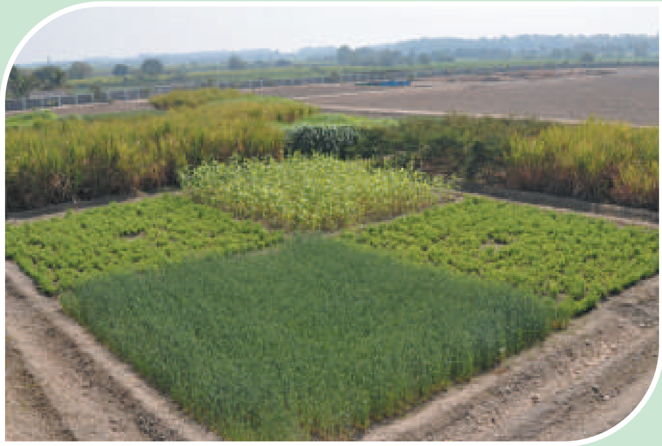
वार्षिक प्रतिवेदन ♦ Annual Report

2013 – 14



राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान, बारामती

National Institute of Abiotic Stress Management, Baramati

वार्षिक प्रतिवेदन | Annual Report
2013-14

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
(भारतीय कृषि अनुसंधान परिषद)
मालेगांव, बारामती - 413 115, पुणे, महाराष्ट्र, भारत

National Institute of Abiotic Stress Management
(Indian Council of Agricultural Research)
Malegaon, Baramati - 413 115, Pune, Maharashtra, India

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General view of field experiments

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Preface

The institute aims to provide dynamic mechanisms and robust tools for managing abiotic stresses that may occur in the present forms or in their amplified version in the future with focus on profit for both farmers and agro-ecosystems. To accomplish this goal, the operational strategy of the institute is to focus on basic research on abiotic stresses faced by the country, development of human resources, creating robust databases and amelioration approaches using frontier technologies with the participation of wide network of national and international centres. Since the institute is in formative stage, efforts were continued for the development of infrastructure facilities in terms of construction works, farm development and procurement of equipments The construction of administrative block is about to be completed soon and some of the residential quarters have been occupied. The institute has initiated multidimensional research to minimise the adverse impacts of abiotic stresses in agriculture. In fact, the foremost achievement of the year has been initiation of a large number of field experiments on wheat, soybean and mungbean in south-side and establishment of horticultural plantations in the north-side farm on drought and edaphic stress management aspects. Micro-irrigation system has been planned for all field plots and auto-irrigation system will be put up after approval of EFC. High end equipments such as Eddy covariance system, Bowen ration system and automatic weather station have been put to use for monitoring gas and energy fluxes. Different districts of Maharashtra were afflicted with unprecedented hailstorms and scientists of the institute were actively involved for developing post-hail recoupment techniques. In addition, several high end equipments have been procured for developing state-of-the-art laboratories, which will become functional after the acquisition of the office-cum-admn block. For developing networks, MoU's were signed with MPKV, Rahuri and VSBT, Baramati and this was followed by meetings of the scientists for fine tuning the research areas for collaborations.

The institute was bestowed with the responsibility of organizing the Annual Conference of Vice Chancellors of Agricultural Universities and Directors of ICAR Institutes at Baramati and same was appreciated by all. The meetings of Research Advisory Committee (RAC) and Institute Management Committee (IMC) were held as per schedule and the valuable suggestions by the members are gratefully acknowledged. I also appreciate the efforts made by the members of the publication committee in compiling this report.

June 26, 2014
NIASM, Baramati

(P. S. Minhas)
Director

Contents

कार्यकारी सारांश

संस्थान के प्रारंभिक अवस्था में होने के बावजूद विगत वर्ष में इसके बुनियादी ढांचे, आदर्श अनुसंधान प्रक्षेत्र एवं उच्च-स्तरीय उपकरणों की खरीद में अपेक्षाकृत अभूतपूर्व प्रगति देखी गई। कार्यालय सह प्रशासनिक खंड का निर्माण कार्य लगभग पूरा होने वाला है जबकि वैज्ञानिक और प्रशासनिक कर्मचारी नवनिर्मित आवास गृह में रह रहे हैं। इसके अतिरिक्त 3.0 हेक्टेयर भूमि क्षेत्र आवसीय परिसर के निर्माण के लिए बारामती शहर में अधिग्रहित की गई है।

एड्डी सहप्रसरण प्रणाली के प्रयोग से फसलों द्वारा छोड़े या लिए जाने वाले कार्बन डाई ऑक्साइड के जांच से पता चला है कि ढैचां और गेहूँ पारिस्थितिकी तंत्र में एक मौसम में औसत 1.5 से 2.0 $\mu mol\ m^{-2}s^{-1}$ कुल कार्बन डाई ऑक्साइड विनिमय होता है। सोयाबीन के नियत और अनिश्चित प्रकार की प्रजाति में प्रकाश संश्लेषण के लिए जरूरी प्रकाश की मात्रा में विभिन्नता पाई गई है। पानी की कमी वाले वातावरण में ऑर्थो-सिलिसिक एसिड का 4 मिलीलीटर प्रति लीटर की दर से प्रयोग गेहू एवं सोयाबीन की उपज बढ़ाने एवं जड़ों के विकास के लिए प्रभावशाली पाया गया।

बायोरेगुलेटर्स जैसे कि थायोयूरिया का प्रयोग गेहूं में पानी की कमी से होने वाले नुकसान को कम कर सकता है, जिसका, उपज पर पानी की कमी का निम्नतर प्रभाव से पता चला। जब पानी की मात्रा 27 सेमी से कम दी गई तब अधिक नत्रजन की खुराक (150 किलोग्राम प्रति हेक्टेयर) देने पर गेहूँ की पैदावार में कोई बढ़ोत्तरी नहीं पाई गई। मृदा मे पर्याप्त नमी होने के बावजूद भी गेहू के कुछ जीनोटाइपों में प्रभावशाली रूप में पत्तियाँ मुड़ने के लक्षण पाये गए।

जड़ के अध्ययन के लिए विकसित किये गए विधि से पौध में एकत्रित जैव भार की मात्रा में भिन्नता को प्रयोगशाला में शुरुआत मे ही पता किया जा सकता है । मोम और गैर मोम वाले पौधों में पत्तियों को ठंडा रखने की क्षमता में कोई अंतर नहीं पाया गया। लोक-1 प्रजाति में उच्च तापमान और मिट्टी में प्रतिबंधित नमी वाले वातावरण मे भी दाने के विकास की दर उच्च पाई गई। शुष्क-सहिष्णुता से संबन्धित जीएम फार्नेसिल ट्रान्सफरेज जीन से चलित पादप क्रिया को रोकने के लिए जीन वेक्टर का निर्माण किया गया।

तापमान प्रतिविम्ब यंत्र की विधि को सोयाबीन लाइनों की अनुवीक्षण के लिए विकसित किया गया। चार जीनोटाइपों अर्थात., जे एस-20-70, सी ए टी - 3041, एम ए यू एस - 704 और जे एस-88-21 का प्रदर्शन मिट्टी की कम नमी में भी सबसे अच्छी स्थानीय किस्म की तुलना में बेहतर पाया गया। मूँग की जल्द फुल देने वाली जीनोटाइप एम एल -2037 ने स्थानीय किस्म (बी पी एम आर - 145) की तुलना में अधिक उपज दिया। इस जीनोटाइप में फली की लंबाई और बीज प्रति फली अधिकतम दर्ज किया गया। स्थानीय किस्मों से बेहतर ब्रेडीराईजोबीयम की किस्म (यू एस डी ए -61, यू एस डी ए - 94 और यू एस डी ए - 110) ने कम पानी के वातावरण मे भी सोयाबीन में अधिक जड़ग्रंथी, जैव भार और अधिक पैदावार के लिए पौधों को सक्षम बनाने में कारगर पाया गया। प्याज की फसल में लगभग 70 % किसानों ने 2012 2013 में सूखे की वजह से और खरीफ 2013 में अतिरिक्त बारिश से 30 % से अधिक उपज के नुकसान का अनुभव किया।

किसानों के खेतों में बहुउद्देशीय ऑफ-बार सह उर्वरक ड्रील मशीन के इस्तेमाल से पेड़ी गन्ने की उत्पादकता में सुधार पाया गया। लवणीय मिट्टी के मेटाजीनोम से बारह जीन अलग किए गए तथा उनके अनुक्रम के बाद उनको जीन बैंक संग्रहालय में जमा किया गया। मछली रोगजनक बैक्टीरिया *एरोमोनास हाईड्रोफिला* के खिलाफ जीवाणुनाशक रजत आयन विनिमय गतिविधि युक्त जीयोलाईट्स की पहचान की गई। *लोबीयो रोहिता* के ऊतक के सार से जीवाणुनाशक चांदी नैनो कणों की एक स्तरीय संश्लेषण प्रक्रिया विकसित की गई। प्रत्येक डिग्री

पर्यानुकूलन तापमान में वृद्धि के साथ सिंघी मछली की बढ़ते तापमान के प्रति सहिष्णुता में 1.34 ^{0}सें. की बढ़ोत्तरी पाई गई। जलवायु परिवर्तन के कारण मिलीबग के संक्रमण में वृद्धि का अनुमान लगाया गया तथा इससे कपास जैसी फसलों पर विपरीत प्रभाव पड़ने की संभावना पाई गई। गन्ना,ल्यूसर्न और नेपियर घास की खेती से मुरुम के विघटन में तेजी देखी गई। चीकू, अमरूद और अनार जैसे फलों की उत्पादकता बढ़ाने के लिए एवं मिट्टी मिश्रण भरने तथा रोपण तरीकों के प्रभाव का आकलन करने के लिए लंबी अवधि के प्रयोग शुरू किए गए। संस्थान ने नंदुरबार जिले के नवापुर तहसील में 25 आदिवासी गावों में टी. एस. पी. योजना को सफलता पूर्वक लागू किया। इस योजना से किसानों के बीच खेती के बारे में जागरूकता के मामले में महत्त्वपूर्ण सुधार देखने को मिला तथा धान की उन्नतशील खेती से इसके पैदावार में 2.5 गुना एवं सुधारित खेती के क्षेत्रफल में 110 एकड़ से बढ़कर 758 एकड़ की वृद्धि हुई।

इस क्षेत्र में फरवरी–मार्च, 2014 के दौरान ओलावृष्टि से फसलों में अभूतपूर्व क्षति देखी गई। बायोरेगुलेटर्स जैसे की ऑर्थो–सिलिसिक एसिड, सैलीसिलिक एसिड और थायोयूरिया का कीटनाशकों के साथ प्रयोग से ओलावृष्टि के बाद फसलो में नुकसान से उबरने में तेजी पाई गई।

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Executive Summary

The institute being in its formative stage witnessed developmental activities in terms of infrastructure, Model Research Farm and procurement of high end equipments. Construction of office-cum-admn. block is nearing completion while some of quarters have been occupied. Additional land area of 3.0 ha has been acquired in Baramati for construction of residential complex.

CO_2 fluxes monitored using Eddy covariance system revealed that dhaincha and wheat ecosystems had seasonal averages of net CO_2 exchange rate of 1.5 and 2.1 µmol $m^{-2}s^{-1}$, respectively. Determinate and indeterminate soybean genotypes varied in light saturation point. Ortho silicic acid applied @ 4 ml L^{-1} enhanced root growth and yield of wheat under soil moisture stress. This was also effective in soybean. Bioregulators like thiourea could alleviate the water stress in wheat as indicated by lesser impact of reduced quantities of applied water on yield. Wheat did not respond to increased N doses (150 kg N ha^{-1}) when water applied was below 27 cm.

The constitutive leaf rolling was observed in some of the wheat genotypes even in the absence of soil moisture stress. *In vitro* methods to screen wheat seedlings for root system could differentiate genotypes varying in plant biomass. No differences were observed in waxy and non-waxy plants for their capacity to keep canopy cool. Lok-1 had higher rate of grain growth even under high temperature and restricted soil moisture conditions. A gene vector for silencing Gm-farnesyl transferase associated with drought tolerance was constructed. Procedure was optimized for screening soybean lines with thermal imaging system. Performance of four genotypes viz., JS-20-70, CAT-3041, MAUS-704 and JS 88-21 was better than the best local variety under deficit soil moisture condition. Early flowering genotype ML-2037 of mungbean had higher yield than the local variety (BPMR-145). This genotype was featured by maximum pod length and seeds/pod. *Bradyrhizobium* isolates (USDA 61, USDA 94 and USDA 110) superior to local varieties enabled plants to produce more root nodules, biomass and grain yield under water stress conditions. Nearly 70 % farmers experienced above 30 % yield losses in onion production due to drought in 2012-13 and unseasonal as well as excess rainfall in *kharif* of 2013.

The use off bar cum fertilizer drill machine in the farmers' fields improved growth of sugarcane ratoon crop. Twelve genes isolated from saline-soil meta-genomes were sequenced and were submitted to GenBank database. Silver-ion-exchanged zeolites having bactericidal activity against fish pathogenic bacteria *Aeromonas hydrophila* were identified. A process was developed for one step synthesis of bactericidal silver nanoparticles from tissue extracts of *Labeo rohita*. Tolerance of Singhi to rising temperature as indicated by CTmax for loss of equilibrium increased @ 1.34 °C for each degree rise after acclimation at 28-34 °C. Mealybug infestation was predicted to increase with climate change and thus can negatively impact crops like cotton. Cultivation of crops like sugarcane, lucerne and napier grass resulted in faster disintegration of murrum. Long term experiments were initiated to assess the impact of filling mixtures and planting methods on productivity of fruit crops such as sapota, guava and pomegranate in shallow basaltic soils. The institute implemented the TSP programme in 25 tribal villages of Navapur tehsil of Nandurbar district. There was significant improvement in awareness among the farmers. The productivity of crop such as rice increased by 2.5 times and the area with improved cultivation practices increased from 110 to 758 acres.

The region witnessed unprecedented damage to crops by hail during February -March, 2014. Application of growth regulators such as ortho-silicic acid, salicilyc acid and thiourea along with pesticides could accelerate post-hail recovery in horticultural and field crops.

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1. Introduction

Farmers, scientific communities and policy makers are always concerned about adverse impacts of abiotic stresses on agriculture. However, the renewed and immense significance has emerged from increasing concerns that their intensity and adverse impact can amplify manifold with climate change and over exploitation of natural resources. Nevertheless, the abiotic stresses even at present level of magnitude are likely to be major concern as dependence of food security for ever increasing population will tend to incline towards fragile agro-ecosystems. Since the productive land are gradually declining with anthropogenic activities, there is a need of well planned basic and strategic research to manage abiotic stresses in agricultural commodities viz., crop plants, livestock, fish and poultry especially in arid and 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 to abiotic stresses. With substantial agricultural land in tropics and subtropics, India is more challenged with penultimate combinations of abiotic stresses spatially and temporally. Though the country has witnessed the bumper food grain production during the recent past, the threat of adverse climate on long term productivity cannot be ignored. Therefore, there is an urgent need to take up focused research on this important area and hence institute has definite role to play for food security in India.

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

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

Role of the Institute

The institute 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, institute 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.

Mission

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

Mandate

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

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

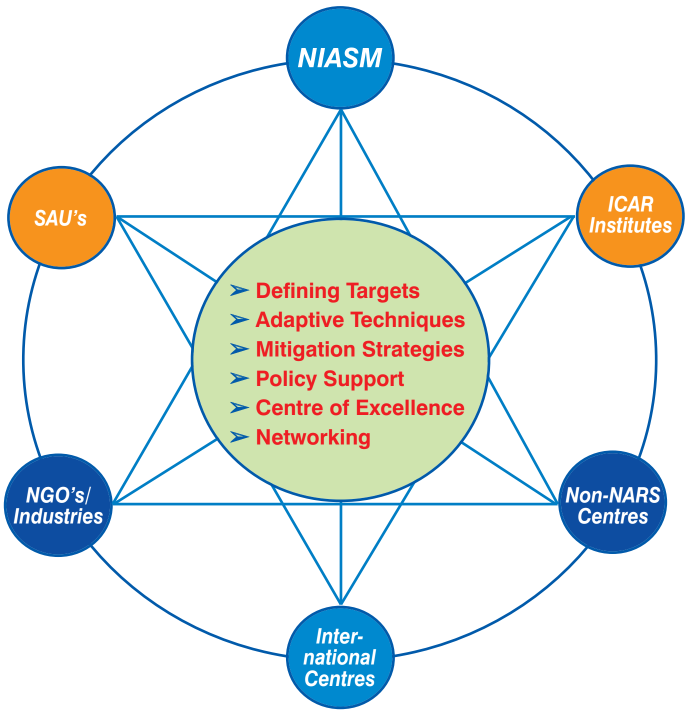

Fig. 1.1 Institute's strategy for achieving mandate

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

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

Status

The Moily Oversight Committee on OBC Reservations recommended the establishment of a dedicated research institute of Deemed-to-be-University status on Abiotic Stress Management. In XI plan, the proposal by Ministry of Agriculture was approved by the Union Cabinet to establish "National Institute of Abiotic Stress Management" with a legal status of Deemed-to-be-University under the Indian Council of Agricultural Research at Gat No. 35, Malegaon Khurd, Baramati, Pune, Maharashtra. After being established as a new institute for abiotic stress management in 2009, NIASM initiated its activities at the camp office at KVK, Sharadanagar, Baramati. The office was then shifted to Gat No. 35, Malegaon Khurd on November 1, 2010 after inauguration of Engineering Workshop by Hon'ble Union Minister of Agriculture and Food Processing Industries. At present, modular office, laboratory and committee room are housed in this 300 m^2 air conditioned workshop. Institute has initiated its developmental activities with emphasis on main building 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 is 34, 13 and 7 respectively. Thus the filled up cadre strength is 55 against 105 sanctioned posts (Table 1.1). The institute has initiated research through four schools with multi-disciplinary approach (Fig.1.2).

Cadre Strength

Table 1.1. Current cadre strength of NIASM, Baramati

Cadre	Sanctioned	Filled	Vaccant
Scientific	50+1*	35*	16
Technical	33	13	20
Administrative	21	06	15
Grand total	105	54	51
*Including Director			

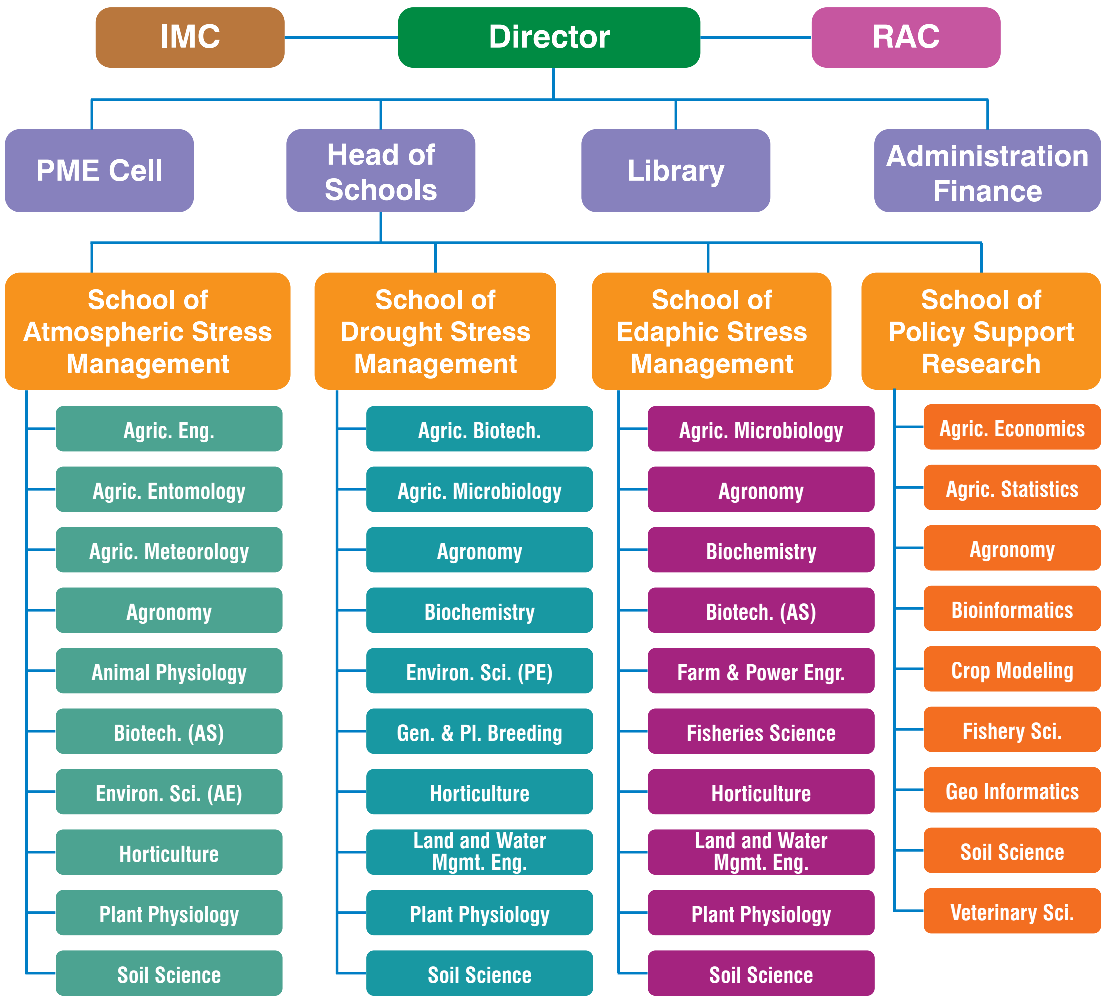

Fig. 1.2 Organogram of the institute

Research Programmes of the Institute

School of Atmospheric Stress Management

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

School of Drought Stress Management

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

School of Edaphic Stress Management

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

School of Policy Support Research

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

Infrastructural Development Activities

Construction work

Table 1.2 Status of ongoing works

Name of work	Status of Work
Office-cum-Admn. Block	RCC work, brickwork and plaster is complete for the entire building. POP work is in progress. Flooring work for Directors Cell, conference rooms, committee room, Admn. Section, Library (GF), Central store is complete. Flooring for Museum, Main corridor, common toilets, Library (FF), Dining (GF&FF) is in progress. Fixing of door shutters, window and structural glazing is in progress. Fixing of Aluminum Composite Panel (ACP) is in progress. Erection of truss and fixing of polycarbonate sheet in main corridor area is in progress (Fig.1.3.a).
Guest House	RCC and brick work for entire building is complete. Plaster and flooring work has also been completed (Fig.1.3.b).
Type VII (1) & IV (6) Quarters	The construction of quarters completed. The CPWD handed over the quarters to NIASM. All the quarters have been allocated and occupied (Fig.1.3.c & d).
NIASM's Residential Complex, MIDC, Baramati	An agreement among NIASM, Maharashtra State Road Transport Corporation (MSRTC) and Maharashtra Industrial Development Corporation (MIDC) was signed for handing over 30, 049 m^2 of land at MIDC, Baramati to NISAM for construction of residential complex. The layout of the complex is being finalized by Sr. Architect, CPWD, Nagpur.


(a)


(b)


(c)


(d)

Fig. 1.3. Construction of office-cum-admn. block (a) and guest house (b) in progress and type VII (c) and type IV quarters (d) completed

Farm Development

The institute is putting up intensive efforts to develop a "Model Research Farm" for 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 Southside and Northside farms.The south farm is divided into six main blocks in north-south direction by five main paths (4.5 m wide). Keeping in view the topography, a uniform slope upto 2% was maintained for preparation of farm paths. 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 68.5 m x 36.5 m size while rest is of 68.5 m x 78.5 m size.

Experiments were carried out with crops like soybean, guar, green gram etc. during *kharif* and with wheat, jowar, chickpea, sorghum and sugarcane in *rabi* (Fig.1.4). 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). Around two ha area has been reserved for setting up of an 'Integrated Farming System Model' and one ha for fodder purpose.

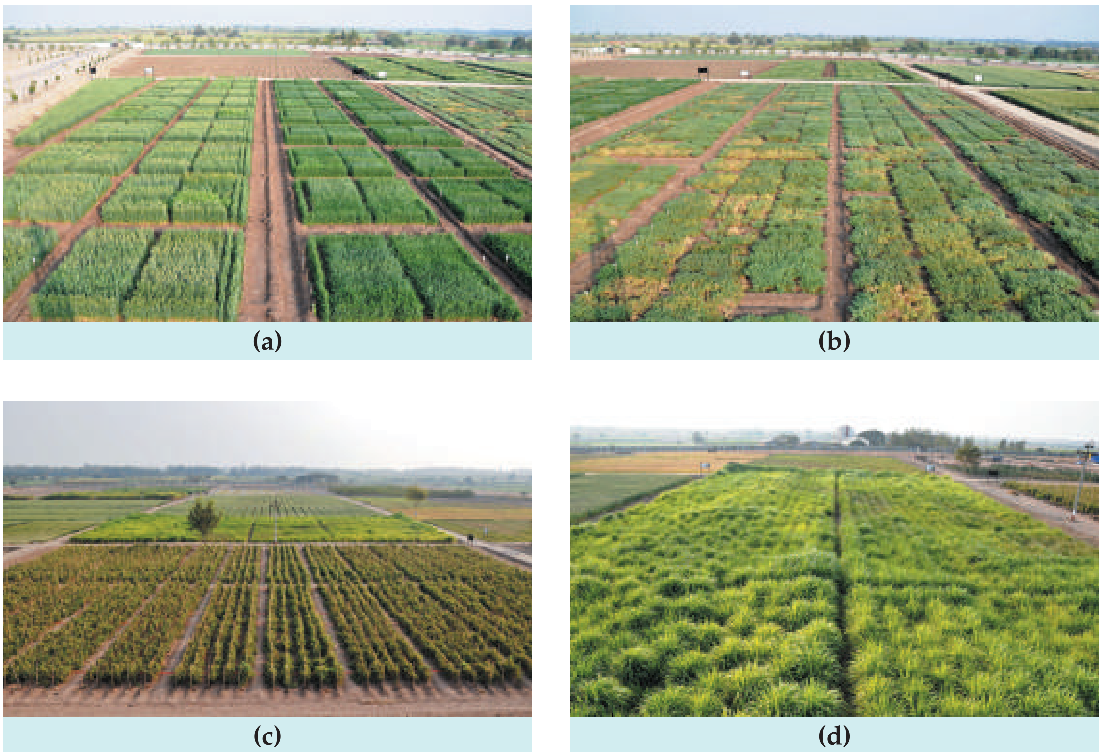

Fig. 1.4. Experimental field with wheat (a), chickpea (b), tomato (c) and napier grass (d)

The North side farm, with a total area of 11 ha, has an average slope of 4 %. This farm has been developed into 11 contour terraces with width of 30-33 m and riser height of 1-1.5 m. Terraces were divided into three major blocks (Fig.1.6). The length of terraces varies from 90-110, 170-200, and 160-200 m in A,B, and C blocks. Fruit saplings have been planted in all the terraces (Table 1.3). The drip irrigation system was designed and installed for all the orchard crops (Fig.1.5).

Table 1.3. Fruit crops planted in different terraces of the Northside farm

Terrace number	Area (ha)	Crop	Spacing (m)	Total plants
A_2	0.33	Acid lime	4.5 x 5.0	154
A_3	0.35	Sweet orange	4.5 x 5.0	176
A_4	0.33	Dragon fruit	3.5 x 3.0	330
A_5	0.33	Papaya	2.0 x 2.0	768
B_3	0.60	Pomegranate	4.5 x 3.0	420
B_4	0.60	Mango	4.0 x 3.0	480
B_5	0.62	Grapes	2.7 x 1.5	1392
B_6	0.62	Custard apple	4.0 x 4.0	390
B_7	0.39	Date palm	8.0 x 8.0	61
C_5	0.40	Pomegranate	4.5 x 3.0	380
C_6	0.54	Guava	4.5 x 4.0	300
C_7	0.69	Sapota	5.0 x 5.5	250

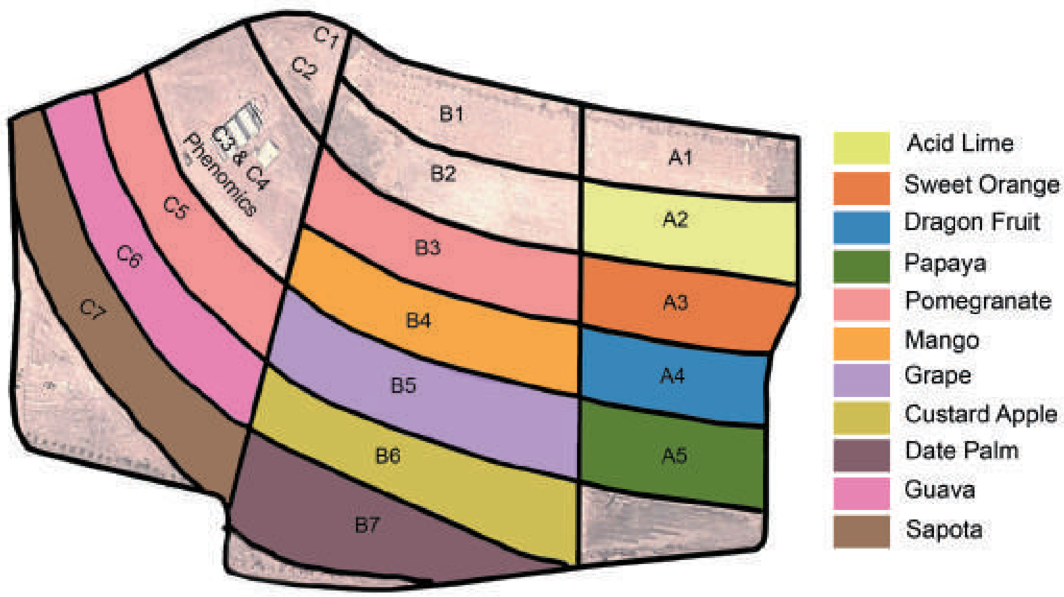

Fig. 1.5. Present layout of irrigation network on Northside farm

Development of this unique farm required heavy machineries like dozer (3500 hp), 200 DX with breaker and excavator, post hole auger digger, 55 hp tractor with front dozer, tractor trolleys and enormous man-hours as the plots were rocky, full of stones and murrum layers. Beside this, micro blasting was also carried out to break the underneath rocky layers and to facilitate ripping (Fig.1.6a and b). While developing these fields, murrum and boulders in the soil were removed using JCB/Poclain and used as base for laying the farm paths and roads in the campus.

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. A total of 48 outlets across the blocks have been provided to facilitate irrigation in each plot. Drip system for the northern terraces as well as for peripheral plantations have been installed (Fig.1.6c and d).

Fig. 1.6. Orchard establishment: auger holes and trenches for filling soil mixtures (a, b), orchards of papaya (c) and pomegranate (d).

Foreseeing the increasing trend of drought coupled with shallow soil depth at NIASM site, it was decided to plant low water requiring trees along the road. More over ornamental trees have been planted only in the 650 m stretch of main road from entrance to the turning for office-cum-admn. block. For this 2-tier system was followed, keeping bottle palm spaced 8 m between plants on either sides of the road and a row of *Ficus* planted inside to the rows of palm. For the road, thereafter up to the main building, similar pattern of planting was followed with *Terminalia* and *Bougainvillea*, respectively. Saplings of coconut (var. Banewoli) were planted along the peripheral road (Fig.1.7). Inner side of the peripheral road has been planted with sapota, jamun, kanchan, ramphal, sitaphal, aonla, tamarind, teak, bael, wood apple and dwarf coconut plants.

Fig. 1.7. Avenue plantations: bottle palm (a) and coconut plantation along boundary wall (b)

Research Laboratory

The research laboratory was further strengthened by procuring sophisticated equipment to upgrade it into state-of-the-art laboratory (Fig.1.8). The institute procured equipment worth 3.98 crores during the year and these include; HPLC with multi detectors and sensors, Tetrad PCR, Vertical Ultralow Temperature Freezer, Hyper-Spectroradiometer, Atomic Absorption Spectrophotometer, Environmental Shaker, Ultra Centrifuge, Refrigerated Centrifuge, Plant Stress Device, Kjeldahl Digestion and Distillation System, BOD Incubator, Online Water Purification System, Porometer, Guelph Permeameter Kit, Advance Microwave Digestion System, Real Time PCR, Laboratory Incubators, Deep Freezer, Net Radiometer, Water Quality Monitoring System, UV Trans-illuminator, GLC System, Clean Airflow Chamber, Flame Photometer, Motorized Sampling Auger, Top Pan Balance, Multisample Concentrator, Electronic (Analytical) Balances, Advanced Photosynthesis System, IR Thermometer, Line Quantum Sensor & Leaf Area Meter, Soil Moisture Meter, Eddy

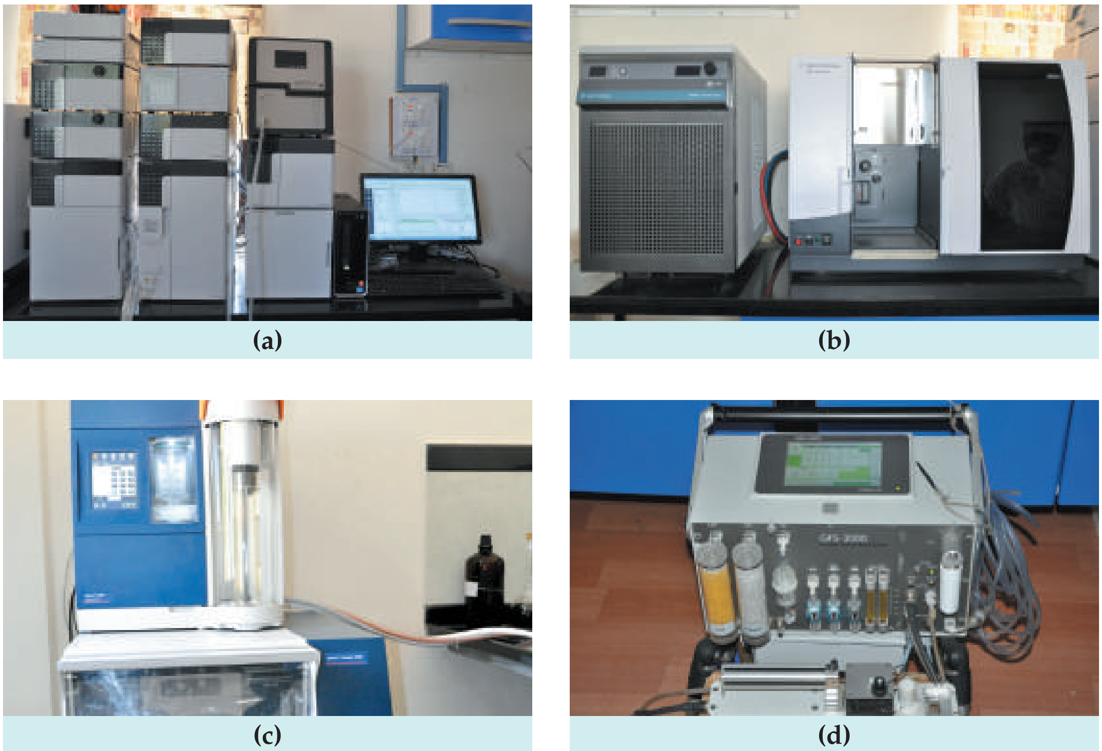

Fig. 1.8. State-of-the art research laboratory equipped with HPLC (a), AAS (b), Kjeldahl Digestion and Distillation System (c) and IRGA with external Fluorescence (d)

Correlation System, Bowen Ratio System, Infrared Thermal Imaging System and Real Time Chlorophyll Fluorescence System.

Library

The Institute library has a good collection of books with areas related to agriculture, animal husbandry and basic science subjects to achieve the mandate of the Institute. Presently, library acquisitions include 932 books, 204 annual reports and other documents like newsletters of NAAS institutes and other open source articles. Looking into the storage, retrieval and future aspects, online access to electronic version(s) of 16 international journals were planned and the access to 5 journals has been activated on the static IP of the Institute. The journals of Plant Cell and Environment, Regional Environmental Change, Agricultural Research and Current Science have also been received in the library. The Institute is also has access to e-journals through CeRA (Consortium of e-Resources in Agriculture).

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2. Research Highlights

School of Atmospheric Stress Management

Monitoring of agro-ecosystem based fluxes of greenhouse gases

Fluxes of CO_2, the most important greenhouse gas, were quantified using the open path Eddy covariance technique from dhaincha grown under rainfed conditions and wheat under irrigated conditions in a shallow basaltic soil. During the 90 days of study (Aug.-Nov., 2013) field sown to Dhaincha released CO_2 at an average rate of 4.1 μmol $m^{-2}s^{-1}$ during night whereas, net CO_2 uptake during the day hours was 7.1 μmol $m^{-2}s^{-1}$ (Fig.2.1). The extreme rates of net ecosystem exchange (NEE) of CO_2, averaged over half-hourly time bins throughout the season were featured by 18.2 μmol $m^{-2}s^{-1}$ of net emission and 43.1 μmol $m^{-2}s^{-1}$ net uptake by the crop. However, seasonal average of nighttime CO_2 emission rate in wheat grown during winter (Dec. 2013-Mar. 2014) was 2.7 μmol $m^{-2}s^{-1}$ where as that of daytime uptake rate was 6.9 μmol $m^{-2}s^{-1}$. Dhaincha and wheat ecosystems, acted as CO_2 sinks with seasonal averages of net uptake rate of 1.5 and 2.1μmol $m^{-2}s^{-1}$, respectively.

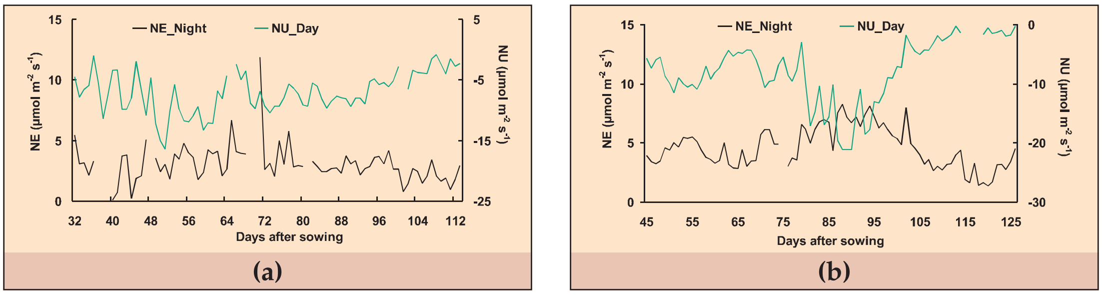


Fig. 2.1. Net ecosystem CO_2 exchange rate during the growing season of dhaincha (a) and wheat (b)

Radiation use efficiency of soybean

Atmospheric brown clouds (ABCs) are basically layers of air pollutants such as black carbon (BC), organic carbon, and dust, which absorb and scatter solar radiation. The nucleation of clouds by aerosols reduces the precipitation efficiency of clouds that further changes the PAR (phtosynthetically active radiation) and thereby alters radiation use efficiency (RUE) of crops. Being a photosensitive crop, soybean is prone to low radiation. Therefore, an experiment was conducted to assess genetic variations in plant responses to low radiation under octagonal shade frustum with green net that could intercept 25 per cent of radiation. There were differences between semi-determinate and determinate genotypes in their net photosynthesis (PN) under reduced phtosynthetically active radiation (PAR) and this was also reflected in their grain yield. The yield obtained in semi-determinate genotype (MACS-1188) was more (3.48 Mg ha^{-1}) than that of the determinate genotype (KS-103; 2.72 Mg ha^{-1}). Further, the genetic variation in light saturation points (LSP) was also observed in these genotypes (Fig.2.2).

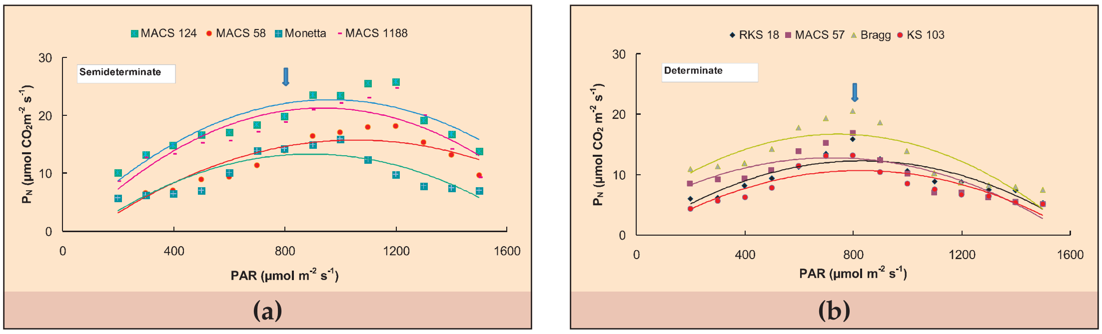


Fig. 2.2. Light saturation point for CO_2 assimilation in semi-determinate (a) and determinate (b) soybean genotypes

Silica as a bioregulator to alleviate water stress

Numerous studies in the past have proved the physiological and biochemical impact of silicon as fertilizer in crop plants. Such fertilizers have been applied to plants through soil application and foliar sprays. Silicon rarely available in free form in soils as it combines with oxygen to form oxides and silicates. Since absorption of silicon by crops is in the form of silicic acid, which changes to irreversible amorphous silica, use of silixol a formulation with an active ingredient of ortho silicic acid (OSA), non-toxic to crops can provide multiple benefits. In an experiment with application of silixol through foliar spray (0, 2, 4, 6 and 8 ml L^{-1}) and soil application (0, 4 and 8 ml L^{-1}) in wheat,it was observed that the OSA @ 4 ml L^{-1} can significantly influence root growth even under water stress (WS) conditions. The nutrients content such as K, P and Si increased in straw and grain under water stress and the silicon present in grain was found to be associated with that in peduncle (r^2=0.87). These results partially explain the potential of ortho silicic acid to enhance wheat yield under WS condition.

Crop water production functions using line source sprinkler system

Installation of line source sprinkler system

Two sets of line source sprinkler (LSS) system of eight sprinklers spaced at 6.1 m were installed to get a usable experimental plot area of size 24.4 m x 24.4 m under each set. The spreader type split nozzles and other pipe accessories produced by Jain Irrigation, Jalgaon was utilized to design system. The sprinkler system was operated at approx. 300 KPa pressure, which an area within 28 to 30 m diameter depending upon the wind speed. The symmetrical water distribution pattern was monitored by using a series of PVC catch cans placed perpendicular to the line source system at 2 m spacing. The decrease in water distribution was observed with increase in distance from main line of LSS. The maximum water of 18-20 mm h^{-1} was receiver near the main line while it was minimum (0-0.5 mm h^{-1}) at 15.0-15.5 m distance.

Response of the bioregulators and nitrogen application

A field experiment was conducted to study the effect of bioregulators and nitrogen levels for determining the water production functions of wheat (HD-2189). Treatment combinations consisted of (i) spraying of five bioregulators namely; thiourea (10 mM), salicylic acid (10 µM), silixol (80 ppm), KNO_3 (1.5 %), GA3 (25 ppm) with control (water only) applied at vegetative, flag leaf and grain formation stage in the main plots and (ii) fourteen irrigation levels (39.0, 37.0, 35.0, 33.3, 31.6, 29.9, 28.2, 26.0, 23.9, 21.8, 19.8, 17.8, 15.8 and 13.1 cm) in sub plots. The grain yield obtained from subplots across the line source sprinkler reflected the effect of applied water. The reduction in yield obtained were 80, 73, 61, 54, 41, 35, 25, 14, 12, 9, 8, 5 and 4 % when applied water equaled to 13.1, 15.8, 17.8, 19.8, 21.8, 23.9, 26.0, 28.2, 39.0, 29.9, 37.0, 31.6 cm as compared with 33.3 cm. Similarly, bioregulators specifically thiourea helped to alleviate the effects of water stress. The reduction in yields obtained with applied water (13.1 cm) were 75, 73, 82, 84,79 and 88 % with thiourea, salicylic acid, silixol, GA3, KNO_3 and control, respectively (Fig.2.3 a).

The effect of bio-regulators was visualized in terms of wheat plant canopy parameters like the highest chlorophyll conten and relative water content of leaves. The minimum canopy temperatures (29-31°C) with high relative water content (70 % w/w) and the maximum SPAD chlorophyll meter reading (48) was observed in thiourea treated plants even at the maximum water stress vis-a-vis minimum water applied condition.

In another experiment the interactive effect of applied N and applied water was studied. Treatment combinations consisted of (i) 4 N levels (60, 90, 120 and 150 kg ha^{-1}) in main plots and (ii) fourteen applied water levels (38.5, 36.6, 34.6, 32.8, 31.1, 29.9, 28.7, 26.8, 24.8, 22.9, 20.9, 19.1, 17.2 and 14.7 cm) in sub-plots. The N applied @ 150 kg ha-1 produced the maximum grain yield until the water applied was 22.9 cm, below which the yield declined steeply (Fig.2.3b). The wheat yields were 80.3, 73.5 and 104.1 per cent when applied N was 60, 90 and 150 kg ha^{-1} respectively as compared with 120 kg ha^{-1} (4.62 Mg ha^{-1}) at the optimum applied water (38.5 cm) while these were reduced to 84.2, 75.2, 70.7 and 73.1 % with N application of 60, 90, 120 and 150 kg ha^{-1} respectively when the water applied was the lowest (14.1 cm).

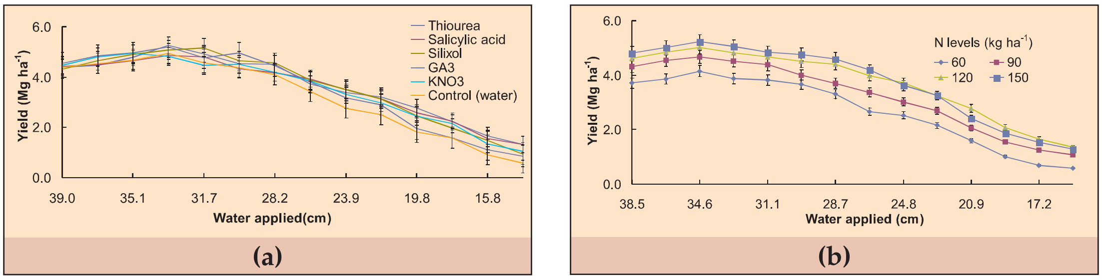


Fig. 2.3. Grain yield of wheat in response to growth regulators (a) and applied nitrogen (b) at different levels of irrigation

Response of wheat varieties to bioregulators

Differential responses in wheat varieties namely HD-2189, Lok-1, NIAW-301, NIAW-34 and PBW-550 were assessed for their responses to Silixol (OSA) and Thiourea. Variety HD-2189 and PBW-550 had higher yields than other varieties. The yield increased in HD-2189 ranged from 10 to 30 % with OSA and 10 to 35 % with thiourea while in PBW-550 it increased by 8 to 25 % and 7 to 28 % with OSA and thiourea, respectively as compare to control.

Soybean response to bioregulators and applied water

The interactive effect of bioregulators and water applied on soybean (J-335) was studied during the *kharif* season of 2013-14 using line source sprinkler system. The field layout consisted of 24 blocks each of size 15 m x 2 m divided into seven subplots. Treatment combinations were (i) spraying of 6 bio-regulators, namely; thio-urea (10 mM), salicylic acid (10 μM), silixol (160 ppm), KNO_3 (1.5 %), GA3 (25 ppm) and water (control) at flag leaf and grain formation stages in main plot and (ii) six levels of irrigation water (31.8, 29.0, 25.9, 22.7, 19.9 and 17.2 cm) applied in four (three sprinkler and one flood) irrigations in sub-plots replicated four times in a split plot design. Apart from irrigation water, the crop received 39.1 cm rain. The highest (2.15 Mg ha^{-1}) yield was obtained with application of salicylic acid. The yield was decreased with reduction in amount of water received from the sprinkler. The yield was reduced to 91.6, 83.8, 78.4, 70.3 and 62.4 % when applied water was 29.0, 25.9, 22.7, 19.9 and 17.2 cm, respectively (Fig.2.4).

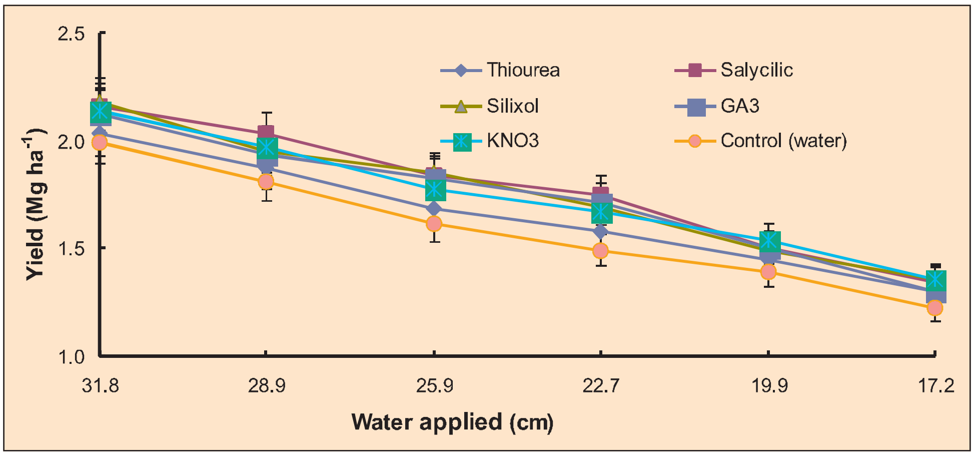
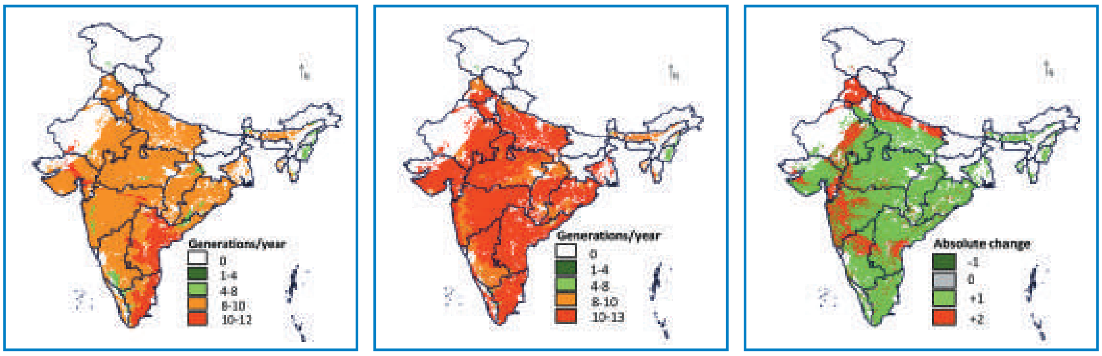


Fig. 2.4. Response of soybean to bioregulators and applied irrigation water

Predicting the impact of climate change on abundance of mealybug

Mealybug is a highly invasive and polyphagous pest of global incidence. An analysis was carried out to study the hypothesis that the temperature variations due to global climate change may affect the future distribution and abundance of the pest and aggravate the crop yield losses. A temperature-based phenology model of *P. solenopsis* in a geographic information system was used for mapping its population growth potentials. The three risk indices viz., establishment risk index, generation index and activity index were computed using interpolated temperature data from Worldclim database for current (2000) and future (2050) climatic conditions. Under current temperature conditions *P. solenopsis* can complete > 4.0 generations per year on ~ 80 % of the cotton production areas but economic losses are likely to occur in areas where at least 8.0 generations can develop in a year; under current climate ~ 40 % areas fall under this category (Fig.2.5). Analysis of increase in population within year at various selected locations in India revealed that *P. solenopsis* attained maximum potential population increase during May-June to October-November i.e. cotton growing season. However, the innate ability of *P. solenopsis* population reduced considerably during off season and cooler winter months. The increased pest activity of *P. solenopsis* due to climate change may intensify the losses in cotton yield.



(a) (b) (c)

Fig. 2.5 Prediction of change in number of generations of *P. solenopsis* in cotton areas based on generation index (GI) for current (a) and future (b) climatic conditions and absolute change in GI (c).

Impact of spent wash and cropping sequences on soil development from murrum

A large area of barren and uncultivable terrain originated from superficially subdued basalt igneous rocks exist in peninsular India. These are porous, shallow in depth, gravelly, low in organic matterand have poor water retention capacity. Hence it is necessary to develop techniques for their quicker rehabilitation. Spent wash, an acidic by-product from sugar factory with high organic load, can accelerate disintegration of murrum into smaller particle. Such benefits for soil formation process can also be accrued by rhizo-depositions, release of organic acids and other metabolites during decomposition of organic residues and irrigation induced softening of murrum. Keeping this in view a long term experiment was initiated during 2012-13 to evaluate the effect of spent wash, cropping sequence and applied water in murrum disintegration. A total of 13 treatments; 10 under irrigated conditions viz. sugarcane cropping with and without spent wash, soybean-wheat, lucerne, maize-sorghum, subabul and napier grass and three under rainfed conditions viz., subabul, anjan grass and sorghum are being replicated four times in randomized block design.The pH of raw spent wash and post methaneted spent wash was 3.8 and 6.75, respectively and it was also analyzed that raw spent wash was having higher concentration of EC, TSS, TDS, OC, total P and total K as compared to post methaneted spent wash. The spent wash has been initially applied @ 0.4 ML ha^{-1}. The experimental field was prepared after ripping and levelling of the experimental rocky and undulated land. Thereafter, dhaincha was cultivated and incorporated at 40 DAS. To further improve the soil, spent mushroom substrate was applied @ 17.5 Mg ha^{-1}. At the initiation of experiment, the soil fraction of the land was only about 23 per cent and rest of the fraction was gravels of different size. The soil was low in organic carbon (~0.07) and available N, P and K were ~14.7, 0.47 and 18.2 kg ha^{-1}, respectively.

With limited nutrient and moisture availability in the virgin soil, the performance of all these crops was poor. The yield obtained in food crops viz., wheat, soybean and maize was almost 50 % of their average yields while in fodder crops viz., napier and lucerne yield was recorded to the tune of 70 to 80 % and it was only 40 % in sorghum. Amongst rainfed crops, establishment of anjan grass was poor, while after establishment all the three crops performed satisfactorily. Application of spent wash improved the crop growth and yield. The applied water for the crops followed the order of lucerne > sugarcane > napier grass > soybean-wheat > maize- fodder sorghum > subabul. Analysis of soil in experimental field revealed the following trend in disintegration of murrum: sugarcane with spent wash > napier grass > lucerne > sugarcane > soybean + wheat with spent wash > soybean+ wheat > subabul > maize-fodder sorghum > fallow with spent wash > fallow under irrigated conditions while it was fodder sorghum > anjan > subabul under rainfed conditions (Fig.2.6).

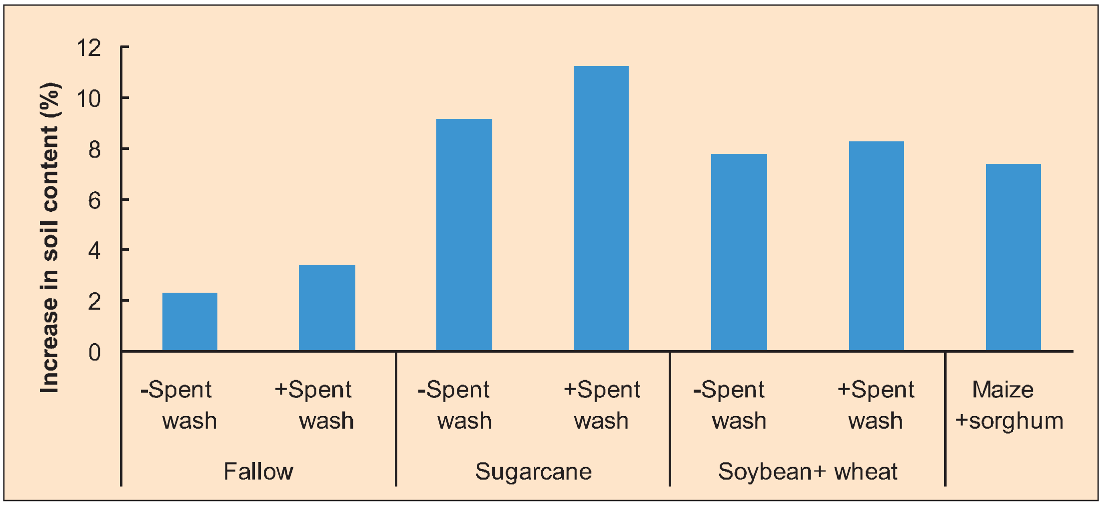


Fig. 2.6. Effect of cropping sequences and spent wash on soil content (< 2 mm)

Genetic polymorphism of heat shock protein (*Hsp*) genes among cattle breeds

The study was undertaken to develop molecular tools for identification of genetic markers associated with HSP genes in Indian dairy cattle, Sahiwal and Frieswal. Physiological parameters like rectal temperature (RT), respiration rate (RR), heat tolerance coefficient (HTC) and milk production traits (total milk yield) were associated with these genetic markers. The first of the two methods was based on PCR-RFLP that could identify the deletion of cytosine within the AP2 box of *Hsp70.1* promoter. Initially a set of primers were used to generate specific gene fragment. Further mutated set of primers were used to re-amplify the gene keeping the single ScrFI restriction site intact. Thus DNA band pattern generated by RFLP helped to diagnose the animal genotype. The second method developed was allele specific-PCR, used to identify the genotype of intronic region within *Hsp90AB1*. The results clearly indicated the genotype having SNP within *Hsp90AB1* (Fig.2.7). Double PCR-RFLP and allele specific PCR could easily detect the genotype of *Hsp* genes in cattle. These techniques will help to study the heat stress response in dairy cattle and further selection for the better relative thermo-tolerance and milk production traits.

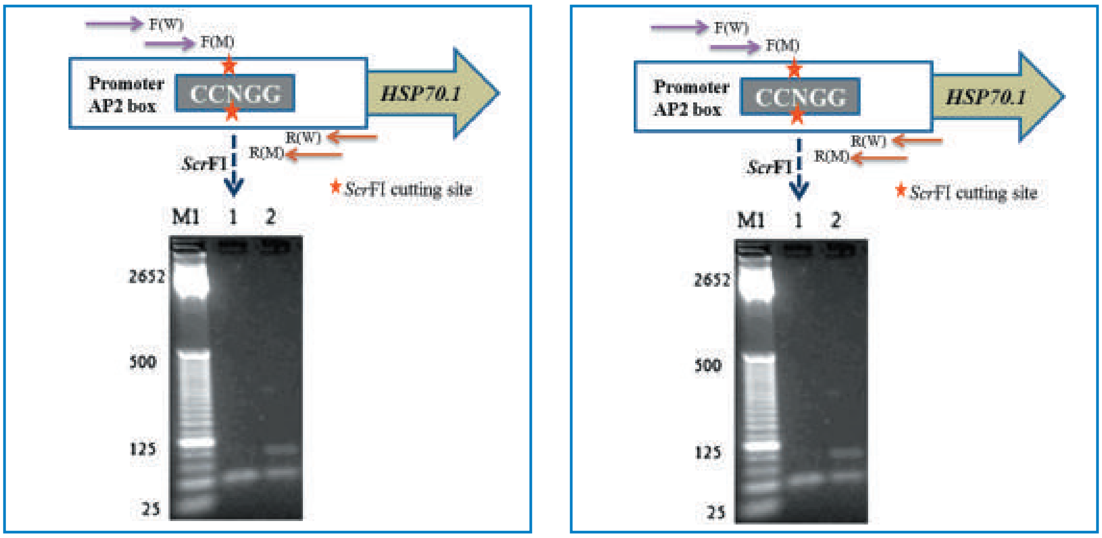


Fig. 2.7. Double PCR-RFLP for different bovine *Hsp70* AP2- box genotypes among Frieswal cattle M1: 25bp ladder; 1: wild type CC genotype,heterozygous mutant C- genotype

Assessment of hailstorm damage in Maharashtra

A number of hailstorm events during Feb-March severely damaged the crops in various parts of Maharashtra especially the high value crops. The recent hailstorms initially thought of as a one-off phenomenon, continued to batter various places of the Maharashtra particularly western zone. Usually, hailstorm activity occurs during the months of April and May, but this time it occurred during Feb-March, which is a severe weather aberration. As per IMD the dynamic instability coupled with the sudden conflict of the easterlies and westerlies and availability of moisture has caused this hailstorm phenomenon particularly in western zone.

Hailstorm damage assessment in Maharashtra

Nagpur district with 25 % losses was the worst hit bythe hailstorm which caused havock in the Marathwada region with huge losses in Osmanabad, Latur, Parbhani, Jalna and Aurangabad districts. Comparatively the extent of losses was less in Northern and Western Maharashtra regions. Economic losses were more mainly because of damage to the high value crops like pomegranate, grapes, papaya, watermelons, onion, vegetables and sugarcane. The damaged crops comprised of wheat, chickpea, sorghum, sugarcane, pigeon pea, onion, tomato, cabbage, and the perennials/orchards crops viz., grapes, mango, acid lime, sweet orange, pomegranate, water melon etc. Due to the impact of large hailstones fruit crops had primary injuries like stem lesions, broken branches and heavy defoliation, resulting in severe cases of like dieback, reduced height increments, staining, bruises, fungal and bacterial infections, blights and rots. Interestingly, the lesions/damage occurred mostly in stems or branches on windward side of the tree. Among fruit crops, the severe impact of hailstorm was noticed in papaya, grapes, pomegranate, watermelon etc. The fruit quality severely deteriorated in grapes, watermelon and was not up to the market standard.

In addition to the losses in high value agri-horticultural crops, the damage to farmland properties like polyhouses, greenhouses, cattle and poultry shades was considerably high. Approximately 2700 farm animals including cattle, sheep and goats and poultry birds have been reportedly died due to hail damage accounting huge economic losses to the farmers (Fig.2.8).

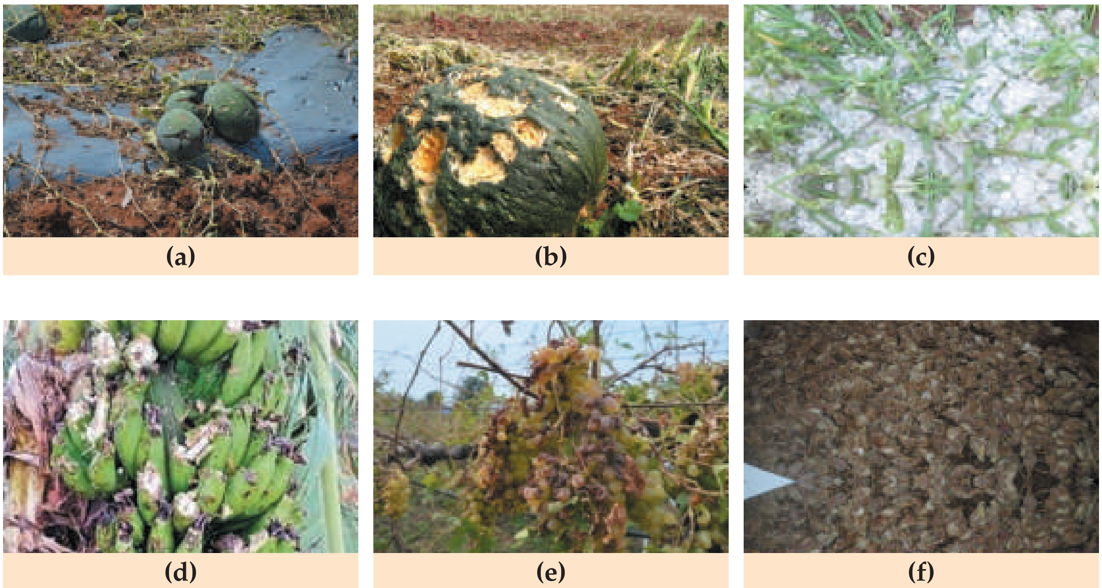


Fig. 2.8. Impact of hailstorm on vegetable crops (a, b, c), fruit crops (d, e) and poultry (f) (Courtesy: Sakal and Agrowon)

The institute campus at Malegaon also witnessed unprecedented hailstorm on March 9th for about 23 minutes (Fig.2.9). Various experiments with *rabi* crops and orchards were severely damaged by the hailstorm.

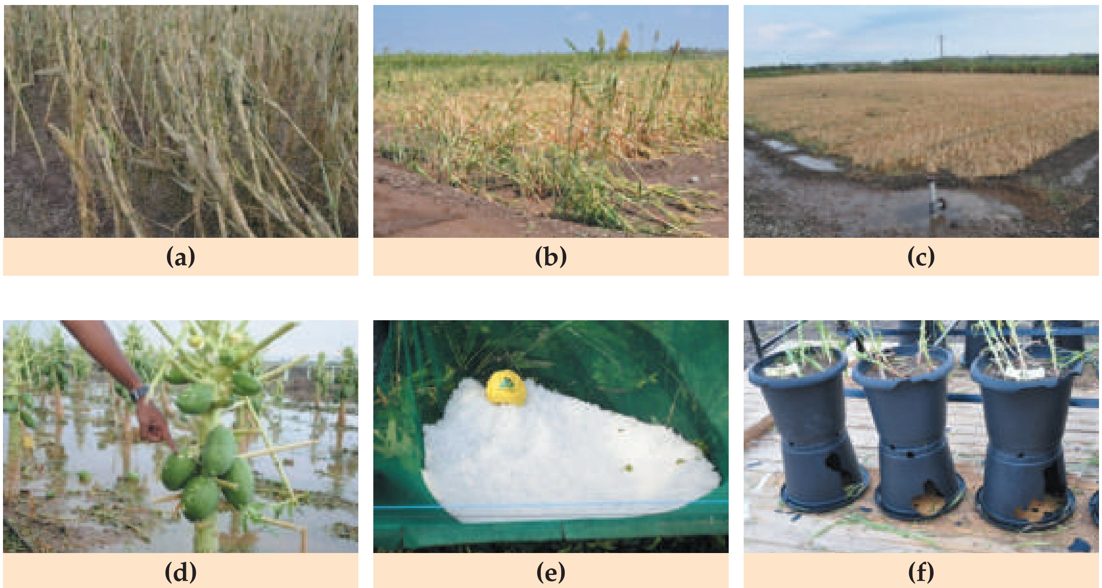


Fig. 2.9. Damaged crops of maize (a), sorghum (b), wheat (c), papaya (d) and the shade net (e) and pot experiments (f) due to hailstorm at NIASM site

Experiments were initiated to hasten the recovery of damaged crops and minimize risks of pests and disease through foliar and soil applications of fertilizers and bioregulators in addition to various pesticides. Salient observations are as follows.

i. Wheat crop was completely damaged and flattened due to heavy and intense hails. It looked as if the crop was harvested with combine. The immediate objective was to take up a catch crop that can effectively utilize stored soil moisture. Hence, mungbean crop was direct seeded with or without residues left on the surface. Though its performance was not up to the mark due to unseasonal crop and suppression with weeds and germination of shattered wheat seed but, it would cover up some losses, it is expected that the productivity of the succeeding crop will improve through symbiotic N fixation (Fig. 2.10a).On the contrary, the mungbean sown after hailstorm on ridges vacated by chickpea was performing well and application of vigore, an organic formulation has further improved its growth and pod formation (Fig.2.10c).

ii. Hailstorm severely damaged foliage and cobs of maize (Fig.2.10b). The effect of different bioregulators was also assessed on hailstorm damaged maize plants. Grain weight of major cob increased due to salicylic acid and urea drenching especially when damage to cob was less than 20 %, while recovery was not possible when the damage to cobs was more than 20 % (Fig.2.10d).

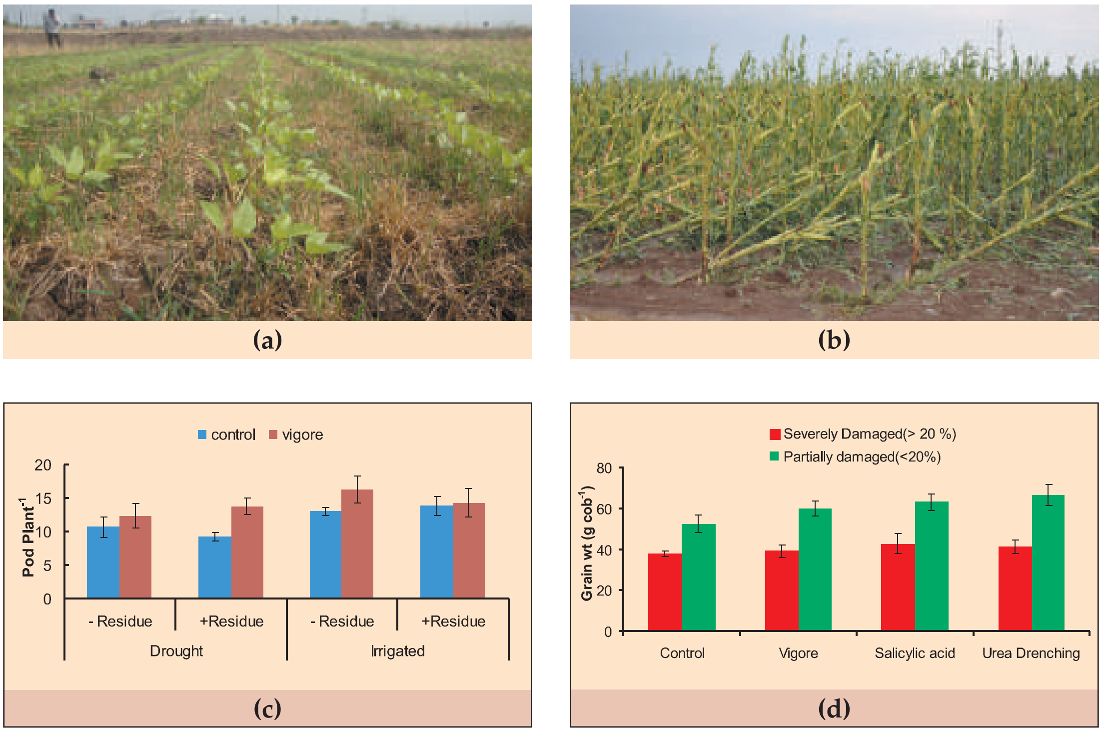


Fig. 2.10. Mungbean seeded in wheat field (a), maize field (b) after hailstorm and effect of vigore (0.62 kg ha^{-1}) in mungbean (c) and effect of bioregulators on grain weight of maize (d)

iii. Two month old sugarcane crop damaged by hailstorm was first treated with foliar spray of Bavistin + Copper oxychloride mixture @ 2 g L^{-1} and responded well to additional N (50 kg ha^{-1}) applied along with either spraying of KNO_3 (1.5 %)or drenching withNPK (2 % of each) (Fig.2.11).

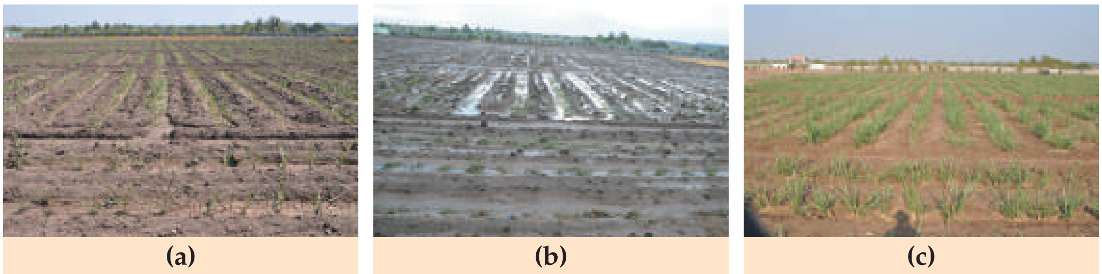


Fig. 2.11 Sugarcane crop 20 days before (a), on the day (b) and 26 days after (c) hailstorm

iv. Pruning, removal of broken twigs and fertigation through drip also helped to recover custard apple orchard, which was severely damaged by hailstorm, while guava showed no recovery (Fig.2.12).

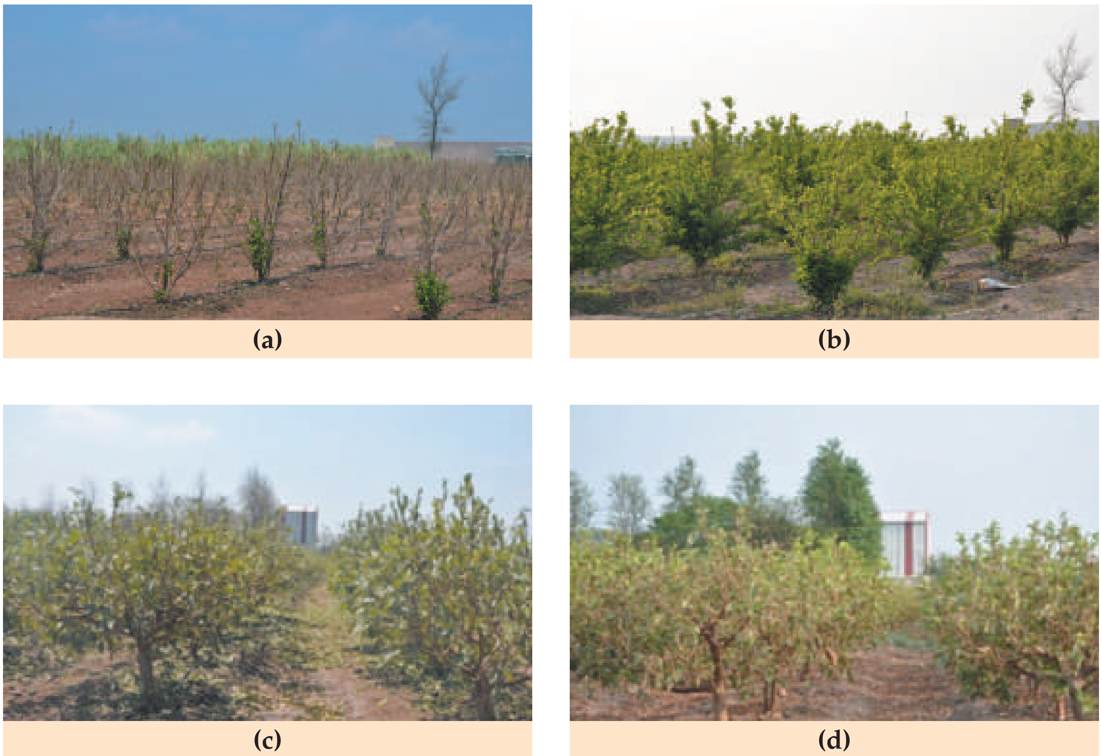


Fig. 2.12. Custard apple a day after (a) and about a month (b); guava a day after (c) and 27 days after (d) hailstorm

v. Pomegranate, which was almost totally defoliated, had broken twigs and had all its flowers and fruits withered could recover rapidly from hail damage in response to post -hailstorm management that included application of bioregulators and pesticides. Copper oxychloride was sprayed the day after hailstorm to prevent secondary infection and then plants were treated with chemicals like cytozyme (100 ppm), vigore (0.1 %), thiourea (0.02 %), potassium nitrate (2 %), hydrogen cyanamide (0.02 %), silixol (4 ml L^{-1}), C7 (bio-formulation which can prevent fungal infection and stimulate the growth). This helped in recovery of plants to original level in about a month (Fig.2.13).

(a) (b) (c)

Fig. 2.13. Pomegranate orchard; 20 days before (a), on the day (b) and 26 days after (c) hailstorm

vi. Watermelon field of a farmer, who decided to replant the crop after huge damages due to hailstorm, was adopted to assess the effect of ortho-silicic acid (OSA) based formulation for stimulating the crop growth. There was an increase in the greenness of foliage, number of flowers, and fruit size within a short period in response to application of OSA through drenching 20 days after planting (DAP) and again through foliar spray (4 ml L^{-1}) 60 (DAP) which coincided with initial fruiting stge. The crops drenched and sprayed with OSA produced very bigger size fruits (5 - 6.5 kg $fruit^{-1}$) than control (2.5 – 4 kg $fruit^{-1}$) without compromising much on fruit numbers per vine (Fig.2.14). The timely intervention and application of bioregulators produced bigger and high quality fruits. The farmer earned more than Rs. 2 lakhs per acre as the demand for water melon was more due to damage of crop in other parts of the state.

(a) (b)

Fig. 2.14. Watermelon field with (a) and without (b) OSA

vii. Cutting management (10-15 cm above ground level) and sprays of thiourea and also the KNO_3 helped in fast recovery of indeterminate crop of brinjal that was severely damaged with hail. The plant vigour and number of fruits also increased with these treatments (Fig.2.15)

Fig. 2.15. Brinjal crop damaged by hailstorm (a) and recovery after 30 days (b)

School of Drought Stress Management

Traits and genes associated with drought tolerance

Several traits have been proposed to be associated with mechanism of adaptations to drought in plants but no single trait in isolation can determine the crop productivity under limited soil moisture condition. Hence, experiments were initiated to investigate traits associated with drought tolerance and possible links between known traits that have been reported to influence the survival and yield of crop under water stress.

Epicuticular wax and canopy temperature in wheat

Sixty wheat genotypes were evaluated for genetic variation in drought tolerance traits, viz. leaf waxiness, leaf rolling and tillers. These were grouped for waxiness in stem, leaves, and all aerial plant parts. About 14 genotypes showed no waxiness, 17 genotypes showed waxiness in their leaves and 17 in both leaves and stem while 5 genotypes showed waxiness in all the aerial parts. Association between the waxiness and capacity of plants to keep its canopy cool was measured by the thermal imaging technologies. Day time canopy temperatures monitored at half hourly interval between 9.00 AM to 3.00 PM showed no difference between genotypes varying in epicuticular wax, which indicated little role of waxiness in transpirational cooling.

Leaf rolling and root traits

Leaf rolling is one of the trait exhibited by plants under water stress environments. Genetic variation for this trait was assessed in diverse set of 60 genotypes. There was no leaf rolling in 30 genotypes while, 14 exhibited very less leaf rolling and 8 exhibited moderate leaf rolling. Only one genotype (IC-542040) showed very severe leaf rolling. Selected genotypes were also grown under *in vitro* conditions to establish association between leaf rolling and roots traits. The genotype IC-73489 showed no lateral roots and root hairs, while IC-542040 had vigorous root hairs in lateral roots. EC-104651 had roots with profuse lateral roots; IC-128364 had tiny lateral roots at proximal end only. Genotype IC-113729 showed lateral roots down to mid-length of roots, while IC-240878 had lateral roots down to distal end of the roots. Local varieties, viz. Lok-1, HD-2189 and Netrawati had profuse lateral roots. The genotypes, which exhibited very less leaf rolling under field condition, had profuse rooting and several lateral branches, while roots of plants with constitutive severe leaf rolling had no lateral branching in vitro. The genotypes, viz. Lok-1 and EC-104651 with higher root biomass showed no leaf rolling (Fig.2.16). Thus, the *in vitro* method for root architecture at early stages of growth could partially explain the leaf rolling beahaviour of wheat genotypes under field condition.

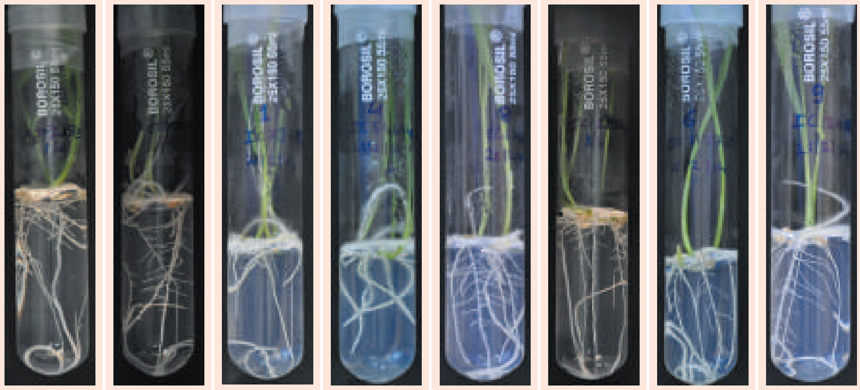
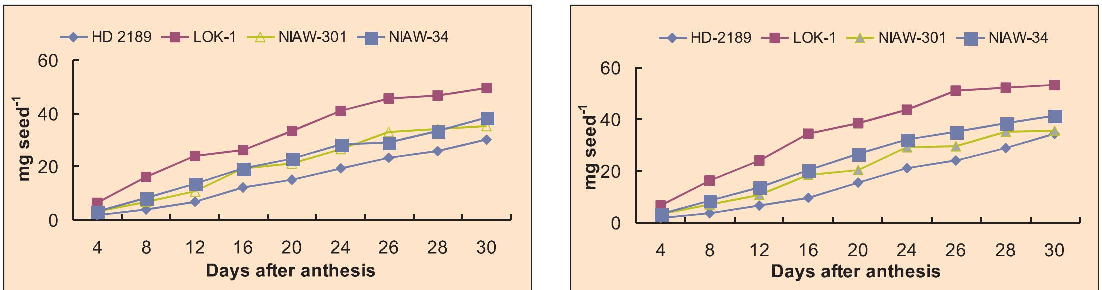
Traits	HD-2189	Netra-wati	IC-73489	IC-542040	EC-104651	IC-128364	IC-113729	IC-240878
Root architecture								
Root weight (mg)	106	58	61	77	120	80	85	90
Wax	Aerial parts	Leaves & stem	Leaves &stem	Aerial parts	No	No	Only leaves	Leaves & stem
Leaf rolling	Less	Less	Severe (Consti tutive)	Severe (Consti tutive)	No	No	No	No
Tillers	14	14	13	13	14	17	15	14

Fig. 2.16. Genetic variability in root traits among wheat genotypes

Grain growth rate

Grain growth rate is one of the important factor that governs the grain size and hence grain yield. Therefore the trait was assessed in local cultivars like Lok-1, NIAW-301, NIAW-34 and HD-2189. Grain weight was recorded at four day interval beginning from anthesis in crop grown with normal and restricted irrigation. Lok-1 had higher grain growth rate than other cultivars under both the conditions (Fig.2.17).



(a) (b)

Fig. 2.17. Variation in grain growth rate in local wheat varieties under restricted (a) and normal irrigated (b) conditions

Soybean cultivars with yield components

Thirty six soybean genotypes were selected based on previous year's performances for further evaluation under normal and drought conditions. Twelve cultivars had plant height more than the best local variety. Yield of four genotypes viz., JS-20-70, CAT-30-41, MAUS-704 and JS-88-21 was higher than the best local varieties under deficit moisture condition, while, seeds plant^{-1} were higher in MAUS-453 and CAT-30-41. Canopy temperatures measured by thermal imaging revealed that genotypes such as MAUS-470 can keep canopy cooler than MAUS-423 and CAT-91B (Fig.2.18).

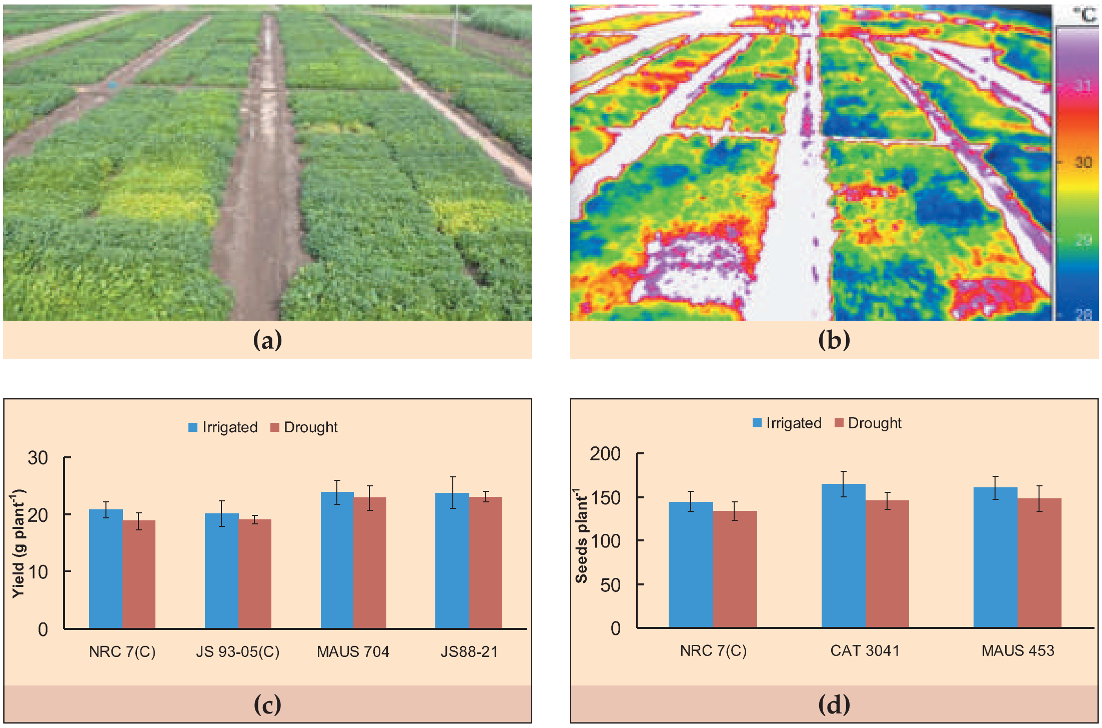


Fig. 2.18. Screening soybean genotypes for drought tolerance : genetic variation as depicted by visible (a), infrared (b) images, grain yield (c) and seeds per plant (d)

Gene silencing construct development

RNAi based gene silencing construct was prepared for down regulating *farnesyl transferase* gene in soybean. Sense and antisense silencing fragments were PCR amplified and then cloned into intermediate vector sequentially. Finally sense-intron-antisense cassette was transferred into a binary vector. This gene silencing construct will be used to generate RNAi lines for studies on tolerance to drought stress. Virus-induced gene silencing (VIGS) based vectors were also constructed for silencing EIN-2, PDS (*Phytoenedesaturase*) and ABA responsive *farnesyl transferase* genes to study the utility of these genes to improve drought stress tolerance (Fig.2.19).

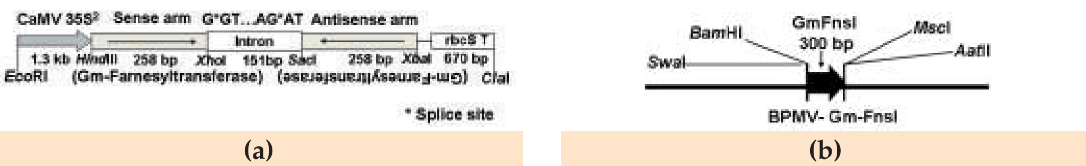


Fig. 2.19. RNAi vector(a) and VIGS vector(b) for silencing of *Fernesyl transferase* gene

Sugarcane genotypes for drought tolerance

Thirty five sugarcane genotypes were collected from different sources including SBI, Coimbatore; VSI, Pune and CSRS (MPKV), Padegaon. Out of these, 20 genotypes were evaluated for drought tolerance under recommended and deficit irrigation conditions. All the genotypes including three local genotypes were characterized in augmented design. Eight promising genotypes had cane yield more than that of the local varieties (Fig.2.20 a). Among them Co-99004, CoM-09057, CoVSI-03102 and Co-0113 genotypes had cooler canopy as revealed by thermal imaging system (Fig. 2.20 b, c).

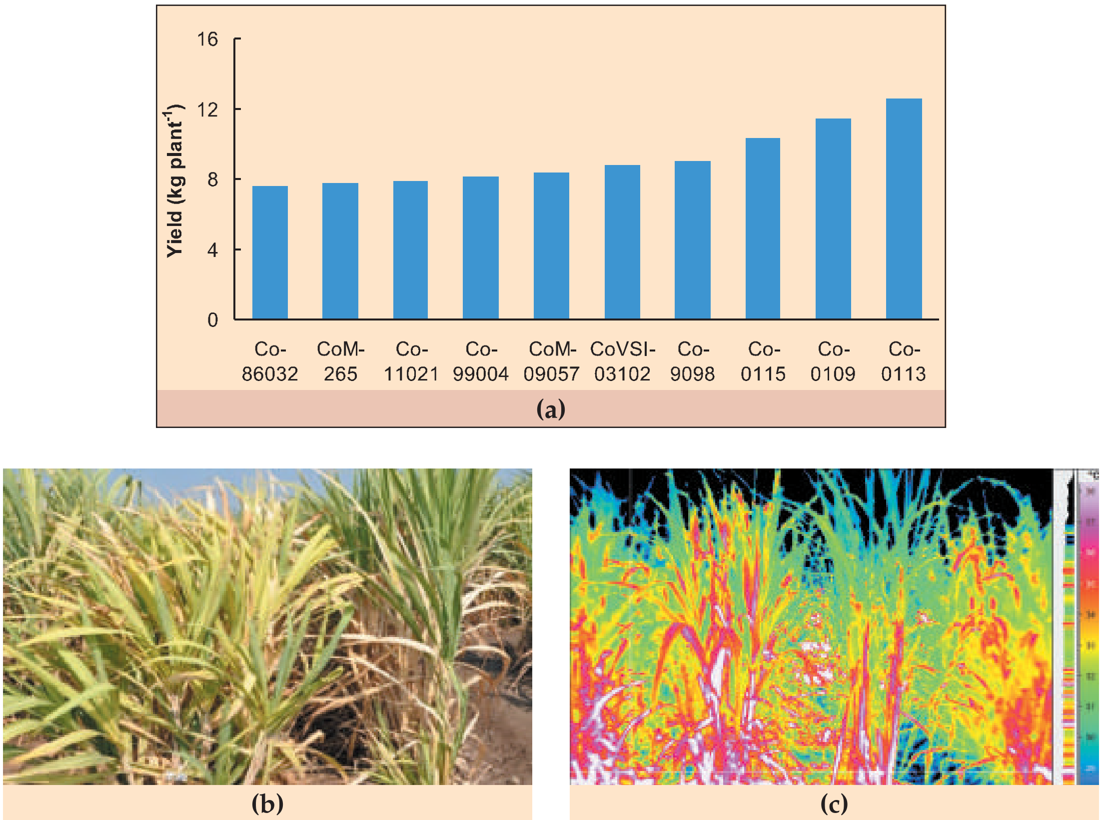


Fig. 2.20. Screening sugarcane genotypes for higher cane yield (a), cooler canopy: variation as depicted by visible (b) and infrared (c) images

Mungbean genotypes for enhanced adaptation to drought

With the aim to identify genotypes tolerant to drought stress, 50 and 100 genotypes of mungbean were obtained from PAU and IIPR, respectively. These genotypes varied in days to 50% flowering between 35-48 DAS. Most of the genotypes obtained from PAU (particularly SML series) flowered early. The yield plant^{-1} ranged from 2.7 g for SML-1338 to 12.6 g for DMG-1050. Most of the genotypes of DMG series performed better under Baramati conditions. Genotypes like DMG-1050, DMG-1058, SML-1023, ML-2037 produced higher yield compared with local varieties viz.,Vaibhav and BPMR-145 (Fig.2.21). Early flowering genotype ML-2037 had maximum pod length, seeds pod^{-1} and higher yield than BPMR-145.

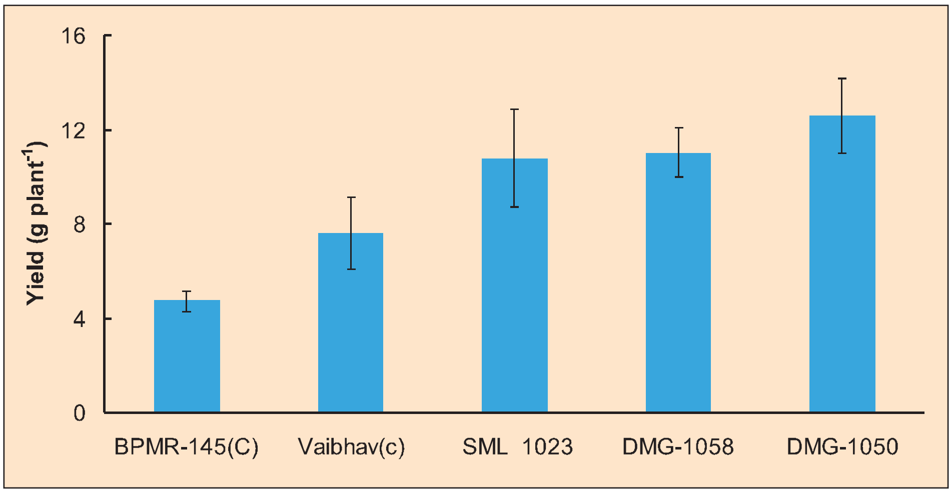


Fig. 2.21. Yield of mungbean genotypes superior to local varieties

Useful microbes to mitigate stress

Soybean-*Bradyrhizobium* sp. interactions under water stress

In the preliminary investigations, it was noticed that none of the isolates of rhizobium from native murrum rich soil had capacity to produce rhizobitoxine. Hence, strains were obtained from USDA National Rhizobium Culture collections to evaluate their utility in imparting drought tolerance in soybean. Presence of rhizobitoxine producing trait in these strains was confirmed by PCR amplification of *rtxA* gene with synthesized degenerate oligonucleotide primers. However, PCR reaction did not give any positive amplification of *rtxA* gene for the genomic DNA of native isolates of rhizobia from mungbean and other legumes, when USDA strains were used as positive control in PCR screening reactions (Fig.2.22).

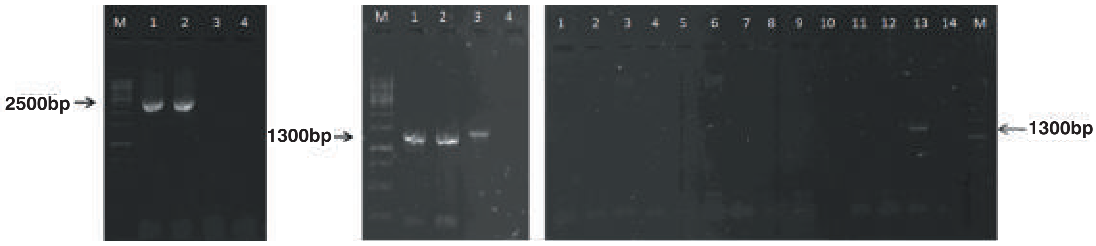


Fig. 2.22. PCR based confirmation of *rtxA* gene in *Bradyrhizobium* type strains and native rhizobial isolates for rhizobitoxine trait

Pot experiments revealed that soybean (cv. NRC-37) could produce more biomass and grains when inoculated with rhizobitoxine producing strains (*B. elekani* USDA 61, *B. elekani* USDA 94 and *B. japonicum* USDA 110). Novel image based screening method where changes in RGB colour could differentiate the plant responses to strains varying in rhizobitoxine production further confirmed the results (Fig.2.23). This was attributed to better nodulation, root system architecture, cooler plant canopy and high chlorophyll content (Fig.2.24).

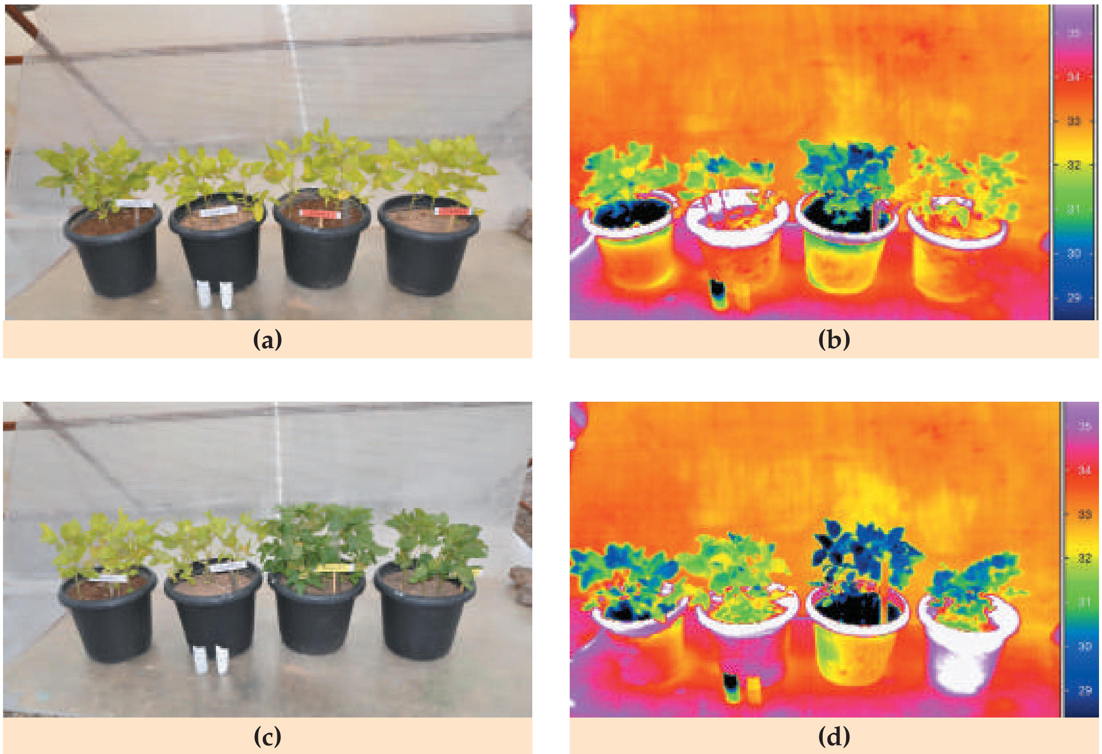


Fig. 2.23. Response of soybean to local (a & b) and promising (c & d) strains of *Bradyrhizobium* under irrigated and water stressed conditions. Pots were irrigated (1), stressed (2) without inoculum; irrigated (3) and stressed (4) with inoculum; infrared images on right side reveal canopy temperatures

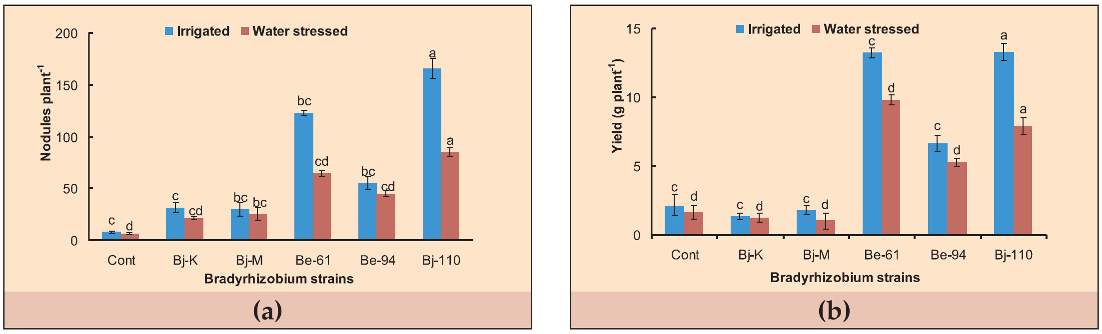


Fig. 2.24. Effect of Bradyrhizobium strains on nodulation (a) and grain weight (b) of soybean

ACC deaminase activity of bacterial endophytes for drought tolerance

ACC deaminase is one of the key enzymes that regulate ethylene, a stress hormone in plants. Hence, the useful microbes carrying this trait are being identified. Since conventional plate method used for screening bacterial isolates for this trait was not efficient, a method for quantitative screening based on ninhydrin reaction was standardised and was effectively used to differentiate the isolates varying in their capacity to utilize ACC. Initially 270 sorghum bacterial endophytes were screened and ACC deaminase activity was observed in 46 isolates while, only 24 isolates could be confirmed with repeated screening. Among these, 8 potential endophytic isolates mostly originated from sorghum cv. Maldhandi 35-1 had higher ACC utilization (Table 2.1).

Table 2.1. ACC deaminase activity of representative bacterial endophytes of sorghum

Isolates	Quantity of ACC utilized (from initial 3 m moles)
M-65	2.89
M-85	2.79
M-96	2.77
PM-125	2.82
PA-132	2.89
M-153	2.79
M-155	2.84
S-269	2.81

Multiple plant growth promoting traits such as P-solubilisation (P), N-fixation (J), ACC deaminase activity (A), IAA (I) and siderophore (S) production were identified in four out of 270 bacterial endophytic isolates of sorghum (Table 2.2). The unique nature of these isolates was confirmed through restriction digestion of each PCR-amplified full length 16S rRNA gene with minimum three restriction enzymes (Hha1, Msp1 and Rsa1) followed by RFLP pattern analysis. 16S rRNA genes sequencing and BLAST analysis of the sequences identified isolate EB-165 as *Ochrobactrum* sp.; EB-65 as *Microbacterium* sp., EB-14 and EB-48 as *Enterobacter* sp.

Table 2.2. PGP traits based diversity grouping of bacterial endophytes of sorghum

PGP traits grade	Isolates with positive traits	Associated Sorghum genotype
5+	EB 165 (PSIJA)	Phule Maulee
4+	EB 14 (PSIJ)	Maldhandi 35-1
3+	EB 48 (PSI) , EB 65 (JIA)	Maldhandi 35-1
2+	29 isolates	From all 4 genotypes
1+	90 isolates	
0+	147 isolates	

Water saving techniques in fruits and vegetables in shallow basaltic soils

Improving the water productivity is one of the options to deal with water scarcity in drought prone areas. Hence a project was initiated to optimize the irrigation schedules and probe the feasibility of deficit irrigation/partial root zone drying in fruit crops. Various morphological parameters of papaya, sweet orange, grapes and pomegranate are being monitored at regular interval to assess the effect of different irrigation treatments. However, the orchards were severely damaged by hailstorm on March 9, 2014 and therefore data are not being reported.

Deficit irrigation, a recent water saving strategy in horticultural crops, were assessed for its utility in tomato grown on shallow basaltic soil. Reponses of semi determinate tomato (cv. Ryna) subjected to growth stage specific deficit irrigation through dripper were measured in terms of yield and quality attributes. The deficit irrigation @ 0.6 ET at vegetative period (20 to 50 DAT) followed by normal irrigation (100 % ET) for remaining growth period did not affect the yield (Table 2.3). It was also evident that 15 % of irrigation water could be saved without affecting yield when irrigation was based on 0.8 ET, while yield was reduced by 23.4 % when irrigation was based on 0.6 ET. Withholding irrigation for 15 days during vegetative phase (30-45 DAT), flowering (60-75 DAT) and fruiting (90-105 DAT) resulted in lower yield by 3.4, 6.6 and 3.5 % respectively where the water saved ranged from 9.2 to 12.6 %. About 16.7 % reduction in yield was observed when irrigation was applied @ 0.6 ET during flowering and fruiting stage. However, water use efficiency (WUE) was 215 kg ha- mm^{-1} when irrigation was provided @ 0.8 ET while it was 187.4 kg ha-mm^{-1} when the irrigation was provided @ 1.0 ET. The higher TSS, Lycopene and Vit C were recorded in plants subjected to water stress with irrigation @ 0.6 ET particularly at fruiting stage.

Table 2.3. Effect of growth stage specific deficit irrigation (DI) strategies on tomato yield and its quality

Irrigation schedules	Irrigation (cm)	Yield (Mg ha^{-1})	WUE (kg ha-mm^{-1})	TSS (Brix)	Lycopene (mg 100 g^{-1})	Vit C (mg 100 g^{-1})
Irrigation throughout based upon						
1.0 ET	46.4	87.0	187.4	5.5	13.9	31.5
0.8 ET	39.5	84.8	215.1	5.1	11.1	22.9
0.6 ET	32.5	66.7	205.1	3.4	7.2	17.3
DI (0.6 ET) for 30 days during						
Vegetative	42.9	91.0	212.1	4.2	9.6	18.4
Flowering	41.7	84.2	201.8	5.1	10.1	19.7
Fruiting	40.7	81.2	199.5	5.3	12.9	25.8
DI (0.6 ET) for 60 days during						
Vegetative and flowering	38.2	72.7	190.4	4.4	9.8	21.3
Vegetative and fruiting	37.2	76.2	205.1	5.1	12.3	24.7
Flowering and fruiting	36.0	72.4	201.1	5.4	13.4	26.8
Withholding irrigation for 15 days						
Vegetative	42.1	84.0	199.4	3.7	8.4	17.9
Flowering	40.8	81.2	199.0	4.3	9.7	20.8
Fruiting	40.6	83.9	206.9	4.8	10.2	20.1
CD (P=0.05)	–	11.1	9.3	0.6	1.5	3.1

Performance of seed guar varieties

Performance of guar cultivars as acquired from CCSUAT, Hissar and RAU, Bikaner was evaluated. About 200 genotypes obtained from CAZRI, Jodhpur were screened in a field trial. Four traits viz., days to flowering, clusters per plant, pods per cluster and number of seeds per pod were associated with seed yield. The highest yield (1.2 Mg ha^{-1}) was obtained in GR-1 among seven genotypes of advanced varietal trial (AVT) while among the 14 genotypes of initial varietal trial (IVT), GR-12 had the highest yield (0.88 Mg ha^{-1}). Branched genotypes had better performance than erect types. RGC-936, a variety from Rajasthan yielded 0.73 Mg ha^{-1} seed yield in the farmer's field under irrigated condition.

School of Edaphic Stress Management

Exploring unculturable microbial diversity of saline soils

Metagenomics approaches were successfully employed to derive full length 16S rRNA sequences from the saline soils. These sequences from metagenomic DNA were submitted to NCBI, which has allotted accession number (KJ561578-585 and KJ638401-408) for these 16 sequences. Out of these, 12 sequences are from uncultured bacterium inhabiting saline soil communities and the clone number 27 showed less than 97 % homology to any known sequence in *Genbank* database (Fig.2.25).

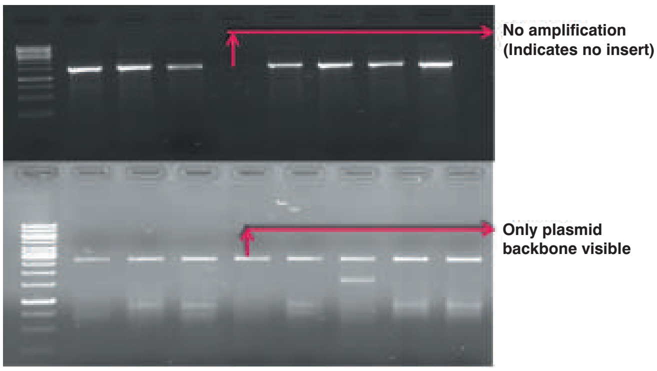


Fig. 2.25. Selection of positive clones with PCR amplification of isolated Plasmid DNA

Synthesis and characterization of silver-ion exchanged zeolites

In order to determine silver ion exchange mechanism, 13 different forms of zeolites namely mesolite, thaumasite, okenite, mordenite, prehnite, thomsonite, gyrolite, scolecite, stilbite, heulandite, stellerite, apophyllite and ferreirite were subjected to silver ion exchange with different concentration of silver nitrate. Silver-ion exchanged zeolites have been characterized using ICP-MS, TEM-EDAX, SEM-EDAX and FTIR, which clearly indicated that calcium plays a very important role in silver ion exchange. ICP-MS of synthesized silver heulandite indicated silver ion exchange up to 1047 ppm (Fig.2.26). Silver-ion-exchanged zeolites were evaluated for their bactericidal activity against fish pathogenic bacteria *Aeromonas hydrophila* using agar well diffusion method. These were found to be effective as evidenced from the zone of inhibitions (0.5 to 1.6 cm) obtained on agar plates.

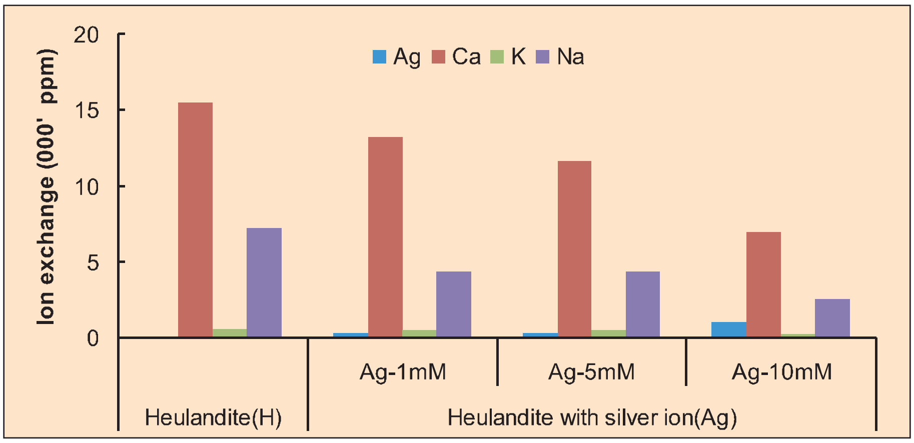
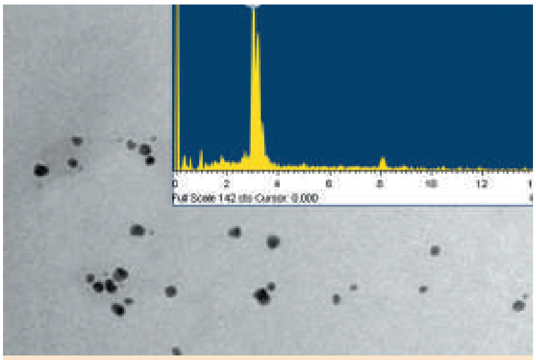


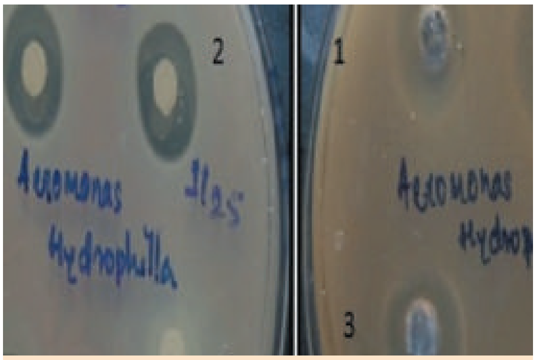
Fig. 2.26. Silver ion exchange of heulandite

Synthesis of bactericidal silver nanoparticles

A patent has been applied at Mumbai for the novel method to synthesize nano silver formulations by using different disposed tissue parts of Rohu (*L. rohita*). Presence of silver nano particles of size 1 to 100 nm in the nanoformulation was confirmed through their peak absorbance maxima at 420 nm.A high and low nano feed were prepared by mixing the nanosilver formulation with conventional fish feed. Nanosilver enriched feed reduced the healing time of wounds of Rohu to half indicating that it can be applied as a non-specific therapeutic to heal wounds and rots in fish (Fig.2.27).



(a)



(b)

Fig. 2.27. TEM-EDAX (a) and bactericidal activity (b) of synthesized silver nanoparticles

Adaptive changes in fish for temperature stress

Singhi, an air breathing fish, is a potential candidate species for aquaculture in the climate change scenario. It possesses an accessory respiratory organ for direct aerial respiration by surfacing the water and gulping the atmospheric air, which is stored in the respiratory organ. This unique character makes this fish culturable in derelict swamps, wetlands and backwaters of reservoirs with low dissolved oxygen. An experiment was conducted to assess the behavioral responses of this fish to temperatures varying from 28 to 34 °C. Critical thermal maxima (CTmax) ranged from 40.1 to 43.1 °C while minima (CTmin) ranged from 13.6 to 15.8°C. Responses of Singhi to changes in acclimation temperature could be explained by CTmax (r^2= 0.93) and CTmin (r^2=0.94). Tolerance of fish to rising temperature as indicated by CTmax for loss of equilibrium can increase @ 1.34 °C for each degree rise in acclimatization temperature in the range of 28 to 34 °C. The tolerance of fish to decreasing temperatures also increased with decrease in acclimation temperature.

Oxygen consumption rate of Singhi increased with acclimation temperature. Mean oxygen consumption (routine) increased from 151.1 ± 0.96 to 193.2 ± 2.30 mg O_2 kg^{-1} h^{-1} when acclimation temperature was raised from 28 to 34 °C. That was due to increase in metabolic rate as indicated by Q_{10} values. The optimum acclimation temperature was found to be 30 ºC as indicated by feed conversion ratio (FCR).

Expression of genes coding for heat shock protein (*Hsp*) 70 was investigated in six different fish species while expression of Myostatin gene was assessed in *Labeo rohita*. Higher expression of *Hsp70* gene was observed in all the species except *Chela chela* and *Cirrhinus mrigala* (Fig.2.28).

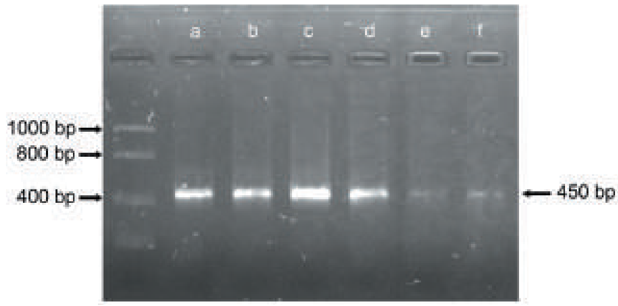


Fig. 2.28. Expression of *Hsp70* in different species of fish (*Labeo rohita* (a), Tor tor (b), *Tor spp* (c), *Barilius barilius* (d), *Chela chela* (e) and *Cirrhinus mrigala* (f)

Rise in temperature stress affects the digestibility of feed, which in turn reflects in reduced or slow growth of fish. Experiments were conducted to screen the microbial flora of fish (Tilapia) gut for identification of probiotic bacteria that can improve digestibility in fish. *Bacillus cereus, Bacillus subtilis, Bacillus simplex, Bacillus infantis, Bacillus megaterium, Bacillus firmus, Bacillus flexus, Edward siellatarda, Pseudomonas otitidis, Staphylococcus epidermis, Staphylococcus hominis, Paenibacillus camelliae* were identified from fish gut. Two microbes *Pseudomonas otitidis* and *Paenibacillus camelliae* exhibited antibacterial property against fish pathogen *Aeromonas hydrophila*.

Refinement of seed production protocol for Singhi

Intra-muscular injections of ovaprim at three different dosages (0.5, 1.0, 1.5 ml kg^{-1} of body weight) were tested to improve hatching and survival of Singhi. Ovaprim @ 1.5 ml kg^{-1} could improve hatching rate while survival was found to be optimum when ovaprim was injected @ 1.0 ml kg^{-1} body weight.

Techniques to obviate edaphic stresses in orchards

Among the fruit crops, sapota, pomegranate and guava are the main crops being grown in this region predominated by shallow basaltic soils. The negative impacts of shallowness in terms of low water retention, hard rocks and murrum etc. are the major constraints for establishment of orchards. Therefore, experiment were initiated with fruit crops such as sapota (var. Kalipatti), guava (var. L 49) and pomegranate (var. Bhagwa) with differential rooting depth to evaluate the various planting methods and soil mixtures for better establishment and productivity. The planting methods included viz., auger planting, trench planting, pit planting (Up to 1 m) along with filling mixtures (native murrum soil, black soil, mixture of murrum and black soil) and in addition micro-blasting was carried out to enhance rooting depth by additional 1 m (Fig.2.29). Treatment combinations in these experiments were 16, 22 and 26 for sapota, guava and pomegranate respectively. Plant responses are being measured in terms of plant height, rootstock and scion girth, no. of branches, canopy spread and physiological responses. In addition, soil parameters are also being monitored to know the impact of treatments. However, due to the hailstorm on March 9, 2014, the orchards were severely damaged. Therefore, the whole sapota orchard is being replanted while the damaged plants of guava have been replaced. The pomegranate saplings have revived their growth and data indicated benefits of replacing murrum with black soil.

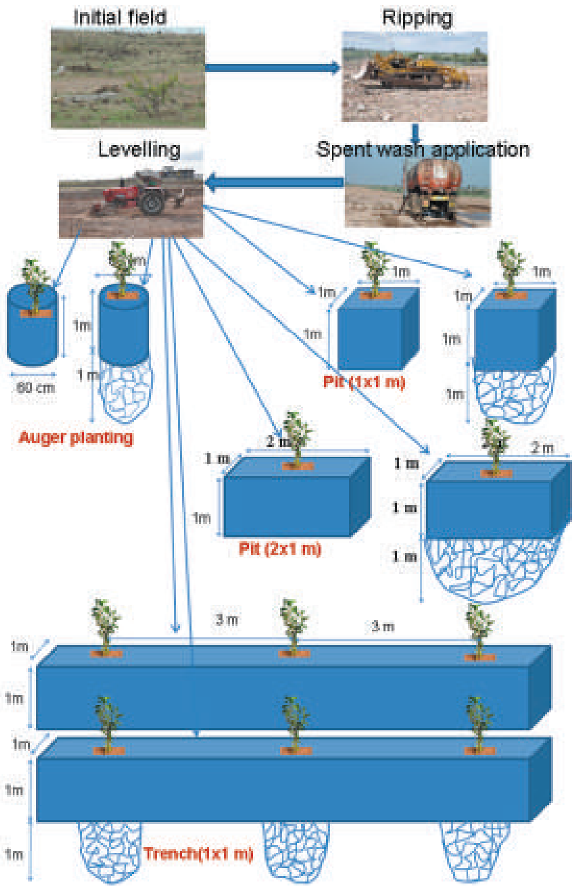


Fig. 2.29. Schematic illustration of different planting methods followed for establishment of sapota, guava and pomegranate orchards

Resource conservation practices for sugarcane ratoon crop

Retention of trash in ratoon sugarcane is one of the major constraints for placement of fertilizers and other intercultural operations, which ultimately reduce fertilizer use efficiency and productivity. Therefore, farmers usually resort to trash burning without caring for environmental and health hazards due to release of soot particles, smoke, greenhouse gases and loss of plant nutrients such as N, S and Ca, besides reduction in beneficial soil microorganisms. Hence, the proper management of trash for enhancing the fertilizer use efficiency in ratoon sugarcane continues to be the major challenge.

Nitrogen management with off bar cum fertilizer drill machine

Fourteen field demonstrations were conducted with this prototype machine at farmer's fields in ratoon sugarcane. There were six treatment combinations including two methods of N application (broadcast as is the farmer's practice, placement with off bar and fertilizer drill machine), two methods of trash management (spreading the trash uniformly in the field after chopping with a trash cutter and burning trash as farmer's practice), fertilizer placement with off bar cum fertilizer drill machine and two doses of N fertilizer (50 % basal + 25 % at 9-10th weeks after ratoon initiation (WARI) + remaining 25 % at 17-20th WARI and 100 % as basal). The trash was also chopped where fertilizers applied with machine. The crop was nourished with 250 kg N, 115 kg P_2O_5 and 115 kg K_2O ha^{-1}. Growth in terms of plant height and tillers was improved by 16-18 % over the existing farmer's practices due to root pruning and fertilizer placement (RPFP) with machine (Fig.2.30). However, only marginal differences were observed in plant height at full and half of the basal N applications. SPAD value indicated that leaves of plants subjected to RPFP treatment with N application had more greener throughout the growth than those raised after burning the trash or retaining chopped trash. Further 50% reduction in nitrogen along with RPFP could help the plants to retain leaf greenness only at early growth stages. The highest millable cane, maximum internodes, lengthiest internode, thickest cane, lengthiest cane and maximum cane weight were also recorded with pruning of roots and placement of 100 % N as basal. The highest cane yield was recorded with pruning and placement of 100 % dose of N fertilizer that was 39 and 26 % higher than trash burnt and trash chopped treatments, respectively where N-fertilizer was broadcasted (Fig.2.30). Chopping of trash helped to improve yield by 10 % over the trash burning. Thus the application of either full or half dose of N through off bar cum fertilizer drill machine improved the N-use efficiency *vis-à-vis* productivity of ratoon sugarcane when trash was retained at the surface.

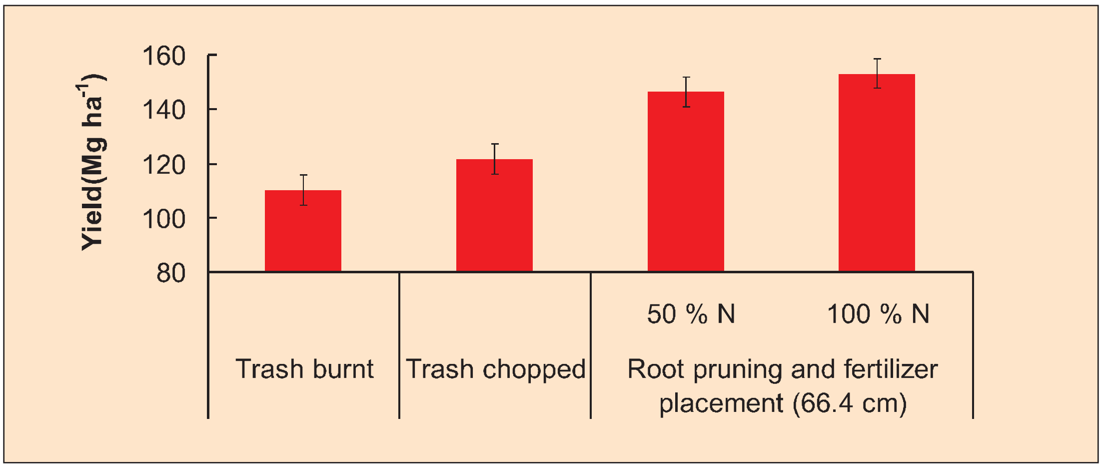


Fig. 2.30. Sugarcane yield as effected by trash management practices

School of Policy Support Research

Climate change vulnerability assessment

In an endeavor to assess the vulnerability of various districts to climate change and to prioritize various interventions and adaptation strategies, a district wise analysis of vulnerability was undertaken in Maharashtra covering 25 districts. Decadal analysis of vulnerability trends was carried out using periodical data sets of agro-socio-economic indicators from the three components contributing vulnerability i.e., exposure, sensitivity and adaptive capacity. The standard IPCC methodology was used to characterize vulnerable districts for the period 1971-2001 on a decadal basis. The study identified that majority of the districts of Maharashtra are vulnerable/very highly vulnerable to climate change. The dynamicity exists in space and time among these districts with respect to climate change vulnerability and this study proposed for a continuous and periodical characterization for priority setting, thereby channelizing resources to the vulnerable regions aimed to enhance climate change resilience.

Climate change imposed vulnerability of onion farming

The primary survey of 110 onion growers in 51 villages of 21 tehsils in 8 districts was conducted during June to December 2013. Nearly 70 per cent farmers experienced yield reduction to the tune of 30 per cent due to drought in 2012-13 and unseasonal as well as excess rainfall in *kharif* 2013 (Table 2.4). This was the major cause of price rise followed by policy initiatives and lack of storage facilities in the region. Contrary to the normal belief, the hoarding of onion was observed to be the least important cause. The family members/friends/relatives were the major source of the market/price information to farmers (34 %) followed by television (28 %) and newspaper (17 %). Thus the improved technology uptake and large scale adoption to climate vulnerability can help in stabilizing the onion farming.

Table 2.4. Farmers perception about price rise during 2013 (Garrets ranking technique)

Causes of price rise	Score	Rank
Drought during 2012	77	1
Policy initiatives	63	2
Excess rainfall in *kharif* 2013	54	3
Heavy rainfall	46	4
Lack of storage facilities	37	5
Hoarding	23	6

NDVI based mapping of abiotic stresses

Efforts are being made to analyse abiotic stress using MODIS data derived NDVI coupled with other stress factors and cropping pattern in terms of crop production. A clear difference was seen in the distribution of stressed area in Anantapur district of Andhra Pradesh when NDVI during deficit (2003) and normal rainfall year (2005) was analysed (Fig.2.31).

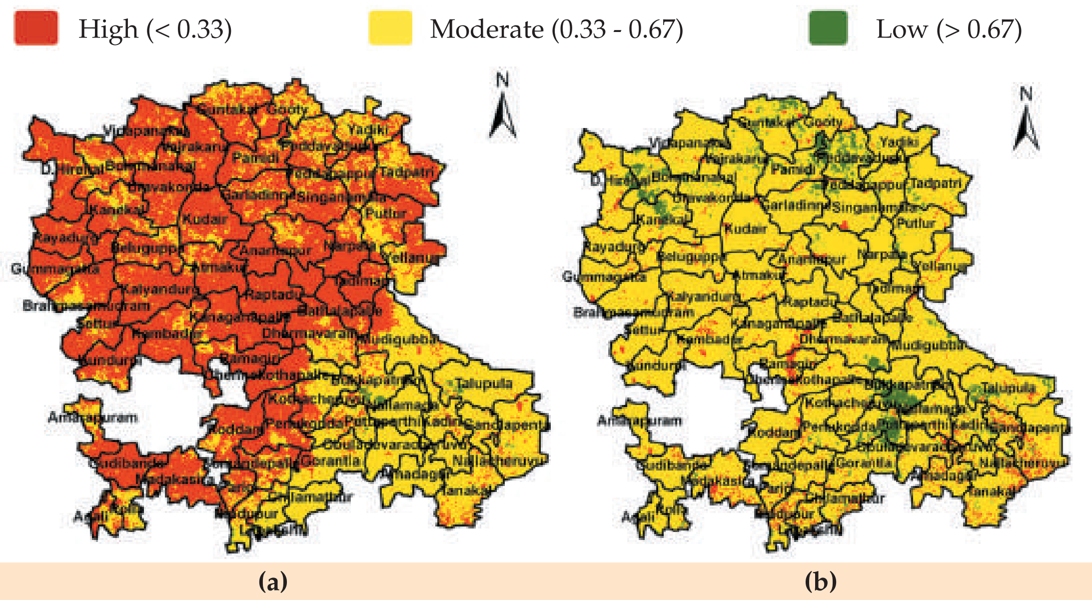


Fig. 2.31. Comparative distribution of stressed area in Anantapur district during deficit rainfall (a) and excess rainfall (b)

Mandal wise distribution of important edaphic factors

The digital soil map was used to generate theme maps of important edaphic factors viz.; soil depth, texture, available water capacity, soil erosion, soil drainage, salinity and sodicity (Fig.2.32).

Anantapur: 43% area has shallow depth; 69 % of area is gravelly; 72 % area suffers from very low to low AWC; 71 % of area is severely eroded and 50 % of area has Aridisols.

Beluguppa: 69 % area is gravelly; very low to low AWC in 73 % area; 12 % area is afflicted by salinity; 20 % area has Aridisols.

Gummagatta: 53 % area has shallow soil depth; 64 % area has very low to low AWC; 21 % of area is afflicted by sodicity; 64 % area is severely eroded; 89 % area has Aridisols.

Kalyandurg: 81 % area is moderately deep but suffers from grvellyness in 96 % area; almost 100 % area has very low to low AWC; 77 % area is severely eroded.

Kambadur: 72 % area is gravelly; 74 % area has very low to low AWC; 21 % area is salinity afflicted; 54 % area is severely eroded.

Kanaganapalle: 73 % area is gravelly; 81 % area has very low to low AWC; 20 % area suffers from salinity; 60 % area is severely eroded.

The possible contribution of edaphic factors to crop stress even during the year of excess rainfall could be explained, however, this needs to be further supported by appropriate statistical model(s).

Fig. 2.32. Relative distribution of edaphic factors in selected mandals

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3. Tribal Sub-Plan

The institute is implementing TSP programme in twenty five villages of Navapur tehsil of Nandurbar district. Tribal farmers of these villages were practicing traditional cultivation methods, which were the major cause of low productivity of crops like sugarcane, rice, groundnut, wheat and soybean. The major constraints in adoption of modern farming practices by the farmers included illiteracy, lack of knowledge about modern technologies, poor access to institutional structures for procurement of agricultural inputs, marketing and finance. Keeping these in view the institute envisaged the four pronged strategies involving human resource development, field demonstrations, improved access to market and creation of productive assets.

Human resource development (HRD)

Various programs were organized to sensitize and motivate tribal farmers by enhancing awareness; skill and knowledge about improved crop production technologies. A total of 250 tribal farmers from selected villages were trained on production technologies of mango, chilli and livestock in addition to marketing management. Three study tours were organized to expose a total of 249 tribal farmers to advanced technologies for groundnut and chilli production. Three field days were organized to demonstrate modern production technologies for rice, sugarcane and okra. Field days to demonstrate rice cultivation technologies organized at Gadad, Vijapur and Wadkalambi villages attracted 300, 700 and 1000 farmers respectively. On the other hand, 300 and 1500 farmers participated in sugarcane and okra field days respectively at four different villages. About 1500 farmers voluntarily participated in the soil and water conservation programme organized in 10 villages of Navapur tehsil. Other activities included the visit of 90 tribal farmers at International Exhibition Centre, Moshi (Pune), tribal farmers meet for about 5000 farmers, agriculture technology week at KVK Nandurbar and the world women day at Gadad village.

Field demonstrations

These were organized to convince the farmer about the advantage of improved technologies for various agricultural enterprises including field crops (Fig.3.1), vegetables, fruits and livestock (Table 3.1). This has resulted into large scale adaption of improved cultivars and packages & practices in tribal villages of Navapur tehsil.

Improved access to market

Various programs and discussions organized by the institute contributed to initiation of "Rangavali Multipurpose Tribal Farmers Associations, Navapur" for facilitating procurement of inputs and marketing of farm produces through farmers groups. Survey of nearby market was conducted to ascertain the demand and supply of various produce in market. Marketing channels were established for vegetables and fruits which yielded in higher returns to the producers.

Table 3.1. Improved technologies demonstrated to tribal farmers during 2013-14

Crop	Coverage	Beneficiaries
Mango	604 plants	71
Rice	380 acre	416
Soybean & Tur	149 acre	154
Sugarcane	110 acre	110
Groundnut	11 acre	22
Chilli	14 acre	56
Okra	68 acre	88


(a)


(b)

Fig. 3.1. Sugarcane plot by traditional (a) and improved method (b) at Vijapur village of Nandurbar

Creation of productive assets

In order to have an effective translation of various technology interventions, implement bank was created on community basis in selected areas by procuring essential farm implements such as HTP sprayer, mini dal mill with polisher, power tiller, soil auger with drill, groundnut decorticator, offset disc harrow, sugarcane multi-operations implement and reverse - forward blades and cultivator. The strategies adopted by the institute for introducing various technological interventions has resulted in significant developmental outputs (Fig.3.2) as evident from visible change in the agricultural landscape of the Navapur tehsil and transformed livelihoods of the farmers.


(a)


(b)

Fig. 3.2. Structures created during soil and water conservation programme Check dam at Jamtalav village (a) and Vanrai Bandhara at Bhavare village (b) of Nandurbar

4. Meetings

Institute Management Committee (IMC)

The 4th IMC meeting of NIASM was held on November 23, 2013 under the Chairmanship of Dr P.S. Minhas, Director, NIASM, Baramati. The members who participated included Sh Rajendra Pawar, Dr S.S. Magar, Dr S.M. Shaikh, Dr V.U.M. Rao, Dr Jagdish Prasad, Prof Nilesh Nalwade, Sh G.C. Prasad and Sh G. F. Shahir. Special Invitees were Dr J. Rane, Dr K.K. Krishnani, Dr M.J. Kaledhonkar, Dr D. P. Patel, Dr N.P. Singh and Sh. Ram Avatar Parashar. The Commissioner, Commissionerate of Agriculture, Government of Andhra Pradesh, Dr B. Mohan Kumar, ADG (Agro & AF), ICAR, New Delhi, Dr G. S. Karibasappa, Principal Scientist (Hort.) NRC for Grapes, Pune and Dr P. R. Bharambe, Principal Scientist & Head, CICR, Nagpur could not attend the meeting due to their pressing prior engagements.

Chairman welcomed all the members and appraised them about the research initiatives, infrastructural and farm developmental activities, which have been undertaken since the last meeting. Dr S.S. Magar, Hon'ble member expressed his happiness on the commendable progress made by the institute in respect of farm and infrastructural developments. Shri Rajendra Pawar, Hon'ble Member representing Rural and Farm interest also expressed happiness over the progress made by the institute in farm and infrastructural works. He appreciated the progress and research initiatives and suggested that institute should also lay impetus on bio-fertilisers for crops grown in saline soil, stress tolerance in sugarcane particularly with respect to high temperature and soil moisture effect on sugar recovery, high temperature tolerance in wheat and sugarcane trash management without chopping and its impact on soil productivity. Later, Director, NIASM clarified that a research project on identification of useful soil microbes for saline soil has already been initiated for alleviating effect of stress on sugarcane productivity and sugar recovery. He also mentioned that research has been initiated to screen promising lines of sugarcane along with local varieties for drought tolerance in collaboration with Regional Station, Padegaon and SBI, Coimbatore. Further, a prototype of a machine for integrated management of trash and fertilizer application in ratoon sugarcane is being developed in collaboration with MPKV, Rahuri. The machine ensures operations of chopping, off barring root pruning and fertilizer application. Dr V.U.M. Rao emphasized need for systematic efforts for integrated data on atmosphere and soil on long term basis for horticultural crops so as to capture effect on different phenological stages of plant. NIASM has a great potential in developing the reservoir of database of such kind. This will be one of its kinds and will aid in exploring climate impacts on fruit crops.

The IMC appreciated the efforts made by the institute for nominating a large number of scientists for various trainings/workshops/seminars/conferences and also for full utilization of budget under both plan and non-planheads and maintaining the Assets Register and reconciling the same with annual accounts.

Fig. 4.1. 4th IMC meeting of NIASM

Research Advisory Committee (RAC)

The 3rd RAC meeting of the institute held on December 6, 2013 was chaired by Dr R.B. Singh, President, (NAAS), New Delhi. The members, Dr (s) S.S. Magar, Mruthyunjaya Hegde, Gaya Prasad, Mohan Kumar and Dr. (Mrs.) Nandini Nimbkar attended the meeting, while Dr B.V. Nimbkar, Founder President of NARI, Phaltan was the Special Invitee. While welcoming the RAC members, Dr. P.S. Minhas, Director highlighted the research initiatives, development of infrastructure and farm for multidisciplinary research related to atmospheric, drought and edaphic stresses. This was followed by detailed discussion on various researchable issues and presentations by Head of Schools. The major recommendations emerged after day long deliberations are:

- Research on water budgeting should continue to be the priority.
- The institute should focus on conservation agriculture involving local and regional stakeholder.
- Local breeds of cattle should be involved in investigation on adaptation of livestock.
- Agroforestry should be included to explore options for mitigating stresses.
- Research on discovery of genes for drought, extreme temperature and salinity to be continued to enhance resilience in crops.
- Studies on useful microbes including endophytic bacteria for drought and salinity stress tolerance should be facilitated.
- Investigation on onion market dynamics to be studied in detail with the latest tools for economic studies.
- Maharashtra state, prone to drought and other stresses, should be prioritized while mapping the abiotic stresses.
- The institute should work in close collaboration with other institutes who share common interest in research on abiotic stress in different crops and commodities.

Fig. 4.2. 3rd RAC meeting of NIASM

Institute Research Council (IRC)

The 4th IRC meeting of NIASM was held on February 18-20, 2014. This commenced with onsite review of the ongoing field experiments which was a unique opportunity for all the scientists across the disciplines to have a glimpse and to critically review the research approaches being followed by fellow scientists. In introductory remarks on Feb. 19, 2014, Dr P.S. Minhas, Director of the Institute, highlighted that the very purpose of this meeting is to critically review the progress made under ongoing research projects and considering new proposals. He emphasized that priority be given to flagship programmes. The heads of schools later presented the status reports on these projects. This was followed by discussion on new research proposals and then the progress made under of the ongoing projects. In all, four new research proposals, 24 ongoing research projects that are in progress and four externally funded projects were discussed in detail.

Fig. 4.3. 4th IRC meeting of NIASM

Monthly Meeting of Scientists & Technical Staff

Institute has conducted 12 monthly scientific & technical meeting. The important scientific and technical issues and monthly target and achievements of all the scientists were discussed in these meetings. The overall progress made with respect to infrastructural development, procurement of equipment's and expenditure incurred is also assessed. The meeting also gave opportunities for scientists to give seminars on scientific issues.

Meeting of Scientists of NIASM & MGGA

The meeting was organised at NIASM on December 9, 2013, Baramati in response to request by Dr T. S. Mungare on behalf of Maharashtra Grape Growers Association (MGGA), Pune. Director, NIASM welcomed the guests and briefed about the research and developmental activities. A brief presentation of research activities at the institute was also made. Director, NRC Grapes, Chairman and members of RAC of the MGGA and Scientists from the NIASM attended the meeting. Director, NIASM emphasized the need for collaborative research work among the three organization to address issues like, alternatives to Dogridge rootstock for drought and salinity tolerance like 110-R and Paulsen; root pruning to induce flowering and better growth in grapes; transcriptor profile expression of the genes involved with various abiotic stresses; effect of high temperature, light intensity and Asian Brown Clouds on grape phenology, fruitfulness and quality parameters. It was also suggested to conduct surveys in important grape growing districts to assess the nature of abiotic stresses.

Meeting of Scientists from MPKV & NIASM

The meeting started with a warm welcome by the Director to all the participants from Horticulture Department, MPKV, Rahuri and NIASM, Baramati on February 15, 2014. At the outset, he praised the quick response of scientists from MPKV for collaborative research after the finalization of MoU. He briefed about the mandates of the institute and research initiatives taken so far. After detailed discussion, areas for collaborative research were identified as: quantification of minimum amount of irrigation water required for survival of fruit crops under dryland conditions, the impact of withholding irrigation, partial root zone drying and regulated deficit irrigation on survival and productivity of fruit and vegetable crops and the impact of these water saving techniques on WUE; soil treatment, filling mixtures, root stock identification, mulching, chemicals, plant growth regulators and anti transpirants for maintaining economic yield of fruits.

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5. Awards and Recognitions

- Dr G.C. Wakchaure, Scientist (ASPE) was awarded *"Yadvindra Young Scientist Award-2013"* for his contributions in area of mushroom research during National Mushroom Conference 2013, held at PAU, Ludhiana during April 16-17, 2013.
- Dr Biplab Sarkar, Senior Scientist (Fisheries) was awarded *"Bioved Fellowship Award-2014"* for the contribution on 'Fishery and Nanotechnology' by Bioved Research Society at Lucknow on Feb. 22, 2014.
- Dr K.K. Krishnani, Head, SESM, was awarded *"Australian Award Mentor-2014"* by Australian Embassy, New Delhi on March 14, 2014.
- Dr V. Govindasamy, Scientist, SDSM, was awarded *"Australian Award Ambassador-2014"* by Australian Embassy, New Delhi on March 14, 2014.

6. Linkages and Collaborations

Research institute	Priortised for research collaboration under MoU
Shri Swami Samarth Agro Inputs, Shrirampur, Ahmednagar	• Development of multipurpose equipment for sugarcane ratoon crop
MPKV, Rahuri, Maharashtra	• Conservation agriculture • Genetic enhancement of crop productivity by using modern tools • Collaboration in academic programme and post graduate research
VSBT, Baramati	• Collaboration in biotechnology and nanotechnology based research programme

Fig. 6.1. MoU being signed with MPKV, Rahuri on December 12, 2013

7. Publications

A. Research Papers in Journals

1. Ahuja, S., Kumar, M., Kumar, P., Gupta, V.K., Singhal, R.K., Yadav, A. and Singh, B. (2014). Metabolic and biochemical changes caused by gamma irradiation in plants. *Journal of Radio Analytical and Nuclear Chemistry*, 300(1): 199-212

2. Bal, S.K., Choudhury, B.U., Sood, A., Saha, S., Mukherjee, J., Singh, H. and Kaur, P. (2013). Relationship between leaf area index of wheat crop and different spectral indices in Punjab. *Journal of Agrometeorology*, 15(2): 98-102

3. Bhushan, B., Pal, A., Kumar, S. and Jain, V. (2013). Biochemical characterization and kinetic comparison of encapsulated haze removing acidophilic xylanase with partially purified free xylanase isolated from *Aspergillus flavus* MTCC 9390. *Journal of food Science and Technology*. (In Print)

4. Bharathi, L.K., Singh, H.S., Shivashankar, S., Ganeshamurthy, A.N. and Sureshkumar, P. (2013). Assay of nutritional composition and antioxidant activity of three dioecious *Momordica species* of South East Asia. *Proceedings of National Academy of Science India*, Section: B, Biolological Science. (In Print)

5. Choudhary, R.L., Kumar, D., Shivay, Y.S., Anand, A. and Nain, L. (2013). Yield and quality of rice (*Oryza sativa*) hybrids grown by SRI method with and without plant growth promoting rhizobacteria. *Indian Journal of Agronomy*, 58(3): 430-433

6. Choudhary, R.L. and Behera, U.K. (2013). Effect of sequential tillage practices and N levels on energy relations and use-efficiencies of irrigation water and N in maize (*Zea mays*) – wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*, 58(1): 27–34

7. Choudhary, V.K., Sureshkumar, P. and Bhagawati, R. (2013). Response of tillage and *in situ* moisture conservation on alteration of soil and morpho-physiological differences in maize under Eastern Himalayan Region of India. *Soil & Tillage Research*, 134: 41–48

8. Choudhary, V.K. and Sureshkumar, P. (2013). Maize production, economics and soil productivity under different organic sources of nutrients in eastern Himalayan region, India. *International Journal of Plant Production*, 7(2): 167-186

9. Deb, R., Sajjanar, S., Singh, U., Kumar, S., Brahmane, M.P., Singh, R., Sengar, G. and Sharma, A. (2013). A promoter variant at AP2 box region of *Hsp*70.1 affect thermal stress response and milk production traits in Frieswal cross bred cattle. *Gene*, 532: 230-235

10. Deb, R., Sajjanar, B., Singh, U., Kumar, S., Singh, R., Sengar, G. and Sharma, A. (2014). Effect of heat stress on the expression profile of *Hsp*90 among Sahiwal (*Bosindicus*) and Frieswal (*Bosindicus* × *Bostaurus*) breed of cattle: a comparative study. *Gene*, 536(2): 435-440

11*. Fand, B.B., Kumar, M. and Kamble, A.L. (2014). Predicting potential geographic distribution of cotton mealybug *Phenacoccus solenopsis* Tinsley. (Hemiptera: Pseudococcidae) based on MAXENT Ecological Niche Model. *Journal of Environmental Biology*, 35(3). (In Print)

12*. Fand, B.B., Tonnang, H.E.Z., Kumar, M., Kamble, A.L. and Bal, S.K. (2014). A temperature-based phenology model for predicting development, survival and population growth potential of mealybug, *Phenacoccus solenopsis* Tinsley. (Hemiptera: Pseudococcidae). *Crop Protection*, 55: 98-108

13. Kaledhonkar, M.J., Gupta, S.K., Saxena, C.K., Sharma, D.P. and Kumar, A. (2013). Emerging issues due to adoption of submersible pump technology in marginal quality areas of Haryana. *Journal of Agricultural Engineering*, 50(4): 58-64

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B. Books/Book Chapters

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C. Conference Proceedings/Abstracts

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2*. Govindasamy, V., Kumar, M., Priya, G., Rane, J. and Minhas P.S. (2014). Phenomics approach to assess soybean-bradyrhizobium symbiotic interactions under soil moisture stress. In: 3rd International Plant Phenotyping Symposium on " *Phenotyping for Agriculture Sustainability*" MSSRF, Chennai, pp. 22

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D. Popular Articles

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2*. Fand, B., Kumar, M., Kamble, A.L., Bal, S.K. and Minhas, P.S. (2013). Temperature-based phenology model for mealybug *Phenacoccus solenopsis*. *ICAR News –A Science and Technology Newsletter*, October-December 2013, 19(4): pp.7-8

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7. Wakchaure, G.C. and Meena, K.K. (2013). Oyster-mushroom processing can be a boon to small-scale mushroom growers. *ICAR News–A Science and Technology Newsletter*, January-March 2014, 19(3): pp.3

* *Publication out of Institutional work*

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8. Participation in Meetings / Conferences / Workshops

Symposia / Conferences

Name	Topics	Place	Period
Dr D.D. Nangare	Recent advances in watershed development programme	Institute of Engineers, Ahmednagar	Sept. 05-06, 2013
Dr V. Govindasamy	3rd International plant phenotyping symposium on phenotyping for agriculture sustainability	M.S. Swaminathan Research Foundation, Chennai	Feb.17-19, 2014

Meetings / Workshops

Name	Topics	Place	Period
Dr (s) D.D. Nangare, P. Sureshkumar	Soil, water and fertilizer management in Grape farming.	VSBT, Baramati	May 01, 2013
Dr (s) V. Govindasamy S.K. Raina	Second annual workshop of NICRA project.	IARI, New Delhi	June 17-19, 2013
Dr V. Govindasamy	NAAS-Brainstorming session on role of root endophytes in agricultural productivity.	NAAS, New Delhi	July 05, 2013
Dr S.V. Ghadge	NAIP consortium strengthening statistical computing for NARS.	CIFE, Mumbai	Aug. 29-30, 2013
Dr K.K. Krishnani	First scientific meeting on nanotech.- Application of nano-biotech. in agriculture	IISc, Bangalore	Sept.25, 2013
Dr S.K. Bal	Need and nature of basic/ strategic research in agriculture (NFBSFARA)	CIFE, Mumbai	Sept. 27-28, 2013
Dr S. Saha	Workshop on Eddy covariance studies and data analysis.	CRIDA, Hyderabad	Nov. 25-27, 2013
Dr R.K. Pasala	Workshop on WU and WUE-phenotyping and their relevance in improving adaptation of crop under water limited conditions.	GKVK, Bangalore	Dec. 02-04, 2013
Dr S. Saha	Implementation of IPv6 (Internet Protocol version 6) in ICAR-Institutes.	NASC, New Delhi	Feb.27, 2014
Dr (s) S.K. Bal N.P. Singh	Establishing a climate change knowledge network for indian agriculture (CCKN-IA).	YASHDA, Pune	Mar. 14, 2014

Lectures / Invited Talks

Name	Topics	Place	Date
Dr V. Govindasamy	Endophytes inducing abiotic stress tolerance- Researchable areas on diversity and functional relevance in agricultural crops	NAAS, New Delhi	July 05, 2013
Dr B. Sarkar	MPEDA sponsored workshop on ornamental fish culture	VSBT, Baramati	Sept. 8-18, 2013
Dr D.D. Nangare	Water and nutrient saving technique for promotion of underutilised fruit crops	MPKV, Rahuri.	Oct. 01, 2013
Dr Y. Singh	Promotion of under utilised fruit crops in semi-arid basaltic soils of India	-do-	-do-
Dr S.K. Bal	Climate change, abiotic stress and its impact on agriculture: from NIASM point of view	ICRISAT, Hyderabad	Oct. 18, 2013
Dr A.K. Singh	Advancement of biotech tools for crop improvement	BSF, Jalna	Mar. 05, 2014

Trainings attended

Name	Training Topics	Place	Period
Dr S. Saha	Recent advances in statistical modelling techniques	CAFT, IASRI, New Delhi	May 31-June 20, 2013
Dr R.K. Pasala	Agricultural research management	NAARM, Hyderabad	July 15- 27, 2013
Dr B. Sarkar	Consultancy project management	NAARM, Hyderabad	Aug. 01-08, 2013
Dr P. Sureshkumar	Biomolecules: functional food compounds	Michigan State University, USA	Sept. 01- Nov. 30, 2013
Dr S. Saha	Using resilience lens for developing climate resilient agriculture	ICRISAT, Hyderabad	Oct. 07- 18, 2013
	Eddy covariance system, Eddy-Pro software and soil sequestration	IITM, Pune	Nov. 11-13, 2013
Dr S.K. Bal	Science administration and research management	ASCI, Hyderabad	Nov. 11-22, 2013
Dr (s) G.C. Wakchaure, R.L. Choudhary	SAS for developing predictive models in agriculture, animal and aquaculture research	CIFE, Mumbai	Nov. 18-23, 2013

Name	Training Topics	Place	Period
Dr A.L. Kamble	Adoption and impact assessment of research and development projects	ICRISAT, Hyderabad	Nov. 27-30, 2013
	Small farmers value chains and markets linkages		Dec. 02-04, 2013
Dr G.C. Wakchaure	Characterization of potential agro-waste/grasses as an efficient feedstock for biofuel production	NCSU, Raleigh, USA	Feb. 03-Mar. 31, 2014

9. Important Events

Annual Conference of Vice Chancellors of the SAU's and Interface of ICAR Directors

Annual Conference of Vice-Chancellors (VCs) of the State Agricultural Universities (SAU's) was held at Baramati on January 17-19, 2014. Secretary, DARE and DG, ICAR, Chairman ASRB; Additional Secretary, DARE, DDG's and ADG's from ICAR headquarters, Vice Chancellors of 45 SAU and Directors of 99 ICAR Institutes participated in the interactive sessions held on January 19, 2014. All the delegates also visited NIASM and had a glance of its research and developmental activities. This was followed by Directors meet at Pune, jointly organized by NIASM, Baramati and NRC Grapes, Pune on January 20, 2014.

Fig. 9.1. Participants of annual conference of SAU's VC's & ICAR Director are visiting NIASM Research Farm

DG, ICAR and Secretary, DARE and DDG, NRM visit

DG, ICAR and DDG, NRM visited NIASM on June 15, 2013 to review the progress in research, farm and infrastructure developmental activities and laid foundation stone of Guest House.

(a) (b)

Fig. 9.2. Reviewing progress by DG and DDG (a) and Foundation stone laying for Guest House (b)

Celebration of National Days

Institute celebrated Independence Day on August 15, 2013 and Republic Day on January 26, 2014 with great enthusiasm in the campus. The Director hoisted the national flag and addressed the staff members on these occasions.

(a)

(b)

Fig. 9.3. Celebration of Independence Day (a) and Republic Day (b)

Vigilance Awareness Week

Vigilance Awareness Week was observed during October 28, 2013 to November 2, 2013 at the Institute. It commenced with a pledge taken by all the officials and staff on October 28, 2013 in the presence of Director of the institute. Series of lectures were organized during this period. All staff members of the institute actively participated in these activities.

हिन्दी सप्ताह समारोह

संस्थान में हिन्दी दिवस का आयोजन हिन्दी सप्ताह (सितम्बर 16 से 22, 2013) के रूप में किया गया। निदेशक महोदय की अध्यक्षता में दिनांक सितम्बर 04, 2013 को राजभाषा कार्यान्वयन समिति की बैठक का आयोजन किया गया। इस बैठक में राज भाषा के प्रचार एवं प्रसार के लिए विस्तार पूर्वक चर्चा की गयी तथा सर्व सम्मति से यह निर्णय लिया गया कि संस्थान में हिन्दी दिवस समारोह को हिन्दी सप्ताह के रूप में मनाया जाये एवं आस-पास स्थित किसी शैक्षणिक संस्थान में भी राजभाषा में प्रतियोगिताएं आयोजित की जायें। राजभाषा समिति ने उद्घाटन एवं समापन समारोह के लिए क्रमशः डा. सी. वी. मुरुमकर, प्राचार्य, तुलजाराम चतुरचंद महाविद्यालय, बारामती और डा. अनिल के. राजवंशी, निदेशक, निंबकर एग्रिकल्चरल रिसर्च इंस्टीट्यूट, तंबमल, फलटण-लोनंद रोड को नामांकित किया।

हिन्दी सप्ताह कार्यक्रम का उद्घाटन 16 सितम्बर 2013 को संस्थान के निदेशक एवं अध्यक्ष, राजभाषा समिति द्वारा मुख्य अतिथि डा. सी. वी. मुरुमकर, प्राचार्य, तुलजाराम चतुरचंद महाविद्यालय, बारामती की उपस्थिति में किया गया। अपने उद्घाटन भाषण में निदेशक महोदय ने राजभाषा के महत्त्व की चर्चा करत हुये सभी कर्मचारियों से राजभाषा के अधिकाधिक प्रयोग पर बल देने का आग्रह किया। मुख्य अतिथि डा. सी. वी. मुरुमकर ने अपने विचार हिन्दी में व्यक्त करते हुये राजभाषा के सरल एवं सहज प्रयोग पर ज़ोर दिया। सदस्य सचिव (राजभाषा) ने सब का स्वागत करते हुये सप्ताह भर चलने वाले कार्यक्रमों की जानकारी दी एवं महानिदेशक भाकृअप द्वारा भेजे गए अभिलेख पत्र को पढ़ कर सुनाया। हिन्दी सप्ताह के दौरान विभिन्न प्रतियोगिताओं जैसे हिन्दी टिप्पण लेखन, हिन्दी निबंध, तात्कालिक वाक्प्रतियोगिता, कम्प्युटर पर हिन्दी टंकण प्रतियोगिता, हिन्दी सामान्य ज्ञान, हिन्दी कविता पाठ एवं वाद-विवाद प्रतियोगिता का आयोजन किया गया। इसी दौरान तुलजाराम चतुरचंद महाविद्यालय, बारामती में छात्रों के बीच वाद-विवाद एवं हिन्दी कविता पठन प्रतियोगिता भी आयोजित की गई जिस में महाविद्यालय के

छात्र छात्राओं ने बढ़चढ़ कर हिस्सा लिया। कार्यक्रम का समापन एवं पुरस्कार वितरण समारोह 21 सितम्बर 2013 को निदेशक महोदय और मुख्य अतिथि डा. अनिल के. राजवंशी, निदेशक, निंबकर एग्रिकल्चरल रिसर्च इंस्टीट्यूट, तंबमल, फलटण-लोनंद रोड की उपस्थिति में सम्पन्न हुआ। इस अवसर पर निदेशक महोदय ने सभी कर्मचारियों को बढ़ चढ़कर हिस्सा लेने के लिए बधाई दी। मुख्य अतिथि डा. अनिल के. राजवंशी ने अपने विचार हिन्दी में व्यक्त करते हुये सभी कर्मचारियों से अपने शोधपत्र एवं लेख हिन्दी में लिखने की अपील की।

निदेशक द्वारा दीप प्रज्वलित कर हिन्दी सप्ताह समारोह का उद्घाटन

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10. New Staff and Transfers

Joined

Administrative and Technical staff	Joining date
Assistant	
Mr Manjeet Singh	08.02.2014
Senior Administrative Officer	
Mr G.F. Shahir	17.07.2013
Technical Officer (Farm)	
Dr P.B.Taware	01.07.2013
Scientific Staff	
Scientists	
Mr R.L. Meena	12.04.2013
Dr S.S. Pawar	29.11.2013
Principal Scientist	
Dr M.J. Kaledhonkar	26.08.2013

Transferred

- Dr. U. K. Maurya, Senior Technical Officer was selected as Senior Scientist (Soil Sciences) for RRS, Kota, under CS&WCR&TI, Dehradun. He was relieved on July 23, 2013.
- Sh. G.G. Harakangi, Chief Administrative Officer was transferred as Deputy Secretary to National Agricultural Innovation Project, New Delhi. He was relieved on October 11, 2013.
- Miss. C.N.Divya, Assistant was transferred to Indian Institute of Spices Research, Kozhikode, Kerala on mutual transfer. She was relieved on February 07, 2014.

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11. Budget

(Rs. lakhs)

Head / Sub head	Plan		Non-Plan	
	Allocation	Expenditure	Allocation	Expenditure
Grants in aid -Capital				
Works		1090.77	–	–
Equipment		397.78	–	–
IT		19.64	–	–
Library		12.04	–	–
Furniture & Fixture		21.88	–	–
Vehicles		–	–	–
Livestock		2.23	–	–
Sub total (1)	1544.50	1544.35	–	–
Grants in aid- Salary				
Pay & Allowances	–	–	409.00	408.89
Sub total (2)	–	–	409.00	408.89
Grants in aid-General				
TA		5.16	6.39	6.39
Contingencies		342.73	94.90	95.40
HRD		17.12	1.00	0.50
Sub total (3)	365.00	365.01	102.29	102.29
Grand total (1+2+3)	1909.50	1909.36	511.29	511.18
NICRA	22.00	21.93	–	–

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12. Research Projects

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. 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)
- 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, K.K. Meena, G.C. Wakchaure)
- Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivars (G.C. Wakchaure, P.S. Minhas, R.K. Pasala, R.L. Choudhary, S.K. Bal, K.K. Meena)
- Design and development of livestock and fishery structures for heat stress management (G.C. Wakchaure, S.V. Ghadge, B. Sarkar)

School of Drought Stress Management

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

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 uncultured microbial diversity of saline soils using metagenomics (S. Kumar, K.K. Krishnani, V. Rajagopal)
- Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (B. Sarkar, M.P. Brahmane, K.K. Krishnani)
- Resource conservation technologies for enhancing productivity and input-use efficiency in sugarcane ratoon crop (R.L. Choudhary, P.S. Minhas, V. Rajagopal, G.C. Wakchaure, K.K. Krishnani)
- Design and development of mini tractor seeder attachment for sugarcane trash farming (S.V. Ghadge)
- Isolation and characterization of biomolecule producing bacteria for salt stress alleviation in major crops (K.K. Meena)
- Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils (P.S. Kumar, P.S. Minhas, D.D. Nangare, Y. Singh, K.P. Bhagat, P.B. Taware)

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)
- Tribal Sub Plan-TSP (A.L. Kamble)

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 NICRA, CRIDA, Hyderabad
- 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
- Predicting the impact of climate change on regional and seasonal abundance of major soyabean insect pests using temperature-driven phenology modelling and GIS-based risk mapping approach (B. Fand) funded by DST, GoI., New Delhi
- Assessment of novel organic compounds for their efficacy on crop plants under drought (M. Kumar, R. L. Meena, J. Rane, P.S. Minhas) funded by Geolife India Pvt. Ltd., Mumbai

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13. Personnel

(As on 01.06.2014)

Scientific Staff	
Dr P. S. Minhas	Director
School of Atmospheric Stress Management	
Dr S.K. Bal	Principal Scientist and *I/C* Head
Dr R.K. Pasala	Senior Scientist (Plant Physiology)
Dr Y. Singh	Senior Scientist (Agronomy)
Dr S.S. Pawar	Scientist (Animal Biotechnology)
Dr G.C. Wakchaure	Scientist (Agricultural Structure & Process Engineering)
Dr B.B. Fand	Scientist (Agricultural Entomology)
Dr K.P. Bhagat	Scientist (Plant Physiology)
Dr S. Saha	Scientist (Agrometeorology)
Dr B. Sajjanar	Scientist (Animal Biotechnology)
School of Drought Stress Management	
Dr J. Rane	Head
Dr D.V. Patil	Senior Scientist (Plant Breeding)
Dr A.K. Singh	Senior Scientist (Agricultural Biotechnology)
Dr D.D. Nangare	Scientist (Sr. Scale) (Soil & Water Conservation Engg.)
Dr S.K. Raina	Scientist (Plant Breeding)
Dr V. Govindasamy	Scientist (Microbiology)
Dr M. Kumar	Scientist (Plant Physiology)
Mr R.L. Meena	Scientist (Agronomy)
School of Edaphic Stress Management	
Dr K.K. Krishnani	Head
Dr M.J. Kaledhonkar	Principal Scientist (Soil & Water Conservation Engg.)
Dr N.P. Kurade	Principal Scientist (Veterinary Pathology)
Dr D.P. Patel	Principal Scientist (Plant Physiology)
Dr B. Sarkar	Senior Scientist (Fish and Fishery Science)
Dr S.V. Ghadge	Senior Scientist (Farm Machinery and Power)
Dr P. Suresh Kumar	Senior Scientist (Horticulture)

Dr K.K. Meena	Senior Scientist (Agricultural Microbiology)
Dr M.P. Brahmane	Scientist (Sr. Scale) (Animal Biotechnology)
Dr R.L. Choudhary	Scientist (Agronomy)
Mr V. Rajagopal	Scientist (Soil Chemistry/Fertility/Microbiology)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Dr Neeraj Kumar	Scientist (Fish Nutrition)
Mr B. Gopalakrishnan	Scientist (Environmental Science)
School of Policy support Research	
Dr N.P. Singh	Principal Scientist and *I/C* Head
Dr D.V.K.N. Rao	Senior Scientist (Soil Chemistry/Fertility/Microbiology)
Dr A.L. Kamble	Scientist (Agricultural Economics)
Technical Staff	
Dr A.V. Nirmale	Technical Officer T-9 (Animal Science)
Dr P.B. Taware	Technical Officer T-5 (Farm)
Mrs Noshin Shaikh	Technical Assistant T-3 (Civil)
Mr Santosh Pawar	Technical Assistant T-3 (Electrical)
Mr 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)
Dr (Mrs) Priya George	Technical Assistant T-3 (Microbiology)
Mr Lalitkumar Aher	Technical Assistant T-3 (Biotechnology)
Mr Sunil Potekar	Technical Assistant T-3 (Agro meteorology)
Mr Patwaru Chahande	Technical Assistant T-3 (Agriculture)
Mr Aniket More	Technical Assistant T-1 (Mali)
Administrative Staff	
Mr G.F. Shahir	Senior Administrative Officer
Mr Ram Avtar	Finance & Accounts Officer
Smt Purnima S Ghadge	Assistant
Mr Pardeep Kumar	Assistant
Mr Manjeet Singh	Assistant
Mr Dayanand Kharat	Assistant

14. Distinguished Visitors

Name	Address	Date of visit
Dr R.K. Singh	Rice Breeder, IRRI, Philippines	22.05.2013
Dr S. Ayyapan	Secretary, DARE and DG, ICAR, New Delhi	15.06.2013
Dr A.K. Sikka	DDG, NRM, ICAR, New Delhi	15.06.2013
Dr J. D. Patil	Project Director, DSR, Hyderabad	10.10.2013
Dr K.E. Lawande	VC, BSKKV, Dapoli	24.10.2013
Shri Rajendra Pawar	Chairman, ADT, Baramati	23.11.2013
Dr S.S. Magar	Ex-Vice Chancellor, BSKKV, Dapoli	23.11.2013
Dr V.U.M. Rao	PC (Agro. Met), CRIDA, Hyderabad	23.11.2013
Dr R.K. Gupta	South Asia Coordinator, CIMMYT, Mexico	25.11.2013
Dr R.B. Singh	President, NAAS, New Delhi	06.12.2013
Dr B. Mohan Kumar	ADG (Agro & AF), ICAR, New Delhi	06.12.2013
Dr Mruthyunjaya	Ex-ND, NAIP, New Delhi	06.12.2013
Dr Gaya Prasad	Director (A), IVRI, Izatnagar, ADG (AH)	06.12.2013
Dr S.D. Sawant	Director, NRC Grapes, Pune	09.12.2013
Dr A.K. Sikka	DDG, NRM, ICAR, New Delhi	14.12.2013
Dr Arvind Kumar	DDG, Education, ICAR, New Delhi	16.12.2013
Dr T.P. Rajendran	Director, NIBSM, Raipur	25.12.2013
Dr Arvind Kumar	DDG, Education, ICAR, New Delhi	10.01.2014
Dr S. Ayyapan	Secretary, DARE and DG, ICAR, New Delhi	19.01.2014
Dr A.K. Sikka	DDG, NRM, ICAR, New Delhi	19.01.2014
Dr Jai Gopal	Director, DOGR, Pune	30.01.2014
Dr S.A. Ranpise	Head, Dept. of Horticulture, MPKV, Rahuri	14.02.2014
Dr V. Tiwari	AICW&BIP, DWR, Karnal	18.02.2014

Appendix

Members of IMC

1. Dr. P.S. Minhas, Director, NIASM, Baramati Pune (Chairman)
2. Director of Agriculture, Govt. of Maharashtra, Central Building, Pune
3. Commissioner, Commissionerate of Agriculture, Fatehmaidan, Hyderabad
4. Prof. Nilesh Nalawade, Principal, CoA (MPKV), Sharadanagar, Malegaon Colony, Baramati
5. Shri. Rajendra Pawar, Chairman, Agriculture Development Trust, Malegaon, Baramati, Pune
6. Dr. S.S. Magar, Ex-Vice Chancellor, Konkan Agricultural University, Dapoli
7. Dr. Jagdish Prasad, Principal Scientist, Div. of Soil Recourses, NBSS&LUP, Nagpur
8. Dr. P.R. Bharambe, Head & Principal Scientist, CICR, Nagpur
9. Dr. G.S. Karibasappa, Principal Scientist (Hort.), IIHR, Bangalore
10. Dr. V.U.M. Rao, Principal Scientist & Project Coordinator (Ag. Met.), CRIDA, Hyderabad
11. Dr. B. Mohan Kumar, Assistant Director General (Agro & AF), ICAR, KAB II, New Delhi
12. Shri. G.C. Prasad, Senior Finance & Account Officer, NBSS & LUP, Nagpur
13. Shri. G.F. Shahir, Senior Administrative Officer, Baramati, Pune (Member Secretary)

Members of RAC

1. Dr. R.B. Singh, President, NAAS, New Delhi, (Chairman)
2. Dr. R.P. Samuel, Dy. Director General, (Agromet. Division), IMD, Shivajinagar, Pune
3. Dr. S.P. Adhikary, Head, Centre for Biotechnology, VBSBS, Santiniketan, West Bengal
4. Dr. (Mrs.) Renu Khanna Chopra, Water Technology Centre, IARI, Pusa, New Delhi
5. Prof. B.N. Goswami, IITM, Pashan, Pune
6. Dr. Gaya Prasad, Director (A) IVRI, Izatnagar, ADG (AH)
7. Dr. Mruthyunjaya, Ex-ND, NAIP, A-701,Vasundhara Apt, Sector-6, Dwarka, New Delhi

8. Dr. Mohan Kumar, Assistant Director General (Agro & AF), ICAR, KAB-II, Pusa, New Delhi

9. Dr. S.S. Magar, Ex-Vice Chancellor, Konkan Agricultural University,Aundh, Pune

10. Shri. Rajendra Pawar, Chairman, Agriculture Development Trust, Malegaon, Baramati, Pune

11. Dr.(Mrs.) Nandini Nimbkar, Director, NDRI, Phaltan

12. Dr. P.S. Minhas, Director, NIASM, Malegaon, Baramati

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

Institute Research Committee

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

Project Monitoring and Evaluation Committee

Dr. J. Rane (Chairman), Dr. N.P. Singh, Dr. R.K. Pasala, Dr. B. Sarkar, Dr. D.V.K.N. Rao (Member Secretary), Mr. G. Madhukar

Result Framework Document Cell

Dr. D.V.K.N. Rao (Chairman), Dr. A.K. Singh, Dr. M.P. Brahmane, Dr. S.K. Raina, G.F. Shahir, Mr. Ram Avtar, Dr. B.B. Fand (Member Secretary)

Purchase Advisory Committee

Dr. K.K. Krishnani (Chairman), Dr. K.K. Meena, Dr. A.L. Kamble, Dr. B.B. Fand, Dr. S. Saha, Mr. Satish Kumar, Mr. Ram Avtar, Mr. G.F. Shahir (Member Secretary)

Works Committee

Dr. M.J. Kaledhonkar (Chairman), Dr. S.K. Bal, Dr. N.P. Singh, Dr. A.V. Nirmale, Mr. G.F. Shahir, Mr. Ram Avtar, Mrs. Noshin Shaik & Mr.Santosh Pawar (Co-opted Members)

Farm Management Committee

Dr. S.K. Bal (Chairman), Dr. S.V. Ghadge, Dr. P. Suresh Kumar, Dr. Yogeshwar Singh, Dr. D.D. Nangare, Dr. A.V. Nirmale, Dr. P.B. Taware, Dr. G.C. Wakchaure (Member Secretary)

Library Advisory Committee

Dr. D.P. Patel (Chairman), Dr. S.K. Bal, Dr. D.V. Patil, Dr. V. Govindasamy, Dr. Mahesh Kumar, Mr. V.Rajagopal, Mr. Ram Avtar, Mr. G.F. Shahir, Dr. A. K. Sharma (Member Secretary)

Publication Committee

Dr.J. Rane (Chairman), Dr. N.P. Singh, Dr. B.B. Fand, Dr. R.K. Pasala, Dr. U. K. Maurya, Dr. A. K. Sharma (Member Secretary)

Institute Technology Management & Consultancy Processing Committee

Dr. K.K. Krishnani (Chairman), Dr. N.P. Singh, Dr. B. Sarkar, Dr. A.L. Kamble, Mr. Ram Avtar, Mr. G.F. Shahir, Dr. P. Suresh Kumar (Member Secretary)

Proprietory Items Committee

Dr. N.P. Singh (Chairman), Dr. S.K. Bal, Dr. A.K. Singh, Dr. K.P. Bhagat, Dr. R.L. Choudhary, Dr. B. Sajjanar, Dr. R.K. Pasala (Member Secretary)

Grievance Cell

Head of Divisions, Mr. S. Pawar, Mr. Ram Avtar, Mr. G.F. Shahir

RTI Cell

Dr. P.S. Minhas, Director (Appellate Authority), Dr. N.P. Singh (CFO), Dr. A.K. Sharma (Assistant Public Information Officer), Dr. S.V. Ghadge (Transparency Officer)

Women Cell

Mrs. P.S. Ghadge (Chairperson), Mrs. Noshin Shaikh, Dr (Mrs.) Priya George, Mr. Ram Avtar, Mr. G.F. Shahir

राजभाषा कार्यान्वयन समिति

डा. पी. एस. मिन्हास (अध्यक्ष), डा. के. के. कृष्णानी (उपाध्यक्ष), डा. डी. वी. पाटील, डा. महेश कुमार, डा. राम लाल चौधरी, श्री जी. एफ. शाहीर, श्री राम अवतार, श्री प्रदीप कुमार, श्री प्रविण मोरे, डा. डी. पी. पटेल (सदस्य सचिव)

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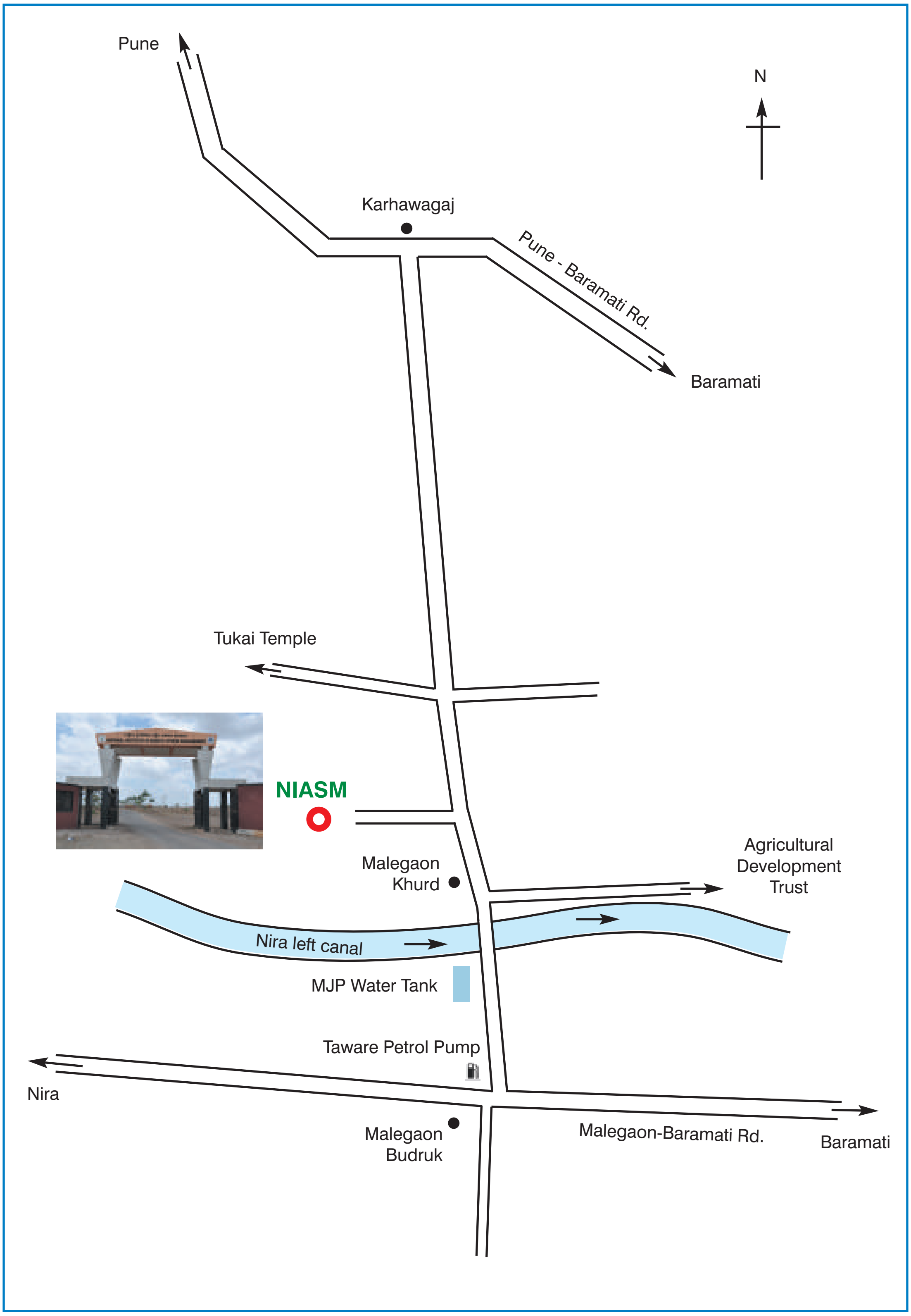
Route Map


Pune
N
Karhawagaj
Pune - Baramati Rd.
Baramati
Tukai Temple
NIASM
Malegaon Khurd
Agricultural Development Trust
Nira left canal
MJP Water Tank
Taware Petrol Pump
Nira
Malegaon Budruk
Malegaon-Baramati Rd.
Baramati

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

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