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2012-13

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
(भारतीय कृषि अनुसंधान परिषद)
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National Institute of Abiotic Stress Management
(Indian Council of Agricultural Research)
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Cover
Administrative block, development and research activities

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Preface

National Institute of Abiotic Stress Management (NIASM) has been established to develop multidimensional research facilities for combating the escalating adverse impacts of abiotic stresses and is a new hope for tomorrow's sustainable agriculture in the era of climate change. Though in its formative phase, it is getting oriented to explore adaptation and mitigation options of abiotic stressors.

During this year, the institute continued to devote on the development of infrastructure facilities and strengthening human resources to accomplish the tasks of research and education. The construction of administrative block is in full swing and residential quarters are nearing completion. The foremost achievement of the year has been the development of a major part of the south side farm (24 ha) and initiation of multidisciplinary experiments specifically on traits and genes associated with drought and heat tolerance in wheat, soybean and greengram, crop-water production functions and the interactive effects of bio-regulators and soil fertility etc. while experiments on resource conservation technologies were initiated at the farm of Agricultural Development Trust, Baramati and also on farmers' fields. The north farm (8 ha) has also been terraced and establishment of horticultural plantations have been planned for the coming monsoon season. The first patent has been filed for synthesis of bactericidal silver nano-particles from tissue extracts of *Rohu* while selected zeolites were characterized for developing nano-particles. The other initiatives were on polymorphism of heat shock protein genes among cattle breeds, development of temperature-based phenology model for mealy bug, rhizospheric microbes to enhance drought tolerance in crop plants, unculturable microbial diversity of saline soils using metagenomics, use of intermediary irrigation water for hapa based fish culture, stress responsive genes in fish, reproduction of Shingi under abiotic stress, NDVI based mapping of drought stress, etc.

To enhance the water resource of the institute, a meeting was held with experts for augmenting and taping ground water. In addition, the institute actively participated in regional stakeholders' meetings periodically organized at different institutes. Scientists in collaboration with KVK, Baramati surveyed the nearby tehsils for assessing impact of drought. To ensure complementarities, the institute continued to establish linkages with national and regional research institutes.

Sincere thanks are due to the members of Research Advisory Committee (RAC) and Institute Management Committee (IMC) for their valuable suggestions. I also thank the members of the publication committee led by Dr. J. Rane for their efforts to compile this report. It is hoped that this report would be useful to different stakeholders including farmers, scientists and planners.

Dated: May 25, 2013
NIASM, Baramati

(P. S. Minhas)
Director

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कार्यकारी सारांश

संस्थान अपने प्रारम्भिक चरण में अजैविक तनाव को कम करने और अनुकूलन के विकल्प तलाशने के लिए उन्मुख रही है। अनुसंधान तथा शिक्षा संबंधी कर्तव्यों को पूरा करने के लिए बुनियादी सुविधाओं का विकास और मानव संसाधन को मजबूत करने का भरसक काम संस्थान द्वारा लगातार जारी है। चारदीवारी, प्रशासनिक ब्लॉक और आवासीय क्वार्टरों का निर्माण कार्य प्रगतिपर हैं। दक्षिणी क्षेत्र (24 हेक्टेयर) के अधिकांश पथरीले भाग को अनुसंधान योग्य बनाना तथा बहु-विषयक प्रयोगों को प्रारम्भ करना वर्ष की सबसे बड़ी उपलब्धि रही है।

फसलों में सूखे और गर्मी की सहनशीलता के लिए आनुवंशिक सुधार पर ध्यान देने के लिए गेहूं की 200, सोयाबीन की 173 एवं मूंग की 100 लाइनों का मूल्यांकन किया गया। अपने को ठंडा रखने की एक प्रवृत्ति के लिए स्थानीय गेहूं की प्रभेदों जैसे HD 2189, NIAW 301 और NIAW 34 का भी अध्ययन किया गया। अठारह जीनोटाइप मे प्रति बाली दानों का वजन, 38 मे प्रति बाली दानों की संख्या एवं 35 मे बाली की लंबाई स्थानीय प्रभेदो से अधिक पाई गई। स्थानीय प्रभेदो मे सूखे के लिए उत्तरदायी जीन जैसे DREB3 और CBFIVa की उच्च अभिव्यक्ति पाई गई। पुष्प के गिरने से संबन्धित DP राइबोसिलसन फेक्टर (RF) के आंशिक जीन अनुक्रम का सफलतापूर्वक क्लोन किया गया और इसके लक्षण का वर्णन किया जा रहा है। सोयाबीन की 173 विभिन्न जीनोटाइप में से CT 2503 ने सर्वश्रेष्ठ स्थानीय किस्म की तुलना में बेहतर पैदावार प्रदर्शित की।

सूखा सहनशील ज्वार के 270 बैक्टीरियल एंडोफाइट में से चार में नत्रजन स्थिरीकरण, फास्फोरस घुलनशीलता एवं सिडरोफोर उत्पादन लक्षण पाये गये। तेरह एंडोफाइट आइसोलेट्स की पहचान ए.सी.सी. उपभोक्ता के रूप में की गई। पीसीआर से प्रवर्धित पूरी लंबाई एसीसी डिअमिनेज जीन (acds) को दो रिजोस्फेयर फ्लोरोसेंट सूडोमोनास से क्लोन किया गया। एक बहू विषयक समूह ने बारामती की छह तहसीलों के 11 गांवों का दौरा किया और खाद्य फसलों, बागवानी फसलों और पशुधन पर व्याप्त सूखे के प्रभाव पर प्रारंभिक जानकारी एकत्र की।

गन्ने की पेड़ी फसल में नत्रजन तथा फसल अवशेष (ट्रेश) प्रबंधन के लिए आजमाए गए विभिन्न विकल्पों में से, नत्रजन को बूंद बूंद सिंचाई तंत्र के साथ एवं क्रो-बार उपकरण के माध्यम से डालने पर नत्रजन उपयोग दक्षता एवं उत्पादकता मे बढ़ोत्तरी प्राप्त हुई। कुट्टी किए हुए अथवा बिना कुट्टी किए गए फसल अवशेष को सतह पर आच्छादित करने से गन्ने की पैदावार, किसान द्वारा अपनाई जाने वाली सस्य क्रियाओ की तुलना में लगभग 14 प्रतिशत आधिक प्राप्त हुई जबकि फार्म यार्ड स्लरी या ट्राइकोडर्मा के उपयोग करने से इसके तेज़ी से अपघटन के कारण गन्ने की उत्पादकता में 16-19% तक वृद्धि प्राप्त की गई। एक नई ऑफ बेयरिंग सह उर्वरक ड्रिल मशीन विकसित की गई है तथा किसानों के खेतों पर इसके प्रारंभिक प्रदर्शनों के परिणाम काफी उत्साहजनक रहे हैं।

पंक्ति माध्यम फब्बारेदर सिंचाई प्रणाली बनाई गई एवं इसका उपयोग गेहूँ मे जल उत्पादन को विकसित करने एवं बायोरेग्युलेटर और मिट्टी उर्वरकता के साथ परस्परिक प्रभाव के लिए उपयोग किया गया। थायो-यूरिया की पहचान पानी की कमी के प्रभाव को कम करने के रूप में किया गया। फार्म विकास के दौरान स्पेण्टवाश मे पत्थर के विघटन की क्षमता देखी गई एवं इस तथ्य को ध्यान मे रख कर कुछ प्रयोग शुरू किए गए हैं जिसमे की स्पेण्टवाश और विभिन्न फसल प्रणाली का सयुंक्त प्रभाव मुर्रम से मृदा निर्माण की प्रकिया का अवलोकन किया जा रहा है। इसी के अंतर्गत वार्षिक एवं बहुवार्षिक फसलें, जो की अपने कार्बनिक भागों को जमीन के ऊपर तथा अंदर छोरने मे विभिन्नता रखते हैं, को लंबे समायावधि के लिए सिंचित तथा बारानी दोनों परिस्थितियो मे अध्ययन किया जा रहा है।

वर्षा संभाव्यता और सूखे के विश्लेषण से पता चलता है की पिछले 26 मे से छह साल 25% या उससे अधिक की वार्षिक वर्षा की कमी का अनुभव किया है जो की मेटेओरोलोजिकल सूखा कहलाता है। जबकि बारामती क्षेत्र में 18 साल कृषि सूखा खरीफ ऋतु के दौरान हुई।

हीट शॉक प्रोटीन (HSP) की अभिव्यक्ति स्थानीय पशु नस्लों मे जीन तापमान तनाव सहिष्णुता के साथ जुड़े पाये गए। तापमान आधारित फ़ीनोलॉजी मॉडल से पता चला है कि 25–35°C मिलीबग के अधिक प्रजनन क्षमता और छोटे पीढ़ी के लिए उपयुक्त है, जो की जलवायु परिवर्तन परिदृश्यों के संदर्भ में कई प्रकार की फसलों के पौधों के लिए एक बड़ा खतरा है।

हापास का उपयोग कर जलकृषि तकनीक मानिकीकरण फार्म तलाब मे मछली पालन के लिए किया गया जो की इस प्रकार सिंचाई के पानी के लिए मूल्य संवर्धन को सुनिश्चित करता है। मछली में तापमान तनाव के प्रभाव को कम करने के लिए नैनो तकनीकी का विकास अनुसंधान की एक और महत्वपूर्ण आकर्षण था और संस्थान का पहला पेटेंट रोहू मछली के ऊतक के अर्क से जीवाणुनाशक चांदी के नैनो कणों का संश्लेषण पर दायर किया गया है। इसके अलावा, मछली में आठ से अधिक थर्मल तनाव के लिए उत्तरदायी जीनों की अभिव्यक्ति के लिए रोहू मछली में अध्ययन किया जा रहा है।

समग्र मोडीस–टेरा डेटा और सरकारी एजेंसियों से प्राप्त फसल संबंधी आंकड़ों के आधार पर आंध्र प्रदेश के सबसे अधिक सूखा प्रभावित जिला अनंतपुर के लिए सूखा तनाव के लिए एन.डी.व्ही.आय. आधारित मानचित्रण बनाने के प्रयास किया जा रहा है। इससे ये पता चला की एन.डी.व्ही.आय. पर आधारित मानचित्रण सूखा एवं अन्य तनाव की पहचान करने के लिए इस्तेमाल किया जा सकता है और डेटा को पुनः संसाधित किया जा रहा है जिससे की सूखे और मृदा से संबन्धित तनाव का सटीक नक्शा तैयार किया जा सके। आदिवासी उप–योजना कार्यक्रम नंदुरबार जिले के पांच गांवों में चलाई जा रही है जहां जागरूकता, प्रशिक्षण, चर्चा मंच का आयोजन एवं औज़ार कोष द्वारा बड़ी संख्या मे किसान लाभान्वित हुए हैं।

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Executive Summary

Though in its formative phase, the institute is getting oriented to explore adaptation and mitigation options of abiotic stressors. The institute continued to devote on the development of infrastructure facilities and strengthening human resources to accomplish the tasks of research and education. The construction of boundary wall, administrative block and some of the residential quarters are progressing fast. The foremost achievement of the year has been the development of a major part of the south side farm (24 ha) from the rocky terrain and initiation of multidisciplinary experiments.

With focus on genetic improvement for drought and heat tolerance in crops, about 200 lines of wheat, 173 of soybean and 100 of green gram were collected and evaluated. A tendency to stay cool was monitored in local cultivars of wheat such as HD 2189, NIAW 301 and NIAW 34. Eighteen genotypes had higher grain weight per spike, 38 genotypes had more grains per spike, 44 more spikelet's per spike and 35 genotypes had longer spikes than the local varieties. Latter had high expression of drought stress responsive genes such as *DREB3* and *CBFIVa*. A partial gene sequence of an ADP ribosylation factor (ARF), associated with flower abscission, has been successfully cloned and its characterization is being done. Out of 173 diverse genotypes of soybean, genotype CAT 2503 produced better grain yield than the best local variety. Out of the 270 bacterial endophytes of drought tolerant sorghum, four isolates were detected as *+ve* for all three traits of N-fixation, P-solubilisation and siderophore production. Thirteen endophytic isolates were identified as ACC utilizers. The PCR amplified full length ACC deaminase gene from two of the rhizosphere fluorescent Pseudomonads were cloned. A multidisciplinary team visited 11 villages of six tehsils in and around Baramati and collected preliminary information on impact of prevailing drought on food and horticultural crops and livestock.

Among the different options tried for trash management in ratoon sugarcane, the application of N through either fertigation or crowbar tool improved the N-use efficiency *vis-a-vis* productivity. Surface retention of either chopped or unchopped trash improved the cane yields by about 14 per cent over the farmer's practice while its faster decomposition using farm yard slurry or *Trichoderma* further improved the cane yield by 16-19 per cent. A new off barring-cum fertilizer drill machine has been developed and results of its initial demonstrations at farmer's fields are very encouraging. Line source sprinkler irrigation systems were fabricated and utilised to develop water production function in wheat and their interactions with bioregulators and soil fertility. Thiourea has been identified to hold potential to alleviate the impact of water stress. Since the impact of spent wash in faster disintegration was visualised during its field application in farm development, studies have been initiated to evaluate the impact of spent wash and cropping systems on development of soils from murrum where different annual and perennial crops leaving differential above and below ground organics are being tried on long term basis both under irrigated and rainfed situations.

Analysis of rainfall probability and drought based on data recorded during 1986-2011 revealed that six out of 26 years experienced annual rainfall deficit of 25 per cent or more and met the criteria of meteorological drought while agricultural drought in the *kharif* occurred during last 18 years in Baramati region. Expression of Heat Shock Protein (Hsp) genes associated with thermal stress tolerance was observed in local cattle breeds. A temperature-based phenology model revealed that 25-35°C favours maximum reproductive potential and shorter generation time of mealybug, a polyphagus pest, which is a major threat to many crop plants in the context of climate change scenarios.

Silver ions could be exchanged predominantly with Ca to an extent of 88 per cent in zeolites like in apophyllite, heulandite, stellerite and stilbite. Aquaculture techniques using hapas have been standardized to rear fish in farm ponds and thus ensuring value addition to irrigation water. Development of nano-technological approach to alleviate impact of temperature stress in fish was another important highlight of research and the first patent has been filed from the institute on synthesis of bactericidal silver nano-particles from tissue extracts of *Rohu*. In addition, expressions of more than eight thermal stress responsive genes in fish have been studied in rohu fish. NDVI based mapping of drought stress on the basis of composite MODIS-Terra data and the crop related data from governmental agencies was attempted for the most affected district of Anantpur in Andhra Pradesh. The initiative indicates that NDVI can be used for identifying the drought and other stressors and data is being further processed to generate precise drought and edaphic stress map of the given region. TSP programme is being implemented in five villages of Nandurbar district where large number of farmers were benefitted from awareness visits and trainings organised, creation of discussion forum and implement banks.

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 semi-arid 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 abiotic stresses. With substantial agricultural land in tropics and subtropics, India is more challenged with penultimate combinations of abiotic stresses partially 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 NIASM 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, NIASM 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 inter-disciplinary research. The institute, which is a Deemed-to-be-University, also plans to focus on imparting education in such specialised areas that are not taught in regular agricultural universities.

Role of the Institute

The institute will 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 will implement important research programmes in a thematic mode and has started functioning through four schools, namely Atmospheric Stress Management, Drought Stress Management, Edaphic Stress Management and Policy Support Research. The institute will emphasize 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, NIASM will make efforts to complement the ongoing R&D under National Agricultural Research System (NARS) without any duplication of research. It will 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.

Goal

To build sustainable livelihood in agro-ecosystems constrained by abiotic stresses through climate resilient farming systems adopting techniques, strategies and policies by effective convergence of national and international research outputs.

Mandate

The mandate of the institute is to enhance the capacity for abiotic stress management through basic, strategic and policy support research.

- To undertake basic and strategic research on management of abiotic stresses of crop plants, animals, fishes and microorganisms through genetic, biotechnological and nano-technological tools and through conservation agriculture methods for enhanced and sustainable productivity, food/feed quality and farm profitability through inter-disciplinary and inter-institutional approaches
- To develop a Global Centre of Excellence by establishing linkages and networking with national and international institutes/agencies
- To act as repository of information on abiotic stress management

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

The institute is primarily focusing on research issues hitherto unexplored and hence at initial phase of its development is giving special emphasis on reviewing the status of research on abiotic stresses to avoid duplication. To complement the research efforts of other institutes, it will establish close collaboration between the scientists associated with abiotic stress tolerance in different commodities at regional and national level. For this purpose, it is establishing state-of-the art laboratories and research facilities that can attract talented researchers and students to investigate basis of mechanisms of tolerance to stresses at cell, organ and whole plant level as well as in agro-ecosystem perspective. Recent advances in genomics, meta-genomics, proteomics, metabolomics and phenomics are planned to understand the mechanisms of tolerance to stresses and also to identify the stress tolerant traits and genes that can ultimately contribute to resilience of agricultural systems to adverse climate and edaphic factors. Simultaneously, natural resource management technologies will be developed to facilitate abiotic stress management through conservation agriculture that can also contribute to mitigation of global warming through appropriate carbon sequestration strategies. The knowledge accumulated on abiotic stresses will be placed in robust database and will be shared with scientific community. This information together with continuous interaction with national and international research institutes will help NIASM to scale up capacity of next generation of scientists to evolve abiotic stress management strategies that can contribute to mitigation of global warming as well as adaptation to adverse effects of climate change.

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. At present, modular office, laboratory and committee room are housed in this 300 m^2 air conditioned workshop. NIASM has initiated its developmental activities with emphasis on main building, schools and the experimental farm. At the same time substantial efforts were 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 has increased to 29, 14 and 7 respectively. Thus the filled up cadre strength is 50 against 107 sanctioned posts (Table 1.1). The institute has initiated research through four schools with multi-disciplinary approach (Fig.1.1).

Cadre Strength

Table 1.1. Current Cadre Strength of NIASM, Baramati

Cadre	Sanctioned	Filled	Vaccant
Scientific*	51	30	21
Technical	34	14	20
Administrative	22	7	15
Grand total	107$$	51	56
*Including Director	$$ Including transferred positions of CAO & Technical Officer (T-9)		

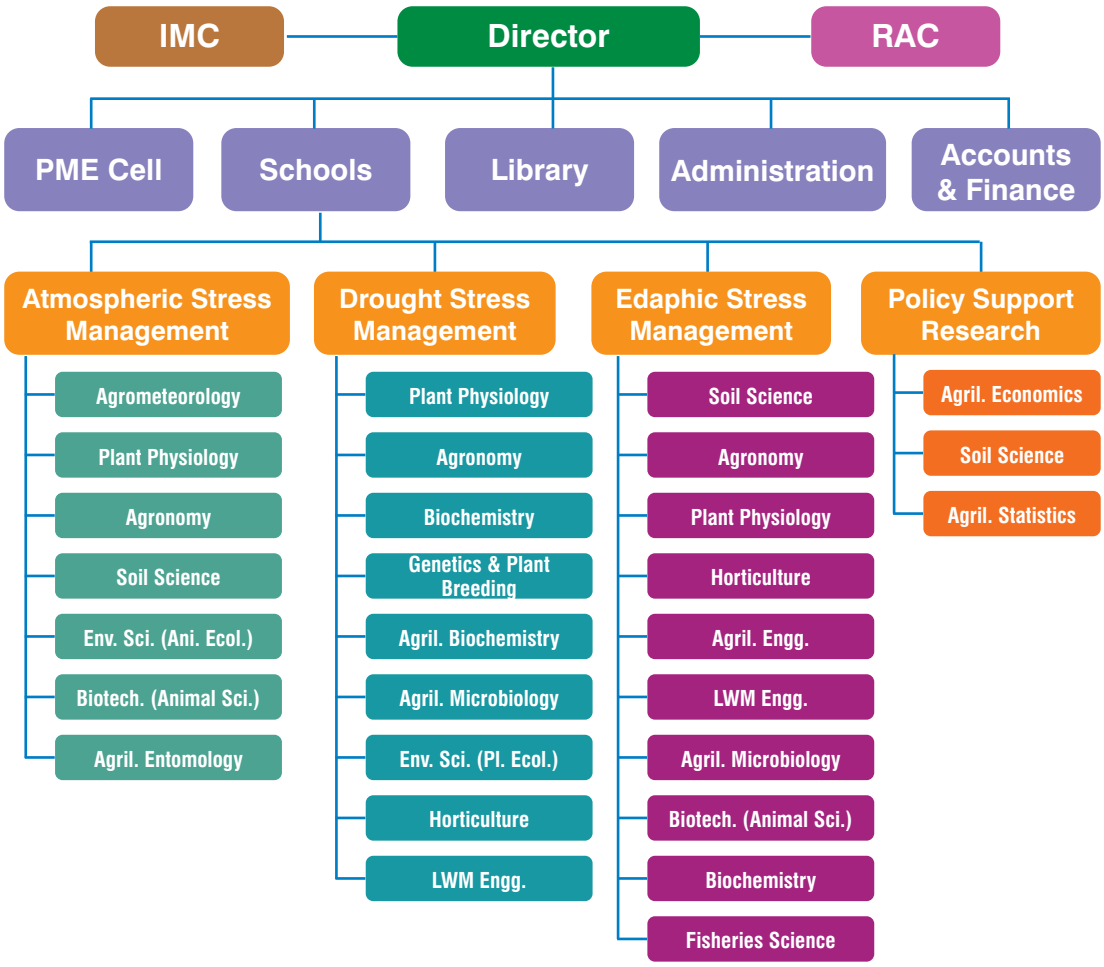


Fig. 1.1 Organogram of the institute

Research Programmes

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
- Impact assessment of adverse weather events on biodiversity at epic enters

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 and apple
- 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)
- Policy research for promoting the adoption of mitigation/adaptation strategies for abiotic stresses

Infrastructural Development Activities

Table 1.2 Status of Ongoing Works

Sl. No.	Name of work	Estimated cost (₹ in lakhs)	Status of work
1	Compound Wall, Entrance Gate, Security Office	248.60	About 800 of the 1105 compartments and entrance gate completed.
2	Office-cum-Administrative Building	2093.00	Casting of first floor slab is complete. Reinforcement work for terrace floor slab is in progress. Brick masonry work on GF is 80% complete (1.2a).
3	Residential Quarter (Type IV, 6 no.)	238.23	RCC brick work and plaster work is complete. Plumbing and finishing works like painting, fixation of doors/windows etc are is in progress (Fig. 1.2b).
4	Residential Quarter (Type VII, 1 no.)		RCC, brick work, plaster work is complete. Plumbing and painting work is in progress (Fig. 1.2c)
5	Construction of Overhead Water Tank for drinking water supply scheme	47.00	MJP has undertaken the work of establishing daily water supply demand of the institute. Construction of tank is complete.
6	Guest House	398.00	Tender has been floated
7	Express Feeder for Uninterrupted Power Supply	70.00 Approx	630 KVA transformer (Fig. 1.2d) has been installed to meet the current requirement of office, phenomics etc.

(a)

(b)

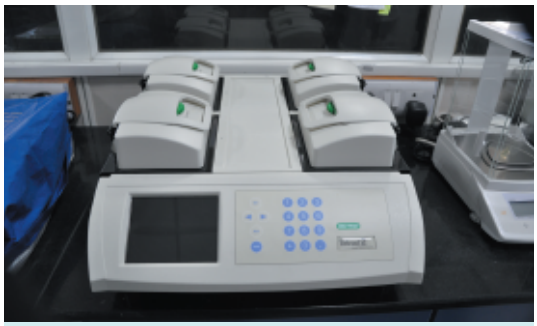
(c)

(d)

Fig. 1.2. Status of construction of administrative building (a), Type IV (b), Type VII quarters (c) and express feeder for electricity (d)

Research Laboratory

The modular research laboratory was further strengthened by procuring sophisticated equipment to upgrade it into the state-of-the art facility. The institute has procured equipment worth 5.06 crores during the current financial year (2012-13) and these included; Hyperspectral Spectroradiometer, Ultra Centrifuge, Leaf Area Meter, Environmental Shaker, GLC System with two detectors, Vertical Ultra Low Freezer, Tetrad PCR (Fig. 1.3a), Kjeldahl Digestion System, Advance Photosynthesis System, Water Quality Monitoring System, IR Thermometer, Line Quantum Sensor, Analytical Sieve Shaker, Guelph Permeameter Kit, Bowen Ratio System, Eddy Correlation System, Atomic Absorption Spectrophotometer, Net Radiometer with data logger, Porometer, Infrared Thermal Imaging System (Fig. 1.3b), Plant Stress Device and Online Water Purification System. These instruments will be useful for multidisciplinary research to address issues related with management of abiotic stresses.



(a)

(b)

Fig. 1.3. Tetrad PCR (a) and Thermal Imaging System (b)

Library

The institute library has a good collection of books in the areas related to the mandate of the institute. The library is now subscribing 16 e-journals covering plant, soil and animal sciences. Presently, the library provides an access to online journals being subscribed by Consortia of Electronic Resources in Agriculture (CeRA), electronic dissertations from *Krishi prabha*, and many open source journals and books through its portal 192.168.1.83:8080. A repository of institute publications is being maintained through the open source software DSPACE. The institute can access to *KRISHIKOSH*, a new digital library of ICAR that will have database of scientific research findings, institute publications, research reports, etc. The acquisitions during this year included : 353 books, 55 annual reports and 120 open source articles thus leading to total collection of 816, 140 and 345 of these documents, respectively.

Research Farm Development

The institute is putting up intensive efforts to develop a "Model Research Farm" demonstrating the soil and water conservation technologies suited to the semi-arid climate of the region. Presently, research farm is being developed over an area of about 40 ha. The design and development of research farm is based on scientific considerations like watersheds, natural drainage pattern, topography, contour map

and layout of various buildings in the approved master plan of the institute. The research farm is divided by existing east-west road into south side and north side farms (Fig.1.4a) The development process of south side farm spread over a total area of 16 ha is almost at final stage. This farm is divided into six main blocks in north-south direction by five main paths (4.5 m wide). For easy farm operations and accessibility, the farm is sub-divided by five cross roads of three meter width. Thus, this farm has been divided into a total of 37 research plots. Of these, centrally located 32 research plots are of regular rectangular shape of size 68.5 m x 36.5 m measuring 2500 m^2 area each while the rest are of the size 68.5m x 68.5m. For developing farm roads, heavy stones collected during preparation of field plots (Fig. 1.4b) were used as bottom layer, channelled using dozer and then a layer of murrum (10-15 cm) was placed on the top (Fig. 1.4c). Keeping in view the topography, a uniform slope upto 2% was maintained for preparation of farm roads (Fig. 1.4d).

Fig. 1.4. Aerial view of the farm (a), Farm road development: heavy stones as bottom layer (b), murrum as top layer (c) and roads after completion of work (d)

All the research plots were initially levelled and ripped with the help of heavy machinery support from the Mechanical Division, Irrigation Department, Govt. of Maharashtra. About 24 million litres of spent wash from Malegaon Sugar Factory was applied over three years in different plots to disintegrate the gravelly murrum. This included 15 million litres of spent wash applied during current year. Thereafter, these plots were levelled using tractors. Where ever needed, the portions of these plots were again ripped using dozers to break the exposed portions of the bed rock. The process has been repeated twice and a major portion of these plots were made ready for planting of *kharif* crops. Since the virgin soils were still gravelly (75-79% gravels of various sizes and rest 21-25% less than 2mm) and low in fertility (organic carbon ~

0.1% and Available P ~ 0.5 kg/ha), 350 brass (991 m^3) of spent mushroom substrate and 120 brass of FYM (340 m^3) were applied to improve the soil fertility. In addition, black soil of 6000 brass (16980 m^3) was applied to 10 research plots over 2.5 ha area during 2011 and another 3500 (9905 m^3) brass have been applied during 2012 to cover another one ha. Dhaincha was cultivated in *kharif* season as green manure and also to test uniformity of soils. Three plots covering 0.75 ha were levelled using tractor operated laser leveller.

After identifying the uniform fields, scientists initiated experiments with crops like soybean, guar, green gram etc. during *kharif* while experiments with wheat (Fig.1.5a-b), jowar, chickpea, sorghum and sugarcane were initiated from the following *rabi* season. Due to scarcity of irrigation water, a strip has been put under rainfed grasses/legumes like marvel grass (0.25 ha), stylo (0.25 ha) and leucaena (0.5 ha) while about one ha has been sown with dhaincha for green manuring (Fig. 1.5c-f). Around two ha area has been reserved for setting up of an 'Integrated Farming System Model' and one ha for fodder purpose.

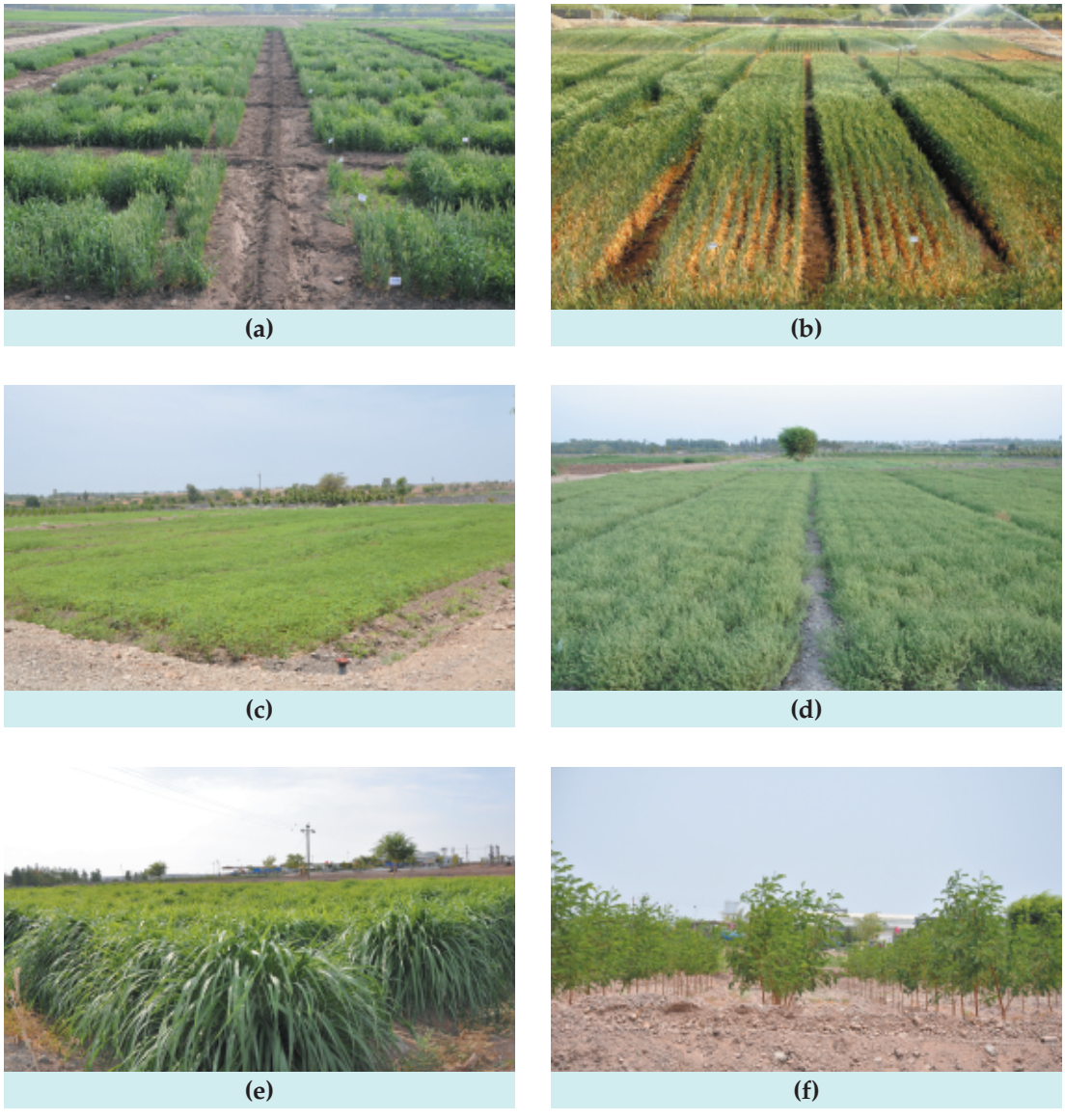


Fig. 1.5. Wheat germplasm screening (a), line source sprinkler system (b), Dhaincha for green manuring as the first crop (c), Stylos (d), napier grass (e) and Subabul (f)

The eastern part of the North side farm has been developed by terracing and levelling of 11 ha area with the help of heavy machinery and tractors with front dozer, back hoe loader, breaker etc. The area was divided into seven terraces with width ranging from 35 to 38 m. Two farm roads running east-west across terraces divide the whole farm into 21 plots. The big boulders and stones were placed at the bottom layer of farm paths with 10-15 cm thick murrum on the top. The terraces were further ripped, levelled, and covered with soil. Horticulture experiments are being planned on an area of six ha covering 10 plots with sapota, guava, pomegranate, tamarind, custard apple, grapes, pineapple, dragon fruit, date palm, fig and papaya etc. These orchards will be irrigated exclusively with drip system.

Coconut trees (var. Banawali) were planted along the outer side of the peripheral road (Fig. 1.6a) while horticultural plants like sapota, jamun, aonla, tamarind, and terminalia have been planted on the inner side. Replanting was also carried out wherever necessary for better establishment of coconut and other horticultural plants. Germplasm lines of cactus are being maintained in nursery. Dragon fruit (*Hydocerus undatus*) cuttings were obtained from local farmers and are being multiplied for establishing experimental plots.

(a)

(b)

Fig. 1.6. Peripheral coconut plantation (a) and germplasm of cactus (b)

Irrigation Network

Irrigation water is being lifted from Nira left canal, about 0.5 km away from the south end of the farm, through a 20 HP pumpset and 5″ main pipeline. For minimising the losses, a layout for the network of underground pipelines has been planned. At present, 1700 m of 5″ and 500 m of 8″ PVC pipe lines have been laid along the main blocks of south side farm (Fig 1.7a and b). A total of 48 outlets across the blocks have been provided to facilitate irrigation in each plot. The north side farm, which has been planned to be put under horticultural plantations, will receive irrigation only with drip system. The laying out of the drip system for the northern terraces as well as for peripheral plantations has been initiated.

(a)

(b)

Fig. 1.7. Trench formation (a) and Laying of PVC pipeline for irrigation (b)

◆ ◆ ◆

2. Research Highlights

School of Atmospheric Stress Management

Rainfall Probability and Drought

Analysis was carried on weekly rainfall probabilities and drought situation in and around Baramati based on the weather data recorded during 1986-2011. For the period relevant for cultivating *kharif* crops (i.e. standard meteorological weeks 21-44), probabilities for wet weeks (total rainfall more than 5 mm) varied between 0.08-0.85. In 15 out of 52 weeks, probability of a week being wet was 0.5 or more falling between May and November. Although the long term average (LTA) annual rainfall of the area is around 560 mm there were 13 instances where in the weekly rainfall exceeded 25% of the annual LTA and with the maximum of 271 mm i.e. 48.4 % which occurred during 24th week, 2010. The maxima of the weekly rainfall and probabilities for the occurrence of wet weeks are depicted in Fig 2.1a and Fig 2.1b, respectively. Six out of 26 years experienced annual rainfall deficit by 25% or more and met the criteria of meteorological drought. Agricultural drought in the *kharif* occurred during 18 years, as per the criteria laid down by the National Commission on Agriculture (1976). In all, five years viz., 1986, 1991, 1994, 2002 and 2003 experienced both types of drought. Interestingly, the year 2011 met the criteria of meteorological drought but did not experience an agricultural drought (*kharif*). The year 2003 was the worst and it received only 151.4 mm rainfall.

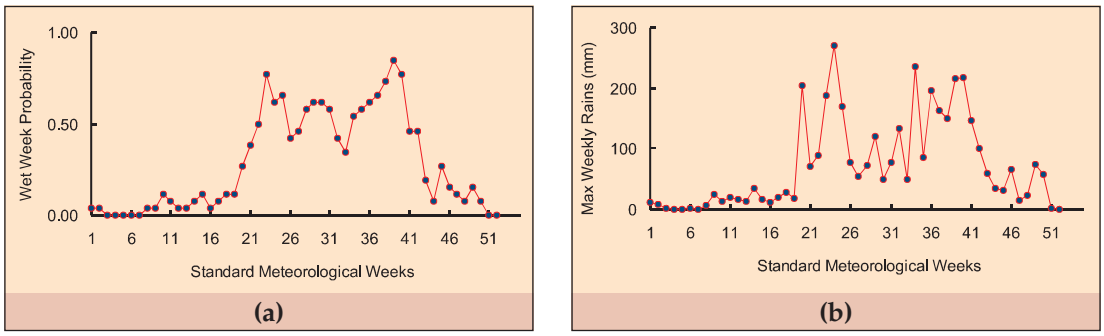


Fig. 2.1. Maxima of the weekly total rainfall during 1986-2011 (a) and probabilities of weeks receiving > 5 mm rainfall (b)

Bio-regulators to Mitigate Drought and Heat stress

Several bioregulators have been reported for alleviating abiotic stresses in crop plants but few have been evaluated on large scale under field conditions particularly in the drought and heat prone areas. Silixol is a component of silica in the form of Ortho-silicic acid, which can regulate plant growth and mechanisms of tolerance to abiotic and biotic stresses. Hence, a field experiment was initiated to evaluate the efficacy of silixol in alleviation of drought stress in wheat variety HD-2189. Foliar application of 4 ml/L of silixol (360 ppm of ortho-silisic acid) showed an impact in terms of increase in relative water content (RWC) and leaf chlorophyll content and

low canopy temperatures. However, the response to silixol application was conspicuous under normal irrigated conditions (Table 2.1). Further, in-depth studies are in progress to understand the role of silixol in mechanisms underlying the drought and high temperature tolerance.

Table 2.1. Effect of foliar application of silixol (ml/L) on yield and yield components of wheat

Parameter	Silixol (ml/L)							
	Normal Irrigation				Water stress after flowering			
	Nil	1.0	2.0	4.0	Nil	1.0	2.0	4.0
Spike length (cm)	8.5	8.9	9.0	9.2	8.7	8.8	8.9	8.8
Spike weight (kg/plot)	1.7	2.1	2.1	2.0	1.5	1.6	1.6	1.6
Grain yield (q/ha)	23.3	30.4	29.0	28.1	20.0	21.9	21.4	21.0
Test weight (g)	40.0	42.0	40.0	41.0	37.0	39.0	39.0	40.0

Genetic Polymorphism of Heat Shock Protein Genes among Cattle Breeds

This study aims at understanding the genetic mechanisms underlying the heat stress tolerance among indigenous breeds of cattle. Heat shock proteins (HSP) may play crucial role during thermal stress and is considered as one of the important mechanisms of stress tolerance. Hence, an attempt was made to assess the genetic polymorphism of *Hsp* in indigenous and cross breed cattle. The genomic DNA was isolated from the blood samples of Sahiwal and Khillar cattle. PCR primers were designed for the polymorphic regions of heat shock protein genes viz., *Hsp70* and 5UTR of *Hsp90*. The method for amplification of partial gene segments of *Hsp70* (544bp) and *Hsp90* (722bp) has been standardized (Fig. 2.2).

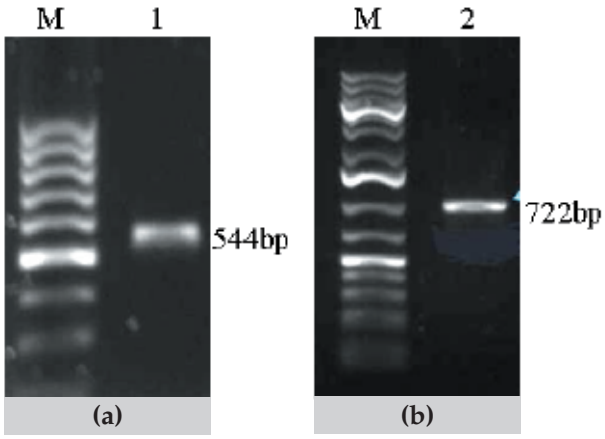


Fig. 2.2. Amplification of partial *Hsp90* (a) and *Hsp70* (b) genes from Sahiwal

Development of Temperature-based Phenology Model for Mealybug

Temperatures throughout the tropics and subtropics are highly congenial for the spread and multiplication of cotton mealy bug (*Phenacoccus solenopsis*), a highly invasive pest which damages many agricultural crops of economic importance. Rise in ambient temperatures due to global warming can aggravate the damage due to this pest. Hence, temperature-dependent population growth potential of *P. solenopsis* was estimated by studying time and rate of development, mortality of immature stages and senescence and fecundity of females at six constant temperatures ranging from 15-40°C in controlled environmental conditions. Overall phenology models were established and the life table parameters were estimated using best-fitting functions (Fig. 2.3). The model predicted that temerature between 25-35°C favours maximum reproductive potential and shorter generation time because of rapid growth, multiplication and survival of mealy bug. This model can be employed in Geographic Information System (GIS) in spatial mode to predict population growth and spread potential of this pest under varied abiotic environmental conditions, especially in the context of rising temperatures.

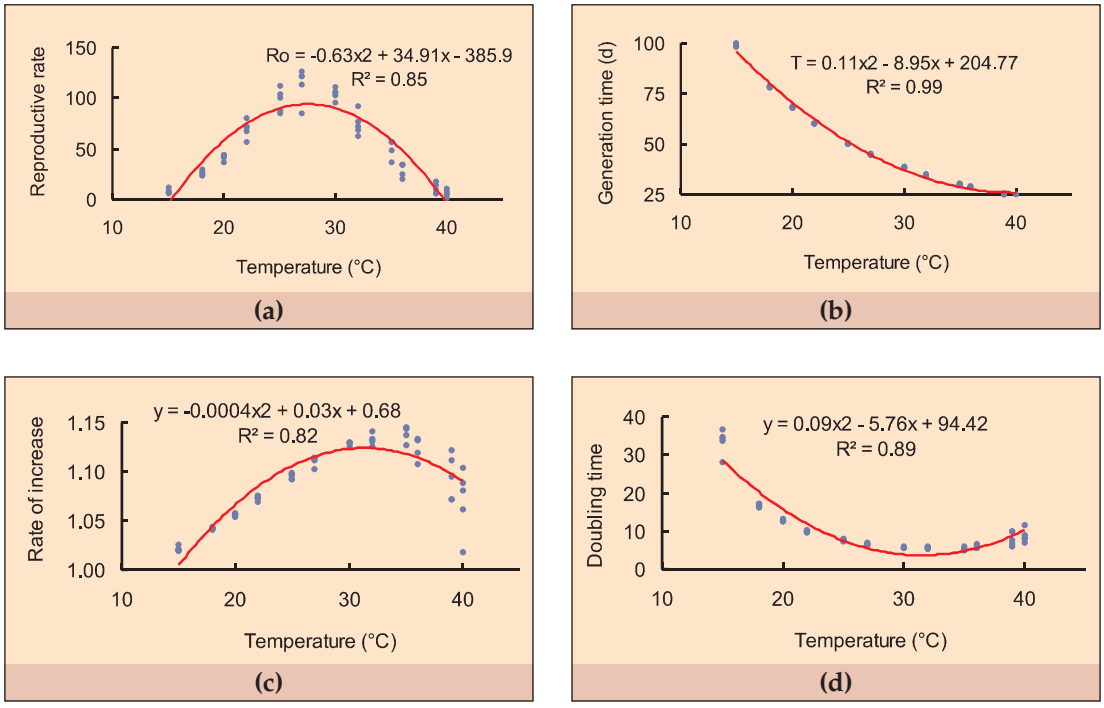


Fig. 2.3. Effect of temperature on net reproduction rate (a), mean generation time (b), finite rate of increase (c) and doubling time (d) in mealy bug.

Role of Systemic Insecticides in Drought Stress Tolerance

Many of the systemic insecticides have been reported to enhance the plant growth and tolerance to abiotic stresses such as high temperature and drought. Hence, a field experiment was conducted using two irrigation methods viz., furrow and drip to evaluate the impact of systemic insecticides viz., imidacloprid (Confidor 17.8 % SL, 0.005%), dimethoate (Tafgor 30% EC, 0.06%) and salicylic acid (2 hydro benzoic acid 99.0%, 0.01% on water stress tolerance in tomato hybrid (var. Abhinav). Aphid incidence was higher on water stressed plants as compared to normally watered

plants, even with the application of systemic insecticides (Fig. 2.4). The causes of high incidence are being investigated taking into consideration physiological and metabolic changes at cellular level.

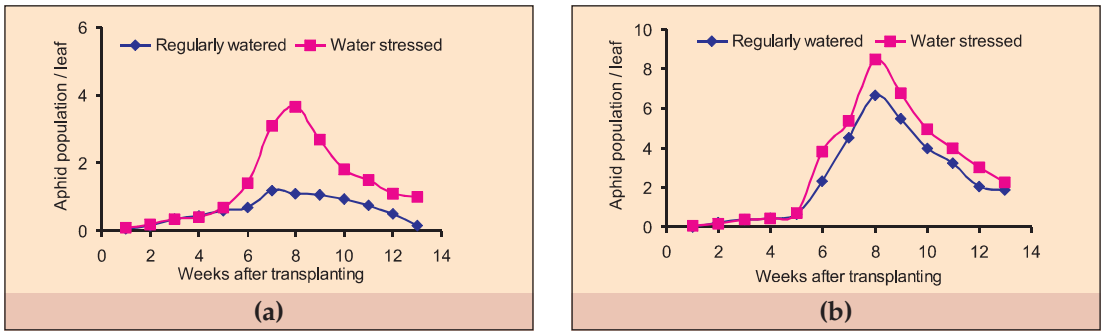


Fig. 2.4. Aphid population with (a) and without (b) systemic insecticides under normal and water stress conditions

School of Drought Stress Management

Assessment of Drought Impact in and around Baramati

Baramati is one of the important agricultural hubs of Pune division and Nira canal acts as it's lifeline. Though the canal water supplies kept the agricultural land covered by crops despite prolonged dry spell, sugarcane, which is the major crop of the region suffered heavily due to deficit rainfall. On the other hand, crops could not be sown/harvested in rainfed areas. The information about the events taking shape in the backdrop of unprecedented drought was collected in 11 villages of six tehsils viz., Baramati, Indapur, Phaltan, Purandar, Daund and Karjat. The selected villages were visited twice during mid *kharif* (August, 2012) and end of *rabi* (May, 2013) seasons.

The area has so far received less than 50% of normal rainfall (500 mm) and that too is unevenly distributed. Thus agriculture was largely dependent on surface and ground water resources. Farmers of Baramati and Indapur tehsils having access to canal water continued to cultivate sugarcane, whereas tehsils like Karjat were reeling under severe scarcity since the water resources have dried down rapidly. General realization is that this years drought is harsher than that occurred during 1972.

The most drought prone Karjat tehsil had 67% (of normal) area sown with grain crops in *kharif* anticipating recovery of monsoon but all or the most of it could not be harvested depending on access to irrigation. However, area under maize increased (28%) due to predicted shortage of fodder. Area under legume crops reduced to 25% while the area under oil seeds was only 1.9%. Some of the citrus, pomegranate, mango and tamarind orchards were drying up and many of the orchards were severely affected and surviving on water either supplied from tanks (Fig 2.5a) or pumped from sources located 5-10 km from the farms. A typical example is from village Durgaon in Karjat where an 18 years old mango orchard has completely dried down (Fig. 2.5b). Farmers, with new ventures like papaya, are trying plastic mulches to ensure efficient use of transported water with tanks. A large number of cattle camps were maintained by local voluntary organizations with the support from government to provide 15 kg

of fodder, 2 kg of feed concentrate per animal in addition to sufficient drinking water (Fig 2.6a). However, the condition that a family member has to stay in the camp seems a major limitation of this scheme.

(a)

(b)

Fig. 2.5. Pomegranate orchard thriving on transported water in tanks in Pimpale village (a) and Dried mango orchard in Durgaon village of Karjat (b)

Similarly, in the Purandar tehsil, area sown to grains and legumes drastically reduced. Among fruit crops, the severe impact of drought was noticed in custard apple, fig, guava, pomegranate and sapota. Custard apple, though having drought adaptation mechanism, was severely affected due to shallow soils with limited water storage capacity. Pomegranate seems a priority since its orchards are put under the best management practices and the farmers even preferred the *Ambe Bahar* fruits which demands regular irrigation through-out its growth period. Some of the marginal and poor farmers did opt for deflowering and were waiting for rainy season to harvest *Mrigbahar* crop. Flower bud initiation had been delayed in sapota due to drought. The fruit quality had also deteriorated and is not up to the market standard. Farmers were trying their best to fill farm ponds with transported water and then irrigating the trees through drippers.

The adaptation techniques were evident in Ramkund village of Indapur where farmers have shifted to drought tolerant horticultural species like pomegranate along with farm ponds for protective irrigation (Fig. 2.6b) though they were earlier cultivating seasonal crops such as vegetables, maize and jowar. The area under maize has drastically reduced due to delay/failure of monsoon. During the past about 8 months, the farm ponds have increased from 4 to 16 and it was stated that the water stored in these ponds is sufficient for the maintenance of orchards for another two months. However, the villagers showed their concern about simultaneous rise in temperature that may induce flower drop; lower fruit set and may also increase the incidence of stem borers and wilt. Covering plant canopy with cloths was being tried as the option to protect fruits from sun burn. But on the whole, there is still a lot of scope for extending soil and water conservation interventions through watershed development program in several villages of Karjat. Further, the drought stress can be minimized for horticultural crops through selection of right type of species/varieties, proper site selection, and appropriate orchard health management (OHM) practices. Scope also exists for the use of proper training and pruning practices and anti-transpirants along with normal spray schedule for pest and diseases. Potential of

aquaculture interventions also exist in the farm pond and specifically some of the Integrated Farming System (IFS) Models should be tried for fetching more income and providing stability to agriculture in this region.

(a) (b)

Fig. 2.6. Cattle camp with sugarcane as major source of green fodder in Pimpalwade village of Karjat (a) and a series of farm ponds to cope up with drought at Ramkund village of Indapur (b)

Traits and Genes Associated with Drought Tolerance

Wheat

A unique set of more than 200 wheat germplasm lines collected from National Bureau of Plant Genetic Resources (NBPGR), New Delhi, were sown in an experiment with three replications in an alpha lattice design. The main objective was to multiply seeds for large scale screening in field and controlled environments and to generate basic information of traits related to drought stress tolerance. Four locally popular varieties namely HD 2189, Raj 3765, NIAW 301 and NIAW 34 were used as checks. About 35 genotypes did not show surface waxiness, 48 genotypes had stem waxiness, 78 genotypes had waxiness in both stem and leaves, and about 38 genotypes had waxiness in all the plant parts. Genotypes were also examined for drought induced leaf rolling/folding since the crop faced a spell of moisture stress after heading due to canal closure. The local genotypes such as NIAW 301 and NIAW 34 exhibited severe leaf rolling. Moderate leaf folding only on flag leaf was observed in 25 genotypes, and about 10 genotypes exhibited very severe leaf rolling. Canopy temperatures were monitored at hourly interval between 8.00 AM to 8.00 PM. Canopy temperature measured in locally adapted cultivars such as HD 2189, NIAW 301 and NIAW 34 was 20°C less than soil surface temperature and about 10°C lower compared with air temperature during the representative noon. Data revealed, that nine out of 200 genotypes had cooler canopy than local checks while 18 had high grain weight per spike, 38 genotypes had more number of grains per spike, 44 genotypes had more spikelet's per spike and 35 genotypes had longer spikes.

In addition to phenotyping, molecular level investigations were carried to assess expression of genes associated with drought tolerance in C 306, NIAW 34, and Raj 3765 which are known for heat and drought tolerance. The expression of drought stress responsive genes such as *Rht-B1a*, *Rht-B1b*, *CBF1*, *CBFII*, *CBFIIIb*, *CBFIVa* and *DREB3* were determined by using semi-quantitative Reverse Transcriptase

Polymerase Chain Reaction (RT-PCR). Expression of transcription factor *DREB3* (Fig.2.7a) and CBFIVa (Fig.2.7b) gave a preliminary indication of involvement of these genes in drought tolerance in all the three varieties but this needs further confirmation.

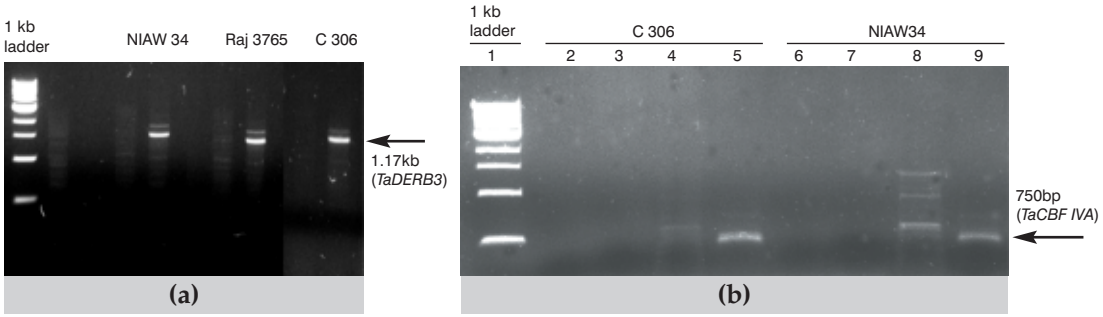


Fig. 2.7. Expression of *DREB3* (a) and *CBFIVa* (b) in local genotypes of wheat

Greengram

About 150 genotypes of greengram were obtained from various sources such as NBPGR, New Delhi; PAU, Ludhiana and IIPR, Kanpur for phenotyping and 24 genotypes were evaluated for genetic variation in flower abscission, and the abscission index (ratio of pods to total number of flowers produced) varied between 0.5-0.8 (Fig. 2.8). Since ADP ribosylation factors (ARF) are an important class of signaling intermediates in flower abscission and recently *NEVERSHED*, an ARF from *Arabidopsis thaliana* has been reported to mediate the abscission phenomenon. A partial gene sequence of an ADP ribosylation factor (ARF) was successfully cloned and characterization of this gene is under progress (Fig. 2.9a).

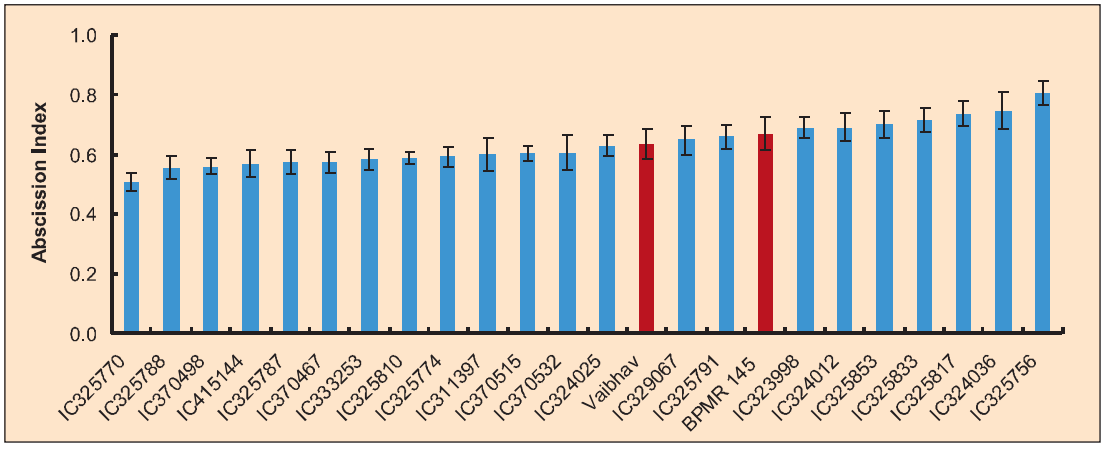


Fig. 2.8. Variation in abscission index of greengram genotypes

Seedlings were treated with PEG8000 with an objective to study the gene expression under moisture stress conditions and expression of NAC domain protein and *CIPK2* genes in response to PEG induced water stress was evaluated. The *CIPK2* gene exhibited increased level of expression in response to stress conditions as compared with control (Fig. 2.9b).

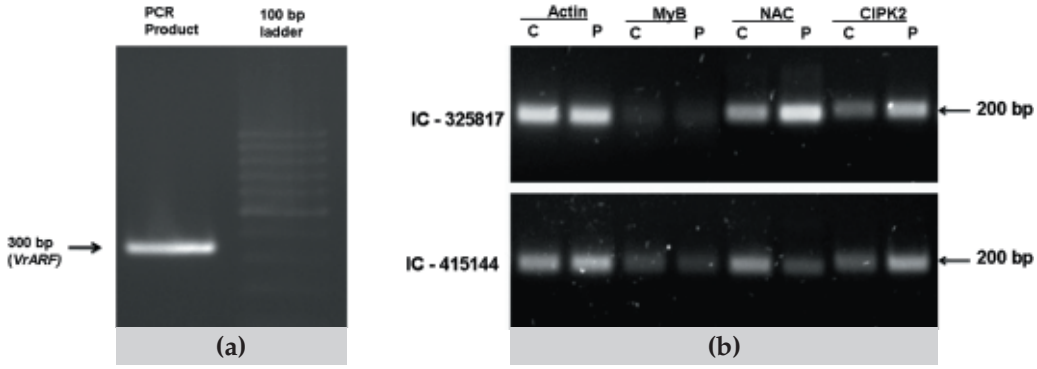


Fig. 2.9. Amplification of ARF cDNA (a) and expression of drought responsive genes in greengram genotypes (b)

Resilience to Water Stress in Soybean

About 173 diverse soybean genotypes were obtained from DSR, Indore, and were sown in two rows on the ridges of 5 meter length spaced 50 cm apart in an augmented plot design. The local cultivars of soybean viz. JS 95-60, JS 93-05, JS 335 and NRC 7 were kept as checks. The genotype CAT 2503 produced the highest grain yield (45.7 g/plant) while it ranged between 6.4 to 17.5 g/plant in local varieties. Test weight ranged from 6-24 g in most of the genotypes and 14.5-16.1 g in check varieties. CAT 2926 had bolder seed compared to the check varieties.

Adaptability of Clusterbean Genotypes to Water Stress

Cluster bean has emerged as one of the important commercial crop fetching substantial income for farmers. Though a crop that is largely cultivated in semi-arid parts of Rajasthan and Western Haryana, it is not that popular in the drought prone areas of Maharashtra. Hence, experiments were initiated to assess the performance of varieties released by SAU's of Rajasthan and Haryana. A total of 18 genotypes including a local check were grown in randomized block design to multiply the seeds and to evaluate their variability in seed yield. The delay in sowing of crop (2nd week of August) resulted in poor growth, however, five guar genotypes viz., HG 563, HG 365, HG 2-20, RGC 1031 and RGC 1017 had seed yield of about 30 g/plant. The experiment will be repeated by including more germplasm.

Plant and Rhizospheric Microbe Interactions for Drought Tolerance

The endophytic interactions play an important role in plant growth and increased adaptation to different stress environments. In an earlier experiment on functional characterization of bacterial endophytes from drought tolerant sorghum, 270 bacterial endophytes were screened for traits like N-fixation, P-solubilization and siderophore production. Number of bacterial endophytes detected positive for N-fixation were

more than those associated with P-solubilization and siderophore production. Only four isolates were detected as *+ve* for all three traits (Table 2.2).

Table 2.2. Number of bacterial endophytes positive for their functional traits

Cultivar	NIASM field soil					Black soil				
	Total	P- sol	Side	N-fixn	All	Total	P- sol	Side	N-fixn	All
Maldhandi 35-1	31	2	1	22	1	32	3	0	8	0
Phule Anuradha	24	2	1	12	1	19	4	2	9	0
Phule Maulee	21	5	0	11	0	10	0	0	1	0
Selection-3	26	6	3	16	1	17	1	0	5	0
Total	102	14	5	61	3	78	8	2	23	0

P- sol : P solublising, Side : Siderophore producing, N-Fixn : N fixers

All the 270 bacterial endophytic isolates were also screened for the production of phyto-hormone Indole 3-Acetic Acid (IAA). Forty seven isolates were able to produce IAA up to 61 µg/ml even in the absence of L-tryptophan (Fig. 2.10). This PGP trait was more conspicuous in bacterial endophytes cultured from original soil of NIASM field (Table 2.3).

Table 2.3. Number of IAA producing isolates obtained from four cultivars of sorghum

Cultivar	NIASM field soil			Black soil		
	No.	Try^+	Try^-	No.	Try^+	Try^-
Maldhandi 35-1	31	13	8	32	6	2
Phule Anuradha	24	11	11	19	6	3
Phule Maulee	21	4	7	10	0	0
Selection-3	26	9	7	17	4	3
Total	102	37	33	78	16	8

No. : Total number of isolates; Try^+ and Try^- : presence and absence of tryptophan respectively

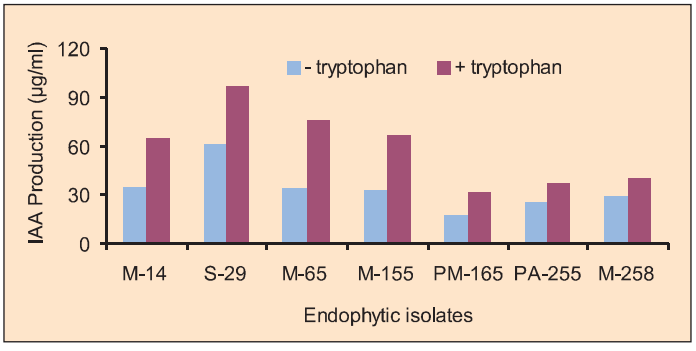


Fig. 2.10. IAA produced by the sorghum endophytes

The experiments were initiated with existing plate screening method to screen all 270 bacterial endophytes for ACC-deaminase activity. Thirteen endophytic isolates were tentatively identified as ACC utilizers as they grew on DF medium containing ACC as the sole source of nitrogen. Since, qualitative plate assay has limitations due to false positives, improved protocol for screening is being standardized to confirm the ACC deaminase activity of the endophytic isolates of sorghum. The PCR amplified full length ACC deaminase gene (*acdS*) from two of the rhizosphere fluorescent Pseudomonds were cloned in to *E. coli* DH5α by using pGEMT-easy vector. The right clones having the correct size of insert (acdS gene) was confirmed both by restriction digestion (to release insert from plasmid) and also by PCR implication from plasmid DNA templates (Fig. 2.11). After confirmation, two clones were sent for DNA sequencing. The sequence data matched with sequence of *Pseudomonas fluorescens* ACC deaminase structural (*acdS*) gene listed in NCBI database. In addition, two more partial *acdS* gene PCR product amplified from endophytic fluorescent pseudomonads of sorghum are being sequenced.

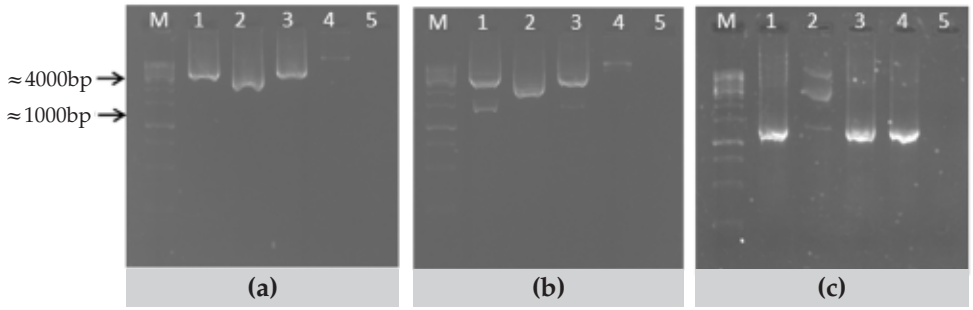


Fig. 2.11. Cloning and confirmation of *acdS* gene: recombinant pGMT - easy vector plasmid (a), restriction digestion of plasmid to release insert (b) and confirmation of right clones (c)

Characterization of *Rhizobium* spp. from Drought Tolerant Greengram

Drought induced inhibition of nitrogen fixation in legume-*rhizobium* symbiosis limits the legume productivity in many arid and semi-arid regions. For increasing nodulation and nitrogen fixation efficiency, it is crucial to identify "Hardy *Rhizobia*" adapted to drought conditions for developing bio-inoculants. A total of 78 rhizobial isolates (initial 55 and 23 currently isolated) were purified from root nodules of 31 drought tolerant greengram accessions and a local variety (var. Vaibhav) grown in pots. In addition, six isolates obtained from the accessions IC 323998, IC 325810 and IC 325770 were grown under field conditions during summer. The rest of the accessions did not show nodulation with native rhizobial populations. The ability of initial 61 rhizobial isolates to form nodules was cross checked by inoculating seedlings on N-free nutrient agar in Jensen tubes and in pots filled with sterile soil. Forty one rhizobial isolates showed nodulating ability in seedlings (Fig. 2.12). Out of 78 isolates collected from pots, 27 had ability to solubilize P, six had siderophore production, 17 isolates could grow on N-free medium and only five isolates had ACC deaminase activity. PCR screening of these rhizobial isolates for the traits imparting drought tolerance like ACC deaminase and rhizobitoxine production (specific to legume-*Rhizobium* symbiosis) was also carried out.

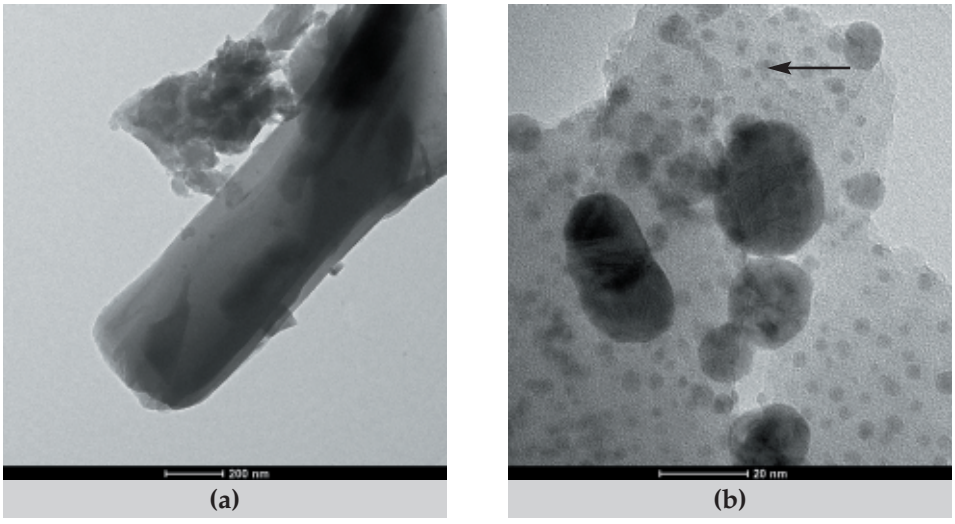
(a) (b)

Fig. 2.12. Greengram seedlings inoculated with *rhizobium* (a) and nodulated roots (b)

School of Edaphic Stress Management

Characterisation of Zeolites for Cation Exchange

Bioremediation is an important option to deal with pollutants in aquaculture and the ion exchange features of zeolites are being projected as new avenue for accomplishing this task. Hence, 13 different forms of zeolites were collected from stone queries in and around Baramati and Pune and evaluated for their ion exchange properties. These zeolites were characterized structurally and chemically using XRD, TEM, SEM and FTIR techniques for identification of mineralogical confirmation, particle shape and size. Four zeolites viz., stilbite, heulandite, stellerite and apophyllite were used to identify the sites for cation exchange with $AgNO_3$. The zeolites showed the dominance of Si followed by Al and Ca (Table 2.4). Their particle size varied between 50-500nm (Fig. 2.13) and the smaller sized (2-20nm) silver nanoparticles were associated with the crystal lattice of zeolite. Ag ions have been exchanged dominantly with Ca in apophyllite, heulandite, stellerite and stilbite to the extent of 88% followed by Si and Al indicating the exchange of cations occurring during their synthesis. Further identification of nanoparticles is being done for possibilities of using these zeolites for bioremediation.



(a) (b)

Fig. 2.13. Stellerite crystals before (a) and after (b) silver nitrate treatment; arrows indicate exchange sites

Table 2.4. Chemical composition (g/g) of both untreated and treated zeolite crystals

Element	Stellerite		Stilbite		Heulandite		Apophyllite	
	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated
C	0.328	0.377	0.246	0.237	0.485	0.330	0.0201	0.212
O	0.313	0.179	0.373	0.127	0.149	0.142	0.358	0.235
Mg	0.003	0.000	-	-	-	0.001	-	-
Al	0.042	0.026	0.068	0.032	0.019	0.032	-	-
Si	0.116	0.081	0.167	0.079	0.050	0.088	0.149	0.134
Ca	0.025	0.001	0.041	0.014	0.010	0.007	0.127	0.113
Ag	-	0.099	-	0.298	-	0.113	-	0.072

Resource Conservation Practices for Ratoon Sugarcane

About 10-15 t/ha of trash is left in sugarcane ratoon which is a major constraint for fertilizer and herbicide placement and can immobilize applied nutrients, ultimately resulting in low fertilizer-use efficiency and reduction in cane productivity. Therefore, farmers usually resort to its burning (Fig. 14a) that leads to release of soot particles and smoke causing human health problems, emission of greenhouse gases (GHGs) and loss of plant nutrients such as N and S. Hence, the proper management of trash and enhancing the fertilizer use efficiency in ratoon sugarcane continue to be the major challenges. To address these issues, following field experiments have been initiated at ADT Farm and farmers' fields in Malegaon, Baramati.

Method of N Application with Surface Retention of Trash

A field experiment was conducted in ratoon sugarcane field with six treatment combinations including three methods of N application (broadcast as is the farmer's practice, placement with a crowbar and fertigation) and two methods of trash management (spreading the trash uniformly in the field as such or after chopping with a trash cutter). The crop was nourished with 252 kg N, 115 kg P_2O_5 and 115 kg K_2O/ha in four splits. First split consisted of 25 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha that was applied two weeks after initiation of ratoon crop. Second (100 kg/ha) and third (27 kg/ha) doses of N were applied 7 and 13 weeks after initiation. The last dose of fertlisers i.e. 100 kg N, 55 kg P_2O_5; and 55 kg K_2O/ha was applied at 16 weeks after start of the ratoon crop and this coinciding with the earthing-up operation. Under fertigation treatment, total N was applied in 12 equal splits at 15 days intervals starting from 15 days after ratoon initiation while P and K were band placed. A crowbar tool was used for placement of the N, while earthing-up machine was used after broadcasting N in sugarcane row for inversion of soil (Fig. 14b). The crop was irrigated through drip irrigation system to meet the water requirement of the crop as and when required. Recommended package of other practices were also followed for raising the crop. The highest chlorophyll contents were recorded with fertigation followed by

band placement of N with crowbar. Least chlorophyll content was recorded when the N was broadcasted with trash left un-chopped. Similarly, application of N either through crowbar tool or fertigation resulted in the maximum tillers and greater accumulation of cane dry matter (DM). The highest millable cane, lengthiest internode and lengthiest cane were also recorded when N was applied either with fertigation or crowbar. The highest cane yield was recorded with the application of N through fertigation that was 20-45 per cent more than rest of the treatments, except when N was applied with crowbar. Yield improvement with chopping of trash was 8.9 and 16.8 t/ha when fertilizers were broadcasted and placed with crowbar, respectively whereas earthing up right with first dose of fertilisers helped to improve yield by 19.5 t/ha (Table 2.5). Thus the application of N through either fertigation or crowbar tool improved the N-use efficiency *vis-a-vis* productivity of ratoon sugarcane when trash was retained at the surface.

Table 2.5. Effects of N and trash management practices on growth and yield of sugarcane ratoon

Trash management	N-fertiliser application	Chlorophyll (mg/g)	DM (g/tiller)	Tillers/clump	Millable cane ('1000)	Internode length (cm)	Cane length (m)	Cane yield (t/ha)
Un-chopped *	Broadcast	2.79	472	17.0	96.0	8.54	1.76	111.7
Un-chopped	Broadcast	2.69	453	16.1	87.4	7.98	1.67	92.2
Chopped	Broadcast	2.72	463	17.5	91.8	8.26	1.73	101.1
Un-chopped	Crow bar	2.85	497	19.5	98.4	9.30	1.78	114.4
Chopped	Crow bar	2.90	502	21.4	111.1	9.64	1.87	131.2
Chopped	Fertigation	2.95	513	20.5	113.7	9.83	1.88	134.0
CD (p=0.05)		0.11	38	2.9	15.6	1.16	0.12	24.3

*Earthing up at each dose of N application

(a) (b)

Fig. 2.14. Trash burning (a) and soil inversion after N broadcasting (b)

Effect of Trash Management Practices

Another field experiment was initiated at the same site for comparing the trash management options on productivity of sugarcane ratoon crop. Six treatments included were: retaining un-chopped trash as such, treating un-chopped trash with liquid extract of cattle yard slurry @ 1.0 litre/m^2 to induce decomposition, chopping trash, treating chopped trash with *Trichoderma viride*, ($2x10^8$ cfu/ml; applied @ 2.0 litres/ha), burning trash (farmer's practice) and removing trash (control). The ratoon crop was nourished with 252 kg N, 115 kg P_2O_5 + 30 litre phosphoric acid and 115 kg K_2O/ha. The total quantity of nutrients was applied through fertigation in 12 equal splits at 15 days intervals starting from 15 days after ratoon initiation. Recommended package of other practices were followed to raise the crop. The higher soil moisture content and moderated temperature conditions coupled with nutrient enriched environment due to trash retention and application of bio-inoculants like *T. viride* and microorganism present in the cattle yard slurry helped in increasing millable cane, cane length and cane weight over the residue burnt and residue removed treatments. Retention of trash either chopped or unchopped improved the cane yields by about 14 per cent over the farmer's practice of burning while treating the trash with cattle yard slurry and *T. viride* further improved the cane yield by about 16 and 19 per cent (Table 2.6). Thus, retention of trash and application of cattle yard slurry and *T. viride* seems a better proposition but the experiment will be repeated to confirm the results.

Table 2.6. Effects of trash management options on growth and yield of sugarcane ratoon

Treatment	Millable cane ('1000)	Internode length (cm)	Cane diameter (mm)	Cane length (m)	Cane weight (kg)	Cane juice (L)	Cane yield (t/ha)
Un-chopped trash	156.3	11.07	29.78	1.95	1.42	0.47	167.9
-do- + Cattle yard slurry	171.7	10.43	28.57	2.06	1.45	0.52	171.0
Chopped trash	163.7	10.59	29.17	1.96	1.43	0.50	168.7
-do- + *Trichoderma viride*	182.3	10.70	30.14	2.01	1.49	0.54	176.2
Trash burnt	151.5	10.12	29.64	1.88	1.31	0.43	147.5
Trash removed (Control)	148.3	10.18	28.40	1.77	1.23	0.40	145.3
CD (p=0.05)	17.7	NS	NS	0.15	0.17	NS	20.5

New Equipment for Off-barring and Fertilizer Application in Sugarcane

Since the non-availability of devices for placement of fertilizers in trash retained fields of ratoon sugarcane is major factor leading to inefficiency of fertilisers and the ratoon can be benefitted from pruning older roots, an attempt has been made to develop a new off barring-cum fertilizer drill machine at the institute (Fig. 2.15). The

prototype has been designed to suite the requirements of black soils those are most prevalent in the sugarcane growing belt of Maharashtra and other southern states. The response of ratoon sugarcane to root pruning and fertiliser placement with this machine is being tested on 13 farmers' field and preliminary results are very encouraging (Table 2.7). Growth in terms of plant height and tillers has improved by 25% over the existing farmer's practices. At initial stages of growth there was no significant differences in responses of plants between full and half of the basal N applications. The SPAD readings indicated better uptake of N by plants under off barring drill. The other soil and plant parameters are being monitored.

Table 2.7. Effects of using off barring drill machine on growth of sugarcane ratoon at farmers' field

Treatment	Plant height (m)	Tillers/ clump	SPAD reading
Off barring + 100 % N as basal	2.01	19.65	51.16
Off barring + 50 % N as basal	1.96	20.28	48.60
Farmers practice (trash burning)	1.70	16.43	37.76
Farmers practice (trash chopping)	1.63	16.03	34.71
CD (p=0.05)	0.15	2.49	5.06

(a) (b) (c)

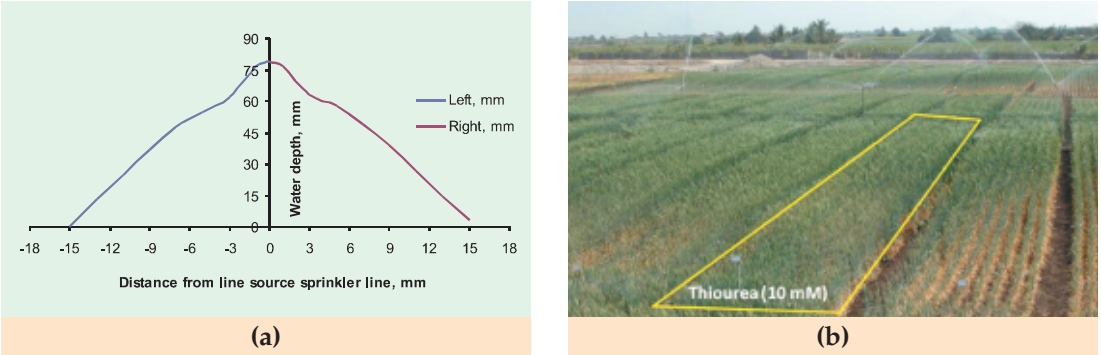
Fig. 2.15. Effects of using off barring drill (a), on plant height and greenness (b) and compared with farmers practice (c) in sugarcane ratoon

Crop-water Production Functions using Line Source Sprinkler System

Design and Development of System

The line-source sprinkler irrigation system provides a continuously variable water application rate, which depends on distance from the line-source and thus offers unique opportunity to investigate water production functions for crops. Having successfully developed experimental fields with varying soil types, institute has planned to utilise line source sprinkler technique to monitor plant responses under various agronomic alternatives those can help to alleviate the impacts of water stress. Initially a line source sprinkler system of eight sprinklers spaced at 6.1 m has been installed to get a usable experimental area of size 24.4 m x 24.4 m. The spacing between two adjacent sprinklers did not exceed 25% of the wetted diameters for producing the

line source effect. The detailed specification of sprinkler nozzles and other accessories are; HDPE pipe (75 mm dia. and 6.1 m length), metal split nozzles with spreader, riser (GI pipe, 12.5 mm dia. and 1.84 m height), HDPE service saddle (75 mm dia.) and HDPE pump connector (with gasket, end cap and tee bend, 75 mm dia). The sprinkler system was operated at a pressure of about 300 KPa that could generate a wetted diameter of 30 m. The water coverage was monitored by using a series of PVC catch canes placed perpendicular to line source system at 2 m spacing. The water distribution pattern perpendicular to the main line was characterised by decreasing trend with increase in distance on both sides of main line (Fig. 2.16a). The maximum water delivered was 19 mm/h near the main line and the lowest was 0–0.4 mm at a distance of 15 m. Almost symmetrical water application pattern was observed when the wind speed was less than 3 km/h but the system continued to be efficient in maintaining the same up to wind speed of 8–10 km/h when the main line was parallel to the wind direction.



(a) (b)

Fig. 2.16. Applied water as a function of distance from Line Source (a) and response of wheat to bioregulators under different soil moisture stress (b)

Response to Bio-regulators

An experiment was initiated with wheat (HD 2189) where the experimental area along the line sprinkler source was divided into 24 blocks each of size 15 m x 2 m and each block was in turn divided into 7 plots each of size 2 m x 2 m. Treatments, replicated four times in a split plot design, consisted of 42 combinations of; i) spraying 4 bio-regulators, namely; thio-urea (10 mM), salicylic acid (10 µM), silixol (80ppm), GA_3 (25 ppm) and control (water only) at flag leaf and grain formation stages in main plot and ii) seven levels of irrigation (38.0, 32.6, 28.4, 22.2, 15.2, 12.5 and 6.9 cm water with seven sprinkler irrigations, in addition to 11.0 cm applied initially with two flood irrigations) in sub-plots. The impact of spraying bio-regulators could be visualized in terms of plant canopy parameters e.g. the highest chlorophyll content (5 mg/g fresh weight), maximum relative water content (73% w/w). The minimum canopy temperatures (31°C) was observed in thiourea treated plants even at the maximum water stressed *vis-a-vis* minimum water applied plots. The grain yield obtained from plots across the sprinkler line source reflect the effects of amounts of water applied and the decline in yield was computed to 84, 72, 53, 32, 22 and 7% when applied water equalled 32.6, 28.4, 22.2, 15.2, 12.5 and 6.9 cm as compared with 37.9 cm. Bio-regulators specifically thiourea helped to alleviate the effects of water stress and more so under

medium and severe conditions (Fig. 2.16b). When compared with 37.8 cm, the yield obtained with 12.5 cm applied water was reduced to 48, 44, 31, 26 and 20 % with thiourea, GA3, silixol, salicylic acid and control, respectively, indicating the benefits of bioregulators in alleviating water stress (Fig. 2.17a). Further, in depth studies are planned to understand the efficacy of bio-regulators on wheat and expressions of aquaporins in wheat under sever moisture stress condition.

Response to Applied N

Another sprinkler line source was replicated as above where the interactive effects of applied nitrogen and water were monitored. Here, the treatments, replicated thrice in a split plot design consisted of 28 combinations of i) four fertiliser nitrogen application rates (60, 90, 120 and 150 kg/ha) in main plot and ii) seven quantities of water applied (36.7, 32.0, 28.4, 23.2, 16.3, 9.8 and 4.1 cm water with 7 sprinkler irrigations, in addition to 11.0 cm applied initially with two flood irrigations) in sub-plots. The N applications were scheduled as 100% N as basal; 67% basal + 33% at CRI stage; 50% basal + 25% at CRI stage+ 25% at tillering stage and 40% basal + 20% at CRI + 20% at tillering stage+ 20% at flowering stage for N application rates of 60, 90, 120 and 150 kg/ha, respectively. The applied N @ 150 kg /ha could sustain the highest grain yields until the water applied was above 23.2 cm, but the decline in yield was faster when water applied was below 23.2 cm. The yields were 76, 85 and 110 per cent at 60, 90 and 150 kg N application when compared with 120 kg N (4.59 t/ha) at the maximum water applied (36.7 cm) while these were reduced to 20.8, 36.9, 41.7 and 39.1% with N application of 60, 90, 120 and 150 kg at applied water of 9.8 cm (Fig.2.17b). The experiment will be repeated to verify the results.

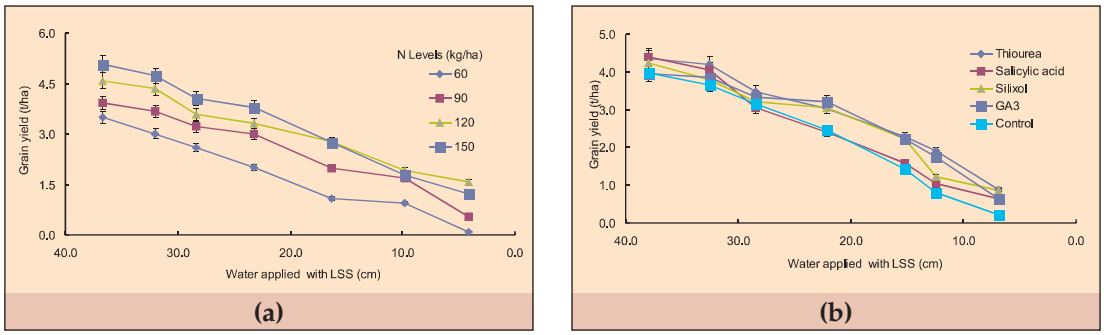


Fig. 2.17. Effects of bio-regulators (a) and nitrogen levels (b) on grain yield of wheat under different quantities of water applied with Line Source Sprinkler

Impact of Cropping Systems and Spent Wash on Murrum and Soil Development

Large areas of barren rocky 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, have high bulk density and poor water retention. Presently there is general lack of techniques for their quicker rehabilitation. Spent wash, a by product from sugar factory is normally used as an organic nutrient supplement but being acidic in nature (pH about 4.2), its utility in disintegration of murrum for faster conversion into smaller particle has not been

evaluated. The other alternative can be to get benefits from differential rhizo-depositions and crop residues under various cropping systems in the region. Therefore, a long term field experiment has been initiated from this *rabi* season to evaluate the impact of spent wash and cropping systems in inducing disintegration of murrum. A total of 13 treatments; 10 under irrigated conditions viz. sugarcane cropping with and without spent wash, soybean-wheat, lucerne, cowpea-sorghum fodder, subabul and napier grass and three under rainfed conditions viz., subabul, anjan grass and sorghum are being replicated four times in randomized block design (Fig. 2.18).

(a) (b)

Fig. 2.18. Progress of different crops, being cultivated during *rabi* season

The spent wash has been initially applied @ 0.4 million l/ha. The experimental field was prepared by ripping the rocky and undulated land followed by levelling of the generated murrum. Thereafter, dhaincha was cultivated and incorporated at 40 DAS. To further improve the soil, spent mushroom substrate was applied @ 17.5 t/ha. Initially the soil fraction is only about 23 per cent while rest is different sized gravels. Organic carbon (~0.07 %) and available phosphorus (~0.47 kg/ha) are very low. The spent wash with pH 4.4, EC 29.1 dS/m, organic carbon 4.12 % and total P 28.4 mg/l was applied as per treatments. Crops like wheat, sorghum, lucerne, napier grass were planted during *rabi* and recommended package of agronomic practices was followed. Subabul was also transplanted but due to its low survival (about 35%), replanting was undertaken. With limited nutrient and moisture availability in the virgin soil, the performance of all these crops was comparatively poor. The grain yield obtained in case of wheat was only 18.0 q/ha, while the green fodder yield of lucerne, napier and sorghum equaled 171, 250 and 97 q/ha, respectively. The soil development and crop performance are planned to be monitored on long term basis.

Unculturable Microbial Diversity of Saline Soils using Metagenomics

Soil microbes are known to play diverse roles viz. fixing atmospheric nitrogen, nutrient cycling, disease suppression and sequestration of carbon, however, 99% of the soil microorganisms are inaccessible as they are unculturable in the common laboratory media. Nevertheless, the development of methods to isolate the nucleic acids directly from environmental sources has opened a window to access gene pool of previously unknown diversity of microorganisms. Experiments were initiated to examine the unculturable microbial diversity of saline soils of Baramati Taluka and

high molecular weight metagenomic DNA has been extracted from collected soil samples with least shearing. The 16S rRNA gene has been amplified from pooled metagenomic DNA isolated from saline soils. Efforts are being made to clone and sequence this gene.

Hapa based Fish Culture in Intermediary Irrigation Water

Storage of rain/runoff water in farm pond/tanks and its latter use is the usual practice in water scarcity zones. Potential exist to utilization of this water for aquaculture before its release for irrigation purposes would not only add to farmer's income but also enrich the water with nutrients. Therefore, such attempts were initiated in water storage ponds of Agriculture Development Trust, Malegaon (Fig. 2.19). Hapas (2.5x1.6x1.5 m^3) were procured from CIFA, Bhubaneswar and were modified into cage structure with the attachment of polyfibre pipe and chains. Advanced fry of *L. rohita* were stocked in these hapa and palleted floating feed was administered twice a day @ 5% body weight. A part of tank water was exchanged regularly and no artificial aeration was provided. To optimize stocking density, experiments were carried out for 6 months with 20, 40 or 60 *rohu* fishes (weighing 0.71g, and 4.5 cm length)/m^3. Fish density 20/m^3 exhibited the best growth while fish of higher density exhibited sign of stress. Samples of blood and major tissue have been collected for hematological, histological and enzymological profiling to evaluate the impact of stress at tissue level.

(a) (b) (c) (d)

Fig. 2.19. Collection (a), stocking (b), maintenance (c) and sampling (d) of fish under hapa culture

Nanoparticles to Remediate Temperature Impact on Gold fish

Gold fish (*Carrassius auratus*) was acclimatized with feeding and aeration in polyfibre aquarium for 15 days. Thereafter, these were subjected to constant temperature of 24°C, 28°C and 32°C for 70 days. Routine feed was provided for initial 35 days and thereafter these were fed with zinc oxide mediated nanofeed for another 35 days. Zinc oxide nanoparticles were synthesised from aquatic plants such as *Pistia* species leaves in a unique method for synthesis of plant derived nanoparticle. Fishes were vivisected and important tissues like gill, gut, muscle, brain etc. were collected at 35 and 70 day. The fish growth retarded when the growth temperature was raised from 24°C to 32°C. ZnO nanoparticles worked as a positive feed supplement against heat stress as indicated by histopathology. Other characterization of zinc oxide nanoparticle, bioaccumulation profiling, proximate composition analysis of feed and expression profiling of some important genes in gill under heat stress are in progress.

Stress Responsive Genes in Fish

Molecular mechanisms associated with physiological and hormonal responses to heat stress were addressed through stress responsive gene expression in *Rohu* fry. The rohu fry were exposed to acute temperatures up to 40°C and then allowed to undergo homeostasis for 3 h before sampling. The fish was used for total RNA extraction and cDNA was prepared. The expression of heat stress responsive genes (Fig. 2.20) was examined using gene specific primers for Na^+/K^+-ATPase, cortisol receptor (PR), NKATpase, somatolactin (STL), heat shock protein 70 (Hsp70), glyceraldehyde 3 phosphate dehydrogenase (GPD), glucokinase (GK), hexokinase (HK) and melanin concentrating hormone receptor (MCHRI). The rohu melanin concentrating hormone receptor I and somatolactin gene sequences have been submitted to Gene Bank under accession nos. KC556886, KC898943 respectively. Temperature dependent expression of *Hsp70* gene was observed at the acclimation temperatures between 28 to 34°C.

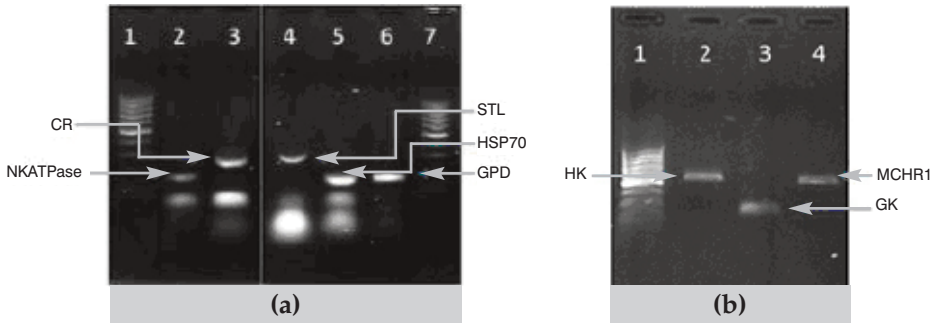


Fig. 2.20. The expression of temperature stress responsive genes viz., NKATPase , CR, STL, Hsp70, GPD (a) and KH, GK, MCHR I (b), lane 1:100bp ladder

Fresh water fish cannot regulate body temperature through physiological means as their body temperatures remain almost similar to the environment they inhabit. Thermal tolerance window for tropical fishes is narrow. In *L. rohita* early fry critical thermal maxima (CTMax) and minima (CTMin) increased with acclimation temperatures. Oxygen consumption rate also increased with acclimation temperature.

Q_{10} values were estimated to be 1.94 (between 28-30°C), 2.05 (30-32°C) and 1.91 (32-34°C). The highest gain in body weight and specific growth rate (SGR) were attained at acclimation temperature of 30°C and with the lowest at 34°C. Feed conversion ratio (FCR) at 30°C was 3.3±0. It is observed from the results that temperature of 30°C is optimal for *L. rohita* early fry but this needs further confirmation.

Reproduction of Shingi under Abiotic Stress

Shingi (*Heteropneustes fossilis*), a stinging catfish, is native freshwater fish to Indian sub-continent. It is an excellent candidate catfish for culture in derelict water bodies and drought prone areas as it can survive in water with low oxygen. Non-availability of quality seed is major problem in aquaculture of this species. For generating good quality seed and for larval rearing, its brood stock was collected from the Ujani reservoir (Fig. 2.21 and 2.22). Mature male and female were segregated one month before induced breeding. Different doses of intra-muscular injection were administered to optimize the ovaprim dose (Table 2.8). Male and female were given equal dose and male female ratio was 2:2. Injected fishes were released in breeding chamber (1 m x 0.5 m x 0.8 m). Induced breeding was carried in afternoon and any disturbance around injected fish was avoided. Fish released eggs after 15-18 hours of hormonal injection. Eggs with size ranging from 1.0 to 1.2 mm were siphoned in small trays for incubation. Hatching took place within 22-23 hours at temperature range of 26-28°C. Newly hatched larvae measured 3-4 mm in length. Larvae were siphoned carefully and transferred to the plastic tub for further rearing. Various observations indicate that ovaprim dose of 1 ml/kg is optimal.

Table 2.8. Reproductive performance of Shingi induced with ovaprim

Ovaprim dose (ml/kg)	Latency period (h)	Eggs per pair	Fertilized eggs* No. (%)	Hatching No. (%)	Survival No. (%)
0.5	18	489	442 (90.3)	325 (73.7)	200 (61.3)
1	17	9308	7666 (82.3)	6111 (79.7)	4596 (75.3)
2	16	624	395 (63.3)	270 (68.0)	149 (55.0)

(a)

(b)

Fig. 2.21. Ujani reservoir (a) and fish haul at Ujani (b)

(a)

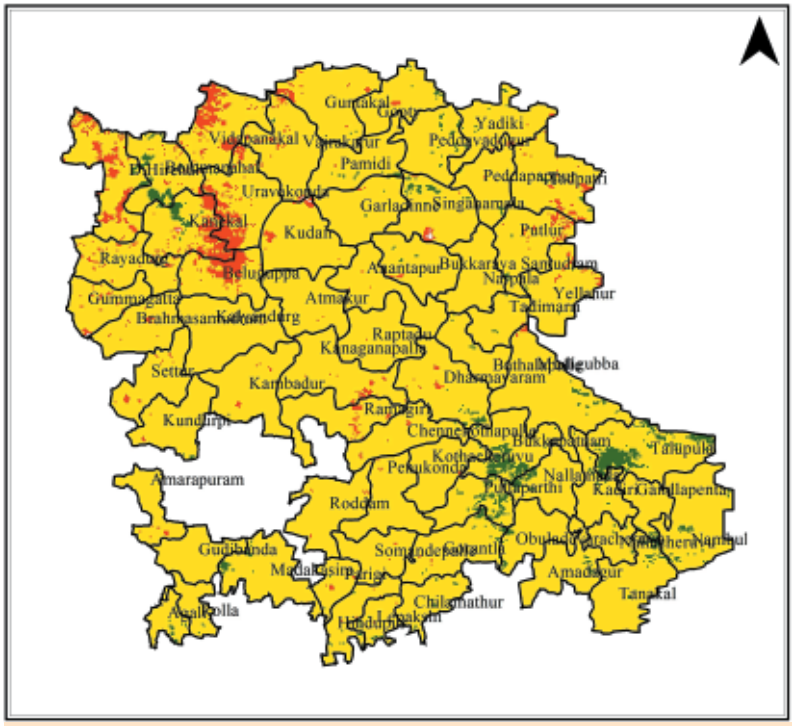
(b)

Fig. 2.22 Survey and fish species collections (a), interaction with fishers (b)

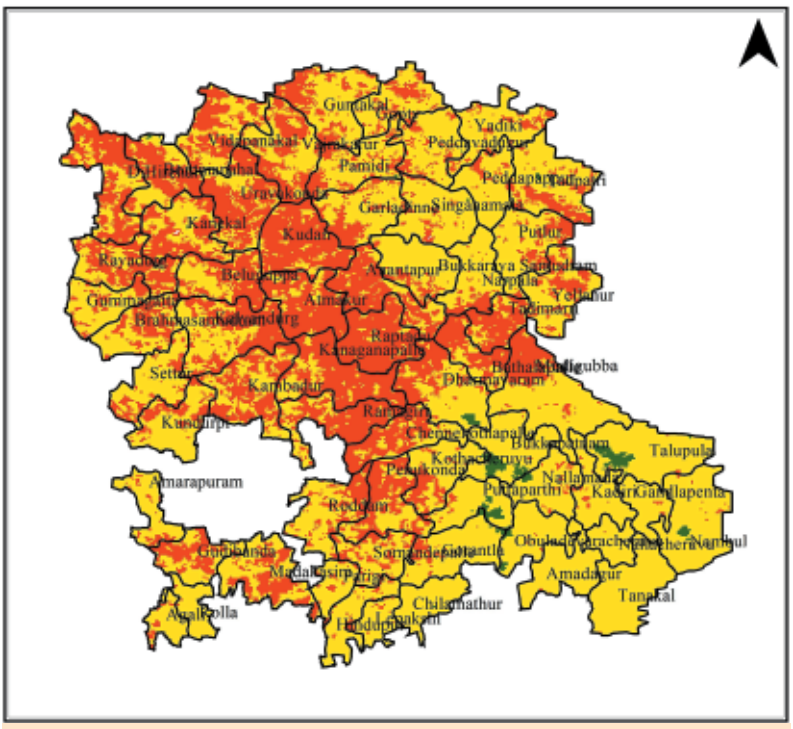
School of Policy Support Research

NDVI based Mapping of Drought Stress

Remote sensing (RS) has got enormous potential in mapping abiotic stressors. Among different vegetative indices derived from RS data, NDVI (normalized difference vegetation index) is most widely used. Besides the utility of NDVI per se, free data are now available from MODIS (moderate resolution imaging sprectro-radiometer) that makes it possible to cover larger regions. However, these tools have not been effectively utilised to understand and map abiotic stressors. Keeping this in view, composite MODIS-Terra data (250 m resolution) corresponding to 3rd week of September were downloaded for the period from 2000 to 2011. District wise area and production statistics were procured from government agencies of Andhra Pradesh. Ananthapur district, which is highly drought prone, was selected to start with. The study years were grouped as deficit (Group 1) excess (Group 2) and normal (Group 3), rainfall taking normal rainfall (550 mm) as the basis. Accordingly, Group 1 included years of 2002 and 2003 and Group 2 of years 2005, 2008 and 2010 while normal rainfall was received during remaining years (Group 3). NDVI images were also grouped accordingly and these clearly depicted the status of drought (Fig. 2.23). Six mandals namely Atmakur, Beluguppa, Kambadur, Ramagiri, Uravakonda and Vidapanakal were identified to be continuously under drought stress even during normal or excess rainfall years. During years of deficient rainfall, the rainfall defined the productivity ($r = 0.33^{**}$). Edaphic stress due to gravelliness was observed in 27.8% of area while 3.2 % area suffers with shallowness of soils while another about 22% area is stressed due both to gravelliness and shallow depth. About 10.3 and 11.2 % area has saline-sodic and calcareous soils, respectively, while rockiness predominates in 11.5 % area. Only 13.6% area is having red clayee, alluvio-colluvial and deep black soils. These initiatives indicate that NDVI can be used for identifying the drought and other stressors and thus data are being further processed to generate precise drought and edaphic stress map of the given region.



(a)



(b)

Stress levels

- High (<0.28)
- Moderate (0.28-0.56)
- Low (>0.56)

Fig. 2.23. Mean NDVI image of group of normal (a) and deficit (b) rainfall of Anantpur

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3. Tribal Sub-Plan

The institute is implementing TSP programme in five villages viz., Gadad, Bokalzar, Vijapur, Jamtalav and Morthava of Navapur tehsil of Nandurbar district. Traditional cultivation methods followed by the tribal farmers was the cause of low productivity of crops like sugarcane, rice, groundnut, wheat, soybean and tur. The major constraints in adoption of modern farming practices by the farmers included lack of awareness about improved technologies, poverty constraints, illiteracy and ignorance, ethics, unavailability of farm inputs and proper marketing of farm produce. Keeping these in view various activities were initiated to promote modern farming which included the following.

Exposure Visits

The exposure visits of 100 tribal farmers including 39 women were organized during December 11-15, 2012 at nine major centers viz., Jain Irrigation System, Jalgaon; MPKV, Rahuri; Model village-Hiware Bazar; KVK Narayangaon; International Exhibition Centre, Moshi (Pune); NRC Grapes, Pune; Gayatri Farmers Club, Malegaon; KVK, Baramati; NIASM, Baramati. Another exposure visit of 110 tribal farmers including 80 women of Jamtalav village was organized on March 5, 2013 at Ralegan Siddhi and Hiware Bazar villages.

Trainings

The four training programmes were organized on some of the important issues of agriculture. A total of 191 tribal farmers from selected villages were benefitted from these trainings. The training on production technologies of mango was organized at KVK Nandurbar on October 1, 2012. The training on production of urea briquettes and application was organized at KVK, Narayangaon during October 4-5, 2012. The training on production technologies of sugarcane was organized at Central Sugarcane Research Centre, Padegaon during October 10-11, 2012. The training on post-harvest technologies in rice was organized at Divisional Agricultural Research Centre, Igatpuri during November 7-8, 2012.

Formation of Farmers' Group

The importance of group farming was realized by tribal farmers during their exposure visit to different districts of Maharashtra. Such an exposure led to formation of several groups of farmers viz., Nandanwan Women Farmers Group, Bokalzar; Saraswati Women Farmers Group, Vijapur; Jalswanrakshan Women Farmers Group, Jamtalav; Ankur Women Farmers Group, Gadad; Annadata Farmers Group, Jamtalav; and Setkari Raja Farmers Group, Vijapur.

Other Activities

The discussion forum for enhancing productivity of *Kharif* crops was organized on April 3, 2012 at Bokalzar village. The agriculture technology week was celebrated during October 15-20, 2012 at KVK Nandurbar. The world women day with theme entitled "Role of Women in Agriculture & Rural Development" was organized on

March 8, 2013 at Jamtalav village. About 1100 tribal farmers from selected villages were benefitted from these programmes.

Adoption of Improved Technologies

Poor quality planting material, imbalanced use of fertilizers, traditional methods of planting and other crop management practices were identified as the cause of low productivity of rice, wheat, sugarcane, groundnut and mango in the selected villages. Therefore, improved technologies were demonstrated to bridge the yield gap (Table 3.1, Fig. 3.1 and 3.2).

Table 3.1. Technologies introduced in tribal villages of Nandurbar district

Technology Introduced	Crop	Acreages	No. of beneficiaries
HYV, INM	Wheat	59	65
Method of planting (5'x2' line spacing)	Sugarcane	52	55
Planting of Seedlings	Sugarcane Seed plot	2.5	-
Modified SRI method	Rice	100	110
Raised bed methods	Groundnut	71	71
Integrated nutrient & pest management	Mango	200 plants	20

(a) (b)

Fig. 3.1. Rice in tribal farmers field by traditional method (a) and Charsutri method (b)

(a)

(b)

Fig. 3.2. Demonstrations of groundnut cultivation on raised beds (a) and sprinkler irrigation for sugarcane (b)

Creation of Productive Assets

Implement banks were created on community basis in selected areas by procuring essential farm implements such as 55 HP tractor, dumping trailer, dozar, mini rice mill, paddy thresher, urea briquetting machines, mini tractors, mini trailers, M.B. ploughs, cultivators, rotavators. In addition, Drip Irrigation System was installed on 51.27 acre of 49 tribal farmers' field. Activities carried out during the current year for promoting modern farming in tribal areas are summarized in Table 3.2.

Table 3.2. Summary of activities carried out under TSP

Strategy	Activities	No of beneficiaries
Human resource development (HRD) in agriculture	Exposure visits(2) Workshop (1) Trainings (4) Discussion forum (1) Agriculture technology week (1) Farmers group formation	(210) Chilli cultivation (26) Mango production (46) Urea briquettes production (46) Sugarcane production (59) Rice post harvest technology (40) (350) (465) 12 groups.
Demonstrations	INM-IPM	Mango (20) Rice (110) Sugarcane (55) Groundnut (71) Wheat (65)
Productive assets	Implement banks	

4. Meetings

Expert Consultancy Meeting on Augmenting and Tapping Ground Water

The meeting was organized on October 17, 2012 in the Conference Hall of Institute as a follow up of recommendation of the committee constituted for reviewing the proposal of geohydrological surveys of ground water resources in the NIASM campus. The purpose of the meeting was discussed in detail with Dr R.A. Duraiswamy, Assistant Professor, Department of Geology, University of Pune and Sh. V. Krishnamurthy, Ground water expert (Retd. Dy Director, GSDA), who are collaborating in implementation of the proposed project. Chairman Dr P.S. Minhas, Director, NIASM in his introductory remarks highlighted the necessity of alternate source of water for consumption at critical stages of crop growth. Dr Duraiswamy supported by Sh. Krishnamurthy made presentation of the project and this was followed by detailed discussions with members of the committee (Fig 4.1). It is decided that Department of Geology, University of Pune will implement the project and the funding will be provided by NIASM. The meeting was attended by Dr (s) J. Rane, S.K. Bal, S.V. Ghadge, D.D. Nangare, G C Wakchaure, RL Choudhary and UK Maurya.

Fig. 4.1. Dr Duraiswamy, Assistant Professor, University of Pune delivering a talk on ground water augmentation

Research Advisory Committee (RAC)

The 2nd RAC meeting of the institute was held on November 19, 2012 at NIASM Conference Room, Baramati (Fig 4.2). The meeting was chaired by Dr R.B. Singh, President, NAAS, New Delhi. The members, Dr (s) S.S. Magar, R.P. Samui, Mohan Kumar, (Mrs) Nandini Nimbkar and P.S. Minhas attended the meeting, while Dr N.S. Pasricha, Former Director, Potash Research Institute of India was the special invitee. Other invitees were Dr (s) J. Rane, S.K. Bal, D P. Patel, N.P. Singh, S.V. Ghadge, D.V. Patil, B. Sarkar, P.S. Kumar, R.K. Pasala, Y. Singh, A.K. Singh and M.P. Brahmane from NIASM. While welcoming the RAC members, Dr P.S. Minhas highlighted the

uniqueness of the institute that has been established for basic and strategic research related to management of abiotic stresses across the agricultural commodities. The major recommendations included: priority to basic and strategic research aiming at development and equitable distribution of natural resources, research on stress tolerance in horticultural crops such as pomegranate and review of recent changes in CG programme for defining the role of NIASM in research and education for abiotic stress management.

Fig. 4.2. 2nd RAC meeting of NIASM

Institute Research Council (IRC) Meeting

The 3rd IRC meeting of NIASM was held on February 21, 2013. In his introductory remarks, Dr P.S. Minhas, Chairman IRC and Director, NIASM highlighted importance of this meeting particularly to critically assess the progress of ongoing research and approve new research proposals. Taking into account the emphasis being given to flagship programmes, the chair invited status reports on these projects from heads of the schools. This was followed by presentations of new research proposals and then the progress of the ongoing research projects. In this meeting, four flagship projects, six new research proposals, 18 research projects that are in progress and three other projects were discussed in detail. The meeting was attended by all the scientists and technical officers of the institute.

Institute Management Committee (IMC) Meeting

The 3rd IMC meeting of NIASM was held on March 16, 2013 under the Chairmanship of Dr P.S. Minhas, Director NIASM, Baramati (Fig. 4.3). The members who participated included Sh. Rajendra Pawar, Dr S.S. Magar, Dr G.S. Karibasappa, Dr Jagdish Prasad, Prof. Nilesh Nalwade, Sh. G.C. Prasad and Sh. G.G. Harakangi. Special Invitees were Dr J. Rane, Dr D.P. Patel, Dr S.K. Bal and Sh. Ram Avatar. The Director of Agriculture, Government of Maharashtra, Pune; The Commissioner, Commissionerate of Agriculture, Government of Andhra Pradesh, Hyderabad; Dr Mohan Kumar, ADG (Agro & AF), ICAR, New Delhi, Dr V.U.M. Rao, Project

Coordinator (Agric. Met), CRIDA, Hyderabad, and Dr P.R. Bharambe, CICR, Nagpur could not attend the meeting due to their pressing prior engagements.

Chairman welcomed all the members and special invitees and briefed about the infrastructural and farm developmental activities which have been undertaken and the progress made during the intervening period between the last and present meeting. Dr S.S. Magar, expressed his happiness over the commendable progress made by the institute in respect of farm and infrastructural development. He further emphasized on procuring state-of-the-art research facilities, equipments, farm machinery and vehicles. Sh Rajendra Pawar while appreciating the pace at which the institute is progressing, proposed to share the germplasm of sugarcane (COM 09022)/ sorghum (Revati) for further improvement. Both Dr Karibasappa and Dr Jagadish Prasad who were associated with the institute since inception stated that they never thought that the institute will develop so fast. Dr J. Rane made the presentation on research highlights and human resource development. The IMC appreciated the efforts made by the institute in encouraging the scientist to nominate for various trainings/workshops/seminars/conferences and also for full utilization of budget under both plan and non-plan heads and maintaining the up to date assets register and reconciling the same with annual accounts.

Fig. 4.3. 3rd IMC meeting of NIASM

Monthly Meeting of Scientists and Technical Staff

Institute has initiated convene monthly scientific and technical staff meeting from July, 2012 and a total of 10 such meetings have been organized. The important scientific and technical issues were discussed during this meeting and the overall programme made with respect to infrastructural development, procurement of equipment and expenditure incurred are also assessed in addition to presentation and seminars by the scientists.

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5. Awards and Recognitions

- **Dr B.B. Fand**, Scientist (Agril. Entomology)
  - Awarded "Best Oral Presentation Award" by Association for Advancement of Pest Management in Horticultural Ecosystems, Bangalore for presentation of his research paper on "Modeling the impact of climate change on potential geographic distribution of polyphagous mealy bug (*P. solenopsis*) in India" at IVth National Symposium on "Plant Protection in Horticultural Crops: Emerging Challenges and Sustainable Pest Management" held at IIHR, Bangalore during April 25-28, 2012.
  - Awarded "Jawaharlal Nehru Award for P.G. outstanding Doctoral Thesis Research in Agricultural and Allied Sciences 2011" by Indian Council of Agricultural Research in the field of Crop Protection at New Delhi on July 16, 2012 (Fig. 5.1).

Fig. 5.1. Dr Babasaheb B. Fand receiving Jawaharlal Nehru Award

- **Dr D.P. Patel**, Principal Scientist (Plant Physiology)
  - Awarded "ICAR Award for Team Research 2009-10 for outstanding research contribution with Multidisciplinary Approach in Natural Resource Management" by Indian Council of Agricultural Research at New Delhi on July 16, 2012.
  - Awarded "Best Poster Presentation Award" for research work on "Effect of different organic amendments on productivity and soil health of different field crop based system in mid altitude of North East India" (Authors: Manoj Kumar et al,) in Session-I: Diversification and Globalization of Agriculture of Third International Agronomy Congress on Agriculture Diversification, Climate Change Management and Livelihoods, November 26-30, 2012, New Delhi, India.

- **Dr K.K. Krishnani**, Head, School of Edaphic Stress Management
  - Awarded the "Best Research Paper Award-2012" for publication of his research paper in *Journal of Environmental and Applied Bioresearch*, 1(1): 5-11, 2012 by Society of Environmental and Applied Bioresearch, Republic of Korea.
- **Dr S.K. Bal**, Principal Scientist (Agrometeorology)
  - Awarded "Best Research Paper Award" for his research paper "Comparative evaluation of WOFOST and ORYZA-2000 models in simulating growth and development of rice (*Oryza sativa* L.) in Punjab" published in the *Journal of Agrometeorology* during 2011-2012 by Association of Agrometeorologists, Anand.

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6. Linkages and Collaborations

Research institute	Areas identified for research collaboration
Central Sugarcane Research Station, Padegaon, Satara (MPKV, Rahuri)	• Improvement of cane recovery of salinity and drought tolerant genotypes • Management of pre harvest bud germination in sugarcane genotypes • Quantification of energy and greenhouse gas fluxes from sugarcane ecosystem • Phenotyping protocols for abiotic stress responses • Physiological, biochemical and molecular investigations on regulation of early arranging • Utilization of endophytes and mycorrhizal associations for stress tolerance
Vidya Pratishthan's School of Biotechnology, Baramati	• Characterization of drought stress responsive genes in wheat and soybean • Enhancing drought stress tolerance in wheat and soybean by introducing genes through cisgenic/transgenic approach • Bioremediation of priority chemical contaminants using molecular techniques • Metagenomics for gene mining and soil microbial diversity • Isolation and characterization of cultured heterotrophic bacteria • Microbial decomposition of sugarcane trash
Privi Life Science Pvt. Ltd, Mumbai	• Assesment of silixol efficacy for drought and heat stress tolerance in wheat
Project Directorate on Cattle, 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
IIPR, Kanpur; PAU, Ludhiana	• Screening mungbean germplasm
CCSHAU, Hisar; RAU, Bikaner and MPKV, Rahuri	• Screening cluster bean germplasm for drought tolerance/ responsive traits
DSR, Soybean	• Screening soybean germplasm for drought tolerance
Department of Physics, University of Pune	• Characterization of zeolite and silver zeolite materials using SEM-EDAX, TEM, FTIR and XRD

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8. Participation in Conferences / Workshops / Trainings

Seminars / Symposia / Conferences

Name	Topics	Place	Period
Dr B.B. Fand	IVth National Symposium on "Plant Protection in Horticultural Crops: Emerging Challenges and Sustainable Pest Management"	IIHR, Bangalore	Apr. 25-28, 2012
Dr D.V.K.N. Rao	3rd National Conference on "Agro-Informatics and Precision Agriculture"	IIIT, Hyderabad	Aug 1-3, 2012
Dr B. Sarkar	Indian Science Congress, Aurangabad Chapter	AU, Aurangabad	Aug. 23-24, 2012
Dr P. Suresh Kumar	International Conference on "Agricultural & Horticultural Sciences (Agri- 2012)"	ICC, Hyderabad	Sept. 14-15, 2012
Dr B. Sarkar	National seminar on "Prospects in Inland Fishery"	NASCC, Ahmednagar	Sept. 17-18, 2012
Dr N.P. Singh	UNU-WIDER International Conference on Climate change	Helsinki, Finland	Sept. 28-29, 2012
Dr J. Rane	VI International Conference on "Legume Genetics and Genomics"	ICRISAT, Hyderabad	Oct. 2-7, 2012
Dr N.P. Singh	Annual Conference of "Agricultural Economics Research Association (AERA)"	IARI, New Delhi	Oct. 9-12, 2012
Dr U.K. Maurya Dr D.V.K.N. Rao	National Seminar on 'Managing Land Resources for Sustainable Agriculture'	NBSS&LUP, Nagpur	Oct. 12-13, 2012
Dr D.V.K.N. Rao	8th International Symposium on "Plant Soil Interactions at low pH"	GKVK, Bangalore	Oct. 18-21, 2012

Name	Topics	Place	Period
Dr D.V.K.N. Rao	3rd National Symposium on "Agriculture Production and Protection in Context of Climate Change"	BAU, Ranchi	Nov. 3-5, 2012
Dr P. Suresh Kumar	5th Indian Horticulture Congress: An international Meet	PAU, Ludhiana,	Nov. 6-9, 2012
Dr Mahesh Kumar	International Conference on Radiation Biology	ICRB, Mumbai	Nov. 22-24, 2012
Dr R.L. Choudhary	3rd International Agronomy Congress on "Agriculture Diversification, Climate Change Management and Livelihoods"	IARI, New Delhi	Nov. 26-30, 2012
Dr(s) N.P. Singh, M. P. Brahamane, D.D. Nangare, G.C. Wakchaure B.B. Fand & A.L. Kamble	47th Marathi Vigyan Adhiveshan	VP, Baramati	Dec. 7-9, 2012
Dr R.K. Pasala	National Seminar on "Physiological and Molecular approaches for Development of Climate Resilient crop"	ANGARAU, Hyderabad	Dec. 12-14, 2012
Dr J. Rane	First Annual Convention on "Sustainable Agriculture and Food Security: Challenges and Opportunities"	CIFE, Mumbai	Jan. 18-19, 2013
Dr S.K. Bal Dr N.P. Singh	National Symposium on "Climate Change and Indian Agriculture: Slicing down the Uncertainties"	CRIDA, Hyderabad	Jan. 22-24, 2013
Dr G.C. Wakchaure & Dr D.D. Nangre	47th Annual Convention of ISAE and International Symposium on "Bio-Energy- Challenges and Opportunities"	CRIDA, Hyderabad	Jan. 28-30, 2013
Dr B.B. Fand	IVth International Conference on "Insect Science"	UAS, Bangalore	Feb. 14-17, 2013

Meetings / Workshops

Name	Topics	Place	Period
Dr D.D. Nangare	AICRP on Application of plastics in Agriculture, Coordination Committee Meeting	CIPHET, Ludhiana	May 4-5, 2012
Dr S.K. Raina Dr V. Govindasamy	First Annual Workshop of NICRA project	CRIDA, Hyderabad	Jun. 12-14, 2012
Dr P. Suresh Kumar	XII Annual Group Meeting of AICRP on Tuber Crops	MPUAT, Udaipur	Jun. 18-20, 2012
Dr S.V. Ghadge	Completion Workshop and Nodal Officers Workshop-cum-Installation Training for "NAIP Consortium Strengthening Statistical Computing for NARS"	CIFE, Mumbai	Jun. 30, 2012
Dr. D.V.K.N. Rao	National Workshop on "Geoinformatics Applications for Decentralised Governance in a Panchayati Raj Framework"	NIRD, Hyderabad	Jul. 11-13 2012
Dr J. Rane	51st All India Wheat and Barley Research Workers Meeting: An overview of Agronomic approaches for Abiotic Stress Management in Wheat	SKRAU Regional Station, Durgapura, Jaipur	Aug. 24-27, 2012
Dr N.P. Singh	Half Yearly review meeting of Village Dynamics Studies in South Asia project	ICRISAT, Hyderabad	Sept. 3-7, 2012
Dr Mahesh Kumar	Computational Techniques in Discovery of Agronomically important Crop Genes	NBPGR, New Delhi	Sept. 24-29, 2012
Dr S.K. Bal	Workshop on "Meteorological Satellite Kalpana: A decade of service to the nation"	SAC, Ahmedabad	Oct. 9, 2012
Dr J. Rane	Sensitization meeting for OIC-PME cell	NDRI, Karnal	Dec. 8, 2012
	Regional meeting of CIMMYT to discuss CSISA and BMZ projects	Kathmandu, Nepal	Dec. 16-20, 2012

Name	Topics	Place	Period
Dr S.K. Bal Dr D.P. Patel Dr J. Rane Dr N.P. Singh	ICAR Hub Meeting with stake holders in the region	NRC Grapes, Pune	Jan. 4, 2013
Dr S. Saha	DST-sponsored National Workshop on "Hyperspectral remote sensing and applications"	M.S. University, Baroda	Jan. 17-18, 2013
Dr J. Rane	MDP Workshop on "PME of Agricultural Research Projects"	NAARM, Hyderabad	Jan. 21 - 25, 2013
Dr D.V.K.N. Rao	Workshop on "GIS Applications for Natural Resources Management"	NAARM, Hyderabad	Feb. 20-23 2013
Dr A.K. Singh	Foresight and Future Pathways of Agricultural Research through Youth in India	NASC Complex, New Delhi	Mar. 1-2, 2013
Dr N.P. Singh	Drought Impacts on Key sectors at High Level Meeting on National Drought Policy (HMNDP)	Geneva, Switzerland	Mar. 11-15, 2013

Lectures / Invited Talks

Name	Topics	Place	Period
Dr J. Rane	High temperature tolerance in wheat: strategies for genetic improvement	International Regional Consultation Meeting on "Improving Wheat Productivity in Asia" jointly organized by APAARI, Bangkok, CIMYYT and FAO at APAARI, Bangkok	Apr. 26-28, 2012
Dr K.K. Krishnani	Biofloc technology for zeroater exchange shrimp (P.monodon) aquaculture	Society of Aquaculture Professionals on Biofloc technology, Chennai	Jun., 28-29 2012
Dr D.V.K.N. Rao	Free and open sources of software and data for applied geoinformatics	National Workshop on "Geoinformatics Applications for Decentralised Governance in a Panchayati Raj Framework" organized by NIRD, Hyderabad	Jul. 11-13, 2012

Name	Topics	Place	Period
Dr P. Suresh Kumar	Influence of abiotic stressors on growth and quality of fruits and vegetables	National Training programme on "Advanced techniques for production of horticultural crops" organized by MPKV, Rahuri	Aug. 22, 2012
Dr B.B. Fand	Abiotic stresses affecting crop-insect pest interactions in the context of global climate change	- do -	
Dr S.K. Raina	Abiotic stress tolerance in fruit crops through biotechnological intervenetions"	- do -	
Dr B. Sarkar	Nanotechnology for improved aquaculture	Indian Science Congress, Aurangabad University, Aurangabad	Aug. 23-24, 2012
Dr J. Rane	Drought stress management	Summer School on "Resource Conservation Practices for Soil Health Security", PDKV, Akola	Sept. 13-14, 2012
Dr B. Sarkar	Prospects of nanotechnology in aquaculture	New Arts, Science and Commerce College, Shevgaon, Ahmednagar	Sept. 17-18, 2012.
Dr S.K. Bal	Futuristic climate change scenarios and its probable impact on Indian agriculture	Anekant Institute of Management Studies, Baramati	Oct. 31, 2012
Dr P.S. Minhas	Edaphic disability of degraded soils: A threat to food security	Akola Chapter of Indian Society of Soil Science, PDKV, Akola	Nov. 1, 2012
Dr D.V.K.N. Rao	Use of freely available resources and geomatic tools in climate change studies	3rd National Symposium on "Agriculture Production and Protection in Context of Climate Change", BAU, Ranchi	Nov. 3-5, 2012
Dr J. Rane	Plant phenotyping tools: Recent advances	Winter School on "Molecular Breeding Approaches for Genetic Enhancement of Oilseed Crops", DOR, Hyderabad	Dec. 13, 2012
Dr D.V.K.N. Rao	Applied remote sensing and GIS techniques in bio-physical resource characterisation	Workshop on "GIS Applications for Natural Resources Management" NAARM, Hyderabad	Feb. 20-23, 2013

Trainings Attended

Name	Training Programmes	Place	Period
Dr S. Saha	Training on "Agromet core course"	IMD, Pune	Apr. 24-May 15, 2012
Dr D.V.K.N. Rao	Refresher Course on "Agricultural Research Management"	NAARM, Hyderabad	Jun. 5-18, 2012
Dr M.P. Brahmane	Summer Short Course on "Genomic and phenomic tools for the analysis of livestock genome"	NBAGR, Karnal	Jun. 14-23, 2012
Dr K.K. Krishnani	Management development program in agricultural research	NAARM, Hyderabad	Jul. 3-7, 2012
Dr R.K. Pasala	Consultancy Project Management	NAARM, Hyderabad	Aug. 7-14, 2012
Mr Satish Kumar	NAIP sponsored Training on "Assessment of microbial diversity by next generation sequencing (NGS) for taxonomic and metabolic reconstruction of gut microbes"	NIANP, Bangalore	Aug. 22- Sept. 4, 2012
Dr S. Saha	Training on "weather based agromet advisory services and use of weather data"	CRIDA, Hyderabad	Sept. 14-15, 2012
Dr R.L. Choudhary	Winter school on "System based conservation agriculture for sustained productivity and soil health"	PDFSR, Modipuram, Meerut, UP	Oct. 3-23, 2012
Mr V. Rajagopal	Modern monitoring tools for enhanced resource use efficiency in rained agriculture	CRIDA, Hyderabad	Oct. 4-13, 2012
Dr D.D. Nangare	ICAR sponsored winter school on "Recent advances in micro-irrigation and fertigation"	CPCT, IARI, New Delhi	Nov. 5-25, 2012
Dr D.V.K.N. Rao	"Space technology for management of flood and drought disasters" under Indo-Russia-China Collaboration Program	NRSC, Hyderabad	Dec. 17-22, 2012
Dr S.K. Bal	Refresher Course on "Agricultural research management"	NAARM, Hyderabad	Jan. 7-19, 2013
Dr B. Sarkar	Winter school on "Sustainable fish feeds and nutraceutricals to grow health promoting fish"	CIFA , Bhubane-swar	Jan. 15 – Feb. 7, 2013
Dr R.L. Choudhary	Researcher's Training program on 'SAS for data reduction and multivariate analysis'	CIFE, Mumbai	Feb. 11-16, 2013
Dr G.C. Wakchaure	Researcher's Training Program on 'SAS for data reduction and multivariate analysis'	CIFE, Mumbai	Feb. 11-16, 2013

Name	Training Programmes	Place	Period
Dr V. Govindasamy	Deputation training on "Bacterial endophytes of drought tolerant wheat genotypes" under the Australia Awards, 2012- Endeavour Research Fellowship	Flinders Univ., Adelaide, Australia	Sept. 1, 2012 – Feb. 28, 2013
Dr K.K. Krishnani	Deputation training on "Enzymatic bioremediation of priority chemical stressors" under the Australia Awards, 2012- Endeavour Research Fellowship	CSIRO, Canberra, Australia	Sept. 24, 2012- March, 23, 2013

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9. Distinguished Visitors

16.04.2012	Dr Gurubachan Singh, Chairman, ASRB, New Delhi
21.04.2012	Dr Sreenath Dixit, PS & Coordinator-TDC NICRA, CRIDA, Hydrabad
20.06.2012	Dr S. M. Pillai, Principal Scientist, CIBA, Chennai
23.08.2012	Dr D. B. Kshirsagar, I/C Tomato Improvement Scheme with 11 trainees from Centre of Advanced Faculty Training, Dept of Horticulture, M.P.K.V. Rahuri.
03.09.2012	Prof. Dik Vanden Beighe, University Qutwen, Belgium
03.09.2012	Mr. Vijay and Team, PRIVI Life Sciences Pvt Ltd, Mumbai.
17.10.2012	Dr R.A. Duraiswamy, Sh. V. Krishnamurthy, Pune University, Pune
16.11.2012	Dr C.S. Murthy, NRSC, Pune
19.11.2012	Dr R.B. Singh (Chairman), Dr Nandini Nimbkar, Dr S.S. Magar, Dr R.P. Samui, Dr Pasricha, Dr Mohan Kumar, members, RAC
19.11.2012	Dr N.S. Pasricha, Former Director, Potash Research Institute, Gurgaon
22.11.2012	Prof. Ian King, University of Nottington UK, Prof. Peter Sharp, University of Sydney, Dr John Foulkes , Dr Scott Young , Dr Erik Muscline, Dr Martin Broadley University of Nottington UK, Dr S.C. Misra, Dr Sujata Tefali , Dr V. Philips ARI, Pune
17.12.2012	Dr A.K. Joshi, Wheat Breeder and South Asia Coordinator, CIMMYT, Nepal
07.02.2013	Dr Ashish Srivastava, Bhabha Atomic Reserch Center, Mumbai.
18.02.2013	Dr Indu Sharma, Project Director, Directorate of Wheat Research, Karnal
19.02.2013	Dr Ratan Tiwari, Wheat Molecular Biologist, DWR, Karnal
20.02.2013	Dr S.K. Sharma, Head Crop Improvement, CSSRI, Karnal

10. Celebrations

Celebration of National Days

Institute celebrated Independence Day on August 15, 2012 and Republic Day on January 26, 2013 with great enthusiasm in the campus. The Director hoisted the national flag and addressed the staff members on these occasions.

(a)

(b)

Fig. 10.1. Celebration of Independence Day (a) and Celebration of Republic Day (b)

Vigilance Awareness Week

Vigilance awareness week was observed during October 29, 2012 to November 3, 2012 at the Institute. It commenced with a pledge taken by all the officials and staff on October 29, 2012 in the presence of Director of the institute. Series of lectures were organized during this period which was delivered by the by AO and FAO of the Institute. All staff members of the Institute participated in the Vigilance Awareness Week.

हिन्दी सप्ताह समारोह

संस्थान मे हिन्दी सप्ताह समारोह 14 से 20 सितंबर 2012 के दौरान मनाया गया। इस समारोह की शुरुवात दिनांक 10 सितंबर, 2012 को संस्थान के निदेशक एवं अध्यक्ष राजभाषा कार्यान्वयन समिति, डा पी. एस. मिन्हास महोदय की अध्यक्षता में की गई जिसमे संस्थान की राजभाषा समिति के सभी सदस्य उपस्थित थे। इस समारोह में हिन्दी में कार्य को बढ़ावा, तिमाही रिपोर्ट और हिन्दी सप्ताह समारोह 2012 के दौरान आयोजित कार्यक्रमों और समारोह मे मुख्य अतिथि के आमंत्रण एवं पुरस्कार के स्वरूप के बारे मे विस्तृत चर्चा हुई।

कार्यक्रम का शुभारम्भ सदस्य सचिव (राजभाषा) डा. यू के मौर्य के स्वागत के साथ शुरू हुआ जिसमे उन्होने संस्थान मे हिन्दी मे किए गए कार्यो की जानकारी दी। कार्यक्रम का उद्घाटन दिनांक 14 सितंबर को संस्थान के निदेशक एवं अध्यक्ष, राजभाषा कार्यान्यवन समिति, डा पी. एस. मिन्हास महोदय ने मुख्य अतिथि श्री प्रशांत भा केसकर, मुख्य शाखा प्रबंधक, भारतीय स्टेट बैंक, बारामती की उपस्थिति मे किया। अपने अध्यक्षीय भाषण मे निदेशक महोदय ने अनुच्छेद 343 का जिक्र किया जिसके तहत भारत के संबिधान मे हिन्दी को राजभाषा का दर्जा दिया गया है। निदेशक महोदय ने संस्थान मे कार्यरत सभी अधिकारियों एवं कर्मचारियों से अधिक से अधिक हिन्दी मे कार्य करने की सलाह दी ताकि हम राजभाषा विभाग द्वारा जारी वार्षिक कार्यक्रम मे निर्धारित किए गए लक्ष्यो को आसानी से प्राप्त कर सके। मुख्य अतिथि श्री प्रशांत भा केसकर ने बताया की नेपाल, फ़िजी, घना, श्रीलंका,

पाकिस्तान, बंगलादेश, नेदरलैंड, ऑस्ट्रेलिया, अमेरिका के अलावा कई देशो में हिन्दी का प्रयोग बढ़ा है। बैंकिंग क्षेत्रों में हिन्दी का प्रयोग बहुत ज्यादा हैं। विदेशी कंपनिया भी अब अपना विज्ञापन ज्यादा से ज्यादा हिन्दी में कर रहे हैं जिससे लोग उनकी तरफ आकर्षित हो सके। इस दिन हिन्दी टिप्पण, हिन्दी निबंध और वाद विवाद (हिन्दी भाषियों के लिए) प्रतियोगितायों का आयोजन किया गया जिनका मूल्यांकन निर्णायक मंडल ने किया। दिनांक 15 सितंबर, 2012 को वाद-विवाद (अहिन्दी भाषियों के लिए), कम्प्युटर पर हिन्दी टंकण, प्रश्नमंच, हिन्दी कविता पाठ, हिन्दी आशुभाषण प्रतियोगितायों का आयोजन किया गया। प्रश्नमंच का कार्यक्रम डा गोरक्ष वाकचौरे ने एक नए अंदाज मे प्रस्तुत किया जिसे सभी ने काफी सराहा।

दिनांक 17 सितंबर, 2012 को हिन्दी प्रशिक्षण का कार्यक्रम आयोजित किया गया जिसका संचालन विशेष अतिथि श्री राजेंद्र प्रसाद वर्मा, सहायक निदेशक, राजभाषा, गृह मंत्रालय, भारत सरकार, पुणे, ने किया। इस प्रशिक्षण के दौरान उन्होने यूनिकोड, श्रुतलेखन सॉफ्टवेयर, राजभाषा विभाग द्वारा जारी सभी कार्यक्रमों, नियमों, संसदीय राजभाषा समिति आदि के बारे मे विस्तृत जानकारी दी। इस प्रोग्राम मे संस्थान के निदेशक महोदय के साथ सभी अधिकारी एवं कर्मचारी शुरू से अंत तक मौजूद थे। दिनांक 18 सितंबर, 2012 को कृषि महविद्यालय, शारदानगर, बारामती मे आशुभाषण प्रतियोगिता का आयोजन किया गया, जिसमे विद्यार्थियो ने बढ़ चढ़ कर भाग लिया। विजयी विद्यार्थियों को पुरस्कार प्रदान किए गए।

समापन समारोह 25 सितंबर 2012 को किया गया जिसमे डा सुरेश सालुंके, प्रोफेसर एवं विभागाध्यक्ष, हिन्दी, तुलजाराम चतुरचंद महाविद्यालय, बारामती मुख्य अतिथि के रूप मे उपस्थित थे। इस समारोह का शुरुवात संस्थान के निदेशक द्वारा मुख्य अतिथि के स्वागत के साथ हुआ। सदस्य सचिव ने हिन्दी सप्ताह समारोह (14-20 सितंबर) के दौरान हुए सभी कार्यक्रमों के बारे मे मुख्य अतिथि को अवगत कराया। इसके बाद पुरस्कार वितरण का कार्यक्रम हुआ जिसमे विजयी प्रतियोगियो को मुख्य अतिथि एवं संस्थान के निदेशक ने पुरस्कार वितरित किए। मुख्य अतिथि ने अपने अध्यक्षीय भाषण मे हिन्दी के बढ़ते कदम के बारे मे चर्चा की और बताया की विश्व के 152 देशों में हिन्दी व्यापार शिक्षा पर्यटन राजनीति के कारण विकसित हुई हैं और हिन्दी जानने वाले 2 करोड़ से अधिक लोग 120 देशो में रहते हैं। संस्थान के निदेशक महोदय ने कार्यक्रम को सफल बनाने के लिए सभी को धन्यवाद दिया।

समारोह का समापन डा कमलेश कुमार मीना के धन्यवाद ज्ञापन के साथ हुआ जिसमे उन्होने मुख्य अतिथि डा सुरेश सालुंके, श्री प्रशांत भा केसकर, विशेष अतिथि श्री राजेंद्र प्रसाद वर्मा एवं संस्थान के निदेशक डा पी. एस. मिन्हास महोदय एवं निर्णायक मंडल का आभार व्यक्त किया। एवं सभी प्रतियोगियो को कार्यक्रम सफल बनाने के लिए और सम्पूर्ण कार्यक्रम की फोटोग्राफी करने के लिए श्री संतोष पवार एवं श्री प्रवीण मोरे को धन्यवाद दिया।

(a) (b)

Fig. 10.2. हिन्दी सप्ताह समारोह में मुख्य अतिथी के साथ संस्थान के निदेशक (a) एवं कार्यक्रमों में भाग लेते हुए प्रतियोगियी (b)

Sports Meet

A 12 member contingent comprising Dr R. K. Pasala, Dr K.K. Meena, Dr Y. Singh, Dr G.C. Wakchaure, Dr R.L. Choudhary, Mr V. Rajagopal, Mr Santosh Pawar, Mr Pravin More, Mr Rushikesh Gopane, Mr Ajay Nakhawa, Mr Sunil Potekar and Mr Aniket More actively participated in various games namely Basketball, Kabaddi, Volleyball, Chess, Badminton, Table tennis, 100 m and 400 m Race, Javelin throw, Discus throw, Shot put etc. in the ICAR Zonal Sports Meet held at NRCC, Bikaner, Rajasthan during February 27 to March 2, 2013. Team was led by Dr S.K. Bal as Chef De' Mission and Mr Ram Avtar as Manager.

(a) (b)

Fig. 10.3. Participation of NIASM contingent in sports meet

11. New Staff and Superannuation

Newly Joined Staff

Newly Recruited	Date of Joining
Dr D.P. Patel, Principal Scientist (Plant Physiology)	07.04.2012
Dr N.P. Singh, Principal Scientist (Agril. Economics)	04.07.2012
Dr B. Sarkar, Senior Scientist (Fish and Fishery Science)	27.04.2012
Dr P. Suresh Kumar, Senior Scientist (Horticulture)	25.06.2012
Dr R.K. Pasala, Senior Scientist (Plant Physiology)	04.07.2012
Dr K.K. Meena, Senior Scientist (Agril. Microbiology)	02.08.2012
Dr A.K. Singh, Senior Scientist (Agril. Biotechnology)	06.09.2012
Dr Y. Singh, Senior Scientist (Agronomy)	29.10.2012
Mr Pardeep Kumar, Assistant	05.07.2012
Miss Divya C.N. , Assistant	28.07.2012
Mr Dayanand Kharat, Assistant	05.09.2012
Mr Satyendra Kumar Rai, Assistant	01.02.2013
On Transfer	
Shri G.G. Harakangi, Chief Administrative Officer	03.12.2012
Dr D.D. Nangare, Scientist Sr. Scale (Soil Water and Cons. Engg.)	04.09.2012
Dr A.V. Nirmale, Technical Officer (T-9)	17.12.2012

Staff transferred

- Dr Chubasenla Aochen, Scientist (Biochemistry-Plant Science) was transferred to ICAR Complex of NE Region, Shilong, Meghalaya. She was relieved on 22.08.2012.
- Er Ajit Pralhad Magar, T-3 (FMP), was selected as Scientist (FMP) and posted at CIAE, Bhopal. He was relieved on 31.12.2012
- Shri Paurav Jani, Administrative Officer, NIASM, joined his new assignment in Custom Department, New Delhi. He was relieved on 30.11.2012

Superannuation

Shri G. Laxminarayana, Administrative Officer of NIASM, superannuated on November 30, 2012. NIASM family wishes Shri G. Laxminarayana a happy retired life.

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12. Budget

(Rs. lakhs)

Head / Sub head	Plan		Non-Plan	
	Allocation	Expenditure	Allocation	Expenditure
Grants in aid –Capital				
Works		847.33	0.00	0.00
Equipment		506.28	0.00	0.00
IT		3.26	0.00	0.00
Library		14.98	0.00	0.00
Furniture & Fixture		3.15	0.00	0.00
Land		0.00	0.00	0.00
Vehicles		0.00	0.00	0.00
Livestock		0.00	0.00	0.00
Sub total (1)	1375.00	1375.00	0.00	0.00
Grand in aid- Salary				
Pay & Allowances	0.00	0.00	309.00	308.98
Sub total (2)	0.00	0.00	309.00	308.98
Grants in aid-General				
TA	17.00	17.00	6.00	6.00
Contingencies	153.50	153.46	75.87	75.87
HRD	9.50	9.50	1.50	1.50
Sub total (3)	180.00	179.96	83.37	83.37
Grandtotal (1+2+3)	1555.00	1554.96	392.37	392.35
NICRA	77.00	76.71		

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13. Research Projects

A. Institute Projects

School of Atmospheric Stress Management

- Monitoring and quantifying abiotic stress in soybean-rabi sorghum genotypes: index based approach for crop water management (S. Saha, S.K. Bal, K.P. Bhagat, Y.P. Singh)
- 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)
- Impact of climate change on physio-biochemical behavior and hormonal regulations in soybean and rabi sorghum (K.P. Bhagat, S.K. Bal, S. Saha, B.B. Fand, R.L. Choudhary)
- Sugarcane yield optimization in Western Maharashtra Scarcity Zone using DSSAT-CANEGRO model (S.K. Bal, S. Saha, K.P Bhagat, D.V.K.N. Rao)
- Study of genetic polymorphism of heat shock protein genes among indigenous and cross breed cattle (B. Sajjanar)
- Impact of cropping systems and spent wash on soil development under irrigated and rainfed conditions (Y. Singh, P.S. Minhas, V. Rajagopal, U.K. Maurya, K.K. Meena, G.C. Wakchaure)

School of Drought Stress Management

- Standardization and development of plant phenomics procedures to support genomics approach for drought and heat stress (J. Rane, S.K. Raina, V. Govindasamy)
- Phenotypic, biochemical and molecular analysis of Green gram lines for identification of drought tolerant genotypes (S.K. Raina, A.K. Singh)
- Enhancing drought and heat stress tolerance in wheat using advanced biotechnological approaches (A.K. Singh, R.K. Pasala, J. Rane, S.K. Raina, M. Kumar,)
- Investigation of traits and genes associated with resilience to moisture stress in soybean (M. Kumar, V. Govindasamy, A.K. Singh, R.L. Choudhary)
- Enhancing adaptability of *Cyamopsis tetragonoloba* L., to drought stress through breeding approaches (D.V. Patil, S.K. Raina, A.K. Singh, J. Rane)
- Functional and genetic diversity of bacterial endophytes of drought tolerant sorghum crop (V. Govindasamy, M. Kumar, D.V. Patil)

School of Edaphic Stress Management

- Nano(bio-) remediation of nitrogenous contaminants using silver-ion exchanged zeolites (K.K. Krishnani, U.K. Maurya, B. Sarkar,V. Rajagopal)
- Identification, cloning and expression analysis of temperature, salinity and hypoxia responsive genes in fish (M.P. Brahmane, B. Sajjanar, S. Kumar)
- Examination of un cultural microbial diversity of saline soils using metagenomics (S. Kumar, K.K. Krishnani, V. Rajagopal)
- Design and development of livestock and fishery structures for heat stress management (G.C. Wakchaure, S.V. Ghadge, B. Sarkar)
- Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (B. Sarkar, M.P. Brahmane, K.K. Krishnani)
- Conservation agricultural practices for enhancing crop productivity and resource-use efficiency (R.L. Choudhary, G.C. Wakchaure, P.S. Minhas, V. Rajagopal, K.K. Krishnani,)
- Design and development of mini tractor seeder attachment for sugarcane trash farming (S.V. Ghadge)
- Impact of salt stress on chemical diversity of plant rhizosphere and its consequences to structural and functional diversity of plant associated Pink Pigmented Facultative Methyl trophic (PPFMs) bacterial community (K.K. Meena)
- Crop water production functions using line source sprinkler system: interaction with bio regulators, soil fertility and crop cultivars (G.C. Wakchaure, P.S. Minhas, R.K. Pasala, R.L. Choudhary, S.K. Bal, K.K. Meena)

School of Policy Support Research

- NDVI based mapping of abiotic stress (D.V.K.N. Rao, S.K. Bal, P.S. Minhas)
- Assessment of climate imposed vulnerability of onion farming in Maharashtra (A.L. Kamble, N.P. Singh)
- Tribal Sub Plan-TSP (A.L. Kamble, N.P. Singh)

Externally Funded Projects

- Evaluation of green gram genotype for resilience to moisture stress (S.K. Raina, V. Govindasamy, A.K. Singh, J. Rane) funded by National Initiative on Climate Resilient Agriculture (ICAR), New Delhi
- Assessment of silixol efficacy on wheat under drought and high temperatures (R.K. Pasala, J. Rane, P.S. Minhas) funded by Privi Life Sciences Pvt. Ltd., Mumbai

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14. Personnel

(As on 02.05.2013)

Scientific Staff	
Dr P.S. Minhas	Director
Dr J. Rane	Head, School of Drought Stress Management
Dr K.K. Krishnani	Head, School of Edaphic Stress Management
Dr S. K. Bal	Principal Scientist and *I/C* Head, School of Atmospheric Stress Management
Dr N.P. Singh	Principal Scientist and *I/C* Head, Schoolof Policy Support Research
Dr D.P. Patel	Principal Scientist (Plant Physiology)
Dr S.V. Ghadge	Senior Scientist (FMP)
Dr D.V. Patil	Senior Scientist (Plant Breeding)
Dr D.V.K.N. Rao	Senior Scientist (Soil Chem./Fert./Micro)
Dr B. Sarkar	Senior Scientist (Fish and Fishery Science)
Dr P. Suresh Kumar	Senior Scientist (Horticulture)
Dr R.K. Pasala	Senior Scientist (Plant Physiology)
Dr K.K. Meena	Senior Scientist (Agril. Microbiology)
Dr A.K. Singh	Senior Scientist (Agril. Biotechnology)
Dr Y. Singh	Senior Scientist (Agronomy)
Dr M.P. Brahmane	Scientist, Sr. Scale (Biotechnology-Animal Science)
Dr D.D. Nangare	Scientist, Sr. Scale (Soil & Water Cons. Engg.)
Dr G.C. Wakchaure	Scientist (Agril. Struc. & Proc. Engg.)
Dr A.L. Kamble	Scientist (Agril. Economics)
Dr S.K. Raina	Scientist (Plant Breeding)
Dr B.B. Fand	Scientist (Agril. Entomology)
Dr V. Govindasamy	Scientist (Microbiology)
Dr K. Bhagat	Scientist (Plant Physiology)
Dr S. Saha	Scientist (Agrometeorology)
Dr Mahesh Kumar	Scientist (Plant Physiology)
Dr R.L. Choudhary	Scientist (Agronomy)
Mr V. Rajagopal	Scientist (Soil Chem./Fert./Micro.)

Scientific Staff	
Dr B. Sajjanar	Scientist (Biotechnology-Animal Science)
Mr S. Kumar	Scientist (Biochemistry–Plant Science)
Mr R.L. Meena	Scientist (Agronomy)
Technical Staff	
Dr A.V. Nirmale	Technical Officer T-9 (Animal Science)
Dr A.K. Sharma	Technical Officer T-7 (Documentation)
Dr U.K. Maurya	Technical Officer T-6 (Geology)
Ms Noshin Shaikh	Technical Assistant T-3 (Civil)
Mr Santosh Pawar	Technical Assistant T-3 (Electrical)
Mr Pravin More	Technical Assistant T-3 (Computer)
Mr Rushikesh Gophane	Technical Assistant T-3 (Horticulture)
Mr Madhukar Gubbala	Technical Assistant T-3 (Information Technology)
Mr Ajay Nakhawa	Technical Assistant T-3 (Fisheries)
Mrs Priya George	Technical Assistant T-3 (Microbiology)
Mr Lalitkumar Aher	Technical Assistant T-3 (Biotechnology)
Mr Sunil Potekar	Technical Assistant T-3 (Agrometeorology)
Mr Patwaru Chahande	Technical Assistant T-3 (Agriculture)
Mr Aniket More	Technical Assistant T-1 (Mali)
Administrative Staff	
Mr G.G. Harakangi	Chief Administrative Officer
Mr Ram Avtar	Finance & Accounts Officer
Smt Purnima S. Ghadge	Assistant
Mr Pardeep Kumar	Assistant
Ms Divya C.N.	Assistant
Mr Dayanand Kharat	Assistant
Mr S.K. Rai	Assistant

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Appendix

Members of RAC

1. Dr R.B. Singh, President, NAAS, New Delhi (Chairman)
2. Dr S.P. Adhikary, Head, Centre for Biotechnology, Visva-Bharati, Santiniketan
3. Prof. B.N. Goswami, IITM, Pune
4. Dr Mruthyunjaya, Ex-ND, NAIP, New Delhi
5. Dr S.S. Magar, Ex-Vice Chancellor, BSKKV, Dapoli
6. Dr Mohan Kumar, ADG (Agro & AF), ICAR, New Delhi
7. Sh. Rajendra Pawar, Chairman, ADT, Malegaon, Baramati, Pune
8. Dr R.P. Samui, Rtd. SC-F&DDG (Agrometeorology Division), IMD, Pune
9. Dr (Mrs) Renu Khanna Chopra, Emeritus Scientist, WTC, IARI, New Delhi
10. Dr (Mrs) Nandini Nimbkar, President, NARI, Phaltan, Maharashtra
11. Dr Gaya Prasad, ADG (AH), ICAR, New Delhi
12. Dr P.S. Minhas, Director, NIASM, Baramati, Pune
13. Dr J. Rane, Head, SDSM, NIASM, Baramati, Pune (Member Secretary)

Members of IMC

1. Dr P.S. Minhas, Director, NIASM, Baramati, Pune (Chairman)
2. Shri A.N. Javale, DEE & MCAR, 132/B, Bhamburda, Bhosale Nagar, Pune
3. Commissioner, Commissionerate of Agriculture, Fatehmaidan, Hyderabad
4. Principal, College of Agriculture, Sharadanagar, Malegaon, Baramati, Pune
5. Sh. Rajendra Pawar, Chairman, ADT, Malegaon, Baramati, Pune
6. Dr S.S. Magar, Ex-Vice Chancellor, BSSKV, Dapoli
7. Dr Jagdish Prasad, Principal Scientist, NBSS & LUP, Nagpur
8. Dr P.R. Bharambe, Principal Scientist & Head, CICR, Nagpur
9. Dr G.S. Karibasappa, Principal Scientist (Hort.) NRC for Grapes, Pune
10. Dr V.U.M. Rao, Project Coordinator (Agro. Met.) CRIDA, Hyderabad
11. Dr Mohan Kumar, ADG (Agro. & AF), ICAR, New Delhi
12. Sh. G.C. Prasad, Sr. Finance & Accounts Officer, NBSS & LUP, Nagpur
13. Shri G.G. Harakangi, CAO, NIASM, Baramati, Pune (Member-Secretary)

PME Cell

Dr J. Rane (In-charge), Dr S.K. Bal, Dr D.V. Patil, Dr DVKN Rao, Dr A.L Kamble, Dr A.K. Sharma, Mr. G. Madhukar

RFD Committee

Dr D.V.K.N. Rao (Nodal Officer), Dr B.B Fand, Dr M.P. Brahmane, Dr A.L. Kamble, Dr S.K. Raina, Dr V. Govindasamy, Sh G. Laxminarayana, Sh Ram Avtar

Farm Development Committee

Dr S.K. Bal (In-Charge), Dr S.V. Ghadge, Dr P. Suresh Kumar, Dr D.D. Nangare, Dr G.C. Wakchure (Farm Manager),

Purchase Advisory Committee

Dr K.K. Krishnani (Chairman), Dr S.K. Bal, Dr B.B. Fand, Dr A.L Kamble, CAO, FAO

Standing Purchase Committee (GFR 146)

Heads of Divisions, Indentor, CAO, FAO

Works Committee

Dr S.K. Bal (Chairman), Dr S.V. Ghadge, Dr G C. Wakchure, Ms N. Shaikh, Mr Santosh Pawar

Grievance Cell

Head of Divisions, Mr Santosh Pawar, CAO, FAO

Women Cell

Ms C. Aochen (Chairperson), Mrs P.S. Ghadge, Ms Noshin Shaikh, Mrs Priya George, CAO, FAO

RTI Cell

Dr P.S. Minhas, Director, NIASM (Appellate Authority), Dr N.P. Singh, CFO, Dr A.K. Sharma, Documentation Officer (Assistant Public Information Officer), Dr SV Ghadge, Sr. Scientist (Transparency Officer).

Hindi Committee

Dr P.S. Minhas (President), Dr K.K. Krishnani (Vice President), Dr D.V. Patil, Dr A.K. Sharma, Dr R.L. Choudhary, Dr Mahesh Kumar, CAO, FAO, Praveen Kumar, Pradeep Kumar, Dr U.K. Maurya (Member Secretary).

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Abbreviations

ABC	:	Atmospheric Brown Cloud
ADP	:	Adenine Di-Phosphate
ADT	:	Agriculture Development Trust
ARF	:	ADP ribosylation factors
CBF	:	CRT (C-repeated) binding factor
CD	:	Critical Difference
CDM	:	Clean Development Mechanisms
CG	:	CGIAR- Consultative Group for International Agricultural Research
CRI	:	Crow Root Initiation
CTMax	:	Critical Temperature Maximum
CTMin	:	Critical Temperature Minimum
DREB	:	Dehydration Responsive Element Binding Protein
DSR	:	Directorate of Soybean Research
DSS	:	Decision Support System
FCR	:	Feed Conversion Ratio
FTIR	:	Fourier Transformed Infra-Red
GA	:	Gibberlic Acid
GHG	:	Green House Gas
GLC	:	Gas Liquid Chromatography
GSDA	:	Groundwater Survey Development Agency
HDPE	:	High Density Poly Ethylene
HSP	:	Heat Shock Protein
HYV	:	High Yielding Variety
INM	:	Integrated Nutrient Management
IAA	:	Indole Acetic Acid
IFS	:	Integrated Farming System
IIHR	:	Indian Institute of Horticultural Research
IIPR	:	Indian Institute of Pulse Research
KVK	:	Krushi Vigyan Kendra
LTA	:	Long term average
M.B. ploughs	:	Mould Board Plough
MJP	:	Maharashtra Jeevan Pradhikaran
MODIS	:	Moderate Resolution Imaging Spectroradiometer
MPKV	:	Mahatma Phule Krishi Vidyapeeth
NAAS	:	National Academy of Agricultural Science
NAC	:	NAM, ATAF 1/2 and CUC2 domain gene
NARS	:	National Agricultural Research System
NBPGR	:	National Bureau of Plant Genetic Resources
NDVI	:	Normalized Difference Vegetation Index
NRC	:	National Research Center
OBC	:	Other Backward Cast
PEG	:	Poly Ethylene Glycol

PGP	:	Plant Growth Promoting
PME	:	Project Management and Evaluation
PVC	:	Poly-Vinyl Chloride
RAC	:	Research Advisory Committee
RAU	:	Rahuri Agriculture University
RFD	:	Results Framework Document
RNA	:	Ribonucleic Acid
rRNA	:	Ribosomal Ribonucleic Acid
RT-PCR	:	Reverse Transcriptase Polymerase Chain Reaction
SAUs	:	State Agricultural Universities
SEM	:	Scanning Electron Microscope
SRI	:	System of Rice Intensification
TEM	:	Transmission Electron Microscope
TSP	:	Tribal Sub-Plan
XRD	:	X-ray Difraction

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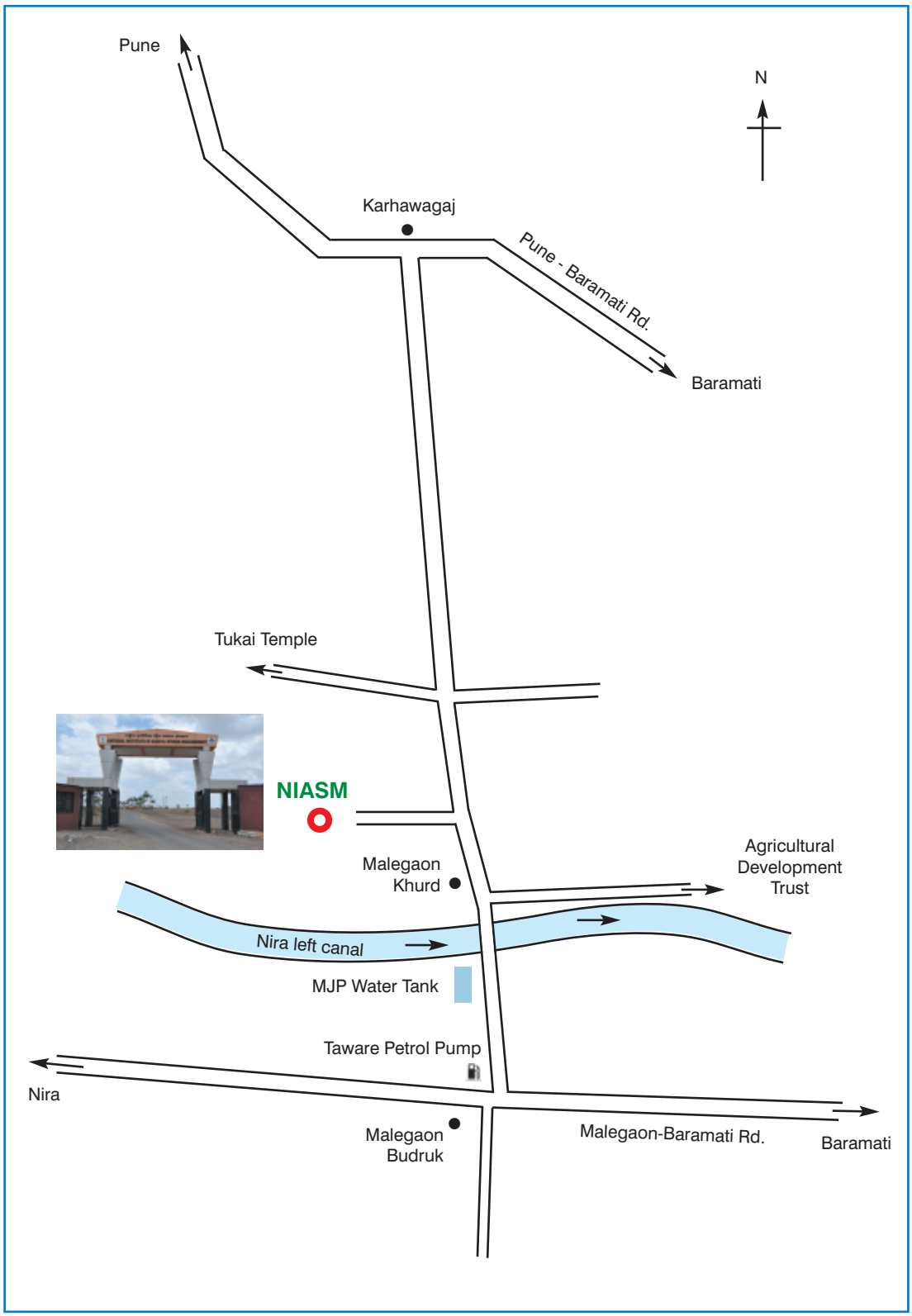
Route Map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