भाकृअनुप
ICAR

वार्षिक प्रतिवेदन ♦ Annual Report

2015 - 16






राअप्रस
NIASM

भाकृअनुप–राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

(समतुल्य विश्वविद्यालय)

ICAR-National Institute of Abiotic Stress Management

(Deemed to be University)

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(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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General view of infrastructural facilities and field experimentation

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Preface

ICAR-NIASM was conceived as a key institute to address abiotic stress management in agriculture seven years ago. It has now more than half of its infrastructure and facilities ready for research and education. Nearly half of its allocated scientific staff recruited for multidisciplinary approaches, the institute has accelerated its efforts for addressing abiotic issues in crops, livestock and fish. Central lab of the institute is now equipped with research facilities for investigating stress tolerance mechanisms at crop, plant, cell and molecular levels. The state of art analytical laboratory for analysis of various elements in plant, animal, fish and soil samples is being now regularly used for investigations on responses to abiotic stresses such as drought, high temperature salinity, waterlogging etc. With research farm established for field and horticultural crops in its main campus, a successful effort has been made recently to acquire additional land on lease and this will be largely used for evaluating and demonstrating technologies for alleviation of abiotic stresses. Plant Phenomics facility has now become fully functional and phenotyping methods are being optimised to identify genotypes that use less water for high biomass.

The institute has generated significant data on CO_2 fluxes under different cropping systems. Different methods have been standardized for assessing responses of plants, microbes, livestock and fish. Metabolites from microbial endophytes, bioregulators and cropping systems are being assessed with focus on stress mitigation and adaptation options. Promising genotypes, traits, genes relevant to drought and high temperature have been identified. The institute has successfully modified a machine with several features for management of trash and nitrogen in ratoon sugarcane and demonstrated its added advantages in farmers' field. In addition to already filed patent on synthesis of silver nanoparticles from fish parts, the second patent on development of a microbially derived polymeric product for gel formation, microbial colonization and metals binding has been successfully filed recently. In addition, the scientific and technical staff actively participated in the survey for assessment of situation due to delayed and deficit monsoon, technology intervention in tribal subplan, interactions with farmers under Mera Gaon Mera Gaurav and in distribution of soil health card to farmers.

The meetings of Research Advisory Committee (RAC), Institute Management Committee (IMC), Institute Research Council were held as per schedule and the valuable suggestions by the members are gratefully acknowledged. My sincere thanks to secretary DARE and DG, ICAR, DDG (NRM) and ADGs at KAB-II for providing us support and guidance. The contributions of various committees in institute development while being actively involved in their research efforts are appreciated. I express my deep sense of gratitude to former Directors of the institute who laid the strong foundations by their great thoughts and actions for the current and future research and institute development activities. My thanks to all the members of publication committee and PME for their sincere efforts that has enabled us to compile this report on time.

Dated: June 29, 2016
ICAR-NIASM, Baramati

(Jagadish Rane)
Director (A)

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कार्यकारी सारांश

पिछले चार वर्षों के दौरान मौलिक और अन्य सुविधाओं के विकास पर मुख्य रूप से ध्यान केन्द्रित रहा है। कार्यालय-सह-प्रशासनिक खण्ड, अतिथि गृह, सड़कों का निमार्ण कार्य तथा भूदृश्य निर्माण पूरा कर लिया गया है। एमआईडीसी, बारामती में छात्रावास और आवासीय परिसर का निर्माण कार्य संतोषजनक रूप से चल रहा है। दक्षिण दिशा के प्रक्षेत्र को विभिन्न फसलों पर वायुमंडलीय, मृदीय तथा सूखे के स्ट्रैस संबंधी प्रयोगों के लिए पूर्णत: उपयोग किया जा रहा है जब कि उत्तर-पूर्वी प्रक्षेत्र को बागानों के प्रयोग के लिए उपयोग किया जा रहा है। रिपोर्ट अवधि के दौरान प्राप्त प्रमुख उपलब्धियों में निम्नलिखित सम्मिलित हैं ।

- मृदीय स्ट्रैस वाले चना फसल में एड्डी कोवेरिएन्स पद्धति से मौसमीय औसत संवेदी तापीय प्रवाह की निगरानी की गई जो 30.7 वाट/वर्गमीटर (डब्ल्यू/मी$^{-2}$) पाया गया। लैंड सर्फेस स्पेकट्रल वेजीटेशन पैरामीटर (एनहांस्ड वेजीटेशन इंडेक्स) तथा वेजीटेशन-एटमॉसफियर स्ट्रैस इंडीकेटर (कैनोपी-एयर टेम्परेचर डिफरेंस) स्वतंत्र रूप से संवेदी तापीय प्रवाह में 60 प्रतिशत से अधिक की भिन्नता को दर्शा सकता है।
- फसल अवधि के दौरान तापमान और वर्षा का परिमाण सोयाबीन में स्टेम फ्लाई *मेलानाग्रोमैजा सोजे* के प्रकोप को बड़े पैमाने पर प्रभावित करता है। स्टेम फ्लाई की मौसमीय सघनता और इसके पैरासिटोयड्य कीट गतिशीलता में अजैविक कारकों एवं क्रॉप फिनोलॉजी की भूमिका को स्पष्ट करता है। *एच. प्रोपिंका* और *एस. निग्रस* को *एम. सोजे* की पैरासिटोयड्य के रूप में पहचान की गई।
- तीन वर्ष के प्रयोग समाप्त होने पर मुर्रम में विघटन की घटती प्रवृत्ति इस क्रम में देखी गई - गन्ना + स्पेंट वाश > सोयाबीन - गेहूँ + स्पेंट वाश > नेपियर ग्रास > गन्ना > सुबबूल > सोयाबीन - गेहूं > लहसुन > सुबबूल(वर्षा आधारित) > मक्का - चारा ज्वार > कंट्रोल + स्पेंट वाश > अंजन (वर्षा आधारित) > चारा ज्वार (वर्षा आधारित) > नियंत्रित।
- अन्य सभी ट्रीटमेंट में से गन्ना + स्पेंट वाश में अधिकतम गन्ना उपज दर्ज की गई और इसके बाद सिंचाई की स्थितियों में घटती प्रवृत्ति इस क्रम में देखी गई, गन्ना + स्पेंट वाश > नेपियर ग्रास > गन्ना > सोयाबीन - गेहूं गेहूं अवशेष + स्पेंट वाश > लूसर्न > सोयाबीन + गेहूं > मक्का - चारा ज्वार जब कि वर्षा आधारित स्थितियों में अंजन > चारा ज्वार में।
- भावी जलवायु के आकलन अनुसार सोयाबीन के इंडिटेर्मिनेट किस्में, डिटेर्मिनेट एवं सेमी डिटेर्मिनेट किस्मों की अपेक्षा उच्च प्रकाश संश्लेषण क्षमता, प्रकाश और कार्बन परिपूर्णता का उच्च स्तर, नमी स्ट्रैस से फसल की विफलता आघात को समाहित करने की क्षमता के संदर्भ में बेहतर होंगे।
- रोहू (*लेबियो रोहिता*) मछली की मांसपेशीयों के नकारात्मक जीन मयोस्टेटिन जीन की बढ़ी हुई अभिव्यक्ति देखी गई। 30^0 तथा 34^0 से. तापमान पर मछलियों में एचएसपी70 की अभिव्यक्ति (एक्सप्रेशन) देखी गई जो रोहू में हीट शॉक प्रोटीन की संरक्षणात्मक भूमिका दर्शाती है और उच्च तापमान पर तापीय स्ट्रैस सूचित करती है।
- एचएसपी 70.1 (mRNA) के प्रेरित अभिव्यक्ति के रूप में हीट शॉक प्रतिक्रिया के बलगति विज्ञान से सूचित होता है कि तापीय स्ट्रैस की प्रारम्भिक अवधि (0-6 घंटे) के दौरान दुधारू पशुओं के साहीवाल और फ्रैजवाल दोनों ही नस्लों में एचएसपी70.1 एमआरएनए का स्तर मुख्य रूप से अधिक होता है।
- तापीय स्ट्रैस के अंतर्गत संवर्धित पौल्ट्री पक्षियों में एचएसपी 70 और 3'यूटीआर के आकृतिमूलक क्षेत्र का चित्रण किया गया। एचएसपी70 का जीन एक्सप्रेशन अध्ययन किया गया।

- एचडी-2189 की तुलना में गेहूं की आईसी-549394, ईसी-573623 प्ररूपों में कैनोपी तापमान कम देखा गया। गेहूं के आईसी-549394, ईसी-573623 प्ररूपों में एचडी-2189 की अपेक्षा सीबीएफ (सीबीएफ 1 एवं 4) तथा सीडीपीके (सीडीपीके 15 एवं 19) जीन में उच्च अभिव्यक्ति देखी गयी। गेहूं के एचडी-2189 की तुलना में आईसी-549394, ईसी-573623 प्ररूपों में फर्नेसल ट्रांसफेरेज (Fnsl) जीन में कम अभिव्यक्ति देखी गई।
- सोयाबीन में पत्ती विस्तार दर, वृद्धि दर और पत्ती सेनेसेन्स के ईमेज प्राप्त कर विश्लेषण के लिए विकसित तकनीक से आशाजनक परिणाम प्राप्त हुए हैं। बड़े पैमाने पर फेनोटाइपिंग के लिए कम लागत वाली गैर-विनाशकारी फेनोटाइपिंग टूल के रूप में इसका उपयोग किया जा सकता है।
- स्थानीय क्षेत्र से अपनाए गए जीन प्ररूप जेएस 335 में मृदा नमी के स्ट्रैस के अंतर्गत भी कैनोपी कवर का त्वरित विकास का वह गुण है, जो उच्च उपज में योगदान देता है। सूखे एवं सिंचाई की स्थितियों में पत्ती क्लोरोफिल फ्लोरेसेन्स सोयाबीन बीज उपज के पूर्वानुमान का द्योतक है।
- 29 अंत:पादपीय बैक्टीरियायी वियुक्तियों में से फ्लोरसेंट सूडोमोनड्स का प्रतिनिधित्व करने वाले ज्वार के सूखा सहिष्णु किस्म मलडांडी 35-1 में सूडोमोनास प्रजाति जैसा उच्च एसीसी डियामिनेज गतिविधि देखी गयी। ईपीएफ-20 तथा इसके 16 एस आरआरएनए जीन सीकवेंस को एनसीबीआई जीन बैंक में वंशक्रम स. केयू258089 के अंतर्गत जमा कराया गया।
- ब्राडीरिजोबियम गुणों को विकसित करने वाले आरटीएक्स की उच्च नोडुलेशन क्षमता से सिंचित एवं सूखे की स्थितियों में सोयाबीन की कार्यिकीय एवं उपज में सुधार हुआ है।
- पेड़ी गन्ना फसल उत्पादन हेतु स्टबल शेविंग, ऑफ-बेरिंग, रूट प्रूनिंग तथा फर्टीलैजर प्लेसमेंट हेतु बहु-उद्देश्यीय मशीन (एसओआरएफ) उपलब्ध कराया गया। ट्रैश चापिंग, ऑफ-बेरिंग, रूट प्रूनिंग तथा फेर्टिलाइजर प्लेसमेंट हेतु एक प्रोटोटाइप बहु-उद्देश्यीय मशीन की रूपरेखा तैयार कर इसे विकसित किया गया।
- किसानों की पद्धतियों की अपेक्षा आधार खुराक के रूप में सिफारिश की गई दो विभाजित खुराकों के बजाय सिफारिश की गई खुराक या नाइट्रोजन के दुगना खुराक के साथ एसओआरएफ के उपयोग से गन्ने की उपज और एनयूई में क्रमश: 16-22 तथा 10-11% वृद्धि देखी गई।
- पेड़ी गन्ना फसल में फर्टीगेशन या क्रो-बार टूल के माध्यम से नाईट्रोजन उर्वरक का उपयोग करने पर एनयूई (12%) तथा गन्ना उत्पादकता (26%) में सुधार हुआ है, जब ट्रैश को सतह पर ही छोड़ा गया है, जिससे अनचाप्पड ट्रैश ब्राडकास्ट नाइट्रोजन उपयोग पद्धति की अपेक्षा रू. 54.95 हजार/हे. का वित्तीय लाभ हुआ है।
- गन्ना उत्पादकता में ट्रैश को बनाए रखने और बायोगैस स्लरी तथा *टी. विरीडे* के उपयोग से ट्रैश जलाने या हटाने की अपेक्षा अधिक वृद्धि देखी गयी जिससे लगभग 25 का अधिक शुद्ध लाभ प्राप्त हुआ।
- मत्स्य गलफड़ों (गिल) के उपयोग से सामान्य तापमान (Room temperature) पर सिल्वर नैनोपार्टीकल्स का संश्लेषण प्रारम्भ किया गया। संश्लेषित सिल्वर नैनोपार्टीकल्स का स्टिलबाइट में ट्रेपिंग प्रारम्भ किया। सिल्वर नैनोपार्टीकल्स के साथ फंसे जियोलाइट्स अमोनिया दूर करने में प्रभावी पाए गए।
- सिल्वर नैनोपार्टीकल्स के साथ फंसे 13 जियोलाइट्स की जीवाणुनाशक गतिविधि का अगर वेल डिफ्यूजन पद्धति से मत्स्य रोगाणु *एरोमोनास हाइड्रोफिला* (संक्रमित सड़न) और झींगा रोगाणु *वायब्रियो हार्वेयी* के विरूद्ध परीक्षण किया गया।
- भारत के महाराष्ट्र राज्य में भीमा नदी (उजनी) के सतही जल, मृदा तलछटों और विभिन्न मत्स्य ऊतकों (मांसपेशीयां, गलफड़ों, याकृत, गुर्दे और जननग्रंथियों) में भारी धातुओं नामत: Cr,

Mn, Co, Ni, Cu, Zn, As, Se, Cd, Hg, Pb, Ga, Sn और Sb की सांद्रणता के मूल्यांकन के लिए एक अध्ययन किया गया। भीमा (उज्जैनी) नदी के वर्तमान परिणामों में देखा गया है कि नदी सामान्य रूप से भारी धातुओं से संदूषित है जिससे पारिस्थितिकीय खतरा बनता है, जो पिछले तीन साल में अपर्याप्त मानसून के कारण हो सकता है ।

- महाराष्ट्र के लवण प्रभावित मृदाओं में सूक्ष्मजीवीय विविधता के परीक्षण के लिए मेटाजेनोमिक क्लोन संग्रहालय के सृजन पद्धति का मानकीकरण सफलतापूर्वक किया गया। 16 एसआर आरएनए जीन सीकवेंसिंग के उपयोग से कुल 13 वियुक्तियों (आइसोलेट्स) की पहचान की गई।
- स्थानीय मुर्रम और काली मिट्टी से भरे गड्डों और खंदकों में रोपित अमरूद के पेड़ों में पेड़ की अधिकतम ऊंचाई, व्यास और कैनोपी विस्तार की निगरानी की गई। अधिकतम उपज मिश्रित मृदाओं में देखी गई और इससे आगे अधिक उपज उन ट्रीटमेंट में देखी गई जहां चट्टानी परत में हल्का विस्फोट किया गया है। यह परिष्कृत मृदा व्यवस्था की देन है जो बिना विस्फोटन (15.0%) की अपेक्षा विस्फोटन के साथ (19.5%) वर्षा जल संरक्षण का परिणाम है।
- उथले बेसाल्ट क्षेत्र में औगर रोपण की अपेक्षा गड्डों या खंदकों में रोपित सपोटा, अमरूद और अनार के बागानों का निष्पादन बेहतर है। सीमित नमी की स्थितियों मैं शत-प्रतिशत काली मृदा की अपेक्षा मुर्रम और काली मृदा के मिश्रण में पौधों की वृद्धि और कार्यिकी बेहतर पायी गयी है।

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Executive Summary

The major efforts during the last four years have been on the development of infrastructure and other facilities. The Office-Cum-Admn Block, the Guest House, roads and landscape development are completed. The construction of School Buildings, Hostels and Residential complex at MIDC, Baramati are progressing satisfactorily. South-side farm is now being fully utilized for experimentation on atmospheric, edaphic and drought stresses in different field crops while the north-east farm has been put under experiment on orchards. Salient achievements during the reporting period have been summarized below.

- Seasonal mean sensible heat flux from the edaphically stressed chickpea crop ecosystem monitored using eddy covariance methodology was 30.7 Wm^{-2}. Land surface spectral vegetation parameter (Enhanced Vegetation Index) and composite vegetation-atmosphere stress indicator (Canopy-Air Temperature Difference) could independently explain higher than 60 % variability in sensible heat flux rates.

- Temperature and amount of rainfall received during the growing season significantly influences the incidence of stem fly *Melanagromyza sojae* in soybean. Seasonal density of stem fly and diversity of its parasitoids revealed the role of abiotic factors and crop phenology in pest dynamics. *H. propinqua* and *S. nigrus* were identified as parasitoids of the *M. sojae*.

- After completion of three years of experimentation, disintegration of *murrum* had followed the decreasing trend in the order of Sugarcane + spent wash > Soybean- Wheat + Spent wash > Napier grass> Sugarcane >Subabul >Soybean-Wheat > Lucerne > Subabul (R) > Maize-Fodder Sorghum> Control + spent wash > Anjan (R) > Fodder Sorghum (R)> Control.

- Maximum sugarcane equivalent yield was recorded 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 *fb* wheat residue incorporation +Spent wash > Lucerne > Soybean+ Wheat > Maize- Fodder sorghum in irrigated condition and Anjan > Fodder Sorghum in rainfed condition.

- Under projected future climate, indeterminate varieties of soybean have an edge over determinate and semi-determinate varieties in terms of higher photosynthetic efficiency, higher level of light and carbon saturation level.

- Increased expression of myostatin gene, a negative regulator of muscle was observed in Rohu (*Labeo rohita*). The fishes exposed at 30°C and 34°C exhibited increased expression of hsp70 suggesting protective role of heat shock protein in response to high temperatures.

- Kinetics of heat shock response in the form of induced expression of Hsp70.1 mRNA indicated that during the initial period (0–6 h) of heat stress, the levels of Hsp70.1 mRNA prominently higher in both Sahiwal and Frieswal breeds of dairy cattle.

- The characterization of polymorphic regions of HSP 70 promoter and 3'UTR in poultry birds reared under heat stress was performed. Gene expression analysis of HSP70 achieved.
- Wheat genotypes IC-549394, EC573623 showed cooler canopy temperature, higher expression of CBFs (CBF 1 & 4) and CDPKs (CDPK 15 & 19) genes and reduced expression of *fernesyl transferase* (Fnsl) gene compared to HD-2189.
- Promising results have been obtained with image acquisition and analysis tool developed to assess leaf expansion rate, growth rate and leaf senescence of soybean and it can work as low cost non-destructive phenotyping tool for large scale phenotyping.
- Rapid canopy cover development is one of the trait that contributed to high yield of locally adapted genotype JS 335 under soil moisture stress. Leaf chlorophyll fluorescence can be a good predictor of seed yield of soybean under drought and irrigation condition.
- One of the 29 endophytic bacterial isolates representing fluorescent pseudomonads of drought tolerant sorghum cv. Maldhandi 35-1 showed higher ACC deaminase activity as *Pseudomonas sp*. EPF-20.
- High nodulation efficiency of rtx producing *Bradyrhizobium* strains improved physiological and yield performance of soybean under irrigated and drought conditions.
- Multi-purpose machine for stubble shaving, off-barring, root pruning and fertiliser placement (SORF) in ratoon sugarcane was made available with some modifications. A prototype of multipurpose machine for trash chopping, off-barring, root pruning and fertiliser placement was designed and developed.
- The uses of SORF machine along with band placement of either recommended or double the dose of N as basal rather than the recommended two splits improved cane yield and NUE by 16 to 22 and 10 to 11%, respectively over farmer's practice.
- Application of fertiliser-N through either fertigation or crow bar tool improved the NUE (12%) and cane productivity (26%) of ratoon sugarcane when trash was retained at the surface.
- Synthesis of silver nanoparticles has been scaled up at room temperature using fish gill. Zeolites trapped with silver nano particles have been found to be effective in ammonia removal.
- Bactericidal activity of thirteen forms of zeolites trapped with silver nano particles have been determined against fish pathogen *Aeromonas hydrophilla* (infectional rot) and shrimp pathogen *Vibrio harveyi* using agar well diffusion method.
- A study conducted to assess the concentration of heavy in Bhima river (Ujjaini) revealed that most of the metals in the river were within safe limit, except few, which may be attributed to deficient monsoon for last three years.

- Plant height, diameter and canopy spread in guava was monitored with pit and trench planting filled up with mixture of native *murrum* and black soil. The maximum yield was recorded in mixed soils and further high yield was noticed in those treatments where the rocky layer was subjected to microblasting, with improved soil moisture conservation.

- Trench or pit planted Sapota, Guava and Pomegranate orchards are performing better than Auger planting under shallow basaltic soil. Growth and physiology of plants were better in mixtures of black soil and native *murrum* than in 100 % black soil under limited moisture conditions.

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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 is more challenged with penultimate combinations of abiotic stresses spatially and temporally. Though the country has witnessed the bumper food grain production during the recent past, the threat of adverse climate on long term productivity cannot be ignored. Therefore, there is an urgent need to take up focused research on this important area and hence institute has definite role to play for food security in India.

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

Keeping in view the extensiveness of the problem, institute has an additional responsibility to maximize the number of qualified researchers and professionals of impeccable quality in the domain of tackling abiotic stresses. The idea is to equip these researchers and professionals with the skills to innovate and conduct seamless interdisciplinary research. The institute, which is a Deemed-to-be-University, also plans to focus on imparting education in such specialized areas that are not taught in regular agricultural universities.

Role of the Institute

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

Mission

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

Mandate

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

Objectives

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

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

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

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

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

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

Strategy

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

Fig. 1.1. Institute's strategy for achieving mandate

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

Assessment of available inputs and their use in a synergistic manner, preventing losses, judicious allocation of inputs among the competing demands for maximizing returns and development of site specific technologies are the means of achieving high resource use efficiencies for sustainable agriculture. NIASM being a Deemed to be University and by virtue of its strategic location, is an ideal place to become a 'Center of Excellence' on abiotic stress research not only in India but also at the global level. It will be the leading center for coordination of abiotic stress research and data repository related to all kinds of drought, edaphic and atmospheric stresses. Joint adaptation and mitigation actions against climate change that can be implemented 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 27, 12 and 6, respectively. Thus the filled up cadre strength is 45 against 105 sanctioned posts (Table 1.1). The institute has initiated research through four schools with multidisciplinary approach (Fig. 1.2).

Cadre Strength

Table 1.1. Cadre strength of the institute as on March 31, 2016

Cadre	Sanctioned	Filled	Vacant
Scientific	51*	27	24
Technical	33	12	21
Administrative	21	06	15
Grand Total	105	45	60
* Including Director			

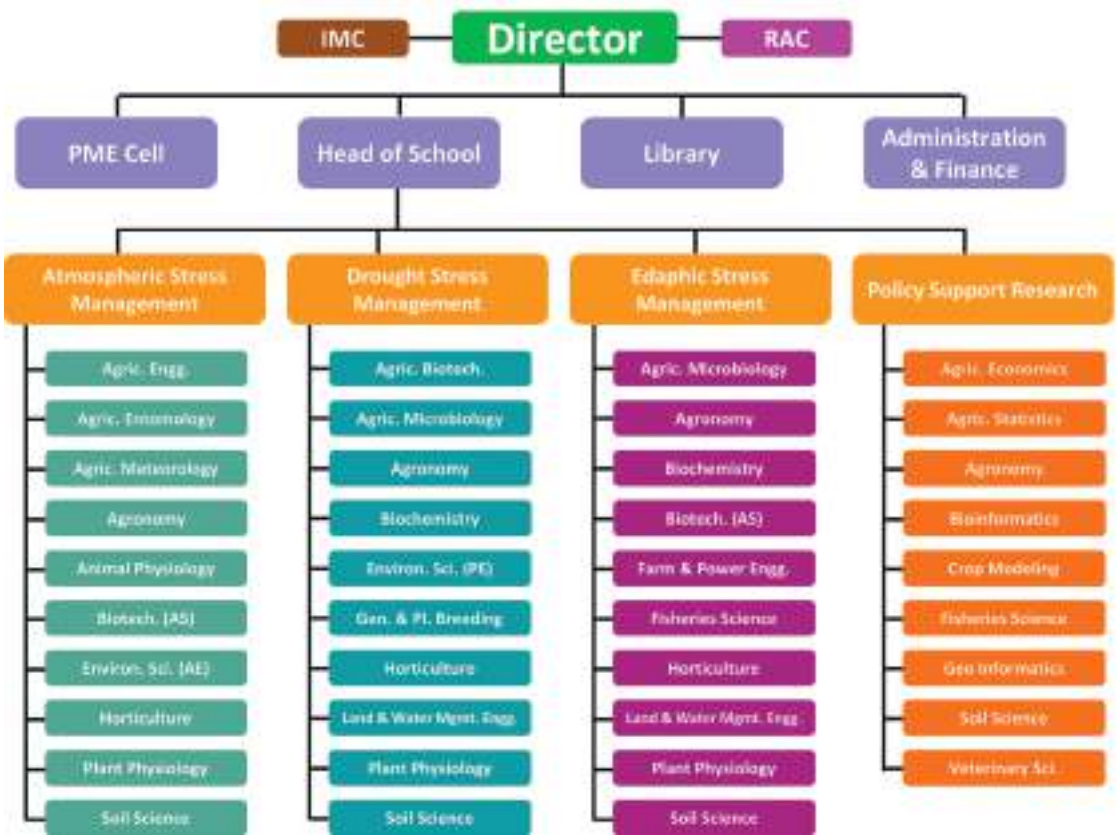

Fig. 1.2. **Organogram of the institute**

Research Programmes of the Institute

School of Atmospheric Stress Management

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

School of Drought Stress Management

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

School of Edaphic Stress Management

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

School of Policy Support Research

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

Infrastructure Development Activities

Office Cum Administrative Building has been taken over on 23rd December 2015. This building has Auditorium with capacity of more than 150 audience, which has been now furnished with chairs, wall paneling, carpeting, wooden flooring, internal lighting and audio-video system. Custom made furniture have been provided to committee room, pantry, kitchen etc. Installation and commissioning of Air Conditioning system has been completed in Auditorium, and Committee Room. The work carried out at Office cum Admin building also includes commissioning of lift system leading to Director's room.

Guest house has been furnished with ready-made furniture in each room and linen material have been procured for guest rooms and has been made ready to accommodate at least 20 guests at any given time. The guest house has well furnished kitchen and dining halls.

The work carried out to finalize the internal roads included concretization of roads, paver blocks and kerb stones on foot path in addition to construction of planter/ flag post platform in entrance of Admin. cum Office Building. Concrete parking area has been provided for Admin. cum Office Building as well as Guest House.

Construction of Bitumastic road adjacent to Phenomics facility and farm road at south side has been completed. Further, the work of drainage lines along with man-holes, septic tank and soak pit has also been completed.

(a)

(b)

(c)

(d)

(e)

Fig. 1.3. Office Cum Admin. Building (a) with Parking (b), Guest House (c), Hostel Building (d) & School building (e) under construction

Being deemed to be University, the budget provision was made earlier for infrastructure to accommodate students in the campus. The foundation stone ceremony was organized on 8th September 2015 for Boys Hostel, Girls Hostel and Dining Block. During the current financial year the RCC work upto 1st floor slab was completed and brick work was in progress. Further construction of School Buildings have been initiated with Foundation stone ceremony on 28th December 2015. Footing work was completed and plinth level work was about to be completed.

The approvals of layout and building drawings, fire NOC and tenements related to ICAR-NIASM residential Complex at Baramati were received from MIDC Authorities and final NOC for construction of ICAR-NIASM residential Complex was received from MIDC, Baramati on 14th March 2016. The construction work for residential complex was started with Bhoomi Pujan on 17th March 2016. Excavation for footing of Type VI was is in progress. The construction of Power Substation and External lighting scheme at main campus has been initiated with Bhoomi Pujan on 5th February 2016. Excavation work of substation Building is in progress.

Research Farm Development

While the past efforts were devoted to develop modern farm facilities for experiments with orchard and field crops at the main campus, it was strongly felt that experiments should be extended to other type of land resembling the farmer's field in the region. Initiatives in this direction resulted in procurement of land on lease at Village-Malad Taluka-Baramati, Pune. The institute had physical possession of this land at Gat no. 152 from the authorities of Remand Home, Baramati on 1st January 2016. Land was measured by the team of scientific and technical staff of the institute in the presence of representatives of Remand Home which matched with dimensions taken from Google Earth Map. Area of land calculated on the basis of measurements was 6.57 ha and it matched with revenue records too. However, final marking of boundaries has to be carried out by Land measurement Department, Govt. of Maharashtra. Widely spread *Prosopis juliflora* bushes in this land have been cleared and preliminary preparations have been carried out to make it suitable for experiments. Now this land will be referred as **Malad Research Farm, ICAR-NIASM, Malegaon.** Tentative layout of the research farm that includes inside roads, irrigation facility, office and fencing has been prepared. This farm will be available for field experiments for the 2015-16 crop seasons.

(a) (b)

Fig. 1.4. Malad Research Farm before (a) after (b) intervention

Research Laboratory

During the current year, the institute procured ICPMS, dual block PCR Machines, Plant growth chambers, Autoclave, Refrigerated shacker, microbial identification system (BIOLOG), ELISA Plate Reader, Nanodrop, electronic weight balance, Hot air Oven, Advance Microwave Digestion System. These are in addition to existing equipment like Tetrad PCR, Ultra-low Temperature Freezer, 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, soil characteristics and to quantify gene expression at transcript and protein level.

Fig. 1.5. Central Laboratory facility

(a)

(b)

(c)

Fig. 1.6. ICPMS (a), BIOLOG (b), Dual Block PCR(c)

Library

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. With recent procurement of 72 books the present library acquisitions has been raised to 1123 books 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. Institute got life membership of Current science association, Bangalore and getting printed current science journal regularly. 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.

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2. Research Highlights

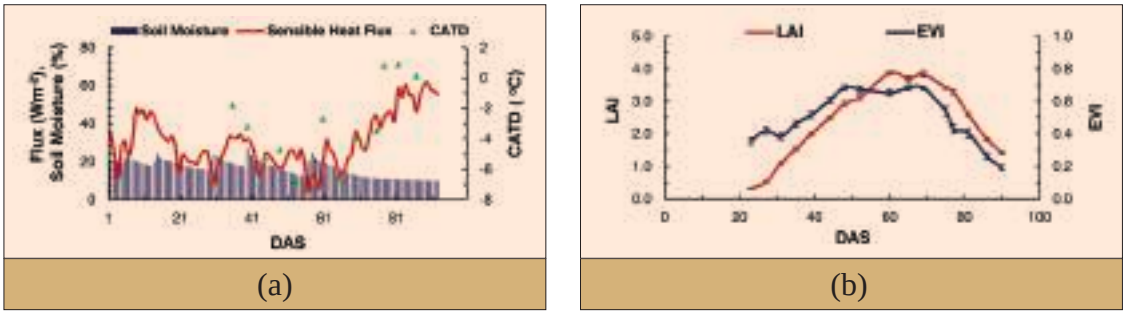
School of Atmospheric Stress Management

Monitoring energy and mass fluxes in stressed crops

Net exchange of sensible heat from chickpea, grown during the 2015-16 *rabi* season in the shallow basaltic soil of NIASM research farm, was monitored using micrometeorological eddy covariance technique. Seasonal mean of the diurnal sensible heat flux rates from the crop ecosystem, spread in an area of about 1.5 ha, during the 92 days study period (22 November, 2015 to 21 February, 2016) was 30.7 Wm^{-2} (Fig.2.1). Maxima for the crop height, leaf area index (LAI) and hyperspectral derived enhanced vegetation index (EVI) averaged over the footprint area were 39.0 cm, 3.9 and 0.69, respectively (Fig.2.2). Sensible heat flux rate during the initial (LAI < 0.3), crop development (LAI: 0.3 to 3), mid season (LAI: 3 to start of senescence) and late season stages of crop growth were 33.4, 23.0, 23.2 and 52.3 Wm^{-2}, respectively which was in accordance to the mean ambient temperature of the above phases. Canopy Air Temperature Difference (CATD) measured in selected days during 35-86 DAS showed a range of 7.7°C with corresponding range in daily diurnal sensible heat flux rate was 49 Wm^{-2}. Vegetation parameter, EVI and combined vegetation-atmosphere parameter, CATD could explain about 61 % ($p < 0.01$) and 63 % ($p< 0.01$) of variability in Sensible heat flux, respectively.

(a) (b)

Fig. 2.1. Measurement of spectral reflectance & LAI (a) and eddy covariance based fluxes (b) in Chickpea crop ecosystem



(a) (b)

Fig. 2.2. Seasonal dynamics of sensible heat flux, (a) soil moisture, leaf area index, (b) enhanced vegetation index and canopy stress indicator in chickpea

Dynamics of parasitism in soybean ecosystem

The density dependence of *M. sojae* parasitoids and percentage of parasitism in field were determined for two crop seasons of 2014 and 2015 by fitting weighted least squares regression (WLS). Weekly *M. sojae* density was used as predictor variable to test the density dependence of parasitoid numbers per plant and field parasitism in *M. sojae* (Table 2.1). The analysis was conducted separately for parasitoids density and per cent parasitism by regressing against mean weekly values of host density of two soybean seasons *i.e.* 2014 and 2015. The significance was tested at $P \leq 0.05\%$ level and residual deviance of fit ≤ residual degrees of freedom. *M. sojae* infestation was initiated at second week after sowing, reached its peak during 7th to10th week and declined towards the end of the season. The mean densities of *M. sojae* measured in our study were 0.75 to 1.58 maggots or puparia per plant, though in few individual cases *M. sojae* number per plant was as high as 4.0. The peak densities generally occurred in the mid-season, by the time most susceptible stage of the crop to *M. sojae* attack had already passed. A parasitoid complex of ten species from five families namely Eurytomidae, Eucoilidae, Pteromalidae, Eulophidae and Braconidae had significant influence on suppressing *M. sojae* populations with mean highest parasitism of 48.67%. The parasitoid population built up concomitant to the host population exhibiting density dependence (Fig.2.3). Fitting of host density as an explanatory variable was meaningful in describing significant deviance in the parasitoids density as well as percent parasitism in the field samples of soybean.

Table 2. 1. Mean seasonal composition (2014-2015) of parasitoid species associated with *M. sojae* in soybean ecosystem of semi-arid tropics of Maharashtra (India)

Parasitoid species	Order: Hymenoptera / Family	Composition (%)
Eurytoma sp.	Eurytomidae	26.24
Gronotoma sp. (= Cynipoidea sp)	Eucoilidae	23.08
Sphegigaster sp.	Pteromalidae	14.00
Syntomopus nigrus Sureshan & Narednran	Pteromalidae	6.29
Syntomopus carinatus Sureshan & Narendran	Pteromalidae	5.00
Halticoptera propinqua (Waterston)	Pteromalidae	4.58
Chlorocytus sp.	Pteromalidae	4.00
Colotrechnus melghaticus Narendran & Kumar	Pteromalidae	2.16
Bracon sp.	Braconidae	4.19
Eulophidae	Eulophidae	1.11

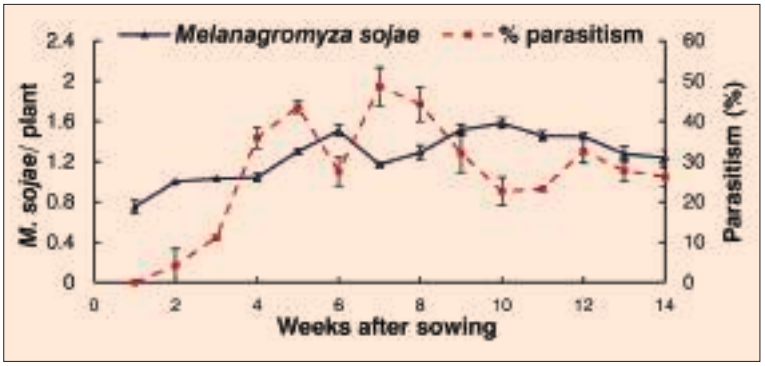


Fig. 2.3. Mean seasonal densities and percentage parasitism of *M. sojae* for the soybean seasons 2014 & 2015 and average of two years.

Impact of spent wash and cropping sequence on disintegration of *murrum*

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. There is general lack of techniques for the quicker disintegration of the *murrum* so that the land can be put into cultivations. Therefore, a long term experiment has been initiated at NIASM farm. 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 ha^{-1} The experimental field was prepared after ripping and leveling of the rocky and undulated land. Thereafter, dhaincha was cultivated and incorporated at 40 DAS. However, it showed poor growth. To further improve the soil, spent mushroom substrate was applied @ 17.5 t ha^{-1}. Initial analysis of the soil samples collected from the experimental field revealed that the soil fraction (< 2mm) 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 experiment involved 13 treatments viz., sugarcane cropping with and without spent wash, soybean-wheat, lucerne, maize-sorghum, subabul and napier grass under irrigated conditions, and subabul, anjan grass and sorghum under rainfed conditions. After completion of three year experimentation it has been observed that treatment comprising spent wash generated in 3.08 to 3.74 per cent higher soil while irrigated conditions has also facilitated *murrum* disintegration. The overall, disintegration of *murrum* followed the trend: Sugarcane + spent wash > Soybean-Wheat + Spent wash > Napier grass> Sugarcane >Subabul >Soybean- Wheat > Lucerne > Subabul (R-Rainfed) > Maize-Fodder Sorghum> Control + spent wash > Anjan (R) > Fodder Sorghum (R)> Control (Table 2.2). Sugarcane equivalent yield was 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 *fb* wheat residue incorporation +Spent wash > Lucerne > Soybean- Wheat > Maize- Fodder sorghum in irrigated condition and Anjan > Fodder Sorghum in rainfed condition. Application of spent wash also improved growth and yield of crops.

Table 2.2. Sugarcane equivalent yield and disintergation of *murrum* under various treatments

Treatment	Water applied (cm y^{-1})	Sugarcane equivalent yield (q ha^{-1})	Fraction of < 2mm soil particles
Control (Left as such)	-	-	22.69±0.31abc
Control + Spent wash	7.98	-	22.82±0.49abc
Irrigated			
Sugarcane	191.49	658.0	21.44±0.17e
Sugarcane+ Spent wash	191.49	974.3	23.2±0.25ab
Soybean-Wheat	119.68	484.7	22.69±0.3abc
Soybean– Wheat-Spent wash	119.68	594.0	23.25±0.15a
Lucerne	215.43	520.2	22.41±0.19cd
Maize- Fodder sorghum	111.70	367.5	22.84±0.5abc
Subabul	95.74	0.00	22.66±0.07abc
Napier grass	151.60	664.8	22.6±0.44abcd
Rainfed			
Subabul	-	0.00	22.51±0.6bcd
Anjan	-	74.9	22.39±0.35cd
Sorghum	-	38.3	21.97±0.9de
CD (P=0.05)	NA	34.3	4.0

Response of plant bioregulators and water production functions of crops using line source sprinkler system

A field experiment was carried to evaluate the interactive effect of irrigation levels and PBR's on grain yield and water productivity of wheat (HD-2189). Treatments were arranged in four replications in split plot design consisted of (i) foliar sprays of five plant bioregulators (PBR's), namely; salicylic acid (10 µM), thiourea (10 mM), potassium nitrate (15 g L^{-1}), gibberellic acid (25 ppm) and ortho-silicic acid (8 ppm) applied at CRI, flag leaf and seed milking stages in main plots along with control (no PBR) and (ii) seven irrigation levels based upon the climatological approach i.e. ratio of cumulative USWB class A open pan evaporation (CPE) and depth of irrigation water (IW). The seven levels of irrigations i.e 1.0, 0.85, 0.70, 0.55, 0.40, 0.25 and 0.10 IW: CPE were maintained using line source sprinkler system (LSS). Exogenous application of PBR's improved the grain yield, total biomass and water productivity (WP) by 5-14%, 4-10% and 0.46-1.23 kg m^{-3}, respectively (Fig.2.4). Thiourea-TU (10 mM) and salicylic acid-SA (10 µM) showed a major role under medium (IW:CPE 0.40-0.69) and severe (0.10-0.39) stress conditions in terms maintenance of leaf water content, modulating the stomatal opening and better water usage and thereby improved yield by 0.11-0.76 Mg ha^{-1}. Thus identified PBR's like TU, SA could mitigate water stress and can help to boost the productions vis-a-vis profitability of wheat under water scarcity conditions.

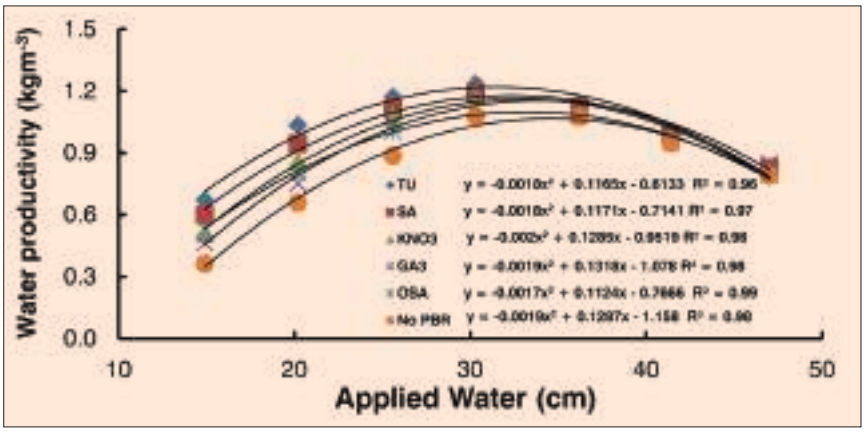


Fig. 2.4. Water productivity as affected by PBR's at various quantities of applied water

In another experiment the interactive effect of application of thiourea (TU-10mM) and ortho-silicic acid (OSA- 32 ppm) with wheat cultivars under supplemental irrigation was studied. Foliar application of TU and OSA at crown root initiation, flag leaf and grain filling stages improved yield by 6-9 % in fully irrigated; 18-19% at medium stress; 12-17% at severe water stress conditions. TU and OSA had various degrees of potential efficacy in alleviation of water stress by efficient use of water through relative water content, modulating canopy temperatures and enhanced total soluble sugars and sink partition are essential for enhanced yield and water productivity under deficit quantity of irrigation applied. It is interpreted that varieties like NIAW 301, NIAW 34 and LOK1 with higher water productivity under medium and severe water stress intensities, though having comparatively low potential yields, should be preferred and exogenous application of PBR's like TU and OSA could further enhance wheat productivity.

During the year 2015-16, the application of PBR's at seedling elongation, reproductive and panicle formation stage enhanced the grain yield, straw yield and water productivity of sorghum by 7.9-19.2%, 6.8-15.6% and 0.45-1.34 kg m^{-3}, respectively**.** The study revealed that application of salicylic acid-SA (10 µM) at moderate irrigation levels and sodium benzoate-SB (100 mg/L) and thiourea-TU (500 ppm) at water deficit regimes performed best to alleviate the impact of water stress (Fig.2.5). Thus PBRs like SB and SA can help to boost the productions of sorghum under water scarcity conditions. However, irrigation is essential to achieve the profitable yield of sorghum with PBRs since grain yield was practically very less under severe water deficit.

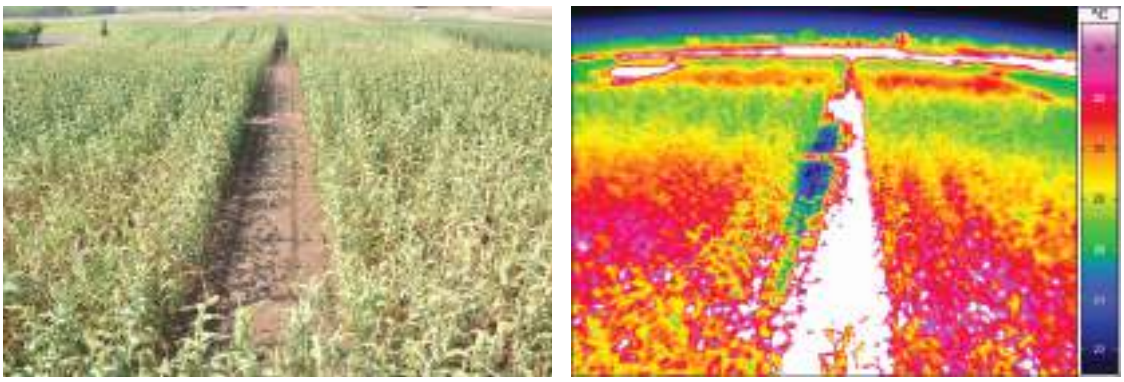


Fig. 2.5. Intensity of water stress on sorghum as indicated by visible (a) and infrared (b) images

Impact of radiation on yield of soybean and *rabi* sorghum

More number of cloudy days and increase in atmospheric aerosol concentration is expected in future climate change scenario which will result in reduction in photosynthetically active radiation (PAR). Soybean, a photosensitive crop, will be highly affected by this change in near future. An experiment was conducted by reducing the levels of PAR at the canopy level to see its impact on photosynthetic rate in determinate, semi-determinate and indeterminate soybean genotypes. There was variation in light saturation points and CO_2 saturation points in these genotypes (Fig.2.6).

To understand the response of different soybean genotypes under moisture stress condition, irrigation was withheld at 60 DAS and per cent reduction in terms of number of pods per plant (Table 2.3) was recorded. The reduction in pods due to stress was nearly 3 to 4 times less in indeterminate relative to other types. Similarly reduction in seed yield was 2 to 5 times less in indeterminate as compared to other genotypes. Under moisture stress condition, indeterminate genotype (26.42 q/ha) high grain yield (q/ha) as compared to semi-determinate JS-335 (23.87 q/ha) and determinate (15.13 q/ha). The only problem with the indeterminate soybean genotype (Kalitur) was more shattering of the pods, if kept for longer time in the field after maturity. Over all, the semi-determinate performed better under normal irrigated conditions in terms of grain yield as compared to determinate and indeterminate soybean types, whereas, under moisture stress condition (60 DAS), indeterminate soybean genotype performed better as compared to semi-determinate and determinate genotypes.

Table 2.3. Yield and yield attributes under normal irrigation (NI) and moisture stress at 60 DAS (MS) in soybean genotypes

Yield Parameters	No. of pods plant^{-1}			Seed yield (q ha^{-1})			Biomass (g plant^{-1})		
	NI	MS	Mean	NI	MS	Mean	NI	MS	Mean
Determinate (JS-93-05)	47.5	35.5	41.5	24.05	15.13	19.59	41.30	32.37	36.84
Semi-determinate (JS-335)	56.4	37.6	47.0	29.04	23.87	26.46	48.75	39.42	44.09
Indeterminate (Kalitur)	72.2	66.8	69.5	28.54	26.42	27.48	55.10	51.00	53.05
Mean	58.7	46.6	52.7	27.21	21.81	24.51	48.38	40.93	44.66
CD (P=0.05)									
Irrigation (I)	8.7			3.23			5.69		
Genotype (G)	3.6			2.24			2.80		
IxG	5.0			3.16			3.96		

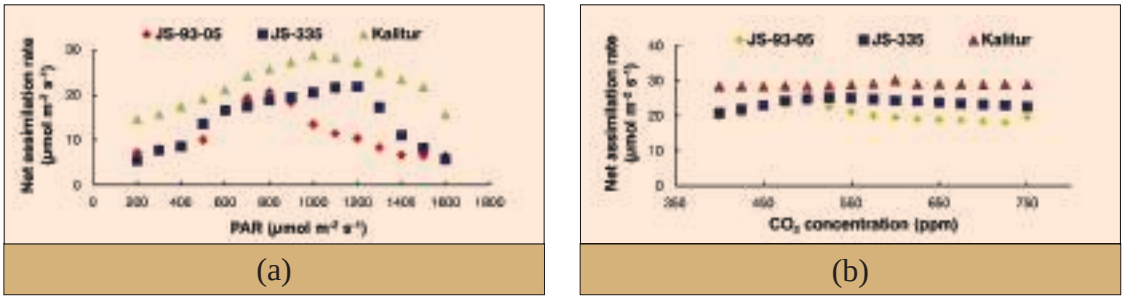


Fig. 2.6. Light saturation point (a) and CO_2 saturation point (b) of determinate, semi-determinate and indeterminate soybean genotypes

Expression analysis of temperature, salinity and hypoxia responsive genes in fish

The impact of rearing temperatures of 25, 30 and 34°C on white muscle morphology of *Labeo rohita* was investigated. Increased hypertrophy was observed in fishes exposed to 30°C. The 20µm, 60 µm and 120µm muscle cells were counted. It was observed that the 60µm cells increased from 38.9% to 44.9% from fishes exposed to 25°C and 30°C. Decline in the 60µm cells was exhibited in fish treated at 34°C. *Labeo rohita* fingerlings were analyzed for expression of hsp70 and myostatin gene. The fishes exposed at 30°C and 34°C exhibited increased expression of hsp70 suggesting protective role of heat shock protein in *Labeo rohita* when exposed to high temperatures (Fig.2.7). Similarly myostatin gene, a negative regulator of muscle, was observed to have increased expression at 34°C. *Oreochromis mossambicus* (Tilapia) Critical Thermal maxima tolerance was analyzed. The CTmax of fishes exposed to 25, 30 and 34°C was 40.3, 41.7 and 42.7°C. *Labeo rohita* fish exposed to 25°C and 34°C were used for generating high throughput sequence data. The transcriptome data is under process.

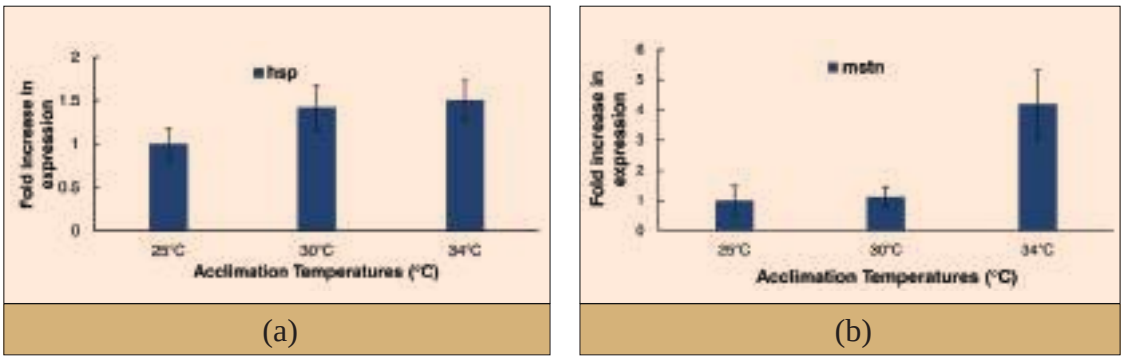


Fig 2.7 Effect of temperature on *hsp* and *myostatin* gene expression

Expression of heat shock protein genes in dairy cattle

To elucidate differential expression of Hsp70.1 in dairy cattle, real-time qPCR was conducted using GAPDH as endogenous control genes. Kinetics of heat shock response in the form of induced expression of Hsp70.1 mRNA was determined in Sahiwal and Frieswal cattle. The results indicated that during the initial period (0–6 h) of heat stress, the levels of Hsp70.1 mRNA expression were prominently higher in both breeds and later the expression levels gradually reduced to the basal level (Fig.2.8). Immediately after heat shock, the expression of mRNA was significantly ($P<0.05$) higher in Sahiwal than Frieswal. This difference in the expression of Hsp70.1 between breeds was prominent up to 6 h of recovery.

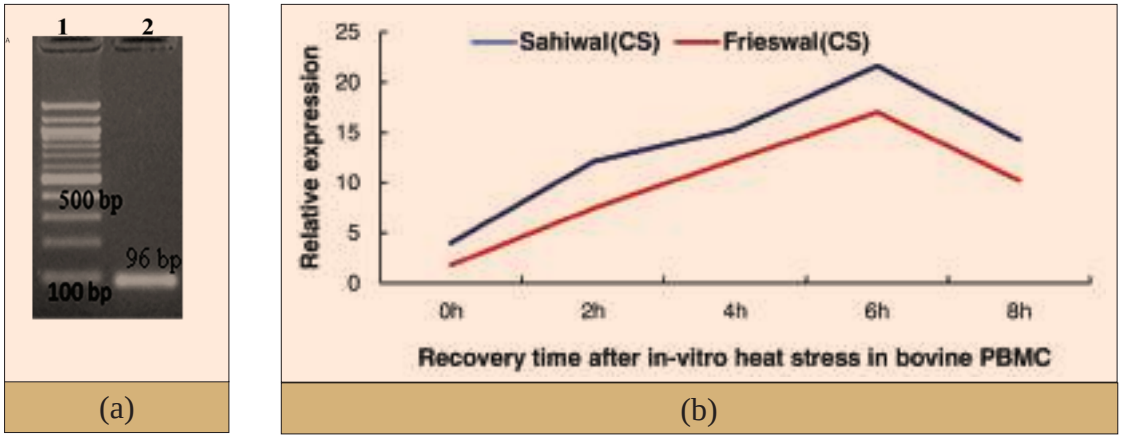


Fig 2.8. PCR amplification (a) and relative expression of Hsp70.1 (b) in bovine PBMC under heat stress

Immune response and HSP genes polymorphism under heat stress in poultry

Poultry meat and egg production systems are considered to be the most efficient animal protein production systems. Presently, poultry meat and egg industry is being viewed as a provider of a healthy alternative to red meat and other protein sources. Heat stress is considered to be one of the major concerns in poultry industry. If the trend of increased poultry production is to be maintained for ensuring food safety, genetic marker assisted selective breeding must be implemented to improve heat resilience and immunity of the birds, which often is weakened under heat stress conditions. Therefore, understanding genetic basis of heat stress and its effect on immunity of the poultry birds is crucial for successful poultry production and welfare. However, there is still inadequate understanding of immune response in poultry with reference to heat stress. A batch of commercial layer birds was reared under summer heat stress for the period of three weeks. The birds were under moderate to severe heat stress (avg. temp. of 29 to 36°C) during the entire experimental period. The optimization of PCR parameters for amplification of HSP gene polymorphic regions i.e., HSP 70 promoter region (364 bp) and 3′ Untranslated region (434 bp) was achieved (Fig.2.9). Gene expression analysis was performed for HSP70 gene in the poultry birds reared under heat stress (Fig.2.10).

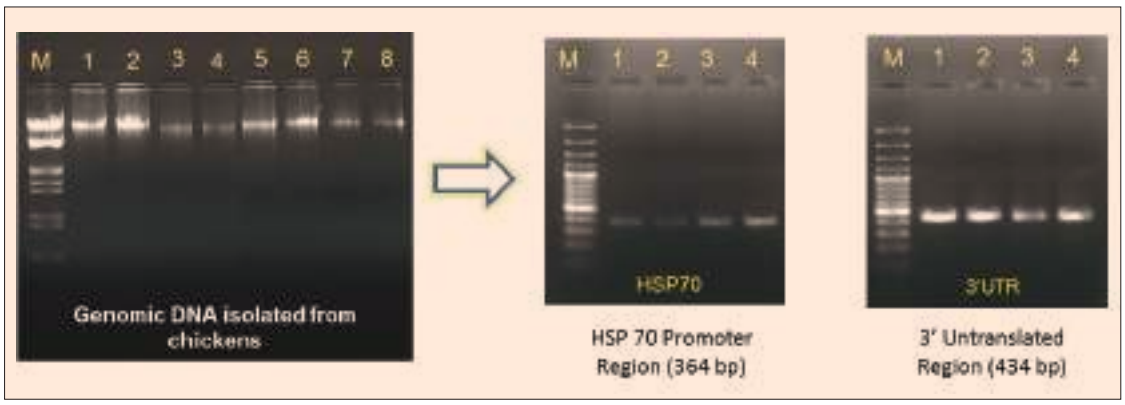


Fig. 2.9. PCR amplification of HSP70 promoter region and 3′ Untranslated region from the genomic DNA extracted from heat stressed poultry birds

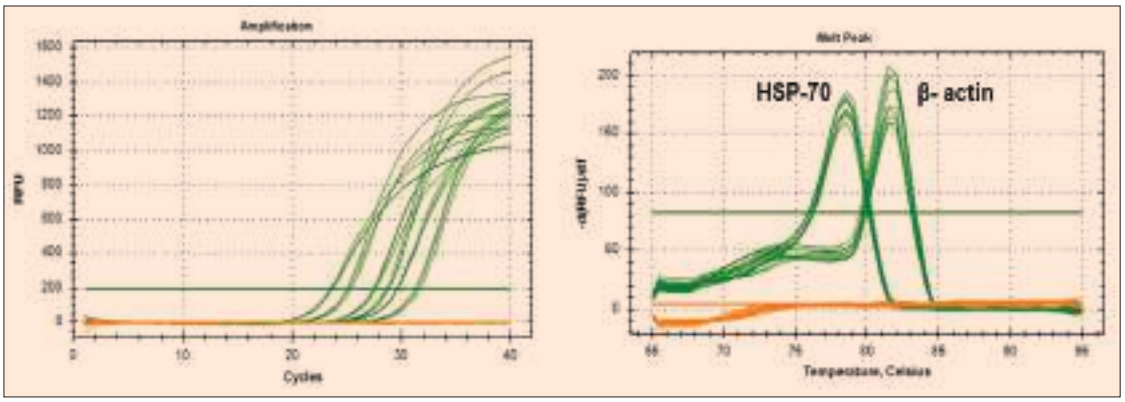
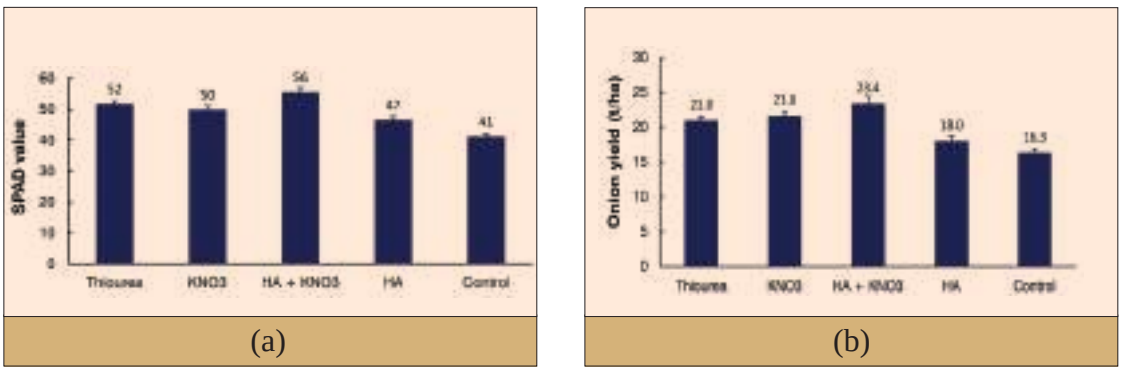


Fig. 2.10. Gene expression analysis of HSP70 gene from heat stressed poultry birds

Retrieval of growth after hail storm damage

In the past two years, hailstorm had severely hit the different parts of Maharashtra due to which huge loss were incurred in Agricultural enterprises. About to harvest *rabi* crops like wheat, tomato, onion, capsicum were damaged and perennial trees were severely damaged with broken branches. Scientists visited farmer's field immediately after hailstorm on 13th March, 2015 and based on the assessment of the damage, planned possible intervention to minimize the losses. A progressive farmer who was who was aspiring to recover from the impact of hail damage was contacted for conducting experiment in his fields. Excess water from the field was drained before imposing treatments. Subsequently, fungicidal spray was given to avoid secondary infection of pathogens in the field after removal of dead and fallen leaves. Four chemical combinations viz., thiourea (4 ml/ L), KNO_3 (4 ml/ L) and humic acid (HA- 4 ml/ L) with and without KNO_3 along with control having water as spray were applied in onion plots. These treatments were imposed through foliar spray, twice at fortnight interval. Experts regularly visited his field and provided timely advice on water and nutrient management beside crop protection, crop management and other best management practices. The yield and yield parameters were recorded when the crop was harvested on 3rd May, 2015 (Fig.2.11). Crop drenched with humic acid (2ml/L) and sprayed with KNO_3 (1.5%) produced 40% more yield (23.4 t/ha) than untreated (16.3 t/ ha) plot. Number of bulbs in Super grade was increased with the combined application of chemicals. Spray of mixture of KNO_3 + humic acid was more effective compared to thiourea, KNO_3, humic acid and control.



(a) (b)

Fig. 2.11. Chlorophyll content (a) and tuber yield (b) of onion influenced by various agro- chemical treatments

School of Drought Stress Management

Genes and traits associated with drought tolerance in wheat and soybean

To identify promising genetic stock for drought tolerance, 60 wheat genotypes were screened, based on known traits such as stay green feature measured by chlorophyll SPAD values, shoot biomass, chlorophyll fluorescence, canopy temperature and yield related attributes under field conditions. Under post-anthesis drought conditions, a genotype IC-549394 was found to be promising as compared to HD-2189, a variety popular in the region. This genotype had higher biomass and relative leaf water content (RWC), green leaves for longer period, more productive tillers and seed weight as compared to HD-2189 (Fig.2.12). Further, techniques developed for *in vitro* root studies revealed significantly different root system architecture in IC-549394 in terms of number of roots and length of roots compared to HD-2189 (Fig.2.13).

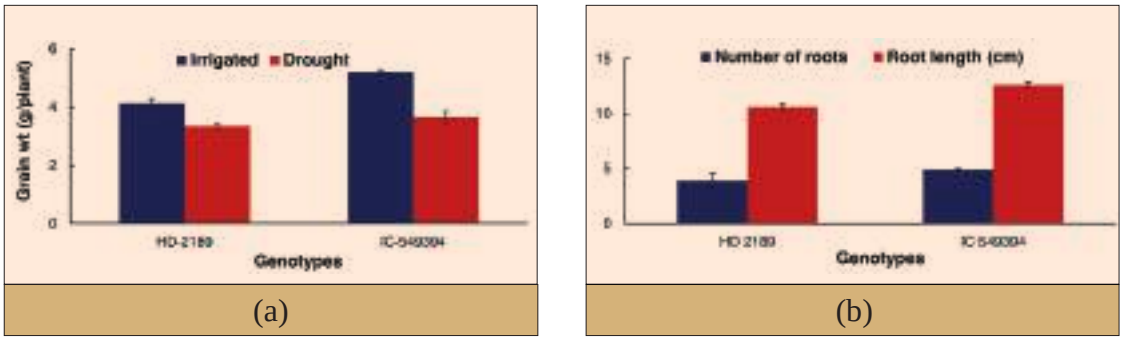


Fig. 2.12. Grain weight (a) and root traits measured *in vitro* (b) in promising wheat genotype relative to local variety HD-2189

Fig. 2.13. *In vitro* root system of HD-2189 (a) and IC-549394 (b)

Quantitative gene expression profiling of drought responsive genes revealed high levels of expression of *CBF4* and *CDPK* (Calcium-dependent Protein Kinase) genes in IC-549394 (Fig.2.14). This genotype and local check HD-2189 were also analyzed for expression of *farnesyl transferase* gene whose down-regulation enhances water stress tolerance. Expression of this gene was low in IC-549394 as compared to HD-2189 under both irrigated and water stress conditions.

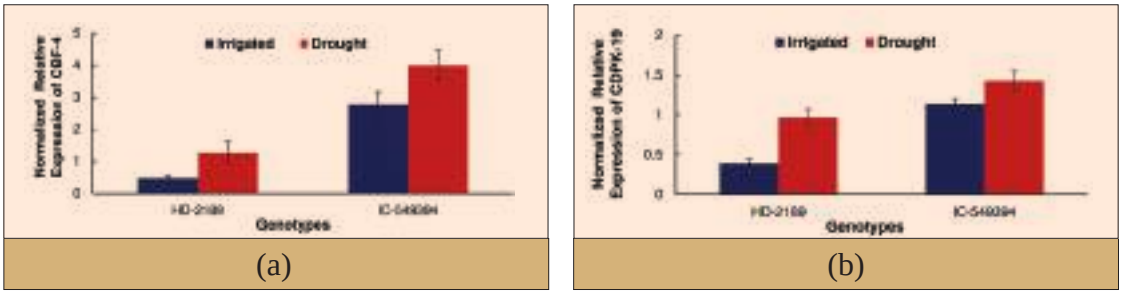


Fig.2.14 Expression of CBF4 (a) and CDPK19 (b) gene in wheat

Virus induced gene silencing (VIGS) technique was successfully used to investigate the role of putative genes associated with drought tolerance in soybean. Selected soybean genotypes including locally well adapted cultivar JS-335, NRC-37 and Harasoy were used in the experiment to silence *Ethylene-In-sensitive2* (EIN2) gene and to validate its role in drought tolerance. EIN2-silenced soybean plants exhibited a drought-tolerant phenotype characterized by low levels of transpiration and enhanced expression of drought-responsive genes. In addition, EIN2 silenced soybean plants exhibited increased expression of SA responsive PR1 gene, reduced expression of JA responsive PR3 genes but had high level of ADP Riboxylation factor and WRKY-39 genes (Fig.2.15) indicating significance of these genes in imparting drought tolerance (Fig.2.16).

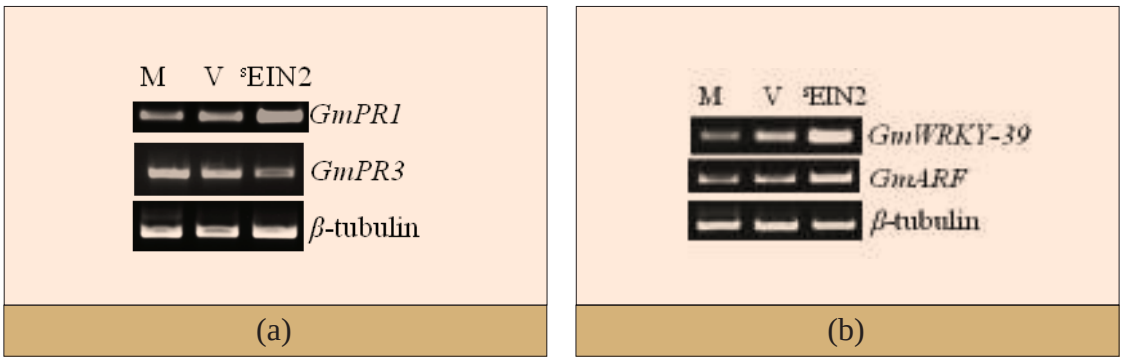


Fig. 2.15. Expression of PR1 and PR3 (a) GmWRKY-39 and GmARF (b) in leaf tissue from mock (M), vector-infected (V) and EIN2 silenced (sEIN2) plants

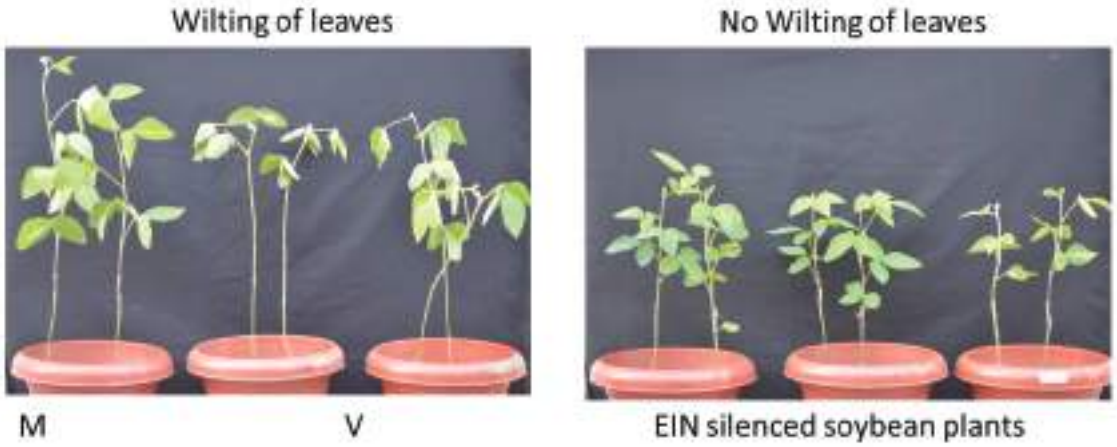


Fig. 2.16. Comparison of water stress tolerance in mock (M), vector control (V) and EIN2 silenced plants after withholding water

Imaging tools for phenotyping wheat and soybean

Non-invasive tools are gaining attention for improved precision in large scale plant phenotyping. Chlorophyll fluorescence imaging is one of the phenotyping tools being employed to assess photosynthetic efficiency of plants based on photosystem-II performance. We used this technique to evaluate a hypothesis that *Triticum durum* is more tolerant than *Triticum aestivum* to desiccation and hence the former is well adapted to dry and hot environment (Fig.2.17). Chlorophyll fluorescence based photosynthetic efficiency was measured in spikes of two *T. aestivum* and three *T. durum* wheat cultivars which were developed in central zone of India. It was observed that the *T. durum* wheat had high photosynthetic efficiency than *T. aestivum* as indicated by chlorophyll fluorescence parameter(Fv/Fm) at similar phenological stage (Fig.2.18). In addition, the rate of decline in photosynthetic efficiency with increase in desiccation was high in *T. aestivum* than in *T. durum*. Similar trend was observed in each of the spikelets except terminal ones. *Durum* wheat had relatively less moisture than the *aestivum* throughout the measurements suggesting that better photosynthetic efficiency in the former than in the later was intrinsic. The results also indicated that chlorophyll fluorescence of spikes could be employed for phenotyping responses of wheat germplasm for drought tolerance.

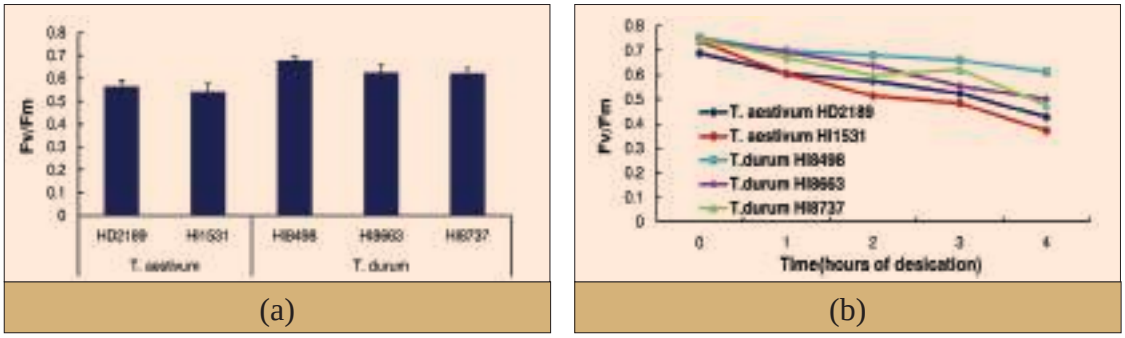


Fig. 2.17. Differences in photosynthetic efficiency expressed as mean value (a) and as affected by duration of desiccation (b) in spikes of *T. aestivum and T. durum*

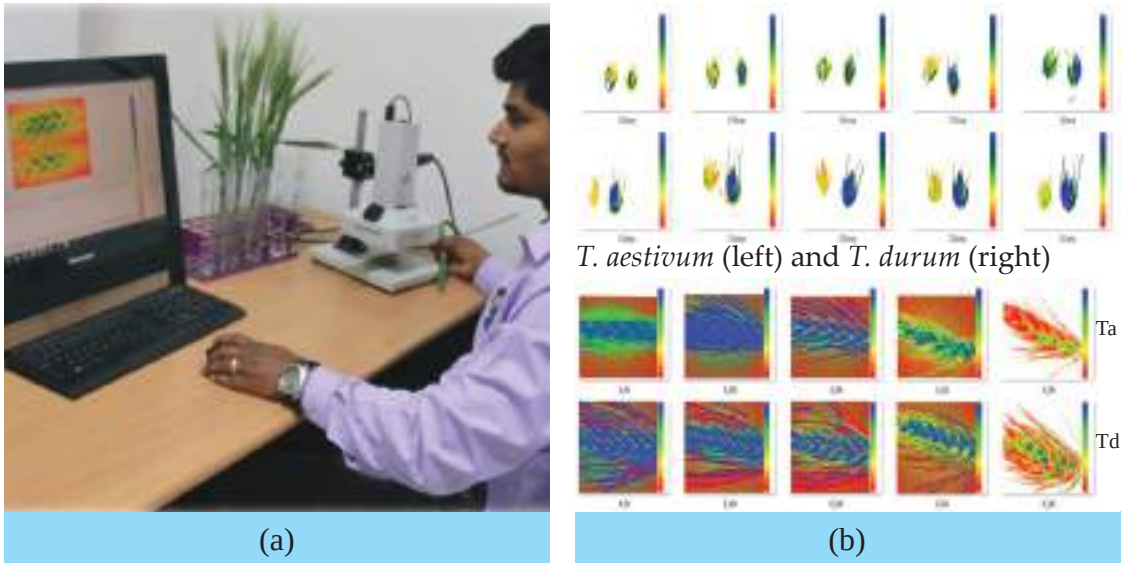
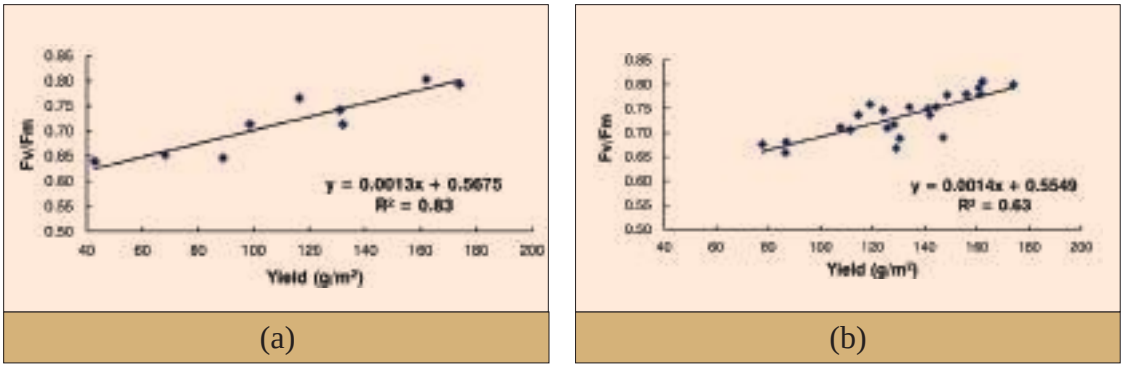


Fig. 2.18. Chlorophyll fluorescence imaging system (a) and differences between *T. aestivum* and *T. durum* (b)

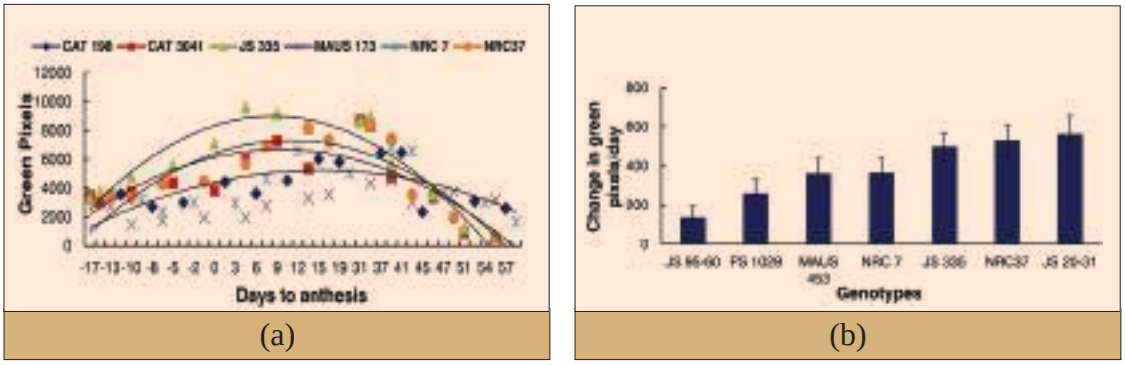
To confirm the association between photosynthetic efficiency revealed by Fv/Fm and yield, 32 soybean genotypes were re-evaluated under irrigated and water-stress conditions in the field. Strong association between Fv/Fm and the seed yield were observed in leaves. Further, it was also observed that high yielding genotypes had high photosynthetic efficiency of pods (Fig.2.19). Hence, this technique can serve as useful non-invasive tool in eco-physiological studies as well as for screening soybean germplasm.

Experiments were conducted to validate an image-based phenotyping technique as a non-destructive measure for assessing genetic variation in plant growth under field conditions. The technique involved a hand operated track mounted trolley loaded with digital camera for acquisition of images and a software that can quantify RGB pixels in each image. These tools were used to capture and analyze images of tagged leaves of 32 genotypes of soybean at an interval of 3-4 days in irrigated as well as soil moisture limited conditions. Hence, the image acquisition and analysis tools were used to to identify genotypes with rapid growth as indicated by fast ground cover and also those with delayed senescence under both sufficient and deficit soil moisture stress environments. These RGB based phenotyping tools can work as low cost non-destructive phenotyping tool for large scale phenotyping. Promising results have been obtained with image acquisition and analysis tool developed to assess rate of ground cover by canopy and leaf expansion rate in soybean. Leaf expansion rate in JS 20-31 was higher than the best local check. Rapid ground cover is one of the traits that contributed to high yield of locally adapted genotype JS-335 (Fig.2.20).



(a) (b)

Fig. 2.19. Association of pod chlorophyll fluorescence and seed yield in early (a) and late (b) soybean genotypes



(a) (b)

Fig. 2.20. Ground cover rate (a) and leaf expansion rate (day^{-1}) (b) in promising soybean genotypes

Plant Phenomics facility has been established at the institute for precise screening of genotypes of crop plants for different stresses such as drought and high temperatures. The facility has automated system to monitor water relations, temperature and development of plant through NIR, IR and visible image based procedures. Phenotyping protocols have been optimized for image acquisition and image analysis for crops such as soybean and mungbean. A series of experiments were conducted to phenotype mungbean genotypes to assess water uptake and water retention in tissues based on weight and NIR image based measurements. Automated precise irrigation and weight measurement systems were used to record water consumed by plants in each of the pots. These procedures could enable us to identify genotypes that retain more water in leaf tissues relative to well adapted variety of mungbean under depleting soil moisture regime. Preliminary results revealed that a mungbean genotype EC693356 uses about 10% less water to produce about 9% more biomass (Fig.2.21).

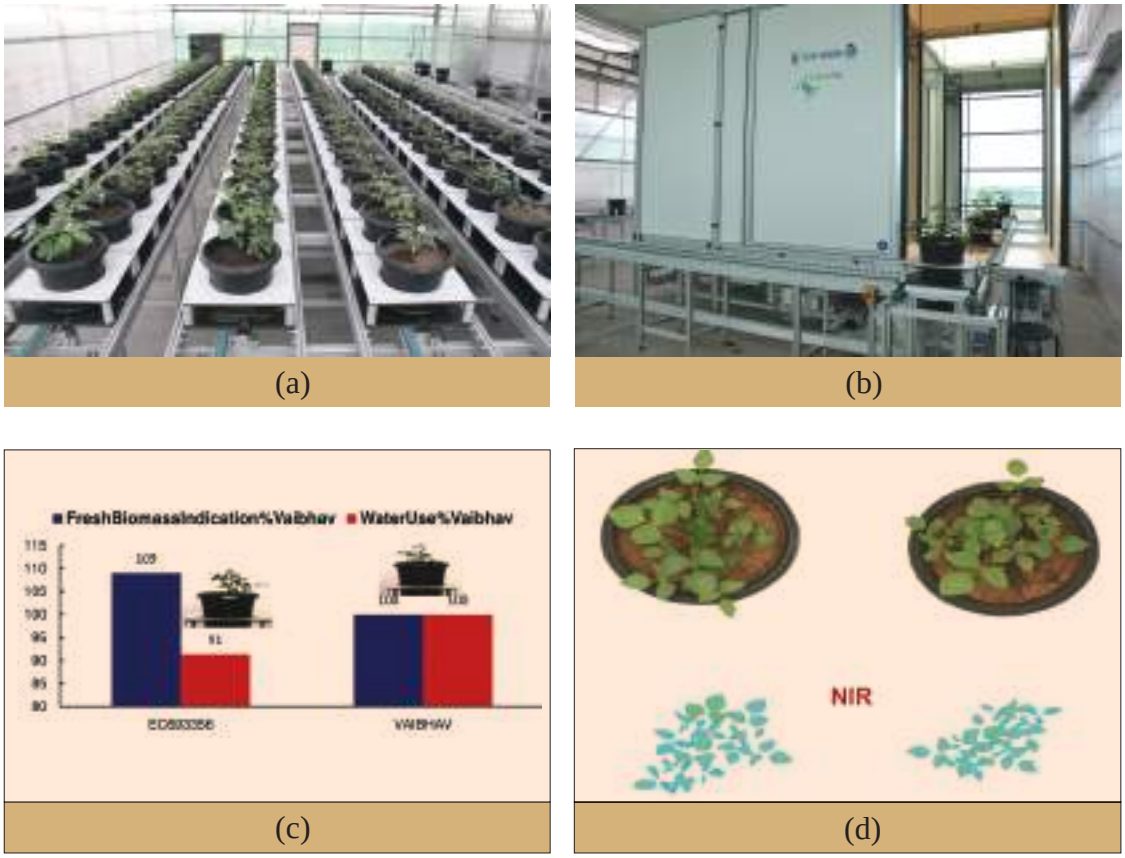


Fig. 2.21. Phenotyping mungbean (a), image acquisition (b) more biomass with less water use (c) as detected by visible and NIR image (d)

Bacterial endophytes and Bradyrhizobium for drought tolerance in crops

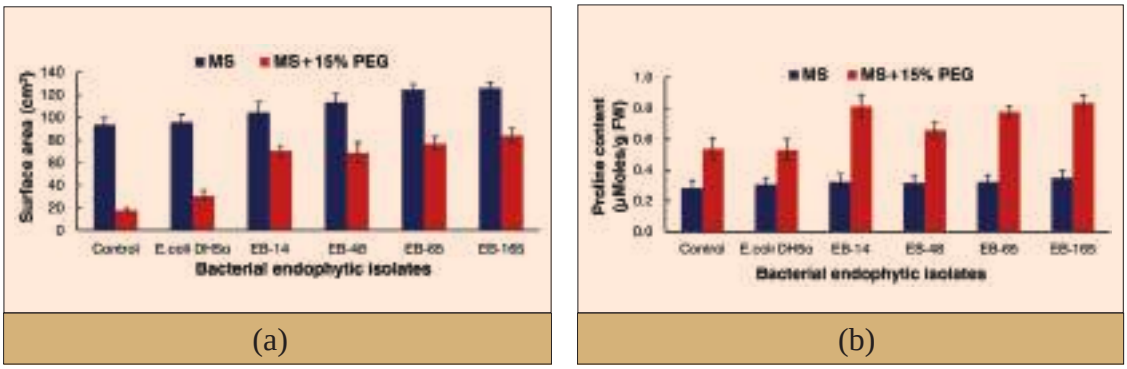
Based on the 16S rRNA gene sequence, 46 sorghum-root bacterial endophytes possessing plant growth promoting (PGP) traits such as P-solubilization, siderophore production and ACCd activity were identified. These bacteria belonged to 9 different genera such as *Bacillus* (29), *Pseudomonas* (3), *Acinetobacter* (2), *Enterobacter* (2), *Geobacillus* (1), *Lysinibacillus* (1), *Microbacterium* (3), *Ochrobactrum* (1), *Paenibacillus* (1) and uncultured bacterium (2). Phylogenetic analysis of these bacterial endophytes revealed the dominance of *Bacillus* spp. belonging to the phylogeny of the Firmicutes (G+ve) in the endorhizosphere of sorghum cultivars. Other bacterial phylogenetic groups identified were α-Proteobacteria (G-ve), γ-Proteobacteria (G-ve) and Actinobacteria (G+ve with

high G+C content in DNA). Gene sequences of all these 44 bacterial endophytes along with initial four multi-PGP trait containing endophytic isolates have been submitted to Genbank of NCBI database and assigned with the Accession Nos. KU258056- KU258088, KU550035-KU550043 and KU885898-KU885903. In addition, one of the representative fluorescent *pseudomonads* purified exclusively from sorghum cv. Maldandi 35-1 having higher ACC deaminase activity was identified as *Pseudomonas* sp. EPF-20 and its 16S rRNA gene sequence submitted to Genbank database of NCBI with Acc. No. KU258089.

Drought tolerance imparting ability of four multi-PGP trait containing endophytic isolates *(Ochrobactrum sp. EB-165, Microbacterium sp. EB-65, Enterobacter sp. EB-14 and EB-48)*, were confirmed *in vitro* and also under field conditions. Under induced drought stress *in vitro* (1/2 MS+15%PEG) as well as imposed low soil moisture *in vivo* (soil-rite), seed bacterization/ treatment with these promising isolates significantly increased root length, root surface area and improved the plant growth (Fig.2.22) and physiological performance of sorghum seedlings (senescent line: R-16) in terms of relative water content (RWC), cell membrane stability index (MSI) and free proline (osmolyte) accumulation in the leaves (Fig.2.23).

(a) (b)

Fig. 2.22. The effect of root-bacterial endophytes on root growth under water stress (a) and symbiotic effectiveness of Rtx strains of *Bradyrhizobium* (b)

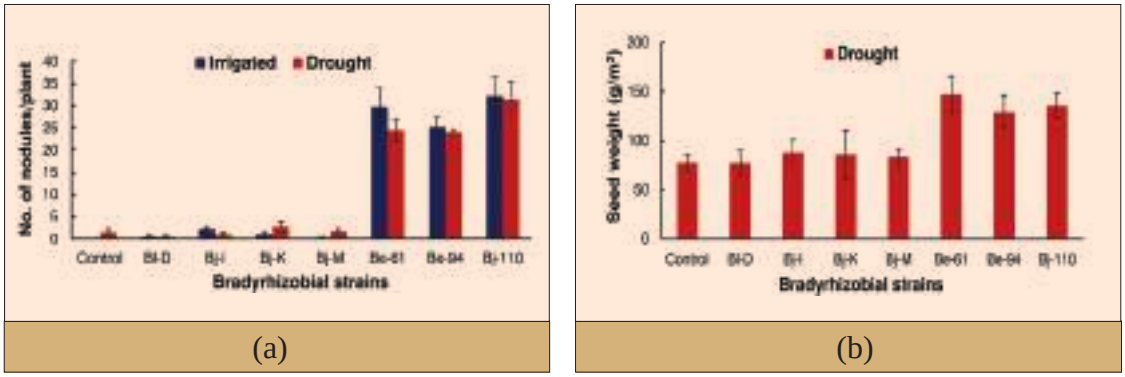


(a) (b)

Fig. 2.23. The effect of root-bacterial endophytes on root surface area (a) and free proline accumulation (b) in sorghum leaves

Field validation was successfully conducted for elucidating the roles of promising *Rhizobitoxine* (rtx) producing strains of *Bradyrhizobium* spp. on soybean drought tolerance. These strains promoted profuse nodulation and high N-fixation by enhancing nodule-legheamoglobin (protein required for nitrogenase enzyme activity)

and nodule, root and leaf-ureides (represents transportable form of biologically fixed N) content in drought sensitive soybean under field conditions . It was also successfully demonstrated that inoculation of these strains of *Bradyrhizobium* spp. significantly improved leaf chlorophyll contents and quantum efficiency of photosynthetic systems; and yield parameters of soybean (Fig.2.24) as compared to non-rtx producing strains in the field under low soil moisture stress condition.



(a) (b)

Fig. 2.24. Symbiotic effectiveness of Rtx producing and non-Rtx producing strains of *Bradyrhizobium* spp. on nodules (a) and seed wt (b) of soybean

Influence of deficit irrigation strategies on physiological parameters and quality of tomato

The field experiment was conducted to study influence of growth stage specific water stress on the physiological parameters like photosynthesis rate, water vapour conductance (WVC), transpiration rate, intrinsic water use efficiency (iWUE) and physiochemical quality of tomato fruits. The higher photosynthesis rate, transpiration and water vapour conductance (WVC) was monitored with full irrigation (FI) during flowering and fruiting stages, followed by deficit irrigation (DI) $DI_{0.6(FL)}$ and regulated deficit irrigation (RDI) $RDI_{0.8}$. The iWUE was also higher during vegetative stages and declined with age especially during fruiting stage. However, the decline in iWUE was non-significant with $DI_{0.6(FL)}$ and $DI_{[0.6(VS+FL)]}$.

The trends in fruit quality traits with different irrigation treatments were contrary to fruit yield except for fruit weight and its shape index. Comparatively bigger sized fruits as indicated by higher weight (115-121g) were monitored under FI, $RDI_{0.8,}$ $DI_{0.6(VS),}$ II_{VS} while the fruit size was reduced considerably (77-81g) under $RDI_{0.6,}$ $DI_{0.6(VS+FL),}$ $DI_{0.6(FL+FT)}$ and II_{FT}. The shape index was also better with FI, $DI_{0.8,}$ $DI_{0.6(VS),}$ and $DI_{0.6(VS+FT).}$ $RDI_{0.8}$ and $RDI_{0.6}$ as well as interruption of irrigation at fruiting (II_{FT}) induced firmness in fruits (N 3.4-3.6) while the fruits with FI were quite soft (N 1.9). Similar was the case with TSS, ascorbic acid and acidity where the values were higher (> 5.0 brix; > 200 ppm Ascorbic acid; > 0.6 % acidity) with $RDI_{0.8}$ and $RDI_{0.6}$. These parameters also got improved with $DI_{0.6FT}$ either alone or in combination with other growth stages. The DI at fruiting either with $RDI_{0.6}$ or $DI_{0.6(FT)}$ and $RDI_{0.6(FL+FT)}$ was observed to improve redness considerably (CI > 43) while the CI was lower (29-33) in case of FI and $RDI_{0.6(VS)}$ and II_{VS} (Table 2.4). The CI ranged between 37.2 and 39.6 under other irrigation treatments.

Table 2.4. Quality parameters of tomato as affected by deficit irrigation strategies

Irrigation schedules	Firmness (N)	TSS (°Brix)	Asc. Acid (ppm)	Acidity (%)	Fruit wt. (g)	Shape index	Colour Index
a) Regulated deficit irrigation							
0.6xETc [$RDI_{0.6}$]	3.6	5.5	315	0.72	77.55	1.11	43.5
0.8xETc [$RDI_{0.8}$]	3.4	5.1	229	0.60	111.1	1.20	39.6
1.0xETc [FI]	1.9	3.4	175	0.44	118.9	1.19	29.1
b) FI except DI (0.6xETc) at growth stage							
Vegetative [$DI_{0.6(VS)}$]	2.8	4.2	187	0.45	115.1	1.21	33.0
Flower [$DI_{0.6(FL)}$]	2.2	5.1	197	0.52	99.3	1.20	35.0
Fruiting [$DI_{0.6(FT)}$]	2.2	5.3	258	0.59	92.5	1.16	43.2
Veg. & Flower [$DI_{0.6(VS+FL)}$]	2.4	4.4	217	0.48	80.3	1.14	38.4
Veg. & Fruiting [$DI_{0.6(VS+FT)}$]	2.1	5.1	257	0.62	89.5	1.21	39.9
Flow. & Fruiting [$DI_{0.6FL+FT}$]	2.0	5.4	267	0.64	80.9	1.09	44.3
c) FI except irrigation interrupted (15 d) during growth stage							
Vegetative [II_{VS}]	2.6	3.7	179	0.43	121.2	1.09	33.2
Flowering [II_{FL}]	2.7	4.3	208	0.47	104.9	1.12	37.2
Fruiting [II_{FT}]	3.4	4.8	201	0.44	80.7	1.07	38.7
LSD (p=0.05)	0.2	0.6	14	0.03	13.5	0.06	4.04

Delayed monsoon and its impact in Maharashtra

Most of the area of Maharashtra witnessed prolonged dry spell in last two years. Impact of delayed monsoon was assessed in 13 districts of six different divisions of Maharashtra. Four team comprising 3-4 multi-disciplinary scientists, from the institute, along with the officials of state agriculture department surveyed the identified region based on severity of conditions. Information was also collected from visit to farmer's field and discussion with agricultural officers at the Division and District headquarters and at the most affected villages during the visit. While attempts to collect the first hand information on losses due to erratic and deficit monsoon, the focus was on researchable issues for management of such inevitable weather events. It was observed that monsoon in Maharashtra was very favourable in the beginning which prompted farmers and concerned authorities to ensure timely sowing of crops. However, the deviation from normal prevailed from the last week of June till mid of July in most parts of Maharashtra including Konkan region, which receives enough rains. Rain shadow areas of Western Maharashtra and highly drought prone areas of this region did not receive sufficient rains for early establishment of crops. Standardized precipitation index

clearly revealed that area with below-normal rains increased drastically throughout the state from the first week of July. Deficit and erratic rainfall resulted in delayed sowing leading to stunted growth and poor crop health. Dry spell in July-August, 2015 reduced productivity of crops by 60-70 %. In most of drought prone areas the compartmental bunding, continuous trenches and recharging of wells were in process under Jalyukta Shivar campaign of Maharashtra state govt. schemes. Demand for cattle camps and in severe situation distress selling of livestock's by farmers in several regions viz., Beed, Latur, and Osmanabad districts was reported (Fig.2.25). Due to water scarcity and restricted release of water into the canals sugarcane crop was severely affected.

(a) (b)

Fig. 2.25. Preference to goat (a) & cotton crop (b) by small farmers

(a) (b)

Fig. 2.26. Drought stress mitigation in cotton (a) and dried pomegranate orchard (b)

Based on the, on-site visits, scientists identified researchable issues such as development of drought tolerant short duration pigeon pea, soybean and cotton cultivar, possible change in cropping pattern suitable to long dry spell, alternative cash crop for replacement of sugarcane, possibility of bio regulators in horticultural crops for survival during water scarcity (Fig.2.26). Development/ refining of existing technologies suited to changing climatic situations are needed to tackle drought. Location /situation specific contingencies, promotion of real time contingency measures for soil and water conservation, small ruminants in the farming system to withstand stress, nutritional measures for cattle's were suggested.

School of Edaphic Stress Management

Resource conservation technologies for enhancing productivity and input-use efficiency in sugarcane ratoon crop

Field experiments were conducted in sugarcane ratoon crop at farmers' fields by using a multi-purpose SORF machine for stubble shaving, off-barring, root pruning and placement of basal dose of fertilizers in soil in a single run (Fig.2.27). The results revealed that irrespective of trash and fertilizer management practices, the number of millable cane increased by 15-39% due to stubble shaving and off-barring (SO) practices. However, improvement was not significant when SO operation was done under un-chopped trash (UCT) condition without root pruning (R) and fertiliser placement (F) practices. The lesser mortality of tillers due to stubble shaving and improved supply of nutrients by the new slush of roots could be reason for highest number of millable canes recorded under SORF+ chopped trash (CT) treatment (Table 2.5). Similarly, cane juice yield improved by 11.9 and 15.7% under SORF+CT followed by 5.3 and 8.9% under SOR+ broadcast application of fertilizers (BC)+CT treatments over the broadcasting of fertilizers under un-chopped trash conditions with and without stubble shaving practices, respectively. Similar kind of improvement was also observed in other yield attributes of sugarcane due to use of SORF machine. The significantly highest cane yield was recorded with SORF+CT treatment that was 38, 20 and 14% higher than BC+UCT, SO+BC+UCT and SOR+BC+CT treatments, respectively. However, no significant difference was observed between SOR+BC+CT and SO+BC+UCT treatments, but former produced significantly higher cane yield over BC+UCT treatment, but significantly lower than SORF+CT treatment. This indicated that placement of fertilisers is also important along with the pruning of old roots and shaving of older stubbles for improving the nutrient use efficiency and cane yield of ratoon sugarcane.

In another experiment conducted with SORF machine at 10 farmers field revealed that the increase in net return averaged 17.5 and 11.9% over the trash burning (farmers' practice) and chopping followed by recommended practices of fertiliser application (0.45, 0.45 and 0.10 N as basal, at earthing up and on-set of monsoon rains, respectively) while B:C ratio increased by 5.9% (Table 2.6). Band placement of double the dose of N as basal rather than the recommended two splits as basal and at earthing-up further increased the net profit and B:C ratio by 23.1 and 12.6 %, over trash burning practices.

Fig. 2.27. Demonstration of stubble shaver, off-bar, root pruner cum fertiliser drill (SORF) machine at farmers' field

Table 2.5. Effects of different ratoon management practices on yield attributing traits of sugarcane ratoon crop.

Treatments	Millable cane (x1000/ha)	Internodes/ cane	Internode length (cm)	Cane length (m)	Cane weight (kg)	Juice yield/ cane (L)	Cane yield (t/ha)
BC+UCT	118.9	16.7	9.3	1.86	1.09	488.3	97.8
SO+BC+UCT	136.7	19.1	9.5	2.01	1.15	505.0	112.7
SOR+BC+CT	150.0	20.3	10.5	2.15	1.29	531.7	118.7
SORF+CT	164.8	21.2	11.1	2.27	1.38	565.0	134.9
LSD (P = 0.05)	24.8	2.4	0.9	0.27	0.17	46.5	15.9

Note: BC: broadcast application of fertilisers; UCT: un-chopped trash; CT: chopped trash; S: stubble shaving; O: off-barring; R: root pruning; F: fertiliser placement in soil

Table 2.6. Effect of trash and N management on economics of sugarcane ratoon crop

Treatment		Net returns (Rs. *1000/ha)	B:C ratio
Trash	Basal N		
Burnt	BC[a]	219.12	4.60
CSR	BC	230.07	4.57
CSR	SORF-1N[b]	257.48	4.87
CSR	SORF-2N[c]	269.78	5.18
LSD (P = 0.05)		28.74	0.44

[a]BC: Broadcasting; [b]SORF-1N: Recommended N as basal with Stubble-shaving, Off-barring, Root-pruning and Fertiliser-drill Machine; [c]SORF-2N: Twice the recommended N as basal; CSR: Chop ped and surface retained

Adoption of individual or in combination with sugarcane ratoon management practices like surface retention of chopped trash, stubble shaving, off-barring, root pruning and placement of fertilizers in soil with the use of SORF machine improved the cane yield by 14-38% over un-chopped trash and application of fertilizers through broadcast. Band placement of either recommended or double the dose of N as basal rather than recommended two splits as basal and at earthing-up through broadcasting increased the net profit of farmers by Rs. 27-50 thousand/ha and B:C ratio up to 12.6 % over farmer's practice. Recently optimised method for lignin estimation can help in studying degradation of sugar trash.

UHPLC method has been standardized for quantitative detection of lignin dimers (Guaiacylglycerol-β-guaiacyl ether) in isocratic mode using the C18 column with a mobile phase of acetonitrile - water – orthophosphoric acid (55:45:0.1) and a flow rate of 0.8 ml/min for 10 min. Lignin dimer isomers were monitored at 275-280 nm and quantified by peak area using different standard concentrations. This work will lead to ascertain lignin degrading capability of bacteria isolated from biogas slurry.

Nano(bio-)remediation for aquaculture system

Novel nanoparticles and their role in environmental remediation is the subject of extensive research. Nano materials have increasingly been used in water treatment because of economical and environmental viability and wider availability. Synthesis of silver nanoparticles has been scaled up by crushing, incubating and filtering gill

of Rohu *(Labeo rohita)* using PBS and silver nitrate. Ag Nps so obtained were further characterized spectrophotometrically, SEM and ICP-MS.

Experiments were conducted with 13 different zeolites to trap silver nanoparticles. Native zeolites and zeolites trapped with silver nano particles were characterized by ICP-MS, which indicated the trapping of silver nanoparticles in zeolites (1. Mesolite, 2.Thaumarite, 3. Okenite, 4.Mordanite, 5.Prehnite, 6.Thomsonite, 7.Gyrolite, 8. Scolerite, 9. Stilbite, 10. Heulandite, 11.Stellerite, 12.Apophyllite, 13. Ferrerite). Bactericidal activity of zeolites trapped with silver nano particles against fish pathogen *Aeromonas hydrophilla* and shrimp pathogen *Vibrio harveyi* were confirmed.

Among the zeolites tested, Stilbite is abundantly available in quarries of Maharashtra, hence was selected for scaling up of silver nanoparticles, which was further characterized by ICP-MS. Cation exchange capacity of Stellerite, and stilbite have been determined using sodium acetate method. CEC of these two zeolites were found to be 2.63 and 2.23 meq/g respectively. Suitable sites for trapping of silver nanoparticles in zeolites have been identified. Thirteen different forms of zeolites and zeolites trapped with silver nanoparticles were analyzed using ICP-MS. (Fig.2.28). From these, it is evident that apart from Cu, Ca, Mn and Fe also play role in trapping of silver nanoparticles.

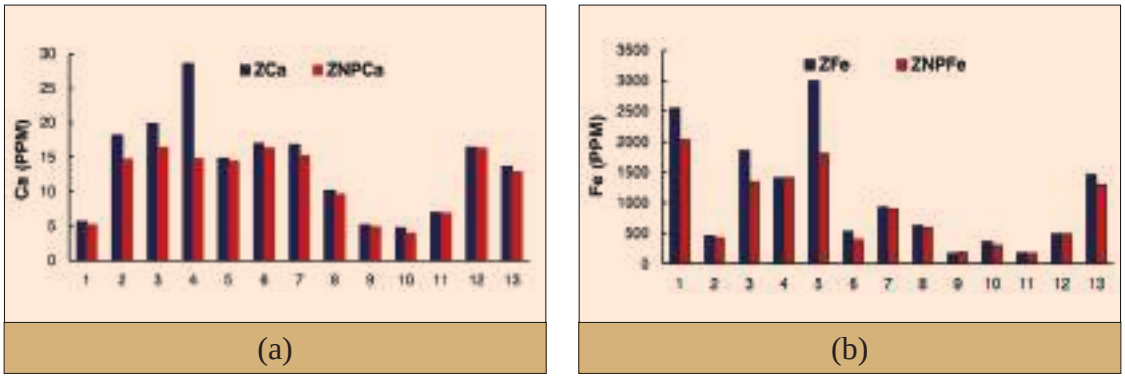


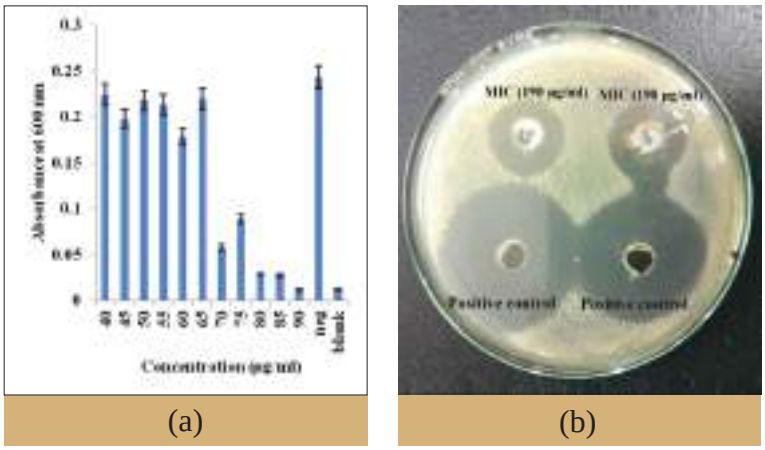
Fig. 2.28. Zeolites trapped with silver nanoparticles for Ca (a) and Fe (b) estimation

Ammonia removal activity of stilbite trapped with silver nanoparticles was evaluated in aquaculture pond. Ag-stilbite was found to be effective not only in decontamination of ammonia but also against pathogens of fin and shellfish in aquaculture systems. Thus nanotechnological interventions can add value to naturally and abundantly available zeolites for alleviating multiple stressors in aquaculture system. Further they can also be used in solid waste management in fisheries.

Antibacterial and photocatalytic functions of Zinc oxide-silver oxide nano-composite

Zinc oxide and silver nanoparticle have important roles in inactivation of animal and fish pathogens. ZnO/Ag_2O nanocomposite was synthesized by chemical co-precipitation followed by hydrothermal treatment from zinc chloride and silver nitrate precursor salts. ZnO/Ag_2O nanocomposites was detected as rod shaped having size in the range of 30-50 nm diameter by atomic force microscopy (AFM). Antibacterial study of nanocomposites was carried out on *Staphylococcus* aureus (MTCC 96) and ***Escherichia coli*** (MTCC 40). Minimum inhibitory concentration (MIC) of nanocomposites was

found to be 190µg/ml and 90 µg/ml for *Staphylococcus aureus* and *Escherichia coli* respectively. Further, antibacterial study was carried out by well diffusion assay for *Staphylococcus aureus* MTCC 96 (Fig.2.29). Zone of inhibition (ZOI) was observed to be 2.2 cm at MIC concentration 190 µg/ml of nanocomposites. Photocatalysis study of nanocomposite carried out with an organic water pollutant congo red dye clearly revealed that about 71.8% photocatalysis takes place within 5 hours.



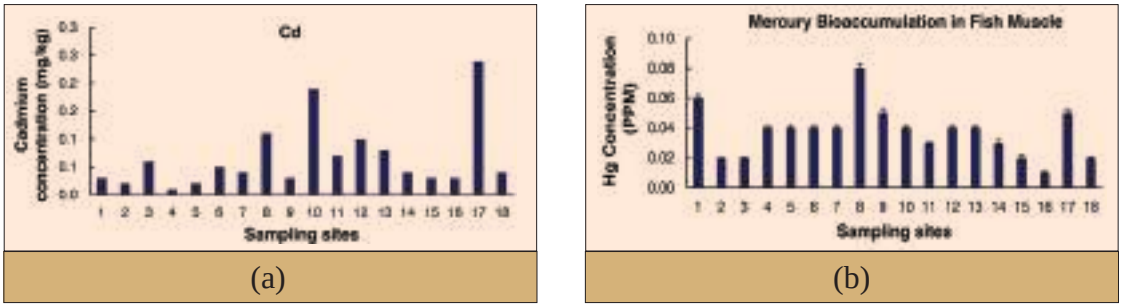
(a) (b)

Fig. 2.29. Antibacterial activity of ZnO/Ag_2O nanocomposite on *Staphylococcus aureus* (a) and well diffusion assay (b)

Selenium is one of essential micronutrients in fish and animals but role of nanoselenium in the degradation of toxicants is recently gaining importance. Nanoselenium was biologically synthesized from plant extracts by hydrothermal method using sodium selenite as precursor salt. Selenium nanoparticles have been characterized by transmission electron microscopy (TEM), energy dispersive X-ray spectroscopy (EDAX) and selected area electron diffraction (SAED). About 50-100 nm diameter and rod shaped selenium nanoparticles were detected by TEM, while polycrystalinity nature of nanoparticles was confirmed by SAED. The EDAX spectrum futher confirmed identify of selenium nanoparticle. Selenium nanoparticle (200ppm) based photodegradation of methylene blue (50 ppm) was studied under direct sunlight irradiation. About 75% photodegradation of methylene blue was observed within 3 hrs of sunlight irradiation.

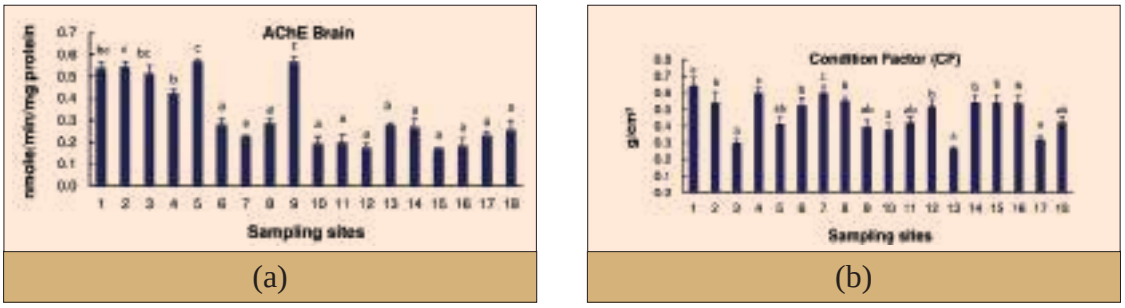
Assessment of heavy metals in Bhima river

A study was conducted to assess the concentration of heavy metals such as Cr, Mn, Co, Ni, Cu, Zn, As, Se, Cd, Hg, Pb, Ga, Sn and Sb in surface water , soil sediments and in different fish tissues (muscle, gill, liver, kidney and gonad) of Bhima river in Maharashtra (Fig.2.30). The present results showed that most of the metal in the river were within the safe limits expect few heavy metals which may be attributed to deficit monsoon for last three years. The correlation between length, weight and heavy metal relation were also determined by Pearson correlation coefficient. The stress biomarker enzymes such as catalase, SOD, GST, AChE, LDH, MDH, ALT, AST, lipid peroxidation in tissue samples and morphological study such as condition factor, hepatosomatic Index and gonadosomatic index determined and it was found that activity of AChE was significantly inhibited and condition factor was found to be less than 1 indicating restricted growth of fish(Fig.2.31). The histopathology of liver and gill were also altered due to moderate contamination of aquatic environment.



(a) (b)

Fig. 2.30. **Cadmium (a) and mercury (b) bioaccumulation in fish muscle of *Oreochromis mossambicus* collected from Bhima river**

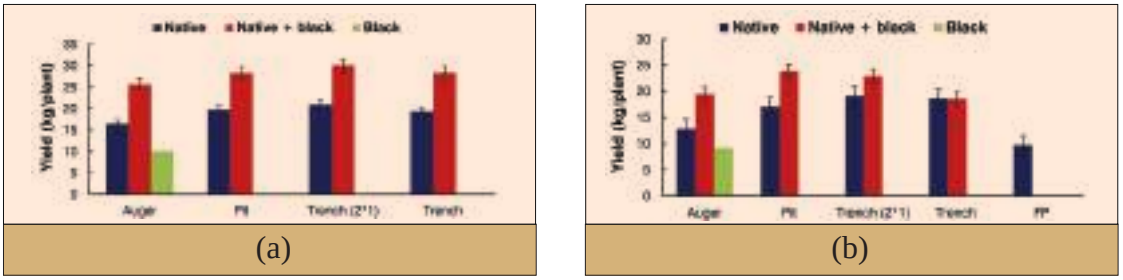


(a) (b)

Fig. 2.31. **Brain acetylcholine esterase (a) and condition factor (b) of *Oreochromis mossambicus* collected from Bhima river**

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

The economic longevity of sapota, pomegranate and guava orchards is limiting factor for obtaining higher yield and profitability in orchards grown on shallow basaltic soils of Deccan region facing sever water scarcity during summer periods. Therefore, an experiment was conducted for developing techniques to overcome these problems with the help of studying the effect of various planting methods and soil mixtures on performance of plants under these conditions. Plant height, diameter and canopy spread in guava was monitored with pit and trench planting filled up with mixture of native murrum and black soil. The maximum yield was recorded in mixed soils and further high yield was noticed in those treatments where the rocky layer was subjected to microblasting (Fig.2.32). This could be attributed to imporved soil moisture regimes resulted from rainwater conservation with blasting (19.5%) than without blasting (15.0%). Pits made by auger filled with black soil recorded more moisture in deeper soil. Trench or pit planting of Sapota, Guava and Pomegranate orchards are performing better than Auger planting . Growth and physiology of plants were better in mixtures of black soil and native murrum than in 100 % black soil under limited moisture conditions.



(a) (b)

Fig. 2.32. **Impact of planting methods and filling mixtures on guava yield with (a) and without (b) microblast treatments**

Alleviation of waterlogging stress in onion

Experiment was conducted during *kharif* 2015 to study the impact of duration of water logging on physiological manifestation and yield of late *kharif* onion var. Bhima Shakti. Fifteen days after transplanting, water logging was imposed by flooding for 0, 2, 4, and 6 days. Soil and foliar application of chemicals were attempted to alleviate the stress. The results indicated that under normal condition additional nutrient application significantly increased bulb weight and over all yields irrespective of mode of application over control. Water logging up to two days did not affect the yield significantly and the plants recovered rapidly in response to the applied nutrients. The effect was predominant with foliar application of KNO_3 and spermidine.

Water logging beyond four days reduced the yield to an extent of 40% of control. The plant were unable to recover after six days of flooding. However, the application of chemicals improved the yield of waterlogged plants by at least 10-15%. Increase in the duration of waterogging enhanced the occurrence of thick neck bulb. This was significantly reduced with foliar and soil application of chemicals. The improvement was much better with foliar application of KNO_3, spermidine and thiourea, whereas sulphur and K application along with humic acid through soil performed better than N application (Table 2.7). Application of N through soil negatively influenced some of the quality and bulb parameters. Sporadic flowering and thick neck bulb percentage was increased. Total soluble sugar (TSS) decreased with the increase in water logging. This ultimately decreased the pungency of the bulb which was reflected through decrease in pyruvic acid content. However, this could be negated with the foliar application of KNO_3.

Table 2.7. Influence of onion yield (t/ha) under various foliar and soil treatments

Water logging duration (Days)	Yield (t/ha) in response to foliar spray						
	Control	250 ppm Ethrelpost	0.05 % Thiourea	1 % KNO_3	2 mM Spermidine	250 ppm Ethrelpre	Mean
0	33.9	32.2	34.7	35.0	35.1	31.5	33.5
2	27.8	28.3	30.5	31.9	31.2	27.2	29.3
4	18.8	19.0	21.4	22.2	21.8	20.5	21.0
6	13.5	16.6	19.7	20.7	20.2	15.2	16.9
Mean	24.0	24.8	27.5	27.6	27	20.2	
CD (P=5%)	I	1.35	F	2.70	IxF	5.1	

Water logging duration (Days)	Yield (t/ha) in response to soil application						
	Control	30 kg N ha^{-1}	20 kg S ha^{-1}	30 kg K_2O ha^{-1}	Humic acid + 30 kg K_2O ha^{-1}	Humic acid + 30 kg N ha^{-1}	Mean
0	32.4	33.8	32.4	33.5	33.9	34.1	32.9
2	23.4	24.9	25.5	26.3	27.1	27.4	25.3
4	16.0	19.7	20.7	21.2	22.0	21.8	20.1
6	13.0	15.3	16.6	17.5	19.5	20.1	16.3
Mean	22	23.7	24.4	24.5	26.2	21.1	
CD (P=5%)	I	1.3	S	3.1	IxS	6.3	

Morphological and functional diversity of methylotrophs

Methylotrophs are important members of the phyllosphere ecology that directly or indirectly influence the growth and development of the host. This is mainly due to the plant growth promoting biomolecules including auxins, cytokinins, siderophore, exopolysaccharide, etc. Hence, attempts were made to isolate promising methylotrophic biomolecule producing bacteria from phyllosphere of grape, sugarcane, custard apple, etc. grown in the institutes experimental fields. Initially, the selection was based on the colony morphology, pigmentation, colony size, etc. (Fig.2.33). These isolates were then characterized for production of IAA and siderophore (Fig.2.34).

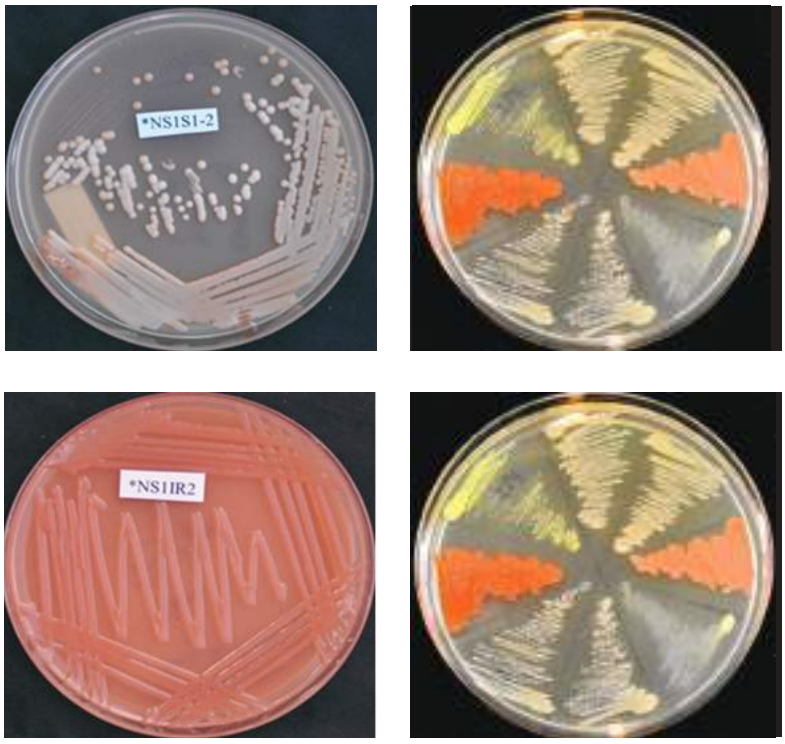


Fig. 2.33. Colonial diversity of Methylotrophic bacteria isolated from phyllosphere

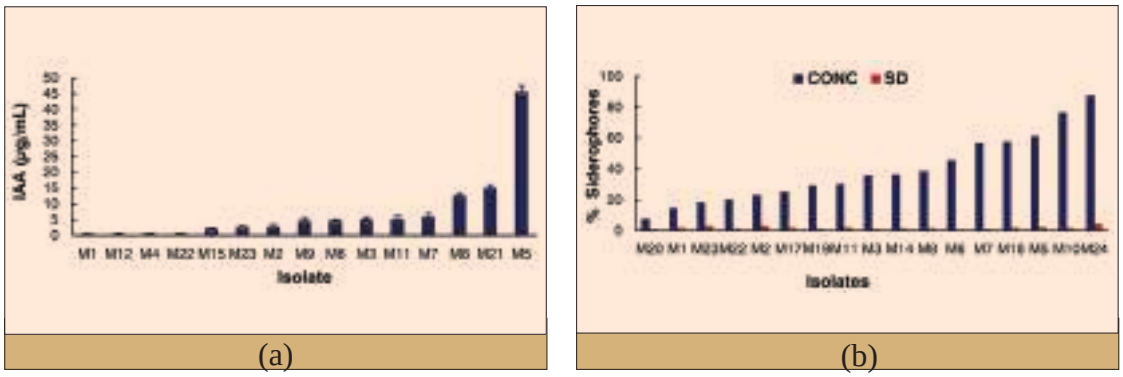


Fig. 2.34. IAA (a) and siderophores (b) produced by methylotrophic bacteria

Extraction of community DNA and metabolite from microbes

The culture independent approaches in combination with the high throughput sequencing technology are crucial for systematic evaluation of the genetic diversity of microbes of different ecosystems. However, the frequent occurrence of PCR inhibitors

is major constraint in protocol for the extraction of metagenomic DNA. Considering these problems, we successfully developed an efficient reagent system for obtaining good quality and sufficient quantity of metagenomic DNA without disrupting the leaf tissues. This reagent was used to harvest the surface microflora from healthy leaves and DNA was extracted from the aliquot by improved phenol-chloroform method. The efficiency of this method was confirmed by absence injury on leaf surface when examined through scanning electron microscopy (Fig.2.35) in contrast to existing method. Further, this was confirmed from contaminated DNA in the traditional method but not in improved method as revealed by DNA examination using agarose gel electrophoresis.

Fig. 2.35. Electron-microscopic analysis of leaves treated and untreated with reagents

XAD 16 based method was successfully standardized for improving efficiency and quality of extraction of metabolites. This method was used for microbial profiling of salt tolerant bacteria isolated from halophytic weed and also from saline soil samples. This method substantially reduces the elution cycles for harvesting high quality metabolites from the microbial culture broth and hence highly useful. UHPLC based methods for rapid determination of plant-growth hormones from phenolics cell free culture extract of bacteria have been developed for rapid detection and quantification of IAA, IBA, GA3, Zeatin and ABA. These high-end methods further resolved the limitations of chemical assays which otherwise could not differentiate IAA and IBA. Using these methods, presence of all the above hormones was successfully determined in the organic extracts of the isolates. The relative magnitudes of responses as observed in chromatogram for different plant hormones in the organic extracts of the isolates were IAA > GA3 > IBA > ABA; while the relative abundance of the hormones was IAA > IBA > GA3 > ABA in the tested isolates. Further, the method for metabolite profiling has also been developed to resolve the finer aspects of bacterial metabolic diversity under different stress situations. This method successfully resolved the differences among the organic extracts of same isolate cultivated under varying stresses. Some dominant unknown peaks in the UHPLC chromatogram of the metabolites are needed to be characterized further to explore the probability of novel molecules for stress alleviation.

Resilient microbes from sugarcane rhizosphere

A total of 360 different halotolerant bacterial isolates were obtained from soil and plant sample collected from normal and saline fields by using five different media (Fig 2.36)

Fig. 2.36. Morphological diversity among halotolerant bacteria

The purified isolates were screened for their ability to tolerate high salt and pH. Majority of the isolates were halotolerant in nature with tolerance limit up to 15 % salt, however, few cultures were able to grow up to 30% salt. Bacterial isolates growing at high salt concentration were also able to tolerate high pH in the same media indicating the high level of tolerance to combined stress. The isolates were also grown in presence of PEG and salt, where maximum isolates were found clustered at 10 and 15% of salt with 0, 10 and 20% of PEG respectively (Fig.2.37).

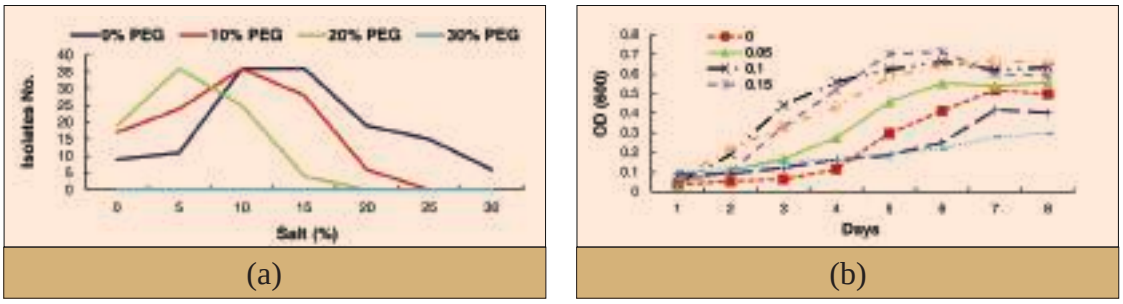
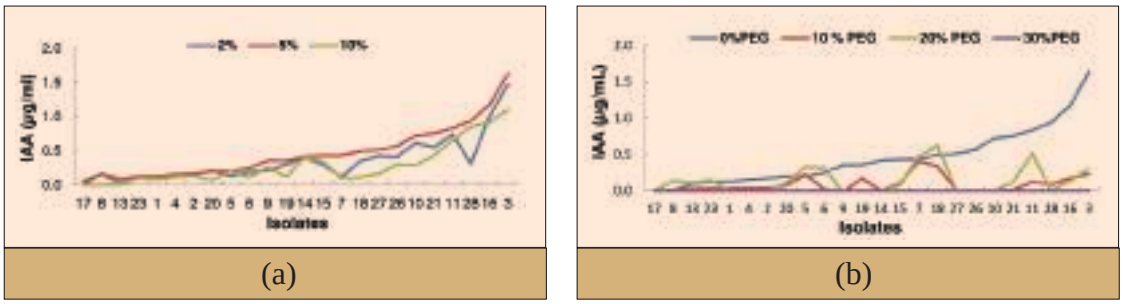


Fig. 2.37. Screening bacterial isolates for salt and drought tolerance (a) and growth pattern under different stress levels (b)

Plant growth promotional traits of Bacteria

Bacterial isolates obtained from different saline soil samples were evaluated for their plant growth promotional traits such as production of IAA and siderophore under simulated drought and salinity stress. At 5% salt concentration, almost all the selected isolates produced higher quantity of IAA as compared to 2 and 10%, whereas most of the isolates were unable to produce siderophore at 1% salt concentration (Fig., 4). The siderophore hyperproducers showed peak activity at 5% salt concentration. Salt concentration-dependent regulatory mechanism was evident from the observation that some isolates which produced siderophores at 1% salt were not capable to do so at 5% salt in the growth media. The maximum IAA was produced by the isolates in the ab-

sence of PEG, however, the quantity of IAA produced by isolates at 20% PEG was more than that at 10% (Fig.2.38).



(a) (b)

Fig. 2.38. Impact of salt stress (a) and simulated drought stress (b) on IAA production

Similarly drought stress induced by PEG reduced the ability of microbes to produce PGP. Some promising isolates which could produce siderphores even at 20% were identified. A total of eight potent salt tolerant bacteria were identified using 16SrRNA gene sequencing. The identified bacterial strains are *Salinicola* sp., *Bacillus* sp., *Staphylococcus* sp., *Arthrobacter* sp., *Halomonas* sp., and *Enterobacter* sp., The phylogenetic analysis of the isolates revealed that the isolates had close phylogenetic association with the existing genera associated with high salt environments.

Halotolerant bacteria from salt tolerant weed

Plant growth promotional traits and salt tolerance potential of bacterial isolates varied as per their habitat. Seventy nine different bacterial morphotypes isolated from different plant parts viz., leaf (surface), root (surface and inside), stem (inside), root nodules and rhizosphere exhibited salt tolerance within the optimum range of 5-7% of NaCl. The isolates were functionally characterized for their plant growth promotion ability. Almost all of the root nodulating population was siderophoregenic (Fig.2.39), indicating the presence of active iron-chelation system to cope up with iron deficient situation. *In vitro* nitrogen fixation was more evident in root epiphytes as well as root endophytes. Similar was the case with exopolysaccharide production, where root endophytes dominated. The rhizosphere isolates showed the highest salt tolerance and IAA production.

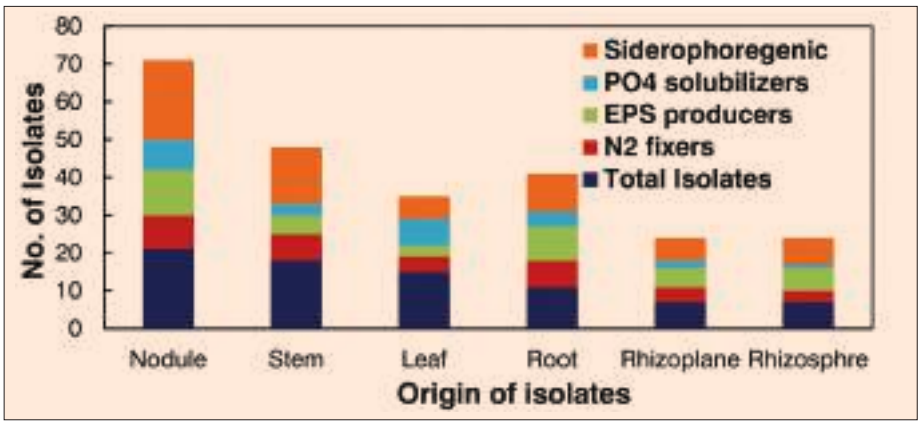


Fig. 2.39. Plant growth promotional traits of the isolates

The candidate isolates were also tested for the ability to utilize variety of carbon sources including different monosaccharaides, polysaccharides, sugar-alcohols and amino acids using Biolog system. Results showed the metabolic flexibility of the isolates. The plant growth promotional ability of the candidate isolates were evaluated using the impact of culture extract of the isolates on seed germination and seedling growth of wheat crop under increased salinity. Significant enhancement in vigour index was noted in case of seeds grown in presence of organic metabolites extracted from these isolates. The shoot-root development pattern and vigour index in wheat clearly highlighted the ability of the isolates to influence the seedling development under salinity stress. Indicating the possibilities of using microbial community of wild origin in agriculture for enhancement of crop productivity. The candidate isolates associated with the weed were subjected for molecular identification using 16S rRNA gene sequencing that revealed the presence of multiple genera including *Bacillus, Pantoea, Marinobacterium, Acinetobacter, Enterobacter, Pseudomonas, Sinorhizobium and Rhizobium.* The sequences were deposited to DDBJ with accession numbers LC027447- LC027459 and LC128410. Detailed biochemical and phylogenetic analysis of the isolates highlighted the novelty of some of the isolates.

Salt stress affects metabolic profile of the soil bacteria

The impact of microbial metabolites on seed germination, root and shoot development was studied under salinity stress. Results indicated the role of microbial metabolites in enhancement of seed germination under saline conditions. UHPLC analyses of metabolites elaborated by potential halotolerant PGP isolates revealed the presence of diverse stress specific unknown metabolites in the culture extracts of the isolates.

School of Policy Support Research

The vulnerability, knowledge level, behaviour and adaptive capacities of cotton farmers are highly critical to cope with pest problems under changing cropping and climatic scenarios featured by rising ambient temperatures. Hence to generate the first hand information about the different aspects of farmers awareness with respect to the insect-pest infestations, 160 cotton growers from sixteen villages of four districts namely Jalgaon, Aurangabad, Amravati and Ahmednagar were interviewed using stratified random sampling method. A pre-tested structured questionnaire was used to collect data from the sampled farmers. The study was based on different qualitative variables. Sixty-four farmers from marginal as well as small category each and 32 farmers from medium and large category were chosen for this study. The study examined farmers' knowledge on cotton pests, factors influencing capacity to detect mealybug infection, weather based pest management, adoption level of scientific practices and constraints. The analysis revealed that yield losses due to mealybug infection in cotton can range from 5-15% (low to medium) in Maharashtra as perceived by the farmers while during the outbreak it can devastate the crop completely (Fig.2.40 a.). Many experts have predicted that increase in temperature will facilitate spread of mealybug as more area under cotton will become conducive for it, and the pest will multiply faster in areas where it is already prevalent. Hence, the study focused on farmer's perception about mealybug incidence in relation to weather parameters.

The various studies on mealybug population have reported positive correlation with temperature and negative correlation with rainfall and humidity. The present study revealed that 28.8 per cent farmers perceive positive correlation between temperature and mealybug population. Its negative relationship with rainfall and humidity was perceived by 31.2 and 3.8 per cent farmers, respectively. The 71.2, 68.8 and 96.2 per cent respondents were not aware about perfect relationship between mealybug population with temperature, rainfall and humidity, respectively (Table 2.8).

Table 2.8. Farmer's perception (%) about mealybug incidence in relation to climatic factors

Relationship	Temperature	Rainfall	Humidity
Positive	28.8	2.5	15.0
Negative	3.8	31.2	3.8
Absent	1.2	3.8	8.7
Don't know	66.2	62.5	72.5

Attempts were made to assess ability of farmers to adopt weather based precautionary measures for controlling mealybug. The result indicated that those who knew about temperature-mealybug relationships were proficient to adopt accurate mealybug management strategies. Such control measures were largely dependent on rise in ambient temperatures perceived by farmers but not relative humidity or rains. This can be attributed to the fact that rains substantially reduce mealy bug incidence. Different statistical approaches were adopted to derive a perception model that can explain factors influencing the awareness of farmers about mealy bug and its control measures. As per the best model that we used, Mass media(MM), Education level of farmer(ELOF), Local sources of information(LSOI) significantly enhanced the farmers awareness as compared to HRD programmes (HRDP), Mobile advisory services (MAS), Private sources of information(PSOI), Government sources of information(GSOI) and Farming experience(FE). Among all these parameters, the role of mass media was highly conspicuous.To avoid future losses due to mealybug outbreak, cotton farmers can be sensitized about temperature-mealybug relationships through mass communication media like television, newspaper, etc. Though the mobiles have recently become more convenient for information dissemination, the present study reveals that they were not as effective as mass communication. Hence, it is suggested that communication through visual images of pest infection can augment farmers' perception as well as adoption of appropriate management strategies against this pest.

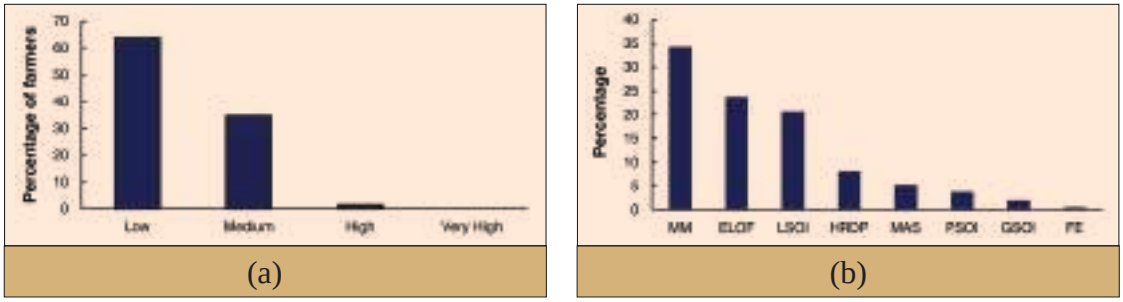


Fig. 2.40. Farmers' perception of cotton yield losses due to mealybug infestation (a) and factors affecting perception of farmers on mealybug (b)

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3.Tribal Sub Plan

Integrated farming for livelihood improvement of tribal farmers

The team of scientists comprising Dr K K Krishnani (Chairman), Dr NP Kurade, Dr DP Patel, Dr Ankush Kamble, Dr RL Meena, Dr Neeraj Kumar and Dr AV Nirmale has successfully implemented technology interventions in field and horticulture crops, dairy, poultry, fish farming and integrated farming in various villages of Navapur Tehsil in Nandurbar District for improving the livelihood of resource poor farmers as part of Tribal Sub-Plan (TSP).

The certified rice seeds of improved variety Indrayani, *Gliricidia* saplings and fertilizers were distributed to 121 farmers of various villages (Gadad, Bokaljhar, Chitwi, Devlipada, Vadsatra, Neemdarda and Bandharpada), Virus-free tissue culture banana plants and fertilizers were distributed to identified farmers at Chitwi and Vadsatra villages and in fisheries, Indian major carp (IMC) fingerlings were stocked in farm/ fisheries ponds at Karanji, Bhom dipada, Borepada, Jamtalav, Chowky and Chitvi. Integrated farming (Agri-aquaculture) in terms of cultivation of rice and banana and aquaculture of IMC has successfully been demonstrated at Chitvi village. Farmers at Gadad and Jamtalav villages have also been identified for dairy farming, backyard poultry and fodder interventions. Root slips of Hybrid nappier "Phule Jayawant" were procured and demonstration plots were established, 150 farmers have been selected for intervention of backyard poultry units and were provided with dual purpose Vanaraja birds along with cages. (Fig.3.1)

Fig. 3.1. Demonstration of implemented activities to villagers

Training programmes pertaining to technology interventions in rice, banana, fodder crops, farm pond preparation and integrated agri-aquaculture were conducted on 8-9th July 2015 at Visarvadi and Navapur where more than 315 farmers from Chitwi, Vadsatra, Devlipada, Neemdarda, Bandharpada Jamtalav, Gadad, Bokaljhar, Mugdhan and nearby villages participated. In training programmes, informative lectures related to technology interventions were delivered by the TSP team and interactive sessions were also held with the participants. Research on fish ponds led to the optimal water

quality and plankton primary productivity. Availability of fish seeds from nearby hatcheries was encouraging farmers to adopt agri-aquaculture.

Farmers field days on "rice crop" and "fish culture" were organized during 3-4 November 2015 for higher productivity and income, where more than 430 farmers from Navapur villages participated and benefitted (Fig.3.2). Integrated agri-aquaculture and Participatory demonstration of "Four point rice production technology" have been successfully implemented. Training programme on "Backyard Poultry Farming" was organized on the 18th December 2015 and 19th March 2016, where more than 400 farmers got benefitted. Two exposure visits were conducted on improved technology interventions in field & horticulture crops, livestock & poultry, & integrated Agri-IMC aquaculture for livelihood improvement of tribal farmers on 3-4 March 2016 and 28-30 March 2016, where 165 farmers participated. Farmers along with TSP team visited KVK Bhabhleshwar, MPKV Rahuri, KVK and NIASM Baramati. Thereafter, farmers participated in interactive session conducted at NIASM and expressed their happiness with the wide exposure related to integrated farming received during this exposure visit.

Fig. 3.2. Exposure visit of farmers

Organization of HRD programmes under TSP

Activity	Technology	No. of farmers	Date
Training programme	Technology interventions in rice, banana, fodder crops, farm pond preparation and integrated agri-aquaculture were conducted, where more than 315 farmers from Navapur villages participated and were benefitted.	315	08/07/2015 - 09/07/2015
Field Day	Rice crop and Fish culture for higher productivity and income, where more than 430 Tribal farmers from Navapur villages participated and were benefitted. Integrated agri-aquaculture and Participatory demonstration of "Four point rice production technology" have successfully been implemented.	430	03/11/2015 - 04/11/2015
Exposure Visit	Recent advances in field & horticulture crops, poultry, dairy and aqua-farming and Integrated agri-aquaculture where 90 Tribal farmers from Navapur villages participated and were benefitted.	90	03/03/2016 - 03/03/2016
	Improved technology interventions in field & horticulture crops, livestock & poultry, & integrated Agri-IMC aquaculture for livelihood improvement of Tribal farmers	74	28/03/2016 - 30/03/2016

4. Mera Gaon Mera Gaurav

As per the mandate of Mera Gaon Mera Gaurav Scheme different teams of scientist have been constituted to make agriculture a profitable business by increasing the farm profitability in sustainable manner. Under this program team visited the nearby places and there after identified various villages for carrying out the targeted activities. Various discussions were held about general and agricultural problems for SWOT analysis in identified villages. Benchmark surveys were also carried out in identified villages prior to initiation of different activities. Various farmer-scientist interaction meeting has been conducted and following discussions were carried out to improve socio-economic condition of the farmers:

- Soil testing under soil health card scheme: All the farmers were briefed about the soil health cards, and its importance in deciding the balanced fertilizer application in their fields
- Technology intervention in horticulture crops to address edaphic and drought related issues; use of diseases free tissue culture seedlings, use of organic residues, use of growth regulators, water management in monsoon to reduce wilt disease, growing green manure crops to increase soil health, post-harvest management in orchards, mulching and other management practices to protect pomegranate, sapota and grapes orchards under water stress condition occurred due to prolonged drought, pests & disease/infections in different seasons, particularly control of oily spot and wilt problems. Inter cropping of drumstick in pomegranate orchard
- Demonstration and application of liquid polymeric microbial product in Watermelon crop at farmer`s field to reduce the water consumption
- Dissemination of knowledge of integrated farming in terms of field and horticultural crops, poultry, dairy and fish farming
- Awareness about irrigation strategies to increase water productivity
- Improved varieties and best management practices in sugarcane, wheat, chick pea, watermelon and other crops cultivation
- BMPs, drip irrigation strategy and improved variety for sugarcane crops for increasing productivity and WUE (water use efficiency)
- Importance of conservation agriculture practices, its consequences and needs to enhance soil organic carbon for sustainable soil health management
- Production and marketing strategy in pomegranate and other crops: scope of pomegranate processing and export
- Vermi-composting, organic farming and management practices

- Generated awareness and introduced dragon fruit in these area
- Awareness about Swachha Bharat Abhiyan
- Mobile-based advisories were also provided for specific situation

Possibilities were also explored to generate ITK and for this various progressive farmers were welcomed for sharing their experiences. Mr. B. B. Shinde, the progressive farmer shared his experience in pomegranate orchard since last 20 years (Fig.4.1). He shared his experience on healthy and disease free orchards maintenance using biofertilizers, bio-fungicides, bio-pesticides, crop mulching, jeevamrut, cow dung slurry, vermicompost, etc.

Fig. 4.1. Interaction of scientists with progressive farmers to share experiences

The team of scientists interacted with famers and discussed on package of practices ranging from input procurement to output marketing i.e. selection of appropriate land for crop cultivation, land preparation, selection of variety and planting material, water management, nutrient management, pest and diseases management, prices and arrival of fruits in various nearby markets as well as future export prospects of high value crops in India, etc.

In addition to that discussion on use of diseases free tissue culture seedlings, use of organic residues, use of growth regulators, water management in monsoon to reduce wilt disease, growing green manure crops to increase soil health, post-harvest management, etc. was held.

World Soil Health Day

The World Soil Health Day was celebrated by our institute on December 5, 2015 in which 263 soil health cards were distributed (Fig 4.2). It contains information about macro and micro nutrient status and other soil parameters along with the recommended crops as per soil health. Besides this on the basis of soil test values fertilisers recommendations were suggested to the farmers. These activities will be helpful in increasing the productivity and profitability of the farmers. The team of scientists comprising Dr K K Krishnani (Chairman), Dr Yogeshwar Singh, Dr RamLal Choudhary, Dr Rajagopal, Dr Neeraj Kumar, and Dr A Balusamy collected soil samples from Navapur villages and analysed samples for 12 different parameters.

Fig. 4.2. World Soil Health Day celebration on December 5, 2015

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5. Meetings

Research Advisory Committee

The 5th RAC meeting of the institute held on October 18-19, 2015 was chaired by Dr. K. Narayana Gowda, Former VC, UAS, GKVK Campus, Bengaluru. The members Dr. D.P.Singh, Dr. C. L. Acharya, Dr. Y.S. Ramakrishna and Dr. K. T. Sampath attended the meeting while Dr. D. K. Marothia and Dr. S.K. Choudhary could not attend. The meeting began with the formal welcome to the members by Dr. P.S.Minhas, Director. He presented the major research achievements of this institute, current status of infrastructural facilities and the constraints being faced in building up the institute. Thereafter a documentary-film on the success story of turning rocky barren landscape into research farm for multidisciplinary research related to crops, horticultural/ agro-forestry tree species, animals/fisheries etc. was displayed. It was suggested that IRC should stick to the mandates of the institute while finalizing the research project and focus should be on major abiotic stresses.

Fig. 5.1. 5th Research Advisory Committee

Key recommendations of the committee

1) IRC-should stick to the mandates of the institute while finalizing the research project and focus should be on major abiotic stresses
2) Intensive monitoring is recommended for soil-water balance, root system architecture and plant traits and parameters for quantification of drought and edaphic stresses.
3) Experiments on drought stress should be conducted under rainfed and/ or stress simulated quantified recharged soil profile using line source sprinkler system. Controlled environment and pot experiments can be restricted to unravel gene functions having role in stress tolerance mechanisms
4) Options for micro-catchment modifications that favour *in situ* rainwater conservation should be included in orchards
5) Necessary infrastructural facilities should be created to expedite research on livestock and this should comply with Animal Ethics norms. Data be generated on nutrient-gene interaction for heat tolerance and nutritional stress tolerance in livestock and biological markers

6) Linkages to be established/continued with other research partners including KVKs for identification of problems and opportunities for reducing losses due to abiotic stresses

Institute Management Committee

The 6th IMC meeting of ICAR-NIASM was held on November 28, 2015 under the Chairmanship of Dr. P.S. Minhas, Director of the institute. The members who participated included Dr R.S. Patil, Dr. S.K. Ambast, Dr. (Mrs.) Anupama, Dr. G. Ravindra Chary, Dr. K.K. Krishnani, Dr. S.K. Dhyani, Mr. Vijaykumar Ingale, Mr. Milind S. Bhatkar, and Dr. N.P. Kurade. Special Invitees were Dr. Jagadish Rane, Dr. M.J. Kaledhonkar, and Dr. S.K .Bal. The Agriculture Commissioner, Government of Karnataka, Bangalore and Deputy Director (Finance) II, ICAR Hqrs. New Delhi could not attend the meeting due to their prior engagement.

At the outset, the Member Secretary welcomed all the members and special Invitees for the IMC meeting. The Chairman briefed about the progress of the Institute during last 5 years along with achievements. He also emphasized on connecting this Institute with other ICAR Institutes working in different disciplines.

Fig. 5.2. 6th Institute Management Committee

Institute Research Council

The 6th IRC meeting of NIASM was held on January 19-21, 2016. In introductory remarks Dr. P.S. Minhas, Director ICAR-NIASM and Chairman, IRC expressed gratification about research efforts by the scientists through their various projects. However, he further stressed that we need to focus mainly on research proposals that are of multidisciplinary nature and aimed at addressing the real time needs. The Chair also said that it is a matter of great pleasure that the institute has acquired an additional land, at Malad Baramati to meet the demand of field experiments on a site that truly represent the area. In this regard, he sugessted to create facilities for early initiation of the experiments at Malad. A total of 11 new project proposals from all the four schools were discussed. The session provoked good scientific interactions and valuable suggestions from the house for further improvement of the projects. The project wise comments/ suggestions are annexed. Besides expressing satisfaction over the progress made in respect to the research targets and achievements, the Chair, IRC and house also suggested corrective measures for further improvement.

Fig. 5.3. 6th Institute Research Council

Monthly meetings of Scientific & Technical staff

Institute has conducted 12 monthly meetings of scientific & technical staff. The important scientific and technical issues and monthly target and achievements of all the scientists were discussed in these meetings. The overall progress made with respect to infrastructural development, procurement of equipment, furniture and expenditure incurred was also assessed. Scientific talks were delivered during these meetings to highlight recent trends in science.

6. Awards and Recognitions

- Dr K K Krishnani Head-School of Edaphic Stress Management has been awarded the Fellow of the National Academy of Agricultural Sciences 2016.
- Dr Neeraj Kumar, Scientist has been awarded Best publication award for year 2014 from Central Institute of Fisheries Education, Mumbai
- Dr Neeraj Kumar, Scientist has been awarded ICAR-Jawaharlal Nehru National Award for PG Outstanding Doctoral Research in Agricultural and Allied Sciences 2014

Fig. 6.1. ICAR-Jawaharlal Nehru National Award received by Dr.Neeraj Kumar

- Mr V.Rajagopal, Scientist has been awarded Young Scientist Award from Global Research Initiatives for Sustainable Agriculture & Allied Sciences for outstanding contribution in the field of Soil Science and Agriculture Chemistry.
- Dr K K Krishnani has been nominated as a Member of Institute Management Committee for three years (2014-2017).
- Dr K K Krishnani has played the role of Australian Awards Mentor.
- Dr. Kiran Bhagat, received the best oral presentation award for his research paper entitled "Impact of Photosynthetically Active Radiation and moisture stress on yield components in determinate, semi-determinate and indeterminate soybean *(Glycine max L.)*" genotypes. In: ISPP West Zonal Seminar on "Enhancement of Crop Productivity through Physiological Interventions" held on 11 May 2015 at Navsari Agricultural University, Navsari and Gujarat.
- Dr. Kiran Bhagat, received the best oral presentation award for his research paper entitled "Physiological and Yield response to Photosynthetically Active Radiation and Moisture Stress in Soybean *(Glycine max L.)*" genotypes under Climate Change Scenario" in the National Seminar on "Breeding of field crops for biotic and abiotic stresses in relation to Climate Change" held at VNMKV, Parbhani during 28-29 March 2016.
- Dr. DP. Patel was awarded IAHF best research paper 2013 for the paper entitled "Multiple Use of Pond Water for Enhancing Water Productivity and Livelihood of small and Marginal Farmers" published in Indian Journal of Hill Farming Vol. 26(1):29-36
- Dr. S.K. Bal has been awarded fellow of Indian Ecological Society

7. Linkages and Collaborations

Research institute	Areas identified for research collaboration
IARI, New Delhi, KVK-Malegaon, NBAIM-Mau, CIFRI-Barrackpore, NRCG-Pune, IISc, Bangalore	• For collaborative research on identification of micro-organisms for drought tolerance.
MPKV, Rahuri	• Conservation agriculture • Collaboration in academic program and post graduate research • Genetic enhancement of crop productivity by using modern tools
CRP on CA, IISS-Bhopal	• Conservation agriculture in sugarcane based cropping system.
CIRC, Meerut	• Study of genetic polymorphism of heat shock protein genes in indigenous and crossbreed cattle
NBPGR, New Delhi	• Screening wheat, common bean and mungbean germplasm for drought and high temperature stress tolerance
NICRA, CRIDA, Hyderabad	• Phenotyping pulses for tolerance to soil moisture stress
NBAIM, Mau Nath Bhanjan	• Functional characterisation of salt tolerant bacteria using multi omics approches and their exploitation for alleviation of salt stress in crop plants
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
IIW& BR, Karnal	• Screening wheat germplasm for drought and high temperature stress tolerance
IISR, Indore and University of Delhi, New Delhi	• A collaborative ICAR Extramural Research Project was approved by ICAR-Crop Science and a budget of Rs. 80 lakhs was sanctioned and ICAR-NIASM is involved in this project as leading centre.
Privi Life Science Pvt. Ltd, Mumbai	• Assessment of silixol efficacy for drought and heat stress tolerance
VSBT, Baramati	• Collaboration in biotechnology and nanotechnology based research program
TC College, Baramati	• Collaborative research with focus on drought/ water quality / salinity tolerance mechanisms in plants/fishes and stress mitigation

8. Publications

Institute Publication

Choudhary, R.L., Wakchaure, G.C., Minhas, P.S. and Singh, A.K. 2016. Response of ratoon sugarcane to stubble shaving, off-barring, root pruning and band placement of basal fertilisers with a multi-purpose drill machine. Sugar Tech, doi 10.1007/s12355-016-0438-x

Kumar, N., Ambasankar, A., Krishnani, K.K., Bhushan, S. and Minhas, P.S. 2016. Dietary pyridoxine protects against stress and maintains immune-hematological status in *Chanos chanos* exposed to endosulfan. Basic & Clinical Pharmacology & Toxicology. doi: 10.1111/bcpt.12589

Kumar, N., Ambasankar, K., Krishnani, K.K., Gupta, S.K. and Minhas, P.S. 2016. Dietary pyridoxine promotes growth and cellular metabolic plasticity of *Chanos chanos* fingerlings exposed to endosulfan induced stress. Aquaculture Research. doi:10.1111/are.13042

Nangare, D.D., Suresh Kumar, P., Singh, Y. and Minhas P.S. 2016. Growth, fruit yield and quality of tomato (*Lycopersicon esculentum* Mill.) as affected by deficit irrigation regulated on phenological basis. Agricultural Water Management. doI: 10.1016/j.agwat.2016.03.016

Ratnakumar P, Khan M.I.R., Minhas P.S., Sultana R., Per T. S, Deokate P.P., Khan N.A., Singh Y., Rane J. 2016. Can plant bioregulators minimize the crop productivity losses caused by drought, heat stress and salinity? An integrated review. Journal of Applied Botany and Food Quality. Vol. 89. doI:10.5073/JABFQ.2016.089.00X

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9. Participation in Meetings/ Lectures/ Workshops/ Trainings

Meetings attended

Name	Topics	Place	Period
Dr S.K. Bal	Climate Services in Maharashtra: Strengthening Knowledge Networks for Climate Resilience	TERI, New Delhi	June 10, 2015.
Dr K.K.Meena	National conference on Inventions, innovations and Regulations in Crop Sciences (IIRCS 2015)	CSIR-IICT, Hyderabad	June 24-25, 2015
Dr Y. Singh Dr A.K. Singh	Refresher Course on Agricultural Research Management	NAARM, Hyderabad	July 13-25, 2015
Dr Y. Singh Dr K.K. Meena	Workshop on "Fruit Cracking and Soil Health Management in Pomegranate"	NRC Pomegranate, Solapur	October 3, 2015
Dr Y. Singh	Participated in Hindi Workshop	ICAR, New Delhi	November 7, 2015
Dr S.K. Bal	2nd Taskforce meeting on "Hailstorm Management"	ICAR & NRC, Grapes, Pune.	November 21, 2015
Dr R.L. Choudhary	1st Annual review meeting of CRP on CA projects (under XII plan)	IISS, Bhopal	March 29, 2016

Lectures/ Invited talks

Name	Topics	Place	Period
Dr D.D. Nangare & Dr Y. Singh	Water saving techniques in orchard	National training programme on "Pre and Postharvest management for enhanced production" organized by MPKV, Rahuri	September 14, 2015
Dr S.K. Bal	National Consultation on "Crop Loss Estimation, Relief and Compensation"	Center for Science and Environment at India Habitat Centre, New Delhi.	November 26-27, 2015
Dr K.K. Krishnani	International conference on Nanomaterials and Nanotechnology (Nano-2015)	SRS College of Engineering and Technology, Tiruchongode	December 7-10 2015
Dr K.K. Krishnani	Research methodologies for the faculties of Chhatisgad colleges	Govt Digvijay College, Rajnandgaon	February 3, 2016
	Interdisciplinary research driven teachings for the faculty of Digvijay College, Rajnandgaon		

Name	Topics	Place	Period
Dr S.K. Bal	Atmospheric Stressors: Concern for crops in future	IES International Conference on "Natural Resource Management: Ecological Perspectives" at SKUAS&T, J&K, India	February 18-20, 2016
Dr Y. Singh	Aerobic rice an option for sustainable agriculture production	International Symposium on "Management of Rice based Agricultural System under Stress Prone Environment held at RAU, Bihar, India	March 17-19, 2016

Workshops

Name	Name of Programme	Place	Period
Dr V. Govindasamy	The 4th Annual Workshop of NICRA	ICAR-CMFRI, Kochi	July 13-14, 2015
Dr S. K. Bal & Dr K.K. Meena	First Workshop of Nodal Officers of "KRISHI: Knowledge based Resources Information Systems Hub for Innovations in Agriculture"	NASC, New Delhi	August 4-5, 2015
Dr K.K.Meena	Workshop Cum Review meeting of SERB –DST project	IISER, Pune	January 7, 2016
Dr V. Govindasamy	6th IPS Confencence-cum-Indian chapter of Asian PGPR satellite workshop on "PGPRs for sustainable crop productivity"	NASC, New Delhi	February 23-26, 2016

Trainings attended

Name	Name of Programme	Place	Period
Mr Balusamy A.	Professional attachment training on Modeling the impact of moisture and temperature stress on wheat yield of Maharashtra	IARI New Delhi	May 10 - August 11, 2015
Mr Prashantkumar S H	Phenotyping Crop Plants for Drought and Heat-adaptive traits for FOCARS training programme	UAS, GKVK, Bengaluru	May 11-August 10, 2015
Dr J. Rane	Project Monitoring Evaluation	NAARM, Hyderabad	June 2-6, 2015
Dr K. K. Meena	Two days training programme on post run data analysis and method development for HPLC	Shimadzu Analytical (India) Mumbai	July 13-16, 2015

Name	Name of Programme	Place	Period
Mr Gopalakrishnan B.	Short course on Remote Sensing and Geographical Information System	National Atlas and Thematic Mapping Organization, Kolkata	July 13-24, 2015
Dr Y. Singh Dr A. K. Singh	Agricultural Research Management	NAARM, Hyderabad	July 13-25, 2015
Mr Ram Avtar Parashar	Training on Administrative and Finance Management	NAARM, Hyderabad	August 11-14, 2015
Dr Neeraj Kumar	Advances in Applications of Nanotechnology	ICAR-CIRCOT, Mumbai	October 05-09, 2015
Dr Mahesh Kumar	"PlantOmics – Emerging Tools and Techniques for Crop Improvement"	ICAR-IARI, New Delhi	November 18-December 8, 2015
Dr M. P. Brahmane	Short term training on Fish Genomic and Proteomic Data analysis with High throughput computing	ICAR-NBFGR, Lucknow	November 19-24, 2015
Dr Basavaraj Sajjanar	"Bioinformatics and high dimensional genome data analaysis"	ICAR-IASRI, New Delhi	November 25-December 15, 2015
Mr Ram Avtar Parashar	MDP on public procurment	NIFM, Faridabad	December 7-12, 2015
Dr R. L. Choudhary	Interaction Meeting cum Training Programme for Partners of CRP on CA	ICAR-CIAE, Bhopal	January 29-30, 2016
Mr Gopalakrishnan B.	Short Course on Remote Sensing and Image Interpretation	Indian Institute of Remote Sensing, ISRO, DOS, Dehradun, Uttarakhand	January 4-February 29, 2016
Dr M. P. Brahmane	CAFT- Computational Tools and Techniques for Molecular Data Analysis in Agriculture	IACR-IASRI, New Delhi	February 2-March 2, 2016

Patents Applied

Patent filed

Meena KK, Sorty A, **Krishnani KK**, Minhas PS. 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 Biplab, Maurya UK, Brahmane MP, Krishnani KK and Minhas PS. Process for one step synthesis of bactericidal silver nanoparticles from tissue extracts of Labeo rohita. Application number- 3255/MUM/2012. Patent Journal No. 30/2014).

Gene sequences submitted to GenBank-NCBI database

GenBank Accession No	Description of sequences
KT963945	White spot syndrome virus clone 29KR VP28 gene, partial cds
KT963944	White spot syndrome virus clone 28KR VP28 gene, complete cds
KT963943	White spot syndrome virus clone 26KR VP28 gene, complete cds
KT963942	White spot syndrome virus clone 25KR VP28 gene, partial cds
KT963941	White spot syndrome virus clone 21KR VP28 gene, partial cds
KT963940	White spot syndrome virus clone 20KR VP28 gene, complete cds
KT963939	White spot syndrome virus clone 19KR VP28 gene, complete cds
KT963938	White spot syndrome virus clone 7KR VP28 gene, complete cds
KT963937	White spot syndrome virus clone 6KR VP28 gene, complete cds
KT963936	White spot syndrome virus clone 17KRISH VP28 gene, partial cds
KT963935	White spot syndrome virus clone 15KRISH VP28 gene, partial cds
KT963934	White spot syndrome virus clone 6KRISH VP28 gene, partial cds
KT963933	White spot syndrome virus clone 2KRISH VP28 gene, complete cds
KU258060	Bacillus sp. clone DWSR101
KU258061	Bacillus altitudinis 126YG20
KU258062	Geobacillus stearothermophilus PPL-SSC5
KU258063	Bacillus subtilis SCSGAB0128
KU258057	Enterobacter sp. GA18
KU258064	Bacillus sp. NII-73 (FJ897479)
KU258065	Bacillus aryabhattai IHB B 6516
KU258066	Bacillus megaterium P3
KU258067	Bacillus cereus H1
KU258068	Bacillus licheniformis WSE-KSU302
KU258070	Bacillus aquimaris NIOT-Cu-5
KU258072	Bacillus sp. RH-25

GenBank Accession No	Description of sequences
KU258074	Acinetobacter lwoffii
KU258075	Paenibacillus sp. ZY-8
KU258077	Bacillus thuringiensis EGY-SXJ1
KU258081	Bacillus mycoides CV18 (KC503976)
KU258082	Lysinibacillus xylanilyticus D27 (KM488476)
KU258084	Uncultured prokaryote clone seq.Bt22-S20 (KP409373)
KU258086	Acinetobacter sp. jxk1-9 (KJ504154)
KU258087	Bacillus sp. AT-11(KM974805)
KU258088	Bacillus megaterium Tm-Meg03 (KM603657)
KU258089	Pseudomonas sp. L23 (DQ300316)

10. Important Events

हिन्दी दिवस 2015

संस्थान में हिन्दी दिवस का आयोजन हिन्दी सप्ताह (14 से 20 सितम्बर 2015) के रूप में किया गया। डा. के. के. कृष्णानी, उपाध्यक्ष, राजभाषा कार्यान्वयन समिति की अध्यक्षता में दिनांक 27.08.2015 को संस्थान की राजभाषा कार्यान्वयन समिति की एक प्रारम्भिक बैठक आयोजित की गयी। इस बैठक में संस्थान में हिन्दी में कार्य को बढ़ावा देने एवं हिन्दी दिवस समारोह के सफल आयोजन हेतु महत्वपूर्ण विषयों पर विस्तार पूर्वक विचार - विमर्श किया गया। पुनः दिनांक 29.08.2015 को संस्थान के निदेशक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति, डा. पी. एस. मिंहास की अध्यक्षता में एक बैठक आयोजित की गयी। इस बैठक में राजभाषा के उचित कार्यान्वयन के लिए विस्तारपूर्वक चर्चा की गयी तथा सर्वसम्मति से संस्थान में हिन्दी दिवस समारोह को हिन्दी सप्ताह के रूप में मनाने का निर्णय लिया गया। राजभाषा समिति ने उद्घाटन एवं समापन समारोह के लिए क्रमशः डा. एम. एस. सेजुल, प्राचार्य, शारदाबाई पवार महिला महाविद्यालय, शारदानगर, बारामती और इं. एन. एस. इरवाडकर, मुख्य अभियंता, महाराष्ट्र राज्य विद्युत वितरण कंपनी लिमिटेड, बारामती को मुख्य अतिथि के रूप में आमंत्रित करने के लिए नामांकित किया।

Fig. 10.1. निदेशक एवं अध्यक्ष, राजभाषा समिति द्वारा हिन्दी सप्ताह समारोह का

हिन्दी सप्ताह कार्यक्रम का उद्घाटन दिनांक 14 सितम्बर 2015 को मुख्य अतिथि डा. एम. एस. सेजुल, प्राचार्य, शारदाबाई पवार महिला महाविद्यालय, शारदानगर, बारामती द्वारा संस्थान के निदेशक एवं अध्यक्ष, राजभाषा समिति डा. पी. एस. मिंहास की उपस्थिति में सम्पन्न हुआ। इस अवसर पर मुख्य अतिथि डा. सेजुल ने अपने विचार हिन्दी में व्यक्त करते हुये महान वैज्ञानिकों के योगदान की चर्चा की तथा इस संस्थान से स्थानीय व देश के लोगों की अपेक्षाओं की ब्याख्या करते हुये सभी अधिकारियों एवं कर्मचारियों से कार्यालय के दैनिक काम-काज में राजभाषा के प्रयोग पर बल देने का आग्रह किया। अपने सम्बोधन में इस कार्यक्रम में आमंत्रण पर खुशी ब्यक्त करते हुये निदेशक व सभी अधिकारियों एवं कर्मचारियों के प्रति आभार प्रकट किया । निदेशक महोदय ने अपने अध्यक्षीय भाषण में वर्तमान सरकार द्वारा किए जा रहे प्रयासों के फलस्वरूप राजभाषा के प्रयोग में आ रही वृद्धि एवं इसके अंतरराष्ट्रीय महत्त्व की चर्चा करते हुये सभी कर्मचारियों को हिन्दी दिवस की हार्दिक बधाई दी तथा राजभाषा के अधिकाधिक प्रयोग पर बल देने का आग्रह किया। डा. डी. पी. पटेल, सदस्य सचिव, राजभाषा समिति ने सबका स्वागत करते हुये सप्ताह भर चलने वाले कार्यक्रमों की जानकारी दी एवं सभी अधिकारियों व कर्मचारियों से इन कार्यक्रमों में भाग लेकर हिन्दी सप्ताह को सफल बनाने की अपील की। हिन्दी सप्ताह के दौरान विभिन्न प्रतियोगिताओं जैसे हिन्दी टिप्पण लेखन, हिन्दी निबंध, अंग्रेजी से हिन्दी में अनुवाद, हिन्दी गायन प्रतियोगिता, कम्प्युटर पर हिन्दी टंकण प्रतियोगिता, हिन्दी सामान्य ज्ञान, हिन्दी कविता पाठ एवं वाद-विवाद प्रतियोगिता का आयोजन किया गया। इसी दौरान स्कूल एवं कालेज के विद्यार्थियों के लिए भी वाद-विवाद प्रतियोगिता का आयोजन किया गया जिसमें आस-पास के स्कूल एवं कालेज से बड़ी संख्या में विद्यार्थियों ने भाग लिया। कार्यक्रम का समापन एवं पुरस्कार वितरण समारोह 19 सितम्बर 2015 को निदेशक महोदय और मुख्य अतिथि इं. एन. एस. इरवाडकर, मुख्य अभियंता, महाराष्ट्र राज्य विद्युत वितरण कंपनी लिमिटेड, बारामती की उपस्थिति में सम्पन्न हुआ। इस अवसर पर निदेशक महोदय ने सभी अधिकारियों एवं कर्मचारियों को सप्ताह भर चले विभिन्न कार्यक्रमों में उत्साहपूर्वक भाग लेने के लिए बधाई दी। हिन्दी सप्ताह कार्यक्रम के सफल आयोजन के लिए राजभाषा कार्यान्वयन समिति के सभी सदस्यों की सराहना करते हुये राजभाषा के और अधिक प्रयोग के लिए सतत प्रयास पर बल देने को कहा। मुख्य अतिथि इं. एन. एस. इरवाडकर ने अपने सम्बोधन में संस्थान के विकास की प्रशंसा करते हुये हर संभव मदत की पेशकश भी की। कार्यक्रम में शामिल होकर खुशी प्रकट करते हुये सभी कर्मचारियों से राजभाषा के प्रयोग को बढ़ाने का आग्रह करते हुये अपना आभार ब्यक्त किया। अंत में धन्यवाद प्रस्ताव के साथ कार्यक्रम सम्पन्न हुआ।

Celebration of National Days

Institute celebrated with great enthusiasm the Independence Day on August 15, 2015 and Republic Day on January 26, 2016 in the campus. The Director hoisted the national flag and addressed the staff members on these occasions.

(a) (b)

Fig. 10.2. Celebration of Independence (a) and Republic (b) Day

Vigilance Awareness Week

Vigilance awareness week was observed during October 26-31, 2015 at the Institute. It commenced with a pledge taken by all the officials and staff on October 26, 2015 in the presence of Director of the institute. Series of lectures were organized during this period. All staff members of the institute actively participated in these activities.

(a) (b)

Fig. 10.3.Oath undertaking during vigilance awareness week

Swachh Bharat Abhiyan

The staff voluntarily participated in weekly campus cleanliness drive initiated in the institute in response to Swachh Bharat Abhiyan call given by Hon'ble. Prime Minister of India.

Fig. 10.4. The staff regularly participated in Swachh Bharat Abhiyan

Participation in ICAR-Zonal Sports Meet (Western Zone)

ICAR-NIASM contingent consisting of 14 members have participated in the various games events of ICAR- Zonal Sports Meet (Western zone) held at ICAR- CSWRI, Avikanagar during November 02-06, 2015. Mr. Prashantkumar Hanjagi, Scientist was second in 200m running. He also bagged second positions in 400m, 800m and 1500m events.

Fig. 10.5. NIASM contingent participating in ICAR-Zonal Sports Meet

11. New Staff, Transfer and Promotions

New Staff

1. Mr Prashantkumar S. Hanjagi, Scientist (Plant Physiology) and Mr. Balusamy A., Scientist (Environmental Science) joined on April 10, 2015.
2. Mr. Milind S. Bhatkar, Administrative Officer joined on October 21, 2015.

Transfer

1. Dr D.V. Patil, Sr. Scientist was transferred to ICAR-Central Institute for Cotton Research, Nagpur (April 20, 2015).
2. Dr Shashikant Vilas Ghadge, Sr. Scientist was transferred to ICAR-Central Institute for Research on Cotton Technology, Mumbai (April 20, 2015).
3. Dr D.V.K Nageswara Rao, Principal Scientist was transferred to ICAR-Directorate of Rice Research, Hyderabad (May 23, 2015).
4. Dr P. Suresh Kumar, Sr. Scientist was transferred to ICAR-National Research Centre for Banana, Tiruchirapalli (May 23, 2015).
5. Dr N. P. Singh, Principal Scientist was transferred to ICAR–National Centre for Agricultural Economics & Policy Research, New Delhi (June 12, 2015).
6. Dr Susheel Kumar Raina, Scientist was transferred to ICAR–Central Institute of Temperate Horticulture, Srinagar (December 03, 2015).
7. Dr. V. Govindasamy, Scientist was transferred to ICAR–Indian Agricultural Research Institute, New Delhi (February 24, 2016).

Promotions

1. Mr Manjeet Singh, Assistant, was selected as Divisional Accountant in the Haryana P.W.D. under the Administrative control of the Office of Accountant General (A&E) Haryana (December 21, 2015 on 2 years lien).
2. Dr M. J. Kaledhonkar, Principal Scientist was selected as Project Coordinator, AICRP on Soil Salinity, ICAR-Central Soil Salinity Research Institute, Karnal (March 23, 2016).
3. Dr Biplab Sarkar, Sr. Scientist was selected as Sr. Scientist (RGP 9000) at ICAR-Indian Institute of Agricultural Biotechnology, Ranchi (March 23, 2016).

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12. Budget Utilisation

Statement Showing Head-wise Actual Expenditure for the Financial Year 2015-16

(₹ in lakhs)

Head/ Sub-Head	Plan		Non-Plan	
	Allocation	Expenditure	Allocation	Expenditure
Grants in aid –Capital				
Works	1815.00	1470.27	148.32	148.32
Equipment		190.81	0.00	0.00
IT		0.33	0.00	0.00
Library		1.57	0.00	0.00
Furniture & Fixture		143.45	0.00	0.00
Vehicles		0.00	0.00	0.00
Livestock		8.57	0.00	0.00
Sub Total -1	1815.00	1815.00	148.32	148.32
Grand in aid- Salary				
Pay & Allowances	0.00	0.00	501.71	491.18
Sub Total -2	0.00	0.00	501.71	491.18
Grants in aid-General				
TA	326.00	9.69	5.00	5.00
Contingencies		308.64	91.29	90.36
HRD		7.17	2.00	2.00
Sub Total -3	515.00	325.50	98.29	97.36
Grant Total (1+2+3)	2265.00	2140.50	748.32	736.86
NICRA	95.80	66.62	-	-

13. Research Projects

School of Atmospheric Stress Management

1. Monitoring and quantifying energy and mass fluxes from edaphically stressed crops in western Maharashtra: micrometeorological approach (S. Saha, S.K. Bal, Y. Singh)
2. Identification, cloning and expression analysis of temperature, salinity and hypoxia responsive genes in fish (M.P. Brahmane, B. Sajjanar, S. Kumar)
3. Abiotic stresses affecting crop-insect pest interactions in the context of global climate change (B.B. Fand, M. Kumar, A.L. Kamble, D.D. Nangare)
4. Impact of Radiation levels on physio-biochemical behaviour yield and yield attributes in soybean (*Glycine max*) and rabi sorghum (*Sorghum bicolor*). (S.K. Bal, S. Saha, B.B. Fand, Y. Singh, R.K. Pasala)
5. Study of genetic polymorphism of heat shock protein genes among indigenous and cross breed cattle (B. Sajjanar)
6. Impact of cropping systems and spent wash on soil development under irrigated and rainfed conditions (Y. Singh, P.S. Minhas, V. Rajagopal, K.K. Meena, G.C. Wakchaure)
7. Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivars (G.C. Wakchaure, P.S. Minhas, R.K. Pasala, R.L. Choudhary, S.K. Bal, K.K. Meena)
8. Design and development of livestock and fishery structures for heat stress management (G.C. Wakchaure, S.V. Ghadge, B. Sarkar)
9. Study of immune response and HSP genes polymorphism in relation to heat stress in poultry (S.S. Pawar)

School of Drought Stress Management

1. Phenotypic, biochemical and molecular analysis of greengram for identification of drought tolerant genotypes (S.K. Raina, A.K. Singh)
2. Investigation on traits and genes associated with adaptation of wheat genotypes to local drought and heat stress environments (A.K. Singh, R.K. Pasala, J. Rane, S.K. Raina, M. Kumar)
3. Investigation of traits and genes associated with resilience to moisture stress in soybean (M. Kumar, V. Govindasamy, A.K. Singh, R.L. Choudhary)
4. 4.Enhancing adaptability of Cyamopsis tetragonoloba L., Taub to drought stress through breeding approaches (D.V. Patil, J. Rane)
5. Functional and genetic diversity of bacterial endophytes of drought tolerant sorghum crop (V. Govindasamy, M. Kumar, D.V. Patil)
6. Evaluation of water saving techniques for fruits and vegetables in shallow soils of semi-arid region (D.D.Nangare, P.S. Minhas, P.S. Kumar, Y. Singh, M. Kumar, S. Saha, Prashanthkumar.H, P.B. Taware)

School of Edaphic Stress Management

1. Nano(bio-) remediation of nitrogenous contaminants using silver-ion exchanged zeolites (K.K. Krishnani, B. Sarkar, V. Rajagopal)

2. Examination of uncultured microbial diversity of saline soils using metagenomics (S. Kumar, K.K. Krishnani, V. Rajagopal)

3. Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (B. Sarkar, M.P. Brahmane, K.K. Krishnani)

4. Resource conservation technologies for enhancing productivity and input-use efficiency in sugarcane ratoon crop (R.L. Choudhary, P.S. Minhas, V. Rajagopal, G.C. Wakchaure, K.K. Krishnani)

5. Design and development of mini tractor seeder attachment for sugarcane trash farming (S.V. Ghadge)

6. Isolation and characterization of biomolecule producing bacteria for salt stress alleviation in major crops (K.K. Meena, D.P. Patel, K.K. Krishnani, R.L. Choudhary, P.S. Kumar)

7. Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils (Y. Singh, P.S. Kumar, P.S. Minhas, D.D. Nangare, J.Rane, P.B. Taware)

School of Policy Support Research

Assessment of climate imposed vulnerability of onion farming in Maharashtra (A.L. Kamble)

Externally Funded Projects

1. Evaluation of green gram genotype for resilience to moisture stress (S.K. Raina, V. Govindasamy, A.K. Singh and J. Rane) funded by NICRA, CRIDA, Hyderabad

2. Assessment of silixol efficacy on wheat under drought and high temperatures (R.K. Pasala, J. Rane and P.S. Minhas) funded by Privi Life Sciences Pvt. Ltd., Mumbai

3. Predicting the impact of climate change on regional and seasonal abundance of major soyabean insect pests using temperature-driven phenology modelling and GIS-based risk mapping approach (B. Fand) funded by DST, GoI., New Delhi

4. Assessment of novel organic compounds for their efficacy on crop plants under drought (M. Kumar, R. L. Meena, J. Rane and P.S. Minhas) funded by Geolife India Pvt. Ltd., Mumbai

5. Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (J. Rane, A.K. Singh and S.K.Raina) funded by BBSRC

6. Development of likelihood model of microbes mediated salt and drought stress alleviation in wheat crop using omics approaches (K.K.Meena) funded by DST,GoI, New Delhi

7. Functional characterization of salt tolerant bacteria usingmultiomics approaches and their exploitation for alleviation of salt stress in crop plants (K.K. Meena, V. Govindsamy, P. Suresh-Kumar, K.K. Krishnani, J.Rane, P.S. Minhas) funded by AMAAS, NBAIM, Mau

8. Conservation agriculture for enhancing resource-use efficiency environmental quality and productivity of sugarcane based cropping system (R.L. Choudhary) funded by Conservation Agriculture (CA) platform of ICAR

9. RNA Interference (RNAi) and Virus Induced Gene Silencing (VIGS) Approaches to Enhance Drought and Heat Stress Tolerance in Soybean (Ajay K. Singh-ICAR-NIASM, Milind B. Ratnaparkhe, ICAR-IISR, Indore, M.V. Rajam, Univ. Delhi, South Campus, New Delhi) funded by ICAR

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14. Personnel

Scientific Staff	
Dr P. S. Minhas	Director
School of Atmospheric Stress Management	
Dr S.K. Bal	In-charge Head and Principal Scientist (Agrometeorology)
Dr M. P. Brahmane	Senior Scientist (Animal Biotechnology)
Dr R.K. Pasala	Senior Scientist (Plant Physiology)
Dr Y. Singh	Senior Scientist (Agronomy)
Dr S.S. Pawar	Scientist (Animal Biotechnology)
Dr G.C. Wakchaure	Scientist (Agricultural Structure & Process Engineering)
Dr B.B. Fand	Scientist (Agricultural Entomology)
Dr S. Saha	Scientist (Agrometeorology)
Dr B. Sajjanar	Scientist (Animal Biotechnology)
Mr Gopalakrishnan B	Scientist (Environmental Science)
School of Drought Stress Management	
Dr J. Rane	Head
Dr. N. P. Kurade	Principal Scientist (Veterinary Pathology)
Dr A.K. Singh	Senior Scientist (Agricultural Biotechnology)
Dr D.D. Nangare	Scientist (Sr. Scale) (Soil & Water Conservation Engineering)
Dr S.K. Raina	Scientist (Plant Breeding)
Dr V. Govindasamy	Scientist (Microbiology)
Dr M. Kumar	Scientist (Plant Physiology)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Dr R.L. Meena	Scientist (Agronomy)
Mr Prashantkumar Hanjagi	Scientist (Plant Physiology)
School of Edaphic Stress Management	
Dr K.K. Krishnani	Head
Dr M.J. Kaledhonkar	Principal Scientist (Soil & Water Conservation Engineering)
Dr D.P. Patel	Principal Scientist (Plant Physiology)
Dr B. Sarkar	Senior Scientist (Fish & Fisheries)
Dr K.K. Meena	Senior Scientist (Agricultural Microbiology)
Dr R.L. Choudhary	Scientist (Agronomy)
Mr V. Rajagopal	Scientist (Soil Chemistry/Fertility/Microbiology)
Dr Neeraj Kumar	Scientist (Fish Nutrition)
Mr. Balusamy A.	Scientist (Environmental Science)

School of Policy Support Research	
Dr J. Rane	In-charge Head
Dr A.L. Kamble	Scientist (Agricultural Economics)
Administrative Staff	
Mr Milind S. Bhatkar	Administrative Officer
Mr Ram Avtar	Finance & Accounts Officer
Smt Purnima S. Ghadge	Assistant
Mr Pardeep Kumar	Assistant
Mr Manjeet Singh	Assistant
Mr Dayanand Kharat	Assistant
Technical Staff	
Dr A.V. Nirmale	Chief Technical Officer (Animal Science)
Dr P.B. Taware	Technical Officer T-5 (Farm)
Mrs Noshin Shaikh	Technical Assistant T-3(Civil)
Mr Santosh Pawar	Technical Assistant T-3 (Electrical)
Mr P. More	Technical Assistant T-3 (Computer)
Mr M. Gubbala	Technical Assistant T-3 (Information Technology)
Mr Rushikesh Gophane	Technical Assistant T-3 (Horticulture)
Dr (Mrs) Priya George	Technical Assistant T-3 (Microbiology)
Mr Lalitkumar Aher	Technical Assistant T-3 (Biotechnology)
Mr Sunil Potekar	Technical Assistant T-3 (Agro meteorology)
Mr Patwaru Chahande	Technical Assistant T-3 (Agriculture)
Mr Aniket More	Technical Assistant T-1 (Mali)

15. Distinguished Visitors

Name	Address	Date
Dr B.K. Bhattacharya	SAC (ISRO), Ahmedabad	22.04.2015
Dr Ramani Ranganathan	Director IINRG and OSD IIAB, Ranchi	01.05.2015
Dr S.K. Ambast	Project Coordinator, AICRP on Management of Salt Affected Soils, CSSRI, Karnal.	04.10.2015
Dr (Mrs) Anupama	Principal Scientist, Division of Agriculture Chemistry, IARI, New Delhi.	04.10.2015
Shri Umakant Dangat	Commissioner, Agriculture, State of Maharashtra	04.10.2015
Dr G. Ravindra Chary	Principal Scientist (Agronomy), CRIDA, Hyderabad	04.10.2015
Dr K. Narayana Gowda	Former Vice-Chancellor, University of Agricultural Sciences, Bengaluru	08.10.2015
Dr C.L. Acharya	Former Director, IISS, Bhopal	08.10.2015
Dr K.T. Sampath	Former Director, NIANP, Bengaluru	08.10.2015
Dr S.K. Chaudhari	ADG (SWM), ICAR, New Delhi	08.10.2015
Dr AK.Sikka	DDG, NRM Division ICAR, Krishi Bhavan, New Delhi	21.11.2015
Dr M.B.Dhonde,	Head, Dept of Agronomy MPKV, Rahuri, Ahmednagar	20.01.2016
Dr A.Arunachalam	Principal Scientist & Scientific Officer, to Secretary DARE and DG, ICAR, New Delhi	10.02.2016
Dr Sukhwinder Singh	CIMMYT-India	19.02.2016

Appendix -I

Members of IMC

1. Dr P.S. Minhas, Director, 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 & 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. Chemistry, IARI, New Delhi.
8. Dr G.Ravindra Chary, Principal Scientist (Agronomy), CRIDA, Hyderabad.
9. Dr K.K.Krishnani, Principal scientist NIASM, Baramati
10. Dr B.Mohan Kumar ADG (Agro & AF), ICAR
11. Shri G.F.Shahir, Senior Administrative Officer, NIASM, Malegaon, Baramati

Members of RAC

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8. Dr P.S. Minhas, Director, NIASM, Malegaon, Baramati
9. Dr J. Rane, Head, SDSM, NIASM, Baramati, Pune (Member Secretary)

Institute Research Council

Dr P.S.Minhas, Director (Chairman), All Scientists (Members), Dr J.Rane: Member Secretary

Priority Setting, Monitoring and Evaluation Committee

Dr J. Rane (Chairman), Dr B. Sarkar, Dr R.K. Pasala, Dr BB. Fand, Dr. P.S. Kumar (Member Secretary), Mr G. Madhukar.

Result Framework Document Committee

Dr P.S. Minhas , Director (Chairman), Dr J. Rane , Dr K.K. Krishnani, Dr S.K. Bal, Dr N.P. Singh, 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.

Innovation cell

Dr P.S. Minhas, Director (Chairman), All staff members, Dr J. Rane (Member Secretary)

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

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Farm Management Committee

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

Library Advisory Committee

Dr N.P. Singh (Chairman); Dr B. Sarkar; Dr Mahesh Kumar; Mr.V.Rajagopal; Dr R.L. Meena; SAO; FAO; Dr V.Govindasamy (Member Secretary)

Publication Committee

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Proprietory Items Committee

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

Institute Technology Management & Consultancy Processing Committee

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Landscape Development Committee

Dr S.K. Bal, Estate Officer (Chairman), Dr P.S. Kumar, Dr Y. Singh, Dr Tarak Nath Saha, Dr P.B. Taware.

Grievance Cell

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

RTI Cell

Dr P.S. Minhas, Director (Appellate Authority), Dr D.P. Patel (CFO), Dr S.K. Bal (Transparency Officer)

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Tribal Sub Plan Implementation Committee

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राजभाषा कार्यान्वयन समिति

डा. पी एस मिन्हास (अध्यक्ष), डा. के. के. कृष्णानी (उपाध्यक्ष), डा. योगेश्वर सिंह, डा. डी. वी. पाटील, डा. महेश कुमार, डा. राम लाल चौधरी, श्री राम अवतार, श्री प्रदीप कुमार, श्री प्रवीण मोरे, डा. डी. पी. पटेल (सदस्य सचिव)

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APPENDIX- II

Results-Framework Document for National Institute of Abiotic Stress Management (2014-15)

भाकृअनुप
ICAR

RFD

Results-Framework Document

For

National Institute of Abiotic Stress Management

(2014-15)

Section 1

Vision, Mission, Objectives and Functions

Vision

Management of abiotic stresses of crop plants, animals, fishes and micro-organisms through genetic, biotechnological and nano-technological tools and agronomic methods for enhanced sustainable productivity, food/feed quality and farm profitability adopting integrated interdisciplinary approaches.

Mission

To develop insight into background, hypotheses to mitigate, strategies to incorporate with a foresight and constitutionally acceptable policy issues with practice of climatically adaptable farming systems to build sustainable and profitable livelihood in stressed environments.

Objective

- Develop screening techniques, evolve stress tolerant genotypes/ breeding stocks and stress mitigation technologies.
- Develop database on abiotic stressors and their management

Functions

- To develop a Global Center of Excellence by establishing linkages and networking with national and international institutes/ agencies.
- To act as repository of information on abiotic stresses and management.
- To act as the Centre of Academic Excellence.
- To coordinate network research on location specific problems of national importance, to achieve higher production and productivity.
- To promote human resource development and transfer of technology.

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Section 2: Inter Se Priorities among Key Objectives, Success Indicators and Targets

S. No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1.	Develop screening techniques, evolve stress tolerant genotypes/ breeding stocks and stress mitigation technologies	73	Development of infrastructure for research	Research farm facilities created	Date	11.0	31/1/15	15/2/15	28/2/15	15/3/15	31/3/15
				Controlled environmental facilities created	Date	8.0	31/1/15	15/2/15	28/2/15	15/3/15	31/3/15
				Lab equipment's procured	No.	9.0	11	9	7	5	3
			Screening genotypes / breeding stock/ strains of crops, horticulture, animals, fish and microorganism for stress tolerance	Germplasm of crops evaluated	No.	10.0	350	300	250	200	150
				Endophytes and rhizobia screened	No.	3.0	60	50	40	30	20
				Number of drought tolerant gene expression investigated	No.	2.0	5	4	3	2	1
				Animal breeds/fishes screened for drought stress responsive genes	No.	8.0	3	2	1	0	-
			Development of technologies for mitigation of drought, other edaphic and atmospheric stresses	Resource conservation practices developed to increase input use efficiency	No.	12.0	4	3	2	1	0
				Screening of silver-ion-exchanged zeolites for bactericidal and ammonia removal activities	No.	2.0	3	2	1	0	-
				Bio-regulators evaluated to mitigate stress	No.	8.0	8	6	4	2	0

S. No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very good	Good	Fair	Poor
							100%	90%	80%	70%	60%
2	Develop database on abiotic stressors and their management	7	Assessment and quantification of the effects of major abiotic stresses on agriculture and develop a repository of information on abiotic stress management	State-wise drought stress maps prepared	No.	7.0	31/01/ 15	15/02/15	28/02/15	15/03/15	31/03/15
*	Publication/ Docu mentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3.0	7	5	3	1	0
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2.0	30/6/ 14	2/7/14	4/7/14	07/7/14	9/7/14
	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2.0	98	96	94	92	90
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2.0	15/5/14	16/5/14	19/5/14	20/5/ 14	21/5/14
			Timely submission of Results for 2013-2014	On-time submission	Date	1.0	1/5/ 14	2/5/14	5/5/14	6/5/14	7/5/14

S. No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/Criteria Value				
							Excellent	Very good	Good	Fair	Poor
							100%	90%	80%	70%	60%
	Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2.0	100	95	90	85	80
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1.0	100	95	90	85	80
*	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2.0	01/11/14	02/11/14	03/11/14	04/11/14	05/11/14
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of Implementation	%	1.0	100	90	80	70	60
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2.0	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2.0	100	90	80	70	60

Section 3: Trend Values of the Success Indicators

S. No.	Objective	Action	Success Indicator	Unit	Actual Value for FY 2012-13	Actual Value for FY 2013-14	Target Values for FY 2014-15	Projected Values for FY 2015-2016	Projected Value for FY 2016-2017
1.	Develop screening techniques, evolve stress tolerant genotypes/ breeding stocks and stress mitigation technologies	Development of infrastructure for research	Research farm facilities created	Date	-	4	15/2/2015	15/2/ 16	15/2/17
			Controlled environmental facilities created	Date	-	1	15/2/2015	15/2/ 16	15/2/17
			Lab equipment's procured	No.	-	10	9	10	6
		Screening genotypes /breeding stock/ strains of crops, horticulture, animals, fish and microorganism for stress tolerance	Germplasm of crops evaluated	No.	-	400	300	350	400
			Endophytes and rhizobia screened	No.	-	-	50	50	60
			Number of drought tolerant gene expression investigated		-	-	4	6	8
			Animal breeds/fishes screened for drought stress responsive genes	No.	-	3	2	2	2
		Development of technologies for mitigation of drought, other edaphic and atmospheric stresses	Resource conservation practices developed to increase input use efficiency	No.	-	3	3	3	3
			Screening of silver-ion-exchanged zeolites for bactericidal and ammonia removal activities	No.	-	3	2	2	2
			Bio-regulators evaluated to mitigate stress	No.	-	6	6	7	8

S. No.	Objective	Action	Success Indicator	Unit	Actual Value for FY 2012-13	Actual Value for FY 2013-14	Target Values for FY 2014-15	Projected Values for FY 2015-2016	Projected Value for FY 2016-2017
2	Develop database on abiotic stressors and their management	Assessment and quantification of the effects of major abiotic stresses on agriculture and develop a repository of information on abiotic stress management	State-wise drought stress maps prepared	No.	-	-	15/2/15	15/2/16	15/2/17
*	Publication/ Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	4	5	8	9
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	-	-	2/7/14	-	-
*	Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	100	100	96	96	96
*	Efficient Functioning of the RFD System	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	-	-	16/5/14	-	-
		Timely submission of Results for 2013-2014	On-time submission	Date	-	-	2/5/14	-	-
*	Enhanced Transparency / Improved Service delivery of Ministry/Department	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	-	-	95	-	-
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	-	-	95	-	-

S. No.	Objective	Action	Success Indicator	Unit	Actual Value for FY 2012-13	Actual Value for FY 2013-14	Target Values for FY 2014-15	Projected Values for FY 2015-2016	Projected Value for FY 2016-2017
*	Administrative Reforms	Update organizational strategy to align with revised priorities	Date	Date	-	-	2/11/14	-	-
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of Implementation	%	-	-	90	-	-
		Implementation of agreed milestones for ISO 9001	% of implementation	%	-	-	95	-	-
		Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	-	-	90	-	-

Section 4 a): Acronyms

S.No	Acronym	Description
1	CGIAR	Consultative Group on International Agricultural Research
2	SAU	State Agricultural University

Section 4 (b): Description and definition of success indicators and proposed measurement methodology

SI. No.	Success Indicator	Description	Definition	Measurement	General Comments
1	Research farm facilities created	Development of experimental fields for screening germplasm for abiotic stress tolerance	Infrastructure development for mandated research in the farm fields	It is the number of field facilities for four different types of crop plants viz. 1. Cereals and pulses, 2. Forage crops, 3. Horticultural crops and 4. Tree crops	Priority is given to create farm facilities for conducting research
2	Controlled environmental facilities created	Creation of controlled conditions including phenomics platform	Facilities for screening under controlled conditions	Establishment of 1. Top green house and 2. Installation of instrument	Testing under controlled conditions are required for initial screening
3	Lab equipment's procured	Development of laboratory facilitated for research	Procurement of various equipment needed for testing the concepts	Development of laboratory facilities, including procurement of ten high end instruments that defines the success indicators individually	Emphasis is to create laboratory facilities for conducting research
4	Germplasm of crops evaluated	Source material for the improved varieties to be evaluated	Material generated from the basic germplasm	Number of germplasm of different crops evaluated	
5	Endophytes and rhizobia screened	Identification of endophytes/ rhizobia imparting drought stress tolerance	Endophytic bacterial isolates purified from sorghum and legumes	Number of isolates of bacterial ebdophytes/ rhizobia studies	
6	Number of drought tolerant gene expression investigated	Expression of genes contributing to drought tolerance	Gene expression is level of transcripts in responses to drought	It is the number of genes studied	

SI. No.	Success Indicator	Description	Definition	Measurement	General Comments
7	Animal breeds/fishes screened for drought stress responsive genes	Source material for the improved breeds to be evaluated	Material generated from the breeds	Number of breeds of animals and fishes tested	
8	Resource conservation practices developed to increase input use efficiency	Conservation of resources in agriculture aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers	Evolution of resource conservation methods through different approaches including water management, yield modeling, microbiological methods, brood stock management and designing of structures for heat stress management etc.	Number of resource conservation practices developed during the period	To ensure increased input efficiency through conservation measures
9	Screening of silver-ion-exchanged zeolites for bactericidal and ammonia removal activities	Zeolite is a source material for bioremediation in aquaculture	Material generated from natural zeolite for exchange reactions	Number of zeolites tested for bioremediation	Priorities to give zeolite with maximum exchange reaction with silver nitrate
10	Bio-regulators evaluated to mitigate stress	Evaluation of efficacy of bio-regulators in alleviating drought stress in crop plants	Minimization of yield losses by crop growth promoters	It is the number of such bio-regulators tested during the period under report	To enhance the crop water balance and yield under drought conditions
11	State-wise drought stress maps prepared	Repository of information on abiotic stresses at regional level is a pre-requisite for research and management	Drought is one of the major abiotic stresses causing substantial crop loss necessitating assessment and quantification of effects to develop a repository of information for drought management	Number of maps	It is a stepwise progression in mapping abiotic stresses at regional level

Section 5: Specific performance requirements from other departments that are critical for delivering agreed results

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this Organization	What happens if your requirement is not met
Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Section 6: Outcome/Impact of activities of Department/Ministry

S. No.	Outcome / Impact	Jointly responsible for influencing this outcome / impact with the following organization(s)/ departments/ministry(ies)	Success Indicator(s)	Unit	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Reduction of crop loss	CGIAR institutes and SAUs	Enhancement in crop productivity under abiotic stressed conditions	%	-	2	2	3	3

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report in respect of RFD 2014-2015 of RSCs i.e. Institutes

Name of the Division : Natural Resource Management

Name of the Institution : National Institute of Abiotic Stress Management, Malegaon, Baramati, Pune, Maharashtra, India – 413 115.

RFD Nodal Officer of the RSC : **Dr. Babasaheb B. Fand**

S. No.	Objectives	Wt	Action (s)	Success indicator (s)	Unit	Wt	Target/Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.*	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	V. good 90%	Good 80%	Fair 70%	Poor 60%		Raw score	Wt. score		
1	Develop screening techniques, evolve stress tolerant genotypes/ breeding stocks and stress mitigation technologies	73	Development of infrastructure for research	Research farm facilities created	Date	11.0	31/01/ 15	15/2/15	28/2/ 15	15/3/15	31/03/15	30/11/14	100	11	-	
				Controlled environmental facilities created	Date	8.0	31/01/ 15	15/2/15	28/02/15	15/3/ 15	31/03/ 15	31/12/ 14	100	8	-	
				Lab equipment's procured	No.	9.0	11	9	7	5	3	11	100	9	122.22	Timely process of tenders and finalization of purchase procedures

S. No.	Objectives	Wt	Action (s)	Success indicator (s)	Unit	Wt	Target/Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.*	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	V. good 90%	Good 80%	Fair 70%	Poor 60%		Raw score	Wt. score		
			Screening genotypes / breeding stock/ strains of crops, horticulture, animals, fish and microorganism for stress tolerance	Germplasm of crops evaluated	No.	10.0	350	300	250	200	150	474	100	10	158.00	Timely and additional availability of germplasm
				Endophytes and rhizobia screened	No.	3.0	60	50	40	30	20	65	100	3	130.00	Timely procurement of equipment and chemicals for research work
				Number of drought tolerant gene expression investigated	No.	2.0	5	4	3	2	1	5	100	2	125.00	-do-
				Animal breeds/ fishes screened for drought stress responsive genes	No.	8.0	3	2	1	0	-	3	100	8	150.00	-do-
			Development of technologies for mitigation of drought, other edaphic and atmospheric stresses	Resource conservation practices developed to increase input use efficiency	No.	12.0	4	3	2	1	0	4	100	12	133.33	

S. No.	Objectives	Wt	Action (s)	Success indicator (s)	Unit	Wt	Target/Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.*	Reasons for shortfalls or excessive achievements, if applicable
							Excellent 100%	V. good 90%	Good 80%	Fair 70%	Poor 60%		Raw score	Wt. score		
				Screening of silver-ion-exchanged zeolites for bactericidal and ammonia removal activities	No.	2.0	3	2	1	0	-	3	100	2	150.00	Timely procurement of equipment and chemicals for research work
				Bio-regulators evaluated to mitigate stress	No.	8.0	8	6	4	2	0	8	100	8	133.33	-do-
2	Develop database on abiotic stressors and their management	7	Assessment and quantification of the effects of major abiotic stresses on agriculture and develop a repository of information on abiotic stress management	State-wise drought stress maps prepared	Date	7.0	31/1/15	15/2/15	28/2/15	15/03/15	31/03/15	31/01/15	100	7	-	
*	Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3.0	7	5	3	1	0	8	100	3	160.00	
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2.0	30/6 /14	2/7/14	4/7/14	7/7/14	9/7/14	30/6 /14	100	2	-	

*	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2.0	98	96	94	92	90	100	100	2	104.17	
*	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2.0	15/5/14	16/5/14	19/5/14	20/5/14	21/5/ 14	15/5/2014	100	2	-	
			Timely submission of Results for 2013-2014	On-time submission	Date	1.0	1/5/14	2/5/14	5/5/14	6/5/14	7/5/214	29/4/ 214	100	1	-	
*	Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2.0	100	95	90	85	80	100	100	2	105.26	
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1.0	100	95	90	85	80	100	100	1	105.26	

*	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2.0	1/11/14	2/11/14	3/11/14	4/11/14	5/11/14	26/10/14	100	2	-	
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of Implementation	%	1.0	100	90	80	70	60	100	100	1	111.11	
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2.0	100	95	90	85	80	100	100	2	105.26	
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2.0	100	90	80	70	60	-	-	-	-	

Total Composite Score : 98

Rating : Excellent

Procedure for computing the Weighted and Composite Score

1. Weighted Score of a Success Indicator = Weight of the corresponding Success Indicator x Raw Score / 100
2. Total Composite Score = Sum of Weighted Scores of all the Success Indicators

*Mandator

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

(समतुल्य विश्वविद्यालय)

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