम्बर 2016 को मुख्य अतिथि श्री अनिल कुमार वलीव, उप–परिवहन अधिकारी, उप–प्रादेशिक परिवहन कार्यालय, बारामती की उपस्थिति में सम्पन्न हुआ। इस दौरान कार्यालय में हिन्दी में लेखन, टंकण एवं बातचीत को बढ़ावा देने के लिए विभिन्न प्रतियोगिताओं जैसे– हिन्दी टिप्पण लेखन, हिन्दी निबंध लेखन, अंग्रेजी से हिन्दी में अनुवाद, हिन्दी गायन प्रतियोगिता, कम्प्युटर पर यूनिकोड में हिन्दी टंकण प्रतियोगिता, हिन्दी सामान्य ज्ञान प्रतियोगिता, हिन्दी कविता पाठ एवं वाद–विवाद इत्यादि प्रतियोगिताओं का आयोजन किया गया। स्थानीय स्कूल एवं कालेज के विद्यार्थियों के बीच राजभाषा हिन्दी के प्रयोग को बढ़ाने के लिए वाद–विवाद प्रतियोगिता का भी आयोजन किया गया जिसमें बारामती के आस–पास के स्कूल एवं कालेज से बड़ी संख्या में विद्यार्थियों ने भाग लिया। दिनांक 14 सितम्बर 2016 को हिन्दी दिवस के रूप में मनाया गया जिसमें श्री सुरजीत कुमार साह, मुख्य प्रबन्धक, भारतीय स्टेट बैंक, बारामती, मुख्य अतिथि के तौर पर शामिल हुए। संस्थान के निदेशक एवं राजभाषा कार्यान्वयन समिति के अध्यक्ष, प्रो. नरेन्द्र प्रताप सिंह ने अपने अध्यक्षीय भाषण में संस्थान के दैनिक कार्यो में राजभाषा हिन्दी के प्रयोग को बढ़ावा देने के साथ–साथ एक हिन्दी पत्रिका के शीघ्र प्रकाशन पर भी बल दिया। कार्यक्रम का समापन एवं पुरस्कार वितरण समारोह 03 अक्टूबर 2016 को प्रो. नरेन्द्र प्रताप सिंह, निदेशक, राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान की अध्यक्षता में सम्पन्न हुआ। इस अवसर पर निदेशक महोदय ने विभिन्न प्रतियोगिताओं में विजयी कर्मचारियों को नकद पुरस्कार एवं प्रमाण–पत्र प्रदान किया। हिन्दी प्रोत्साहन योजना के अंतर्गत गतवर्ष के दौरान राजभाषा हिन्दी के प्रयोग में उल्लेखनीय योगदान देने वाले कर्मचारियों को भी नकद पुरस्कार एवं प्रमाण–पत्र देकर सम्मानित किया गया। निदेशक महोदय ने अपने सम्बोधन में संस्थान के राजभाषा कार्यान्वयन समिति के सदस्यों एवं सभी कर्मचारियों को हिन्दी चेतना मास व हिन्दी दिवस के सफल आयोजन एवं उनके सक्रिय भागीदारी के लिए बधाई देते हुए भविष्य में राजभाषा हिन्दी के प्रयोग में और आधिक योगदान देने का आग्रह किया। इसके साथ ही सभी वैज्ञानिकों एवं तकनीकी अधिकारियों से सभी राजभाषाओं का सम्मान करते हुए स्थानीय भाषा में अपने लेख लिखने के लिए प्रेरित किया। हिन्दी चेतना मास कार्यक्रम का समापन डा. डी. पी. पटेल, प्रधान वैज्ञानिक (पादप कार्यिकी) एवं प्रभारी हिन्दी अधिकारी के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ।

Fig. 10.1. निदेशक एवं अध्यक्ष, राजभाषा हिन्दी समिति, राअस्ट्रैप्रसं द्वारा हिन्दी दिवस समारोह का सम्बोधन

Swachh Bharat Pakhwada

Swachh Bharat Pakhwada was organized in the institute during 16-31 October 2016. Various events like swachhata oath, elocution competition, poster presentation, demonstration of solid waste management, etc was carried out during the entire period. All the staff members of the institute and students from nearby colleges actively participated in the event. The Pakhwada was concluded with prize distribution ceremony in the presence of the Director.

Fig. 10.2. Various events carried out during Swachhata Pakhwada

Celebration of National Days

Institute celebrated with great enthusiasm the Independence Day on August 15, 2016 and Republic Day on January 26, 2017 in the campus. The Director hoisted the national flag and addressed the staff members on these occasions. In his speach, director appriciated the efforts of the staff in establishing the institute and encouraged the scientist to transfer their thechnologies to farmers for improving their livelihood. Hel slo emphasized on initiating research programs related to on-farm problems faced by farmers especially in rainfed areas.

(a)

(b)

Fig. 10.3. Celebration of Independence Day (a) and Republic Day (b)

Vigilance Awareness Week

The "Vigilance Week" organized from 31st October – 5th November 2016 at the institute focused on the theme "Public participation in promoting integrity and eradicating corruption". Scientific, Technical and Administrative staff as well as senior research fellows, young professionals of ICAR-NIASM participated in the various events conducted during the week. Prof. Narendra Pratap Singh, Director, ICAR-NIASM, chaired the programme and emphasized the need to be vigilant in day to day life as well as in professional activities. Various informative talks on eradication of corruption through traditional ways like Yoga and meditation, public participation in promoting integrity and eradication corruption, observing vigilance, LTC, TA and advance and Do's and Don't's were delivered by various participants. The quiz competition on eradicating corruption and related matters elicited enthusiastic response from the participants and served as the main mode of communication about the importance of vigilance.

Fig. 10.4. Oath undertaking during vigilance awareness week

Participation in ICAR-Zonal Sport Meet (Western Zone)

ICAR-NIASM contingent consisting of 14 members have participated in various games events of ICAR- Zonal Sports Meet (Western zone) held at ICAR- NRCC, Bikaner during September 24-27, 2016. NIASM contingents participated in various games namely Volleyball, Kabaddi, Basketball, Football, Table tennis, Badminton, Chess, Shotput, Discus throw, Carrom and 200, 400, 800 and 1500 m Race from 24.09.16 to 27.09.16. Mr Prashantkumar received three medals viz., Gold, Silver and Bronze in

200, 400 and 1500 m race, respectively. Our Kabaddi and football team reached upto semi-final.

Fig. 10.5. ICAR-NIASM contingent participating in ICAR-Zonal Sports Meet and Mr. Prashant Kumar Hanjagi receiving Gold Medal in 200 m race

World Soil Day-2016

ICAR-NIASM celebrated World Soil Day at the Institute on the 5th December 2016, where more than 75 farmers from various villages near Baramati, participated in the event. Prof. Narendra Pratap Singh, Director, NIASM, gave an overview of importance of soil health cards in ensuring balanced use of fertilizers, enhancing crop productivity along with reduction in cost of cultivation and advised the gathering to popularize the soil health card based farming among all the farmers to improve the production and quality of the produce, in turn uplift the socio-economic status of the farming community. He highlighted the problems and concerns of farmers in the region. He also emphasized that relevant information may be made available in local language of farmers. Dr K K Krishnani, Head-School of Edaphic Stress Management addressed the gathering on the need for soil health assessment, soil test based nutrient recommendations, edaphic stresses and their management through integrated farming and Integrated Nutrient Management (INM).

Fig. 10.6. World Soil Day at ICAR-NIASM on 5th December 2016

Agricultural Education Day

Agricultural Education Day was celebrated at ICAR-NIASM, Baramati on 3rd December 2016 with the participation of school children along with their teachers, farmers, District Agriculture Officers, Officials from ATMA, Pune and staff of ICAR-NIASM. The programme was inaugurated by Prof. Narendra Pratap Singh, Director, ICAR-NIASM followed by his address to the ICAR-NIASM staff. The drawing

competition based on the theme of Indian Farming was conducted for the school children wherein, more than 50 school children of the Zillah Parishad Prathamik School, Malegaon Khurd, Baramati participated. The interactive meeting was organized between the scientists of ICAR-NIASM and farmers, District Agriculture Officers and Officials from ATMA, Pune. The visit of institute facilities and experimental fields at ICAR-NIASM was arranged for the farmers, District Agriculture Officers and Officials from ATMA, Pune. They were briefed about the work carried out at the institute and the experiments which are undertaken at the experimental fields.

Fig. 10.7. Agricultural Education Day at ICAR-NIASM, Malegaon, Baramati

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11. New Staff, Transfer and Superannuation

New Staff

1. Prof. Narendra Pratap Singh, Director ICAR-CCARI, Goa joined ICAR-NIASM, Baramati as Director on September 12, 2016.
2. Ms Bandela Saravanti, Scientist (Spices, Plantation and Medicinal and Aromatic Plants), joined on April 7, 2016.
3. Mr Rajkumar, Scientist (Agricultural Entomology) and Mr. Paritosh Kumar, Scientist (Environmental Science) joined on April 11, 2016.

Transfer

1. Dr. Ratna Kumar Pasala, Senior Scientist (Plant Physiology) was transferred to ICAR-Indian Institute of Oilseeds Research, Hyderabad, Talangana (Apr 16, 2016).
2. Dr B.B. Fand, Scientist (SS) Agricultural Entomology was transferred to ICAR-National Research Centre for Grapes, Pune (May 19, 2016).
3. Shri. Ram Avtar Parashar, F and AO was transferred to ICAR-Central Institute for Research on Buffaloes, Hisar, Haryana (May 31, 2016)
4. Shri. Milind S. Bhatkar, Administrative Officer took voluntary retirement from this institute w.e.f. Sep 21, 2016 (F.N)
5. Mrs. Bandela Sravanthi, Scientist (Spices, Plantation, Medical & Aromatic Plants) was transferred to ICAR–Central Plantation Crops Research Institute, Kudlu P.O., Kasaragod, Kerala (Nov 19, 2016)
6. Dr. Sunayan Saha, Scientist (Agricultural Meteorology) was transferred to ICAR-Central Potato Research Station, Model Town, Jalandhar, Punjab (Mar 31, 2017)
7. Dr. Rang Lal Meena, Scientist (Agronomy) was transferred to ICAR-Central Sheep and Wool Research Institute, Avikanagar, via Jaipur, Rajasthan (Mar 31, 2017)
8. Mr. Balusamy A, Scientist (Environmental Science) was transferred to ICAR Research Complex for NEH Region, Umroi Road, Umiam, Meghalaya (Mar 31, 2017)

Promotions/Selections

1. Dr. Manoj P. Brahmane, Senior Scientist Biotechnology (Animal Science), Dr Ajay Kumar Singh, Senior Scientist (Agricultural Biotechnology), Dr. Ratna Kumar Pasala, Senior Scientist (Plant Physiology), Dr. Biplab Sarkar, Senior Scientist (Fisheries Resource Management), Dr. Kamlesh Kumar Meena, Senior Scientist (Agricultural Microbiology), Dr. Yogeshwar Singh, Senior Scientist (Agronomy),

Dr.P. Suresh Kumar, Senior Scientist (Fruit Science) were promoted to Next Higher Grade (Rs 37400-67000+ RGP 9000/-) as recommended by the DPC meeting held at this institute on Dec 20, 2016 and Jan 20, 2017.

2. Dr. Mahesh Kumar, Scientist (Plant Physiology), Dr Basavaraj Sajjanar, Scientist (Animal Biotechnology), Dr. Ankush L. Kamble, Scientist (Agricultural Economics), Dr. Sunayan Saha, Scientist (Agril. Meteorology), Dr. Ram Lal Choudhary, Scientist (Agronomy) were promoted to Next Higher Grade (Rs 15600-39100+ RGP 7000/-) as recommended by the DPC meeting held at this institute on December 20, 2016 and Jan 20, 2017.

3. Noshin Shaikh, (Civil), Mr. Santosh Manohar Pawar, (Electrical), Mr. Pravin Hari More (Computer), Mr. Rushikesh Shivaji Gophane, (Horticulture), Mr. Madhukar Gubbala (IT), Mrs. Priya George (Microbiology), Mr. Lalitkumar Bhausaheb Aher (Biotechnology), Mr. Sunil Vishnu Potekar, (Agrometeorology), Mr. Patwaru Ranbhid Chahande, (Agriculture) were promoted from Pay band 5200-20200+ GP of Rs. 2800/- (Technical Assistant) to next higher Pay band 9300-34800 +GP of Rs. 4200/- (Senior Technical Assistant) as recommended by the DPC meeting held at this institute on Feb 28, 2017 and Mar 01, 2017.

4. Mr. Aniket Tukaram More, Technician T-1 (Farm) was promoted from Pay band 5200-20200+ GP of Rs. 2000/- to next higher grade pay band 5200-20200+ GP of Rs. 2400/- as Senior Technician (T-2) (Farm) as recommended by the DPC meeting held at this institute on Feb 28, 2017.

5. Mr. Pardeep Kumar, Assistant was selected as Assistant Registrar in Central University of Rajasthan, NH-8, Bandarsindri, Kishangarh, Ajmer, Rajasthan.

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12. Budget Utilisation

Expenditure for the Financial Year 2016-17 (in lakhs)

Head / Sub head	Plan		Non-Plan	
	Allocation	Expenditure	Allocation	Expenditure
Grants in aid –Capital				
Works		1064.85	–	–
Equipment		312.02	4.00	4.00
Information Technology		14.63	–	–
Library	1429.00	29.47	–	–
Furniture and fixures		3.90	–	–
Vehicles and Vessels		–	–	–
Livestock		4.13	–	–
Sub Total -1	1429.00	1429.00	4.00	4.00
Grand in aid- Salary				
Pay and Allowances	–	–	549.84	534.68
Sub Total -2	–	–	**549.84**	**534.68**
Grants in aid-General				
Travelling allowance	305.00	305.00	6.00	6.00
Contingencies	–	–	145.22	144.16
HRD	–	–	2.50	2.50
Sub Total -3	**305.00**	**305.00**	**153.72**	**152.66**
Grant Total	**1734.00**	**1734.00**	**707.56**	**691.34**
NICRA	31.85	30.70	–	–

13. Research Projects

Institute Projects

S. No	Project Title	PI	Co-PI
School of Atmospheric Stress Management			
1.	Impact of radiation levels on physio biochemical behaviour, yield and yield attributes in soybean and *rabi* sorghum (IXX09650)	S.K. Bal	S. Saha Y. Singh
2.	Monitoring and quantifying abiotic stresses in soybean, *rabi* sorghum genotypes: index based approach for crop water management (IXX09647)	S. Saha	S.K. Bal Y. Singh
3.	Identification, cloning and expression analysis of temperature, salinity and hypoxia responsive genes in fish (IXX09672)	M.P. Brahmane	B. Sajjanar S. Kumar
4.	Impact of cropping systems and spentwash on soil development under irrigated and rainfed conditions (IXX10215)	Y. Singh	V. Rajagopal K.K. Meena G.C. Wakchaure
5.	Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils (IXX10720)	Y. Singh	D.D. Nangare P.B. Taware J. Rane Gopalakrishnan B.
6.	Study of immune response and HSP genes polymorphism in relation to heat stress in poultry (IXX11251)	S.S. Pawar	N.P. Kurade
7.	Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivars (IXX11584)	G.C. Wakchaure	R.L. Choudhary S.K. Bal K.K. Meena
8.	Study of genetic polymorphism of heat shock protein genes among indigenous and cross breed cattle (IXX09671)	B. Sajjanar	S.S. Pawar Rajib Deb
School of Drought Stress Management			
9.	Evaluation of nutritional stressors and their indicators in cattle population In different drought prone areas (IXX11259)	N.P. Kurade	S.S. Pawar A.L. Kamble Gopalakrishnan B. Neeraj Kumar R.L. Meena
10.	Investigation on traits and genes associated with adaptation of wheat genotypes to local drought and heat stress environments (IXX09675)	A.K. Singh	J. Rane M. Kumar

S. No	Project Title	PI	Co-PI
11.	Phenotyping for tolerance to drought and salinity in pulse crops (IXX10721)	D.D. Nangare	Y. Singh M. Kumar S. Saha P.B. Taware P. Hanjagi
12.	Investigation of traits and genes associated with resilience to moisture stress in soybean (IXX09645)	M. Kumar	A.K. Singh R.L. Choudhary
13.	Maximizing sorghum yield and water use efficiency by optimizing plant density, cultivars and sowing times for shallow to medium deep black soils of Deccan Plateau (IXX12491)	R.L. Meena	Prashant Kumar Hanjagi
School of Edaphic Stress Management			
14.	Nano(bio-) remediation of nitrogenous contaminants using silver-ion exchanged zeolites (IXX09651)	K.K. Krishnani	V. Rajagopal K.K. Meena M.P. Brahmane Neeraj Kumar Balusamy A. Paritosh Kumar
15.	Enhancement of waterlogging tolerance in soybean (*Glycine max* L.) (IXX12489)	D.P. Patel	V. Rajagopal
16.	Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (IXX09673)	Neeraj Kumar	M.P. Brahmane K.K. Krishnani
17.	Isolation and characterization of biomolecules producing bacteria for salt stress alleviation in major crops (IXX10378)	K.K. Meena	D.P. Patel K.K. Krishnani R.L. Choudhary
18.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	Balusamy A. K.K. Krishnani Paritosh Kumar
School of Policy Stress Management			
19.	Assessment of climate imposed vulnerability of onion farming in Maharashtra (IXX08617)	A.L. Kamble	–

Externally Funded Projects

S. No	Project Title	PI	Co-PI	Funded by
1.	Phenotyping for tolerance to drought and salinity in pulse crops (OXX01737)	J. Rane	Prashant kumar Hanjagi	NICRA, CRIDA, Hyderabad

S. No	Project Title	PI	Co-PI	Funded by
2.	Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (OXX03111)	J. Rane	A.K. Singh	DBT, GoI - BBSRC, UK
3.	Development of likelihood model of microbes mediated salt and drought stress alleviation in wheat crop using omics approaches (OXX02835)	K.K. Meena	–	DST, GoI New Delhi
4.	Functional characterization of salt tolerant bacteria using multiomics approaches and their exploitation for alleviation of salt stress in crop plants (OXX02840)	K.K. Meena	G.C.Wakchaure K.K. Krishnani J.Rane	AMAAS, NBAIM, Mau.
5.	Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (OXX03595)	S.K. Bal	Gopala-krishnan B. Y. Singh Mahesh Kumar Sunayan Saha Rajkumar	DST, GoI, Network project
6.	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (OXX03355)	R.L. Choudhary	Mahesh Kumar Sunayan Saha	ICAR, Conservarion Agricultural Platform
7.	RNA interference and Virus Induced Gene Silencing approaches to enhance drought and heat stress tolerance in soybean (OXX03432)	A.K. Singh	–	ICAR–Extra Mural Project

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14. Personnel

Scientific Staff	
Prof. Narendra Pratap Singh – Director	
School of Atmospheric Stress Management	
Dr S.K. Bal	Head (I/c) and Principal Scientist (Agrometeorology)
Dr M.P. Brahmane	Senior Scientist (Biotechnology – Animal Science)
Dr Yogeshwar Singh	Senior Scientist (Agronomy)
Dr S.S. Pawar	Scientist (Animal Biotechnology)
Dr G.C. Wakchaure	Scientist (Agricultural Structure & Process Engineering)
Dr B. Sajjanar	Scientist (Animal Biotechnology)
Mr Gopalakrishnan B.	Scientist (Environmental Science)
Mr Rajkumar	Scientist (Agricultural Entomology)
School of Drought Stress Management	
Dr J. Rane	Head and Principal Scientist (Plant Physiology)
Dr N.P. Kurade	Principal Scientist (Veterinary Pathology)
Dr Ajay K. Singh	Senior Scientist (Agricultural Biotechnology)
Dr D.D. Nangare	Scientist (Soil & Water Conservation Engineering)
Dr Mahesh Kumar	Scientist (Plant Physiology)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Mr Prashantkumar Hanjagi	Scientist (Plant Physiology)
School of Edaphic Stress Management	
Dr K.K. Krishnani	Head
Dr D.P. Patel	Principal Scientist (Plant Physiology)
Dr K.K. Meena	Senior Scientist (Agricultural Microbiology)
Dr R.L. Choudhary	Scientist (Agronomy)
Mr Rajagopal V.	Scientist (Soil Chemistry/Fertility/Microbiology)
Dr Neeraj Kumar	Scientist (Fish Nutrition)
Mr. Paritosh Kumar	Scientist (Environmental Science)
School of Policy Support Research	
Dr J. Rane	Head (I/c)
Dr A.L. Kamble	Scientist (Agricultural Economics)

Administrative Staff	
Smt Purnima S. Ghadge	Assistant Administrative Officer
Mr Dayanand Kharat	Assistant
Technical Staff	
Dr A.V. Nirmale	Technical Officer T-9 (Animal Science)
Dr P.B. Taware	Senior Technical Officer T-6 (Farm)
Mrs Noshin Shaikh	Senior Technical Assistant T-4 (Civil)
Mr Santosh Pawar	Senior Technical Assistant T-4 (Electrical)
Mr Pravin More	Senior Technical Assistant T-4 (Computer)
Mr M. Gubbala	Senior Technical Assistant T-4 (Information Technology)
Mr Rushikesh Gophane	Senior Technical Assistant T-4 (Horticulture)
Dr (Mrs) Priya George	Senior Technical Assistant T-4 (Microbiology)
Mr Lalitkumar Aher	Senior Technical Assistant T-4 (Biotechnology)
Mr Sunil Potekar	Senior Technical Assistant T-4 (Agro-Meteorology)
Mr Patwaru Chahande	Senior Technical Assistant T-4 (Agriculture)
Mr Aniket More	Senior Technician T-2 (Farm)

*As on 31st March, 2017

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15. Distinguished Visitors

1. **PadmaVibhushan Hon. Sh Sharadchandraji Pawar**, Member of Rajya Sabha and Ex Union Minister of Agriculture, Govt. of India
2. **Dr Trilochan Mohapatra**, Secretary DARE and DG, ICAR, New Delhi
3. **Dr W.S. Dhillon**, ADG (Horticulture), ICAR, New Delhi
4. **Dr R.K. Pal**, Director NRC pomegranate, Solapur
5. **Dr Suzanne Boschma**, Research Agronomist, Department of Primary Industries, Australia
6. **Dr K.L. Chadha**, DDG (Horticulture), ICAR retired officer
7. **Dr B.P. Mohanty**, Head and Principal Scientist (Animal Biochemistry), ICAR-CIFRI, Barrackpore, Kolkata
8. **Dr R.G. Dani**, Vice Chancellor, PDKV, Akola
9. **Dr K.P. Vishwanatha**, Vice Chancellor, MPKV, Rahuri
10. **Dr Kisan Lawande**, Ex. Vice Chancellor, MPKV Rahuri
11. **Dr Umakant Behra**, Principal Scientist (Agronomy), IARI, New Delhi
12. **Dr S.K. Dhyani**, Principal Scientist, NRM Division, ICAR, New Delhi
13. **Dr S.K. Singh**, Head FHT, IARI, New Delhi
14. **Dr B. Ramkrishnan**, Principal Scientist, IARI, New Delhi
15. **Dr P.S. Badal**, Professor and Head of Department of Agriculture Economics, Banaras Hindu University, Varanasi
16. **Dr Amit Kar**, Principal Scientist, IARI, New Delhi
17. **Dr. N.V.K. Chakravarty**, Principal Scientist, IARI, New Delhi
18. **Dr D.L.N. Rao**, Project Coordinator, ICAR-Indian Institute of Soil Science, Bhopal
19. **Dr V.U.M. Rao**, Former Project Coordinator, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
20. **Dr G.S. Singh**, Professor of Agronomy, Narendra Deva University of Agriculture and Technology, Faizabad
21. **Dr. Sumitra Arora**, Principal Scientist, ICAR-National Center of Integrated Pest Management, New Delhi
22. **Dr Ashwini D Pathak**, Director, ICAR-Indian Institute of Sugarcane Research, Lucknow

23. **Dr B.D. Sharma**, Head DCP, ICAR- Central Institute for Arid Horticulture, Bikaner, Rajasthan

24. **Dr U.K. Maurya**, Senior Scientist, ICAR-Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand

25. **Dr P.R. Ojasvi**, Head, ICAR-Indian Institute of Soil and Water Conservation, Dehradun, Uttarakhand

26. **Dr P.S. Minhas**, Ex- Director, ICAR-NIASM

27. **Dr Anil Kumar Saxena**, Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Kusmaur, Mau Nath Bhanjan

28. **Dr V.K. Mishra**, Head, Central Soil Salinity Research Institute, Karnal (Regional station)

29. **Dr Badre Alam**, Principal Scientist, ICAR-Central Agroforestry Research Institute, Gwalior, Jhansi

30. **Dr G.P. Obi Reddy**, Principal Scientist and Incharge, GIS Section, ICAR-NBSS and LUP, Amravati Road, Nagpur

31. **Dr K.N. Agrawal**, Principal Scientist, ICAR-Central Institute of Agricultural Engineering, Bhopal

32. **Dr H.S. Talwar**, Principal Scientist (Plant Physiology), ICAR-Indian Institute of Millets Research Rajendranagar, Hyderabad

33. **Dr P.S. Basu**, Principal Scientist (Plant Physiology), ICAR-Indian Institute of Pulses Research, Kanpur

34. **Dr G.K. Satpute**, Senior Scientist (Plant Breeding), ICAR-Indian Institute of Soybean Research, Indore

35. **Dr Ratan Tiwari**, Principal Scientist (Crop Improvement), ICAR-Indian Institute of Wheat and Barley Management, Karnal

36. **Dr R. Madhusudhana**, Principal Scientist (Plant Breeding), ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad

37. **Dr K.N. Ganapathy**, Principal Scientist (Plant Breeding), ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad

38. **Dr K.K. Sharma**, Principal Scientist (Plant Pathology), ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad

39. **Dr Jitendra Kumar**, Director, Directorate of Medicinal and Aromatic Plants Research, Gujarat

40. **Dr B. Singh**, Director, ICAR- Indian Institute of Vegetable Research, Varanasi

41. **Dr B.D. Sharma**, Head (Division of crop production, Soil Science), ICAR- Central Institute for Arid Horticulture, Rajasthan

42. **Dr S.D. Sawant**, Director, ICAR-National Research Centre for Grapes, Pune

43. **Dr S.D. Ramteke**, Principal Scientist (Plant Physiology), ICAR-National Research Centre for Grapes, Pune

44. **Dr Anuradha Upadhyay**, Principal Scientist (Plant Biotechnology), ICAR-National Research Centre for Grapes, Pune

45. **Dr. S.M.K. Naqvi**, Director, ICAR-Central Sheep and Wool Research Institute, Avikanagar, Rajasthan

46. **Dr N.V. Patil**, Director, ICAR-National Research Centre on Camel, Bikaner, Rajasthan

47. **Dr E.B. Chakurkar**, Director (A), ICAR-Central Coastal Agricultural Research Institute, Goa

48. **Dr Sohanvir Singh**, Nodal Officer NICRA, ICAR- National Dairy Research Institute, Karnal

49. **Dr Subodh Gupta**, Principal Scientist, ICAR-Central Institute of Fisheries Education, Mumbai

50. **Dr U. Rajkumar**, Principal Scientist, ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad

51. **Dr K.N. Bhilegaonkar**, Principal Scientist, ICAR- Indian Veterinary Research Institute, Bareilly, Uttar Pradesh

52. **Dr V.R. Suresh**, Head (Fisheries Resource Management), ICAR - Central Inland Fisheries Research Institute, Barrackpore, West Bengal

53. **Dr Hirak Kumar Barman**, Principal Scientist, ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar

54. **Shri. Santosh Bargade**, Taluka Agriculture officer Krishi Bhavan , Baramati Taluka Agriculture Officer Baramati, All Mandal AO of Baramati Taluka, All Agriculture Supervisors Agriculture Assistance of Baramati Taluka visited March 10, 2016

55. **Mrs Prerana Gupta**, President of Red Cross Committee, Baramati

56. **Mrs Trupti Phatale**, Branch Manager, SBI In-Touch, Baramati

57. **Miss Nilprabha Bhosale**, Govt. Advocate, Baramati

58. **Miss Priyanka Kate**, Govt. Advocate, Baramati

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Appendix -I

Members of IMC

1. Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati
2. Commissioner, Agriculture, State of Maharashtra, Central Building, 3rd floor, Pune-411001, Maharashtra
3. Agriculture Commissioner, Government of Karnataka, Sheshadri Road, K.R.Circle, Bangalore-560001, Karnataka
4. Vice Chancellor/Director of Research, Mahatma Phule Krishi Vidyapeeth, Rahuri- 413722, Dist. Ahmednagar, M.S.
5. Chief Finance and Accounts Officer, Central Institute of Fisheries Education , Panch Marg, Off Yari Road, Versova, Andheri (West), Mumbai- 400061, M.S.
6. Dr S.K. Ambust, Project Coordinator, AICRP on Management of Salt Affected Salts, CSSRI, Karnal.
7. Dr (Mrs.) Anupama, Principal Scientist, Division of Agri. Chmeistry, IARI, New Delhi.
8. Dr G. Ravindra Chary, Principal Scientist (Agronomy), CRIDA, Hyderabad.
9. Dr K.K. Krishnani, Principal scientist NIASM, Barmati
10. Dr B. Mohan Kumar ADG (Agro & AF), ICAR
11. Senior Administrative Officer, NIASM, Malegaon, Baramati

Members of RAC

1. Dr K. Narayana Gowda, Former Vice-Chancellor, University of Agricultural Sciences, No 3 New Jakkur Extn Navanagar, Bangalore 64.
2. Dr D.P. Singh, Former Vice-Chancellor, JNKVV, Jabalpur, H. No. 140, Sector 15-A, Hisar-125001, Haryana.
3. Dr Y.S. Ramakrishna, Ex- Director, CRIDA (ICAR) Flat-107 Green Meadows, Auto Nagar Junction, Near Karnati Gardens, Vanasthalipuram, Hyderabad Telangana.
4. Dr C.L. Acharya, House No. 28, Nagarkot Colony, Thakurwara, Po- Maranda, Palampur-176102 (HP).
5. Dr Dinesh K. Marothia, Former Chairman, CACP, 19, Professor Colony, Krishak Nagar, Raipur-492006.
6. Dr K.T. Sampath, FF 02, Passion Paradise, 45, First Main, First Block, Thyagarajanagar, Banglore-560028.

7. Dr S.K. Chaudhari, ADG (SWM), ICAR, New Delhi - 110012.

8. Prof. Narendra Pratap Singh, Director, NIASM, Baramati, Pune 413115

9. Dr J. Rane, Head, SDSM, NIASM, Baramati, Pune (Member Secretary)

Institute Research Committee

Prof. Narendra Pratap Singh, Director (Chairman), All Scientists (Members), Dr J.Rane (Member Secretary)

Priority Setting, Monitoring and Evaluation Committee

Dr J. Rane (Chairman), Dr B Sajjanar, Dr Neeraj Kumar, Dr BB. Fand, Mr G. Madhukar, Dr K K Meena (Member Secretary)

Result Framework Document Committee

Prof. Narendra Pratap Singh, Director (Chairman), Dr J. Rane, Dr K.K. Krishnani, Dr S.K. Bal, Mr M.S. Bhatkar, Mr. Ram Avatar Parashar, Dr B.B. Fand (Member Secretary)

Result Framework Document Cell

Dr B.B. Fand, Nodal Officer, Dr Mahesh Kumar, Dr R.L. Choudhary , Dr A.L. Kamble, Mr. S.V. Potekar.

Purchase Advisory Committee

Dr N.P. Kurade (Chairman), Dr D.P. Patel (OIC Central Stores); Dr M.P. Brahmane; Dr K.K. Meena; Dr S. Saha;, Dr Prashant Hanjagi, FAO, SAO/AAO(Member Secretary)

Works Committee

Dr K.K. Krishnani (Chairman), Dr M.P. Brahmane, Dr Yogeshwar Singh, Dr G.C. Wakchaure, Dr B Sajjanar; Dr A.V. Nirmale; SAO/AAO

Farm Management Committee

Dr S.K. Bal (Chairman & OIC Farm); Dr Yogeshwar Singh, Dr S.S. Pawar; Dr D.D. Nangare; Dr R.L. Choudhary, Dr P.B. Taware (Farm Manager and Member Secretary)

Library Advisory Committee

Prof. Narendra Pratap Singh (Chairman), Dr J. Rane, Dr K.K. Krishnani, Dr S.K. Bal, Dr M.P. Brahmane, Dr A.K. Singh, Dr Y. Singh, Dr D.D. Nangare Dr Neeraj Kumar, SAO, FAO, Dr Mahesh Kumar (Member Secretary)

Publication Committee

Dr J. Rane (Chairman), Dr K.K. Meena, Dr B.B. Fand, Dr B. Sajjanar, Dr Neeraj Kumar, Dr Yogeshwar Singh (Member Secretary)

News Letter Publication Committee

Dr D.P. Patel (Chairman), Dr M.P. Brahmane, Dr A.K. Singh, Dr S.S. Pawar, Dr Neeraj Kumar, Mr Gopalakrishnan B. and Mr Balusamy A.

Institute Technology Management and Consultancy Processing Committee

Dr D.P. Patel (Chairman), Head of Schools, Dr A.K. Singh, Dr A.L. Kamble, SAO, FAO, Dr B. Sajjanar (Member Secretary)

Proprietory Items Committee

Dr S.K. Bal (Chairman), Dr A.K. Singh, Dr Gopalakrishanan B., Dr R.L. Choudhary, Dr Neeraj Kumar (Member Secretary)

Landscape Development Committee

Dr S.K. Bal (Chairman), Dr Y. Singh and Dr P.B. Taware

Sports Committee

Dr S.K. Bal (Chairman), Dr Y. Singh, Dr R.L. Choudhary and Dr Prashantkumar Hanjagi (Member Secretary)

Hindi Committee

Dr Narendra Pratap Singh (Chairman), Dr K.K. Krishnani, Dr Y. Singh, Dr R.L. Choudhary, Dr Mahesh Kumar, Mr Pardeep Kumar and Dr D.P. Patel (Member Secretary)

Swach Bharat Implementation Committee

Dr M.P. Brahmane (Chairman), Dr D.D. Nangare, Dr S.S. Pawar, Dr R.L. Meena, Mr Gopalkrishnan B. and Mr Rajkumar

Institute Biosafety Committee

Dr Narendra Pratap Singh (Chairman), Dr Vidya Gupta, Dr S. Anadan, Dr J. Rane, Dr K.K. Krishnani, Dr M.P. Brahmane and Dr A.K. Singh (Member Secretary)

Public Relation Committee

Dr M.P. Brahmane (Chairman), Dr D.D. Nangare, Dr S.S. Pawar, Dr A.L. Kamble and Dr R.L. Choudhary

Grievance Cell

Head of Divisions, Mr S. Pawar, Mr Ram Avtar, Mr M.S. Bhatkar

RTI Cell

Prof. Narendra Pratap Singh, Director (Appellate Authority), Dr D.P. Patel (CFO), Dr S.K. Bal (Transparency Officer)

Women Cell

Smt. Purnima S. Ghadge (Chairman), Mrs. Noshin Shaikh, Smt. Priya George, Administrative Officer (Member Secretary)

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Abbreviations

ABC	:	Atmospheric Brown Cloud
ADP	:	Adenine Di-Phosphate
ADT	:	Agriculture Development Trust
ARF	:	ADP ribosylation factors
CBF	:	CRT (C-repeated) binding factor
CD	:	Critical Difference
CDM	:	Clean Development Mechanisms
CG	:	CGIAR- Consultative Group for International Agricultural Research
CRI	:	Crow Root Initiation
CTMax	:	Critical Temperature Maximum
CTMin	:	Critical Temperature Minimum
DREB	:	Dehydration Responsive Element Binding Protein
DSR	:	Directorate of Soybean Research
DSS	:	Decision Support System
FCR	:	Feed Conversion Ratio
FTIR	:	Fourier Transformed Infra-Red
GA	:	Gibberlic Acid
GHG	:	Green House Gas
GLC	:	Gas Liquid Chromatography
GSDA	:	Groundwater Survey Development Agency
HDPE	:	High Density Poly Ethylene
HSP	:	Heat Shock Protein
HYV	:	High Yielding Variety
INM	:	Integrated Nutrient Management
IAA	:	Indole Acetic Acid
IFS	:	Integrated Farming System
IIHR	:	Indian Institute of Horticultural Research
IIPR	:	Indian Institute of Pulse Research
KVK	:	Krushi Vigyan Kendra
LTA	:	Long term average
M.B. ploughs	:	Mould Board Plough
MJP	:	Maharashtra Jeevan Pradhikaran
MODIS	:	Moderate Resolution Imaging Spectroradiometer
MPKV	:	Mahatma Phule Krishi Vidyapeeth
NAAS	:	National Academy of Agricultural Science
NAC	:	NAM, ATAF 1/2 and CUC2 domain gene
NARS	:	National Agricultural Research System
NBPGR	:	National Bureau of Plant Genetic Resources
NDVI	:	Normalized Difference Vegetation Index
NRC	:	National Research Center
OBC	:	Other Backward Cast
PEG	:	Poly Ethylene Glycol
PGP	:	Plant Growth Promoting
PME	:	Project Management and Evaluation
PVC	:	Poly-Vinyl Chloride
RAC	:	Research Advisory Committee
RAU	:	Rahuri Agriculture University
RFD	:	Results Framework Document
RNA	:	Ribonucleic Acid
rRNA	:	Ribosomal Ribonucleic Acid
RT-PCR	:	Reverse Transcriptase Polymerase Chain Reaction
SAUs	:	State Agricultural Universities
SEM	:	Scanning Electron Microscope
SRI	:	System of Rice Intensification
TEM	:	Transmission Electron Microscope
TSP	:	Tribal Sub-Plan
XRD	:	X-ray Difraction

View of the North Block of ICAR-NIASM Farm

View of the South Block of ICAR-NIASM Farm

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Web : www.niam.res.in

Printed at :
Flamingo Business Systems, 19, Laxminagar Commercial Complex No. 1, Shahu College Road, Pune 411 009. Tel. : 020-24214636, 09049400137
Email : flamingo.b.s@gmail.com, srgupta.tej@gmail.com