2019

वार्षिक प्रतिवेदन ◆ Annual Report

भाकृअनुप-राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

ICAR-National Institute of Abiotic Stress Management

(समतुल्य विश्वविद्यालय / Deemed to be University)

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

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

भाकृअनुप
ICAR

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NIASM

ICAR-NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT

Annual Report
2019

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(समतुल्य विश्वविद्यालय)/(Deemed to be University)
भारतीयकृषिअनुसंधानपरिषद,कृषि अनुसंधान एवं शिक्षा विभाग
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Preface

Abiotic stresses including drought, water stagnation, salinity, high and low temperature limit agricultural productivity and threaten food security. These abiotic stresses can be more frequent, intense and devastating due to climate change. Therefore, management of these abiotic stresses is urgently needed for sustainable agriculture across the harsh agro-ecologies. The concern of global food security and reduction in agricultural productivity necessitate carrying out frontier research by multidisciplinary team of scientists to minimize the adverse impacts of abiotic stresses in agriculture and to develop of climate smart crops. It also encourages establishing linkages and wide network with national and international centres to accomplish the task.

The institute aims to provide dynamic and advanced tools for minimizing loses in agricultural productivity due to various abiotic stresses. To accomplish this task, ICAR-NIASM has taken lead to carry out research for delivering technologies for the benefit of farming community through basic and strategic research in crops, livestock and fisheries. The institute has state of the art laboratory facilities, high-tech greenhouses, phenomics facility, experimental research farm, animals and fisheries experimental research units. It has also made efforts on human resource development by conducting workshop and training programme. The information on the various disciplines is reflected in technologies developed by the institute as well as publications in peer reviewed journals, book chapters, technical bulletins, technical folders and popular articles.

I extend my sincere thanks to Dr Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Sushil Kumar, Additional Secretary (DARE) & Secretary (ICAR); Shri Bimbadhar Pradhan, Additional Secretary & Financial Advisor (DARE/ICAR); Dr K Alagusundaram, DDG, NRM (ICAR); Dr Suresh Kumar Chaudhari, ADG, Soil & Water Management and Dr S Bhaskar, ADG, AAF & CC for their continued support to ICAR-NIASM. The contributions of various Committees in institute development are highly appreciated. I also appreciate the efforts made by the members of the Publication Committee in compiling this report.

Date: 31-12-2019
ICAR-NIASM, Baramati

(Jagadish Rane)

Contents

कार्यकारी सारांश

- सोयाबीन जीनोटाइप EC-333901, EC-241995, SL-958, EC-546882, JS-2029 और EC-333859 ने गैर-तनाव के तहत कूलर कैनोपी का प्रदर्शन किया और जाँच किस्मों JS-9752 और NRC-37 की तुलना में कम तनाव की स्थिति भी देखी। जीनोटाइप MAUS-71, DURGA, EC-241995, MAUS-1, EC-333901 और EC-287754 ने JS-9752 और NRC-37 किस्मों की तुलना में उच्च Fv/Fm दिखाया।

- सोयाबीन जीनोटाइप JS-7105, EC-39376, EC- 95815, MAUS- 47, JS- 2034, EC- 457464, BR- 15A में पानी की ठहराव तनाव की स्थिति के तहत चेक किस्मों की तुलना में बेहतर पौधे की ऊंचाई में वृद्धि देखी गई। सोयाबीन जीनोटाइप्स EC-95815, AMS-MB-5-18, EC-396067, BR-19 ने जेएस 9752 और NR2 37 की किस्मों की तुलना में पानी की ठहराव तनाव की स्थिति के तहत उच्च NDVI दिखाया।

- सोयाबीन जीनोटाइप एजीएस- 116, एजीएस- 166, ईसी- 114527, एजीएस- 38, ईसी- 467282, डीएस- 321, एजीएस- 157, एजीएस- 150, ईसी- 175329, ईसी- 389154 में जड़ के संख्या के संदर्भ में कुशल जड़ प्रणाली थी।, लंबाई, मूल शाखा और सोयाबीन जीनोटाइप AGS-02, EC-250591, AGS-38, TGX-702-4-8 में JS-9560 की तुलना में बायोमास के संदर्भ में कुशल जड़ प्रणाली थी।

- सोयाबीन जीनोटाइप एमएसीएस-1034, EC-333901, MAUS-71, EC-538807, TGX 86011-D और EC-287754 ने जेएस 9752 और NR2 2017 की किस्मों की तुलना में उच्च NDVI दिखाया। सोयाबीन जीनोटाइप्स JS-2098, PK-308, DSB- 23, MAUS-71, PUSA-37, JS-8011 और CO-SOYA-2 ने JS-9752 और NRC-37 की तुलना में उच्च सापेक्ष पानी की सामग्री को दिखाया ।

- गेहूं के जीनोटाइप्स NI-5439, सोनार-64, एनपी-404 और C-306 ने सिंचित और कम मिट्टी की नमी की स्थिति में अच्छी मात्रा में दक्षता बनाए रखी। जीनोटाइप्स NI-5749 ने चयनित जीनोटाइप के बीच, मिट्टी की नमी की स्थिति के तहत अधिकतम quantum efficiency प्रदर्शित किया।

- गेहूँ के बीजों का ह्लोटोलरेंट एंटरोबेक्टर से लेप लगाना, गेहूं में अंकुरण, स्थापना और लवणता सहनशीलता को बढ़ाता है।

- गेहूं में लवणता के तनाव को कम करने के लिए बैक्टीरियल कल्चर एक्सट्रैक्ट (बीसीई) को शामिल करना प्रभावी पाया गया। बीसीई के साथ बीज प्राइमिंग ने भौतिक-रासायनिक स्थिति, एंटीऑक्सिडेंट एंजाइम दोनों को बढ़ाया और इसलिए इसका उपयोग गेहूं में लवणता तनाव सहिष्णुता को बढ़ाने के लिए किया जा सकता है।

- औषधीय और सुगंधित पौध उद्यान 5.0 एकड़ के क्षेत्र में स्थापित किया गया, जिसमें राष्ट्रीय औषधीय पौधे बोर्ड, आयुष विभाग, नई दिल्ली की वित्तीय सहायता के तहत 65 प्रजातियों के पेड़, झाड़ियाँ की प्रजातियाँ शामिल हैं।

- औषधीय वृक्षों की प्रजातियाँ जैसे नीम, apple wood, पलाश, शमी, शिवन, पुटर्रजीवा, coral tree, बेल, महुआ, हरा, बहेड़ा, लाल चन्दन, नीलगिरी, करी पत्ता, नीबू, कुटज, सेसबानिया, निर्गुड़ी को मुर्रम मिट्टी में लगाया गया है। अच्छी तरह से स्थापित पौधों में क्लोरोफिल की मात्रा अधिक पायी गयी और कैनोपी तापमान भी कम पाया गया। यह वर्तमान मिट्टी और जलवायु परिस्थितियों में अनुकूलता का संकेत देता है।

- फोल्डस्कोप, एक पोर्टेबल ऑप्टिकल माइक्रोस्कोप जिसे एक बैटरी के साथ कागज, लेंस और एक प्रकाश उत्सर्जक डायोड की एक शीट से बनाया जा सकता है और पराग व्यवहार्यता अध्ययन के लिए उपयोग किया जा सकता है।

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

- पादप फिनोमिक्स सुविधा में छवि मापदंडों से प्राप्त किए जा सकने वाले संभावित सरोगेट लक्षणों पर ध्यान देने के साथ पौधों की प्रतिक्रियाओं का आकलन करने के लिए पादप फीनोमिक्स सुविधा में मूँग, चना, अरहर और मसूर के साथ प्रयोग किया गया।

- हरे, लाल और नीले पिक्सलों को परिमाणित करने के लिए छवि विश्लेषण विन्यास उपकरणों का उपयोग किया गया, जो कि पत्ती के बारे में और साथ ही चना जैसी दलहनी फसलों में होने वाली वृद्धि दर के बारे जानकारी प्रदान कर सकता है।

- NIR से पत्तियों के ऊतक में नमी की कमी को प्रभावी ढंग से समझा जा सकता है। उत्तल पतवार क्षेत्र, कॉम्पैक्टनेस और मिट्टी की नमी में कमी के दौरान पत्तियों की turgidity में परिवर्तन की व्याख्या किया जा सकता है।

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

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

- पत्ती के हरेपन में आनुवंशिक भिन्नता के गैर-विनाशकारी मूल्यांकन के लिए छवि-आधारित विधि सोयाबीन में विकसित की गई । जीजी / आरजीबी, आर / आरजीबी जैसे आरजीबी रंग सूचकांकों को क्लोरोफिल सामग्री के साथ काफी सहसंबंधित पाया गया और एसपीएडी मूल्यों ने दर्शाया कि इस विधि का उपयोग सोयाबीन में पत्तियों की हरियाली में भिन्नता का आकलन करने के लिए किया जा सकता है।

- लेम्नाटेक एचटीएस-स्केन्लिज़र और आईसीएआर-एनआईएएसएम में विकसित स्वदेशी साधनों का उपयोग करके छवि विश्लेषण द्वारा छोले और सोयाबीन में मात्रात्मकता की मात्रा निर्धारित की गई थी। इस छवि अधिग्रहण और विश्लेषण उपकरण के माध्यम से हम इन फसलों के तेजी से और साथ ही धीमी गति से जीनोटाइपिंग की पहचान कर सकते हैं।

- फसल के घटक, पशु घटक और कृषि अपशिष्ट और प्राकृतिक संसाधनों के उपयोग से एकीकृत जैविक कृषि प्रणाली मॉडल विकसित किया गया है।

- पोस्ट quality- फसल की गुणवत्ता के मानकों के अनुसार, ज्यामितीय माध्य व्यास, स्थानीय खेती का औसत कांदा और औसत काँदे के वजन परीक्षण किए गए अन्य सभी प्याज की तुलना में बेहतर पाया गया।

- प्याज की फसल के भंडारण के लिए स्थानीय और भीम किरण की बेहतर भूमिका होने की पहचान की गई।

- 250 बैक्टीरियल एंडोफाइट्स को लक्षित Opuntia प्रजातियों से अलग किया गया है और उनके पीजीपीए (प्लांट ग्रोथ प्रमोशन एक्टिविटी) के लिए मूल्यांकन किया गया है। 59 ऑपंटिया लीफ एंडोफाइट्स को सिडरफोर उत्पादन क्षमता के

साथ पाया गया है, 38 पत्ती एंडोफाइट्स फॉस्फेट घुलनशीलता गतिविधि को प्रदर्शित करते हैं और 29 पत्ती एंडोफाइट्स नाइट्रोजन फिक्सिंग क्षमता के साथ दिखाई देते हैं।

- 16 Opuntia लीफ एंडोफाइट्स को भी अलग किया गया है जो कि साइडरोफोर उत्पादन, फॉस्फेट घुलनशीलता गतिविधि और नाइट्रोजन निर्धारण गतिविधि को प्रदर्शित करता है।

- उर्वरकों (40% आरडीएफ) की 40% घटी हुई मात्रा और कचरे की सतह प्रतिधारण के साथ एसओआरएफ तकनीक को अपनाने से पारंपरिक किसानों की कचरा जलाने और उर्वरकों के डालने के तरीकों और मिट्टी के गुणों में सुधार हुआ।

- एक मैटलैब ऐप "वीडियो फ्रेम क्लासिफायर v1.0" को डीप लर्निंग एल्गोरिदम का उपयोग करके छवि वर्गीकरण के लिए वीडियो से छवि डेटासेट बनाने के लिए विकसित किया गया था।

- उथली मिट्टी और अर्ध-शुष्क क्षेत्र में फल और सब्जी के लिए जल बचत तकनीकों का मूल्यांकन किया गया। RWC को सैलिसिलिक एसिड ट्रीटमेंट की PRD60 + मल्च + फोलियर स्प्रे में अधिकतम पाया गया और न्यूनतम सिंचाई (DI40) में बिना ज्यादा और पर्ण स्प्रे ट्रीटमेंट के अधिकतम पाया गया।

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

- ज्वार के चारे के साथ गन्ने के टॉप्स (एसटी) को 25, 50, 75 और 100% एसटी और 100% ज्वार के साथ खिलाने का प्रयोग किया गया। मिश्रित चारा विशेष रूप से ज्वार चारा के साथ 50% एसटी, पशुओं द्वारा चारा सेवन और वरीयता के संदर्भ में बेहतर पाया गया।

- वीट बी-2 @ 10 मिलीग्राम/किग्रा आहार के साथ प्रतिशत वजन बढ़ने, एंटी-ऑक्सीडेटिव स्टेटस जैसे कि कटेस, सुपरऑक्साइड डिसूटेज, ग्लूटाथियोन-एस-ट्रांसफरेज़ और ग्लूटाथियोन पेरोक्सीडेस में सुधार हुआ, लेकिन आर्सेनिक और उच्च तापमान समूह और नियंत्रण आहार के साथ मछली में कम वृद्धि का प्रदर्शन किया गया।

- जस्ता के डाइटरी सप्लिमेंटेशन ने सीसा युक्त और उच्च तापमान के तनाव को कम किया और मछली के शरीर क्रिया विज्ञान में मदद की। 10 मिलीग्राम / किग्रा आहार पर जस्ता के आहार पूरकता को सेलुलर चयापचय तनाव को कम करने और *पंगासियनोडोन हाइपोफथाल्मस* की संवर्धन के दौरान पूरे शरीर के हेमोस्टेसिस को बनाए रखने के लिए इष्टतम पाया गया।

- आरएफ 5 मिलीग्राम / किग्रा आहार और एसई-एनपी के साथ सप्लीमेंट 0.5 मिलीग्राम /किग्रा आहार आर्सेनिक और थर्मल तनाव के खिलाफ मछली को संरक्षण प्रदान कर सकता है और *पी॰हाइपोफथाल्मस* की बढ़ी हुई थर्मल दक्षता / सहनशीलता प्रदर्शित किया।

- उच्च दैनिक तापमान (26.1-37.2°C) ने *Oreochromis mossambicus* मछलियों में तेजी से विकास को प्रेरित किया और मांसपेशी बायोमास में वृद्धि हुआ। इसे *MyoD* और *MyoG* जीन की उच्च अभिव्यक्ति के साथ सहसंबद्ध किया गया।

Executive Summary

- Soybean genotypes EC-333901, EC-241995, SL-958, EC-546882, JS-2029 and EC-333859 exhibited cooler canopy under non-stress and also drought stress condition compared to check varieties JS-9752 and NRC-37. Genotypes MAUS-71, DURGA, EC-241995, MAUS-1, EC-333901 and EC-287754 showed higher Fv/Fm compared to check varieties JS-9752 and NRC-37.
- Soybean genotypes JS-7105, EC-39376, EC-95815, MAUS-47, JS-2034, EC-457464, BR-15A showed better plant height enhancement than the check varieties under water stagnation stress conditions. Soybean genotypes EC-95815, AMS-MB-5-18, EC-396067 and BR-19 showed better NDVI than the check varieties under water stagnation stress conditions.
- Soybean genotypes AGS-116, AGS-166, EC-114527, AGS-38, EC-467282, DS-321, AGS-157, AGS-150, EC-175329, EC-389154 had efficient rooting system in terms of root length. Soybean genotypes AGS-02, EC-250591, AGS-38, TGX-702-4-8 showed higher biomass compared to check variety JS-9560.
- Soybean genotypes MACS-1034, EC-333901, MAUS-71, EC-538807, TGX 86011-D and EC-287754 showed higher NDVI compared to check varieties JS-9752 and NRC-37. Soybean genotypes JS-2098, PK-308, DSB-23, MAUS-71, PUSA-37 , JS-8011 and CO-SOYA-2 showed higher relative water content compared to check varieties JS-9752 and NRC-37.
- Wheat genotypes NI-5439, SONARA-64, NP-404 and C-306 maintained good quantum efficiency in both irrigated and depleted soil moisture conditions. Genotypes NI-5749 showed maximum non photochemical quenching under depleted soil moisture conditions, amongst selected genotypes.
- Coating of wheat seeds with halotolerant Enterobacter enhanced germination, establishment and confers salinity tolerance in wheat.
- Incorporation of Bacterial Culture Extract (BCE) was found effective for mitigation of salinity stress in wheat. Seed priming with BCE enhanced both the physicochemical status, antioxidative enzymes and hence could be used for enhancing salinity stress tolerance in wheat.
- Medicinal and aromatic plant garden was established in an area of 5.0 acres comprises of 65 species of trees, shrubs and climber species under the financial assistance of National Medicinal Plants Board, Department of AYUSH, New Delhi.
- The medicinal tree species, i.e., Neem, Wood apple, Palash, Shami, Shivan, Putranjeeva, Coral tree, Bael, Mahuva, Hirda, Behda, Red sanders, Eucalyptus, Curry leaf, Lime, Kutaj, Sesbania, Nirgudi adopted in poor soil condition in murrum soil. The well-established plants have higher chlorophyll content and also cooler plant canopy temperature. This indicates the adoption to the present soil and climatic conditions.
- Foldscope, a portable optical microscope which can be assembled from a sheet of paper, lens and a light emitting diode along with a watch battery can be used for pollen viability study.

- Method to estimate pollen viability was standardized in *Vinca rosea* and determined in different crops like soybean, sorghum, wheat, chickpea and pomegranate. Temporal variation and effect of drought on pollen viability revealed existing genetic variation in these crops.
- Experiments were conducted with mungbean, chickpea, pigeon pea and lentil in plant phenomics facility to assess the responses of the plants with focus on possible surrogate traits that can be derived from image parameters in plant phenomics facility and the results indicated that plant fresh biomass can be predicted from image-based parameters like digital volume and boundary point count.
- Image analysis configuration tools were used to quantify green, red and blue pixels, which could provide fare idea about the leaf senescence as well as the rate at which it occurs in pulse crops like chickpea.
- Methods have been optimized for data organization and handling large data using features of excel and R software. Attempts were made to engage some machine learning algorithm to prioritize the image parameters that are closely associated with digital biomass and also can be used as surrogate parameters.
- NIR values could effectively explain the loss of tissue moisture content from leaves. Convex hull area, compactness and eccentricity could explain the changes in turgidity of leaves during soil moisture depletion.
- Excised Leaf Water Loss (ELWL) was identified as a trait which can differentiate crop genotypes based on their ability to loose moisture in environment. Indirect methods to estimate ELWL using NIR sensors demonstrated in crops like soybean, chickpea and wheat. It can be used as one of the drought screening traits in these crops.
- Image-based method for non-destructive assessment of genetic variation in leaf greenness was developed in soybean. RGB colour indices such as G/RGB, R/RGB were found to be significantly correlated with chlorophyll content and SPAD values suggesting that the method can be used for assessing the variation in greenness of leaves in soybean.
- Quantification of senescence was done in chickpea and soybean by image analysis using LemnaTec HTS-Scanalyzer and also with indigenous tools developed at ICAR-NIASM. Through this image acquisition and analysis tools we could identify the fast as well as slow senescing genotypes of these crops.
- Climate resilient integrated organic farming system model, involving crop component, animal component and utilization of farm waste and natural resources, has been developed at.
- Climate resilient integrated organic farming system model, involving crop component, animal component and utilization of farm waste and natural resources has been conceptualised and being implemented.
- The post-harvest quality parameters viz., geometric mean diameter, sphericity and average bulb weight of local cultivar were found superior to all other onion cultivars tested.

- Onion cultivars viz., local and Bhima Kiran were identified to have better role for post–harvest storage of onion
- 250 bacterial endophytes have been isolated from the targeted cactus species and evaluated for their PGPA (Plant Growth Promoting Activity). 59 Opuntia leaf endophytes have been found with siderophore production ability, 38 leaf endophytes displaying phosphate solubilisation activity and 29 leaf endophytes with showed nitrogen fixing ability.
- 16 Opuntia leaf endophytes have also been isolated which exhibited siderophore production, phosphate solubilisation activity and nitrogen fixation activity.
- Adoption of SORF techniques along with 40% reduced dose of fertilizer (40% RDF) and surface retention of trash improved the soil properties over conventional farmers' practices of trash burning and broadcast application of fertilizers.
- A Matlab App "Video Frame Classifier v1.0" was developed for generating image datasets from video for image classification using deep learning algorithms.
- Water saving techniques was evaluated for fruits and vegetable in shallow soils and semi-arid region. RWC was maximum in PRD60+mulch+foliar spray of salicylic acid treatment and was minimum in deficit irrigation (DI40) without mulch and foliar spray treatment.
- Feeding experiment with silage of sugarcane tops (ST) along with Jowar fodder, as 25, 50, 75 and 100% ST and 100% Jowar has been conducted. The mixed silage particularly 50% ST with Jowar fodder revealed better acceptance in terms of feed intake and preference by animals.
- The per cent weight gain, anti-oxidative status such as catalase, superoxide dismutase, Glutathione S-Transferase and Glutathione Peroxidase improved with application of Vitamin B-2 @ 10 mg/kg diet, but the growth performance drastically reduced in fish treated with arsenic and high temperature group and fed with control diet.
- Dietary supplementation of zinc mitigated lead and high temperature stress and helped in modulating physiology of the fish. Dietary supplementation of zinc at 10 mg/kg of diet was found optimum to reduce cellular metabolic stress and to maintain the whole body hemostasis during culture of *Pangasianodon hypophthalmus*.
- Supplementation with RF @ 5 mg/kg diet and Se-NPs @ 0.5 mg/kg diet could confered protection to the fish against arsenic and thermal stress and led to enhanced thermal efficiency/tolerance of *P. hypophthalmus*.
- Higher diurnal temperature (26.1-37.2°C thermal regimes) induced faster growth in *Oreochromis mossambicus* fishes and accumulated higher muscle mass and it was correlated with higher expression of *MyoD* and *MyoG* genes.

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. Therefore, it is a need of well-planned basic and strategic research to manage abiotic stresses in agricultural commodities viz., crop plants, livestock, fish and poultry especially in arid and semiarid regions. In order to address these concerns, National Institute of Abiotic Stress Management (NIASM) was established on February 21, 2009 as one of the national institutes under Indian Council of Agricultural Research (ICAR).

The ever-increasing population together with various abiotic stresses threatens global food security. Abiotic stresses like drought, extreme temperatures (both high and low), water stagnation, salinity, acidity, mineral toxicity and nutrient deficiency have emerged as major challenges for production of crops, livestock, fisheries and other commodities. With increasing challenges posed by climate change, it is predicted that incidence of drought, flood and heat events will be more frequent and severe and these events will further reduce crop yield in the tropics and subtropics. 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. 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 meager considering the magnitude of the problem. Moreover, new tools have emerged in the areas of conservation agriculture, irrigation technologies, biotechnology, nanotechnology, remote sensing, information technology, polymer science, etc., which have opened up new avenues for crop improvement as well as natural resource management to tackle abiotic stresses. Nevertheless, there is a need to evolve a holistic and systems approach to get the best combination of technologies for agro-ecosystems that are often afflicted with multiple stressors. Therefore, it is of paramount importance to initiate high quality research programmes, which are of global standard and also to capture, synthesize, adopt and apply the technological advances taking place within and outside the country. Keeping in view the extensiveness of the problem, institute has an additional responsibility to maximize the number of qualified researchers and professionals of impeccable quality in the domain of tackling abiotic stresses. The idea is to equip these researchers and professionals with the skills to innovate and conduct seamless interdisciplinary research. The institute, which is a Deemed-to-be-University, also plans to focus on imparting education in such specialized areas that are not taught in regular agricultural universities.

Role of the Institute

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

Mission

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

Mandate

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

Objectives

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

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

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

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

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

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

Strategy

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

Fig. 1.1 Institute's strategy for achieving mandate

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

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

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

Status

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

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

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	25	25
Technical	33	13	20
Administrative	21	05	16
Grand Total	**105**	**44**	**61**

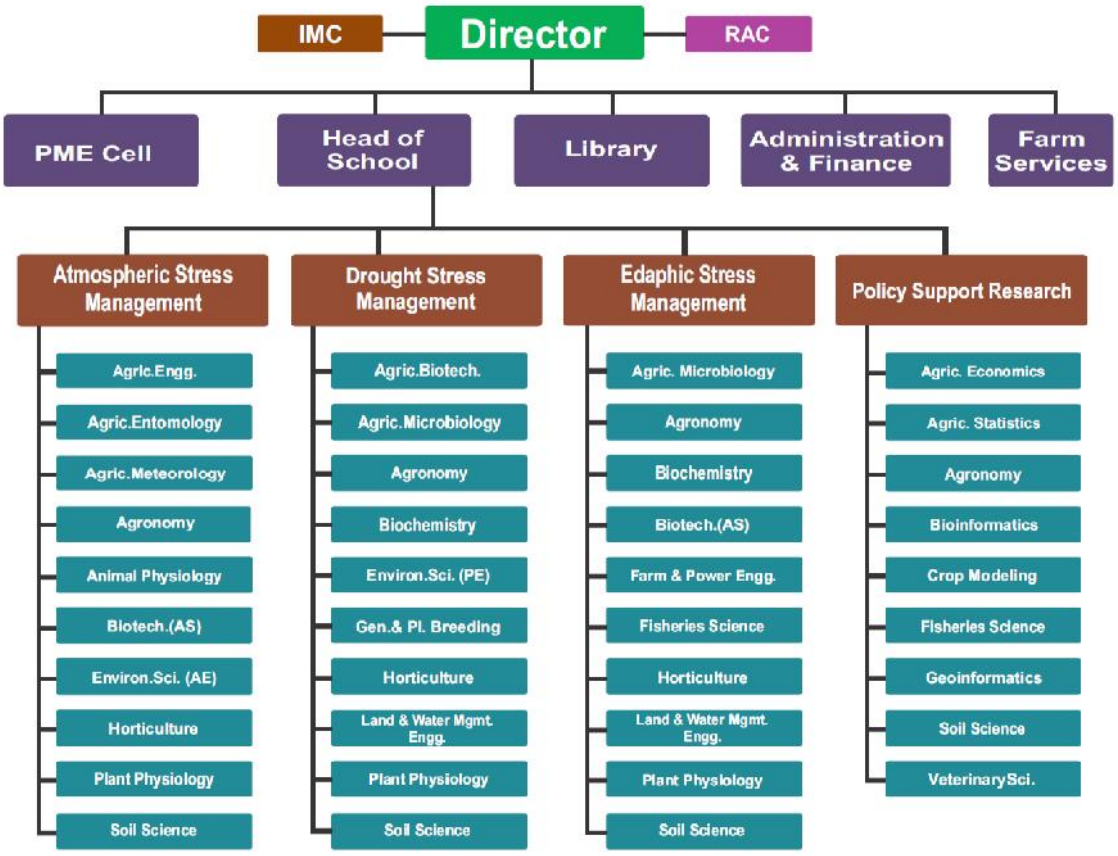


Fig. 1.2 Organogram of the institute

Research Programmes of the Institute

School of Atmospheric Stress Management

- Assessing vulnerability of crops, livestock and fisheries to atmospheric stressors.
- Unravelling the mechanisms and traits for atmospheric stress tolerance in crops and animals.
- Developing adaptation and mitigation strategies for atmospheric stress management.
- Developing decision support systems for optimizing input use and climate proofing.

School of Drought Stress Management

- Unravelling the mechanisms and traits contributing to water stress tolerance in plants.
- Optimizing novel genetic improvement approaches for enhancing resilience of crops to water stress.
- Exploring alternative crops and cropping systems for alleviating water stress.
- Developing precision agriculture for higher water productivity in crop, horticulture, livestock and aquaculture.

School of Edaphic Stress Management

- Exploring mechanisms and traits of soil stress response in crop, livestock and fisheries.
- Developing adaptation and mitigation strategies for soil stress management.
- Mitigating the adverse impacts of nutrient imbalance and pollution in agriculture.
- Developing integrated farming systems for abiotic-stressed regions.

School of Policy Support Research

- Assessing impacts of abiotic stressors on agricultural income, market and trade.
- Evaluating techno-economic feasibilities of multiple stress tolerant adaptation and mitigation technologies.
- Harnessing information and communication technologies for assessment and dissemination of technologies.
- Evolving model capacity building programmes for abiotic stress management.

Weather at ICAR-NIASM, Baramati

(Sunil Potekar and R N Singh)

Information on weather is of paramount importance for agricultural production system. Daily observations of weather parameters are being recorded at agromet observatory of the institute. Observations of weather parameters recorded during January to December 2019 are discussed here.

Temperature

The monthly maximum, minimum and mean temperature during different months at ICAR-NIASM is presented in fig.1.3. During this year, the monthly mean temperature varied between 20.2°C (January) and 30.9°C (May). Monthly maximum temperature reached its peak in May (39.8°C) and dipped to 29.1°C in Dec. For minimum temperature, May recorded the highest (23.7°C) and January recorded the lowest (10.7°C) value. It was observed that monthly mean temperature increased from 20.2°C (January) to 30.9°C (May). Then it reduced to 25.7°C in August due to cooling effect of the monsoon winds. A slight increase was observed in September (26.1°C) then it started decreasing and attained a value of 23.2°C in December (Table.1.2).

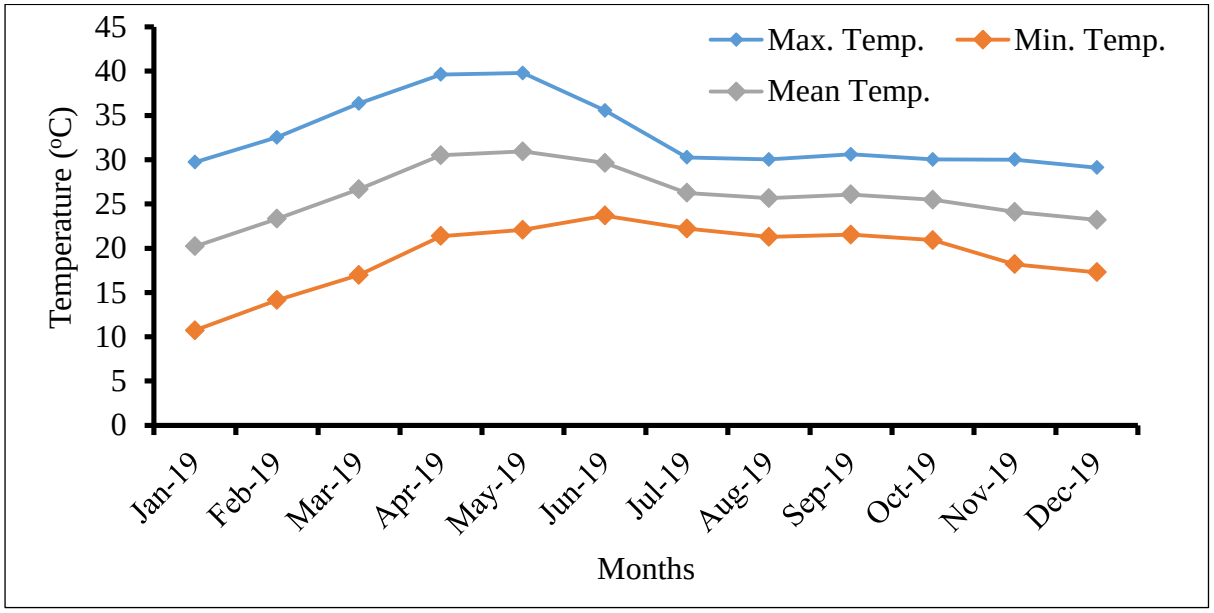


Fig. 1.3. Monthly mean maximum, minimum and mean temperature at ICAR-NIASM, Baramati during 2019

Monthly maximum temperature recorded in April, May and June of this year was observed highest in this decade. A quick rise in daily maximum temperature in last week of April achieving a maximum of 42.8ºC on 27 April was observed, during this period the daily maximum temperature shoot above 40°C which was (>2.0°C) higher than the normal temperature of corresponding days. This marks an extreme event for the region which can be

described by the absence of any strong wind system over Maharashtra region, very less moisture incursion and no rains in that period. Soil was mostly dry and heat absorption is more due to black cotton soil. The high heat load and cyclone *Fani* affected the moisture conditions of area adjacent to central and north peninsula which resulted into rise in temperature and heat wave like conditions over the region.

Table 1.2. Mean monthly weather parameters recorded at ICAR-NIASM from January to December 2019.

Parameters	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Max Temp (°C)	29.7	32.5	36.4	39.6	39.8	35.6	30.3	30.0	30.6	30.0	30.0	29.1
Mean Min Temp (°C)	10.7	14.1	17.0	21.4	22.1	23.7	22.2	21.3	21.5	20.9	18.2	17.3
Mean morning RH (%)	73	70	56	54	55	77	90	88	88	92	89	88
Mean afternoon RH (%)	27	23	15	15	18	45	70	67	64	65	52	50
Mean Wind Speed (km/h)	4.1	5.5	6.1	7.9	10.6	11.6	11.1	11.4	8.7	5.4	4.0	4.6
Sunshine (Hrs/day)	8.6	9.4	9.0	9.4	10.5	4.7	3.2	4.4	3.6	5.2	7.5	4.7
Total rain (mm)	0.0	0.0	0.0	0.0	0.0	36.4	162.6	19.6	162.6	332.4	25.6	0.4
Total rainy days	0	0	0	0	0	4	12	2	6	10	3	0
Pan Evaporation (mm/day)	4.2	6.2	8.6	11.0	12.1	8.3	4.1	4.5	4.1	3.5	3.4	3.3

Relative humidity

Relative humidity measured at standard hours in the morning (0700 LMT) and afternoon (1400 LMT) during the year 2019 were used for computation of monthly statistics. Monthly mean relative humidity during the different months has been depicted in fig. 1.4. Relative humidity at morning varied between 54% (April) and 92% (October). On the other hand, variation in afternoon relative humidity was between 15 (March and April) to 70% (July). The mean morning and afternoon relative humidity was found to be decreasing from January to May, which is due to the effect of increasing temperature, and then it reaches to its highest value during monsoon months and again declined in December due to winter. Annual mean relative humidity averaged over the entire year stood at 60 % and ranged between 35% and 80%. Higher diurnal ranges (more than 45%) in RH were observed in the months of January and February. Lowest diurnal range was observed in the month of July (20%) followed by August (21%).

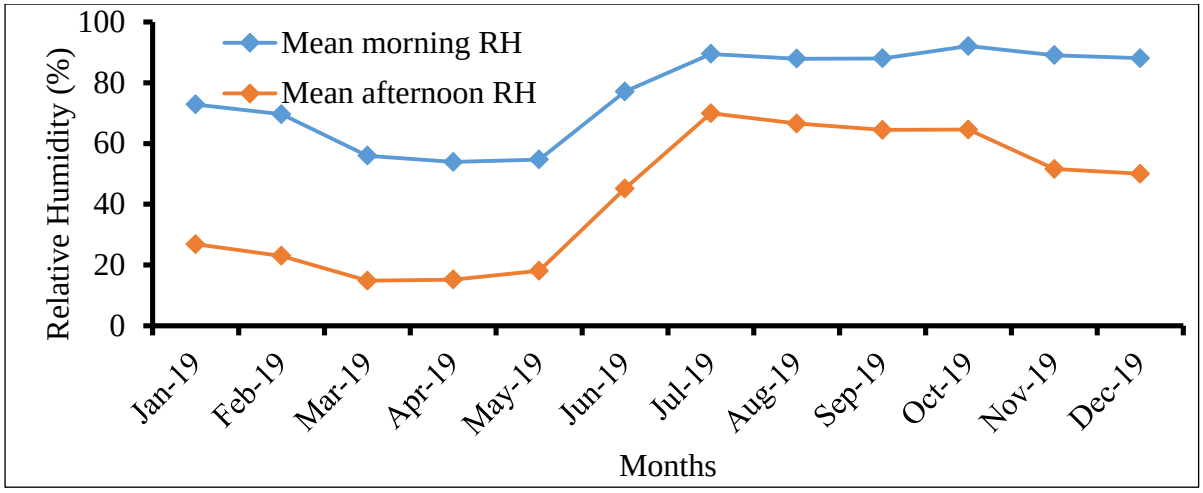


Fig. 1.4. Monthly mean morning and afternoon relative humidity at ICAR-NIASM during 2019.

Rainfall

This year Baramati received about 129% of its long period average annual rainfall distributed among 37 meteorological rainy days and yielded 739.6 mm of total rainfall. The onset of monsoon was delayed by 2 weeks and the monsoon rainfall commenced on 28th June. Last rainfall from the south west monsoon was on 7th of November. The monthly cumulative rainfall during different months recorded at ICAR-NIASM, Baramati has been given in fig. 3. During the monsoon season the maximum rainfall was received during the month of July and September (162.6 mm each), followed by June (Table.1.2). In the monsoon season there are 24 rainy days which resulted a total rainfall of 381.2 mm which was 96% of normal rainfall of the region during the monsoon season. A long dry spell was observed during the monsoon season between 1st August to 15th September. During this peak monsoon period of 45 days only 27 mm of rainfall was received. During post monsoon season late withdrawal of monsoon resulted in incessant rains during October and early November. In the post-monsoon season, highest rainfall occurred in October (332.4 mm) and there is no rainfall during the summer season (Fig. 1.5).

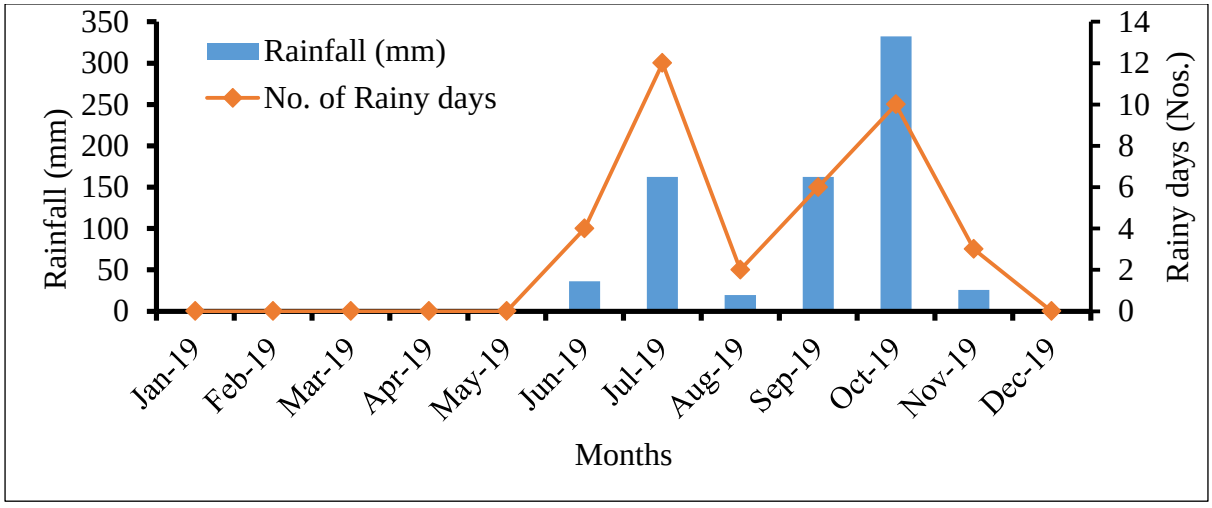


Fig. 1.5. Monthly cumulative rainfall and number of rainy days at ICAR-NIASM during 2019.

Wind speed and Pan evaporation

Monthly mean wind speed and mean evaporation rate recorded during different months of this year at ICAR-NIASM is presented in fig.4. Monthly average wind speed values have been found to vary between 4.1 (January) to 11.6 km/h (June) and annual average for the daily wind speed stood at 7.6 km/h. It is observed that wind velocity was higher during May-July (>10.0 km/h) compared to rest of the months (Table.1.2). Annual open pan evaporation (Pan-E) aggregates to 2230.5 mm which was about 3 times this year's total rainfall. It was found that the evaporative demand gradually increased from January and reached to the highest value in May (12.1 mm/day) and declined thereafter to 4.1 mm/day in July. From July to December average daily Pan Evaporation remained between 3.3 to 4.5 mm/day (Fig. 1.6). The lowest evaporation rate was recorded in December (3.3 mm/day). The annual average of daily Pan-E was 6.0 mm.

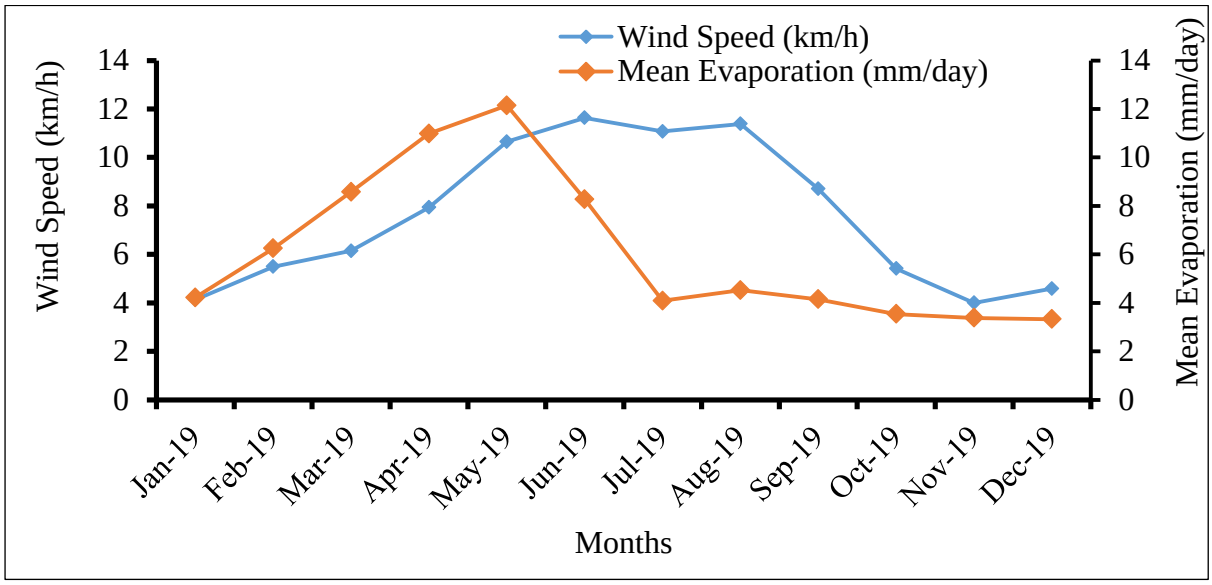


Fig.1.6. Monthly mean wind speed and mean evaporation rate at ICAR-NIASM during 2019.

Extreme weather observation recorded in 2019

The warmest and coldest days in the entire year obtained through selection based on daily mean temperature and it was found that 27th April (35.0°C) and 10th February (17.0°C), were the warmest and coldest days respectively (Table 1.3). Daily maximum temperature was reached up to 42.8°C (27th April) while lowest daily minimum temperature dipped up to 6.2°C (9th February). The warmest months calculated based on monthly mean temperature and it was found to that May (30.9°C) was the warmest month and January (20.2°C) was the coldest month during this year (Table. 1.3). The cumulative rainfall during the month was highest in October (332.4 mm). It was found that this year's monthly rainfall in October was highest in last 34 years at Baramati. The highest rainfall (108.8 mm) was reported on 21st October 2019. Highest evaporation rate was observed on 30th May (14.8 mm/day). Daily mean wind speed was recorded highest on 8th August (20.3 km/h).

Table.1.3. Extreme weather observations recorded in agromet observatory during 2019.

Particular of weather parameter	Value	Date
Highest daily mean temperature	35.0°C	27 April 2019
Lowest daily mean temperature	17.0°C	10 February 2019
Highest maximum temperature	42.8°C	27 April 2019
Lowest minimum temperature	6.2°C	9 February 2019
Highest monthly mean temperature	30.9°C	May 2019
Lowest monthly mean temperature	20.2°C	January 2019
Highest daily rainfall	108.8 mm	21 October 2019
Highest monthly cumulative rainfall	332.4 mm	October 2019
Highest rate of pan evaporation	14.8 mm/day	30 May 2019
Highest wind speed	20.3 kmph	8 August 2019

2. Research Highlights

School of Atmospheric Stress Management

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

M P Brahmane, MP Bhendarkar and Neeraj Kumar

Diurnal temperatures are going to change with rise in atmospheric temperature. As temperature is a major abiotic stress factor having ability to influence the other physico-chemical properties of water, it is important to analyse the response in fish with higher rise in the maximum diurnal temperature during day time. Live fishes were brought from the Bhima river. *Oreochromis mossambicus* larvae (5 dph) subjected to diurnal water temperature exhibited increased growth. The fishes were exposed to three average diurnal water temperature regimes during day time, (1) 25.4-28.1°C, (2) 26.1-30.3°C, (3) 26.1-37.2°C for a period of 90 days. The fishes experiencing 26.1-37.2°C temperature regime were daily exposed to faster rise in temperature for 3 hours from 14:00 to 17:00 hrs from 29.6 to 37.2°C, respectively. It was observed that the total weight of fishes (n=50) experiencing 25.4-28.1°C was 119.4 gm, fishes experiencing 26.1-30.3°C thermal regime accumulated biomass of 125.6 gm and the fishes which experienced higher thermal regime of 26.1-37.2°C exhibited a total biomass of 144.8 g. Similarly, gene expression induced by different diurnal thermal regimes were analyzed, *MyoD* and *MyoG* expression increased in the fishes exposed to the 26.1-37.2°C regime. These results suggest that the diurnal temperature a high as 37.2^{o}C can induce faster growth in fishes leading to accumulation of higher muscle mass.

Table 2.1. Diurnal average water temperature regimes during day time.

	Diurnal Average Temperatures		
Time	**OT-DT25.4-28.1°C**	**OT-DT26.1-30.3°C**	**OT-DT26.1-37.2°C**
9	25.4	26.1	26.1
10	25.9	26.8	26.8
11	26.4	27.7	27.7
12	26.7	28.3	28.3
13	27.0	28.9	28.9
14	27.4	29.6	29.6
15	27.7	30.0	33.4
16	27.9	30.2	35.7
17	28.1	30.3	37.2

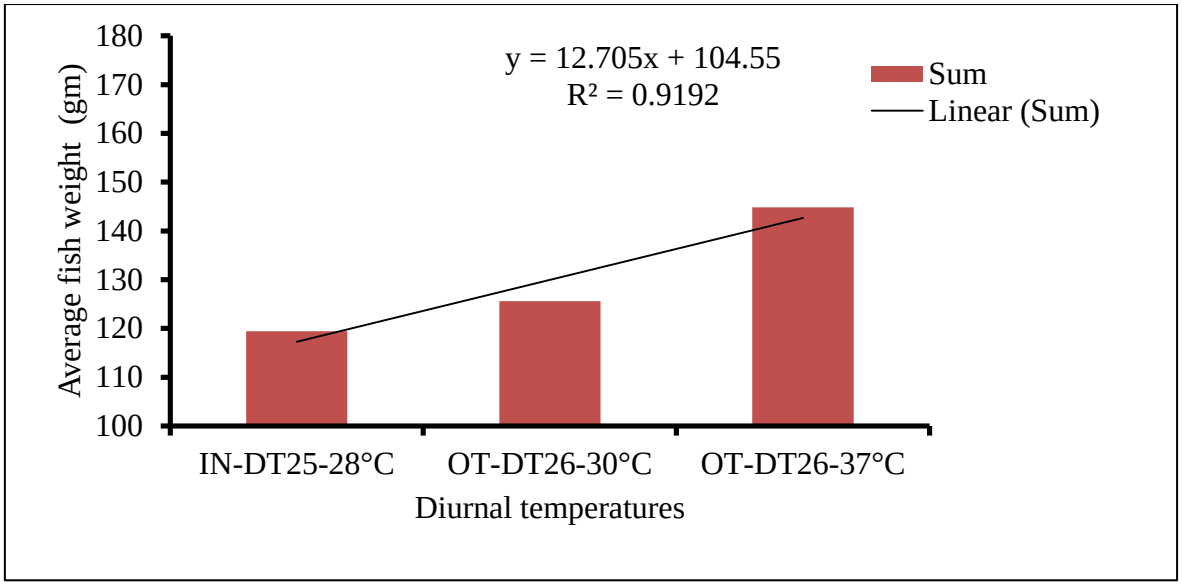


Fig. 2.1. Thermal regime and accumulated biomass.

Study of immune response and *HSP* genes polymorphism in relation to heat stress in poultry (IXX11251)

S S Pawar and NP Kurade

A study was carried out to assess the level of thermal stress risk in poultry birds during 2019 summer season using temperature humidity index (THI) as indicator of thermal stress. The environmental parameters namely, temperature and relative humidity were recorded during the experimental period and THI was determined to assess heat stress in poultry birds reared during summer months April (Fig. 2.2), May (Fig. 2.3) and June (Fig. 2.4). The stress threshold was determined at ≤70. The THI of 70-75 is considered as mild, 76-81 as moderate and ≥82 was determined as severe stress. It was observed that during summer months the thermal stress risk is greater in poultry with stress level of moderate to severe and the thermal stress aggravated with rise in relative humidity (Fig. 2.5).

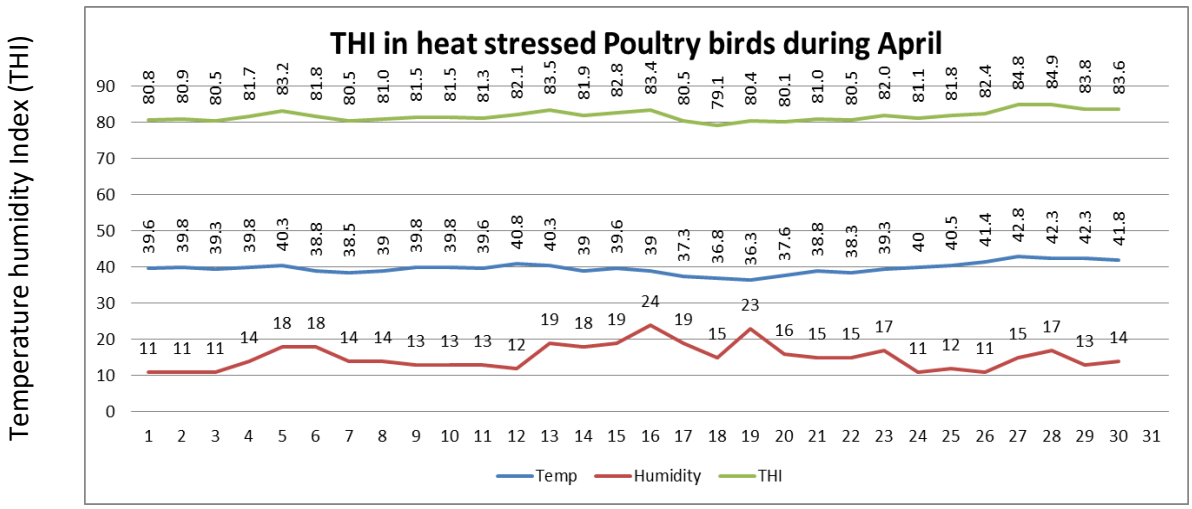


Fig. 2.2. THI in heat stressed Poultry birds during April

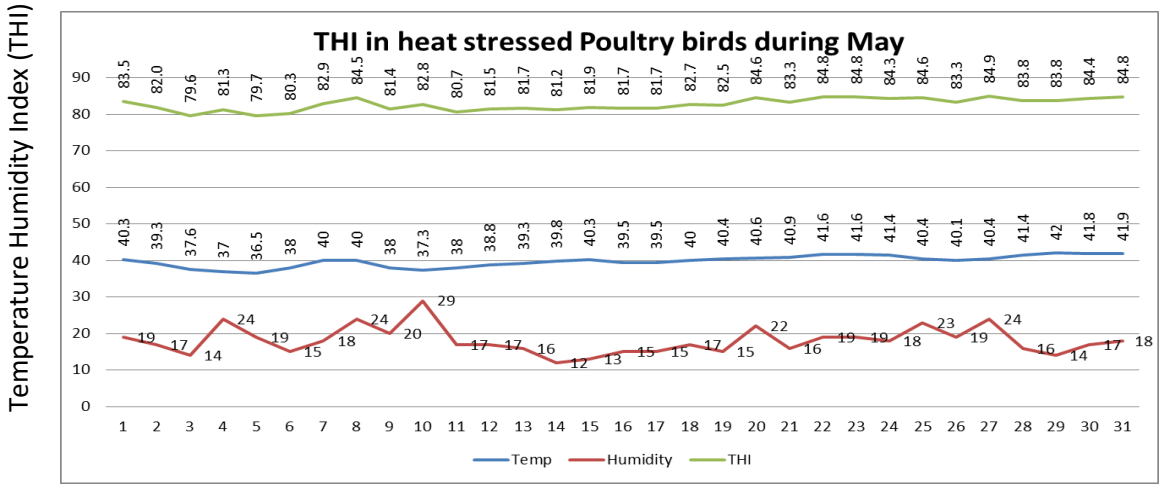


Fig. 2.3. THI in heat stressed Poultry birds during May

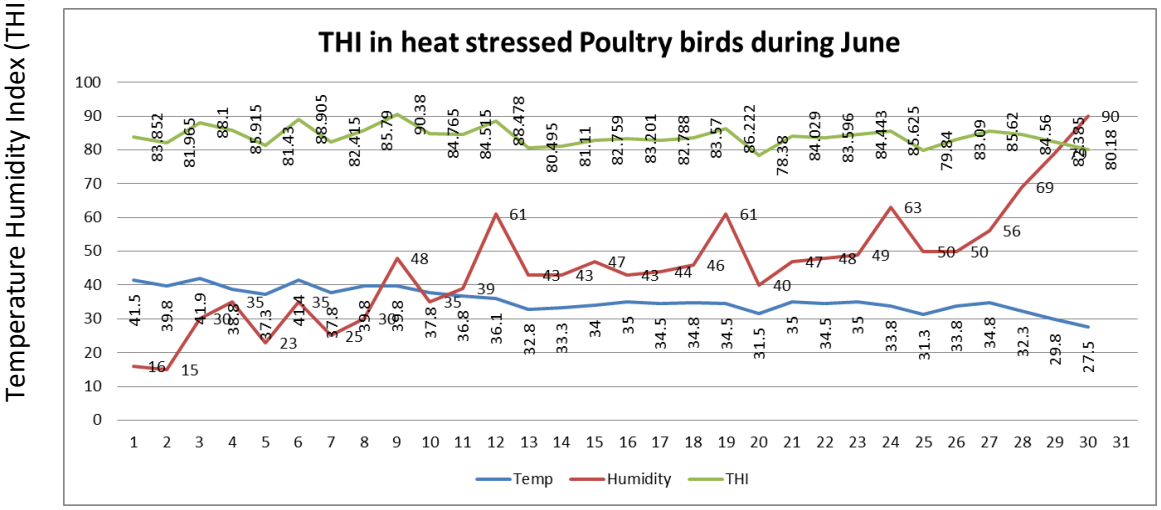


Fig. 2.4. THI in heat stressed Poultry birds during June

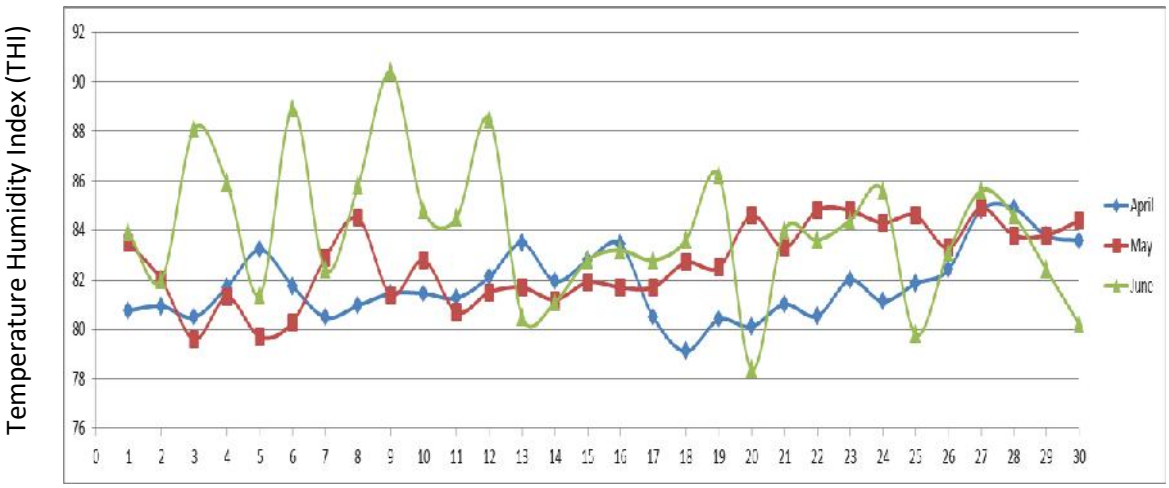


Fig. 2.5. Comparative THI in heat-stressed poultry birds during summer season

Spawning and larval development of snakehead, Channa spp, and Nile Tilapia (*Oreochromis nilolicus*) under abiotic stress environment (IXX14249)

M P Bhendarkar, MP Brahmane and Neeraj Kumar

Exposer to multiple salinity level reveals growth response of GIFT Tilapia

A two months study was conducted in rectangular aquarium tanks having dimension 2x1x1 feet to investigate the effect of different salinity levels on growth performance and survival of Nile tilapia (*Oreochromis niloticus*). Experimental designs were prepared with variable salinity levels such as 15 ppt, 10 ppt, 05 ppt, freshwater (control) and saline water (control) designated as T1, T2, T3, T4 and T5, respectively with three replications each. Fishes of an average initial weight 0.9±0.001 g were randomly assigned to each aquarium tank at the rate of 10 fishes per tank. Fish were fed with 28% protein diet @ 10% of its wet body weight on daily basis. No survival was recorded in the 15 ppt (T3) and saline water control (T4).

Fig. 2.6. Fisheries wet lab

Fig. 2.7 A pit of 20x20x3 feet dimension to investigate the effect salinity on growth performance and survival of Nile tilapia (*Oreochromis niloticus*)

Experiment was conducted in farmer's field affected by salinization with 5-7 ppt salinity by constructing a pit having dimension 20x20x3 feet to investigate the effect salinity on growth performance and survival of Nile tilapia (*Oreochromis niloticus*). A total 27 fishes on an average initial weight 28 ±5.0 g were randomly stocked. It was observed that there were clear positive response in the growth rates. Average body weights (ABW) attained by tilapia was 323 ±10 g after 2 months of culture (feeding was carried twice a day @ 05% ABW in the first month and 02% ABW in second month).

Length-weight relationship of GIFT Tilapia under culture condition

The regression equations obtained are shown in graph, with 'X' variable as length and 'Y' variable as weight. It was found that the total 828 specimens were examined (LT = 3.9 to 29.7 cm, W = 2.27 to 383.38 g) during sampling (under culture pond) for the length-weight relationship. Independent statistical analysis of their length and weight relationship gave the following regression equations. This study was conducted to investigate growth variations of GIFT tilapia among the three different storage tank *viz* FRP tank, cement tank and polythene lining pond. Total length and body weight was measured initially during stocking having

average length 2.50 ± 0.04 cm and weight 0.2 g ABW. It was observed that the average body weight attained by tilapia was 370 ± 30.2 g during sampling with 0.8 FCR. W = 0.0156 L 3.0999

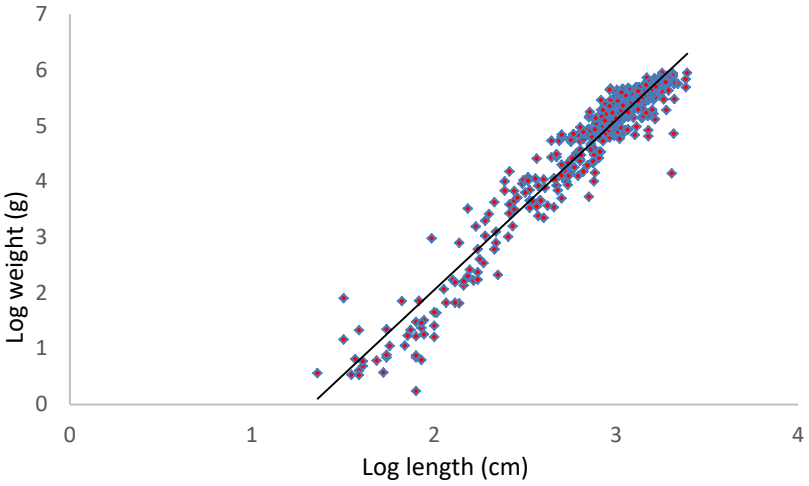


Fig.2.8 Logarithmic relationship between total length and weight of GIF tilapia

Simulation and visualization of potential population growth in pulse beetle, *Callosobruchus chinensis* L. (Bruchidae: Coleoptera) in Pigeonpea (*Cajanus cajan* L. Millsp) under changing climatic conditions and its geographic distribution" (IXX14278)

Rajkumar and AK Singh

Monitoring of fruit flies in mango

The fruit flies are the most important pests of mango infesting the economic part to cause heavy damage both quantitatively and qualitatively. There are three species of fruit flies: *Bactrocera dorsalis, B. correcta* and *B. zonata* which were reported infesting the mango. To understand the population dynamics of fruit flies in mango and to study the host shift mechanism, 12 Parapheromone traps were erected in the mango orchard and the observations were recorded at the weekly interval.

Fig. 2.9. Monitoring of fruit flies in mango

During April-2019 all the three species of fruit flies reported wherein *Bactrocera dorsalis* was found abundant followed by *B. zonata* and *B. correcta*. There was a less number of *B. dorsalis* and *B. zonata* during first three weeks, but in the last week of April 2019 there was a significant increase in catch. The population of *B. correcta* (BC) remains non-significant all the four week of April-2019. During May and June-2019 there was more catch of *B. dorsalis* (BD) and *B. zonata* (BZ) than the *B. correcta* (BC).

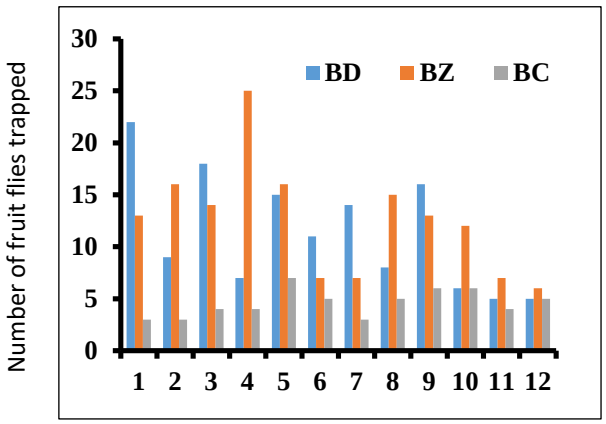


Fig. 2.10. Fruit flies species abundance during April 2019

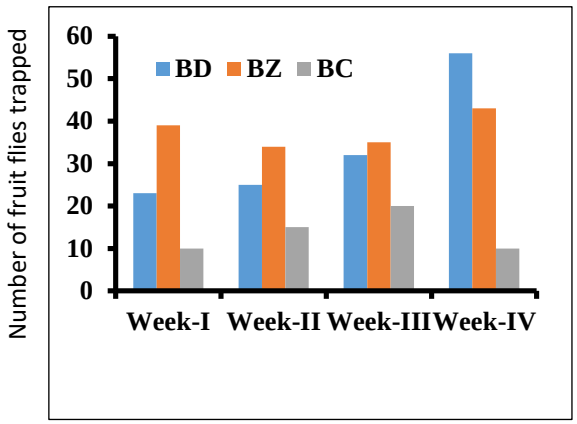


Fig. 2.11. Weekly abundance of Fruit flies species during April 2019

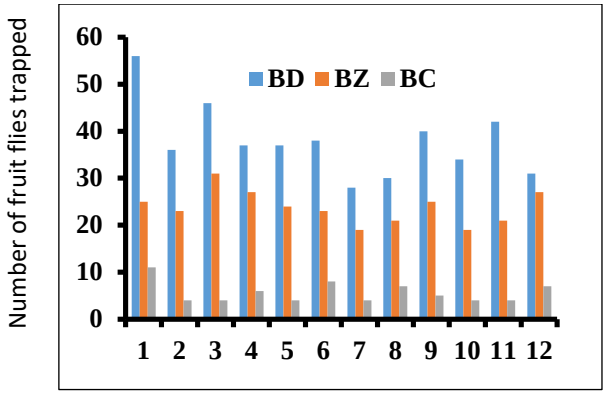


Fig. 2.12. Fruit flies species abundance during May 2019

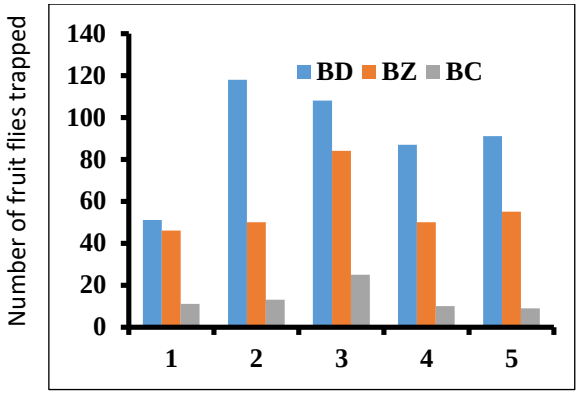


Fig 2.13. Weekly abundance of Fruit flies species during May 2019

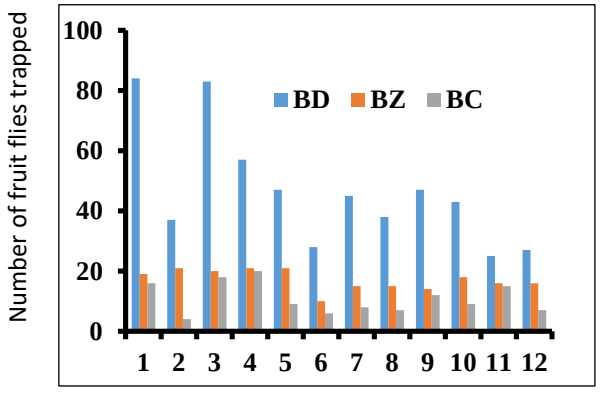


Fig 2.14. Trap wise abundance of fruit fly species in mango orchard during June 2019

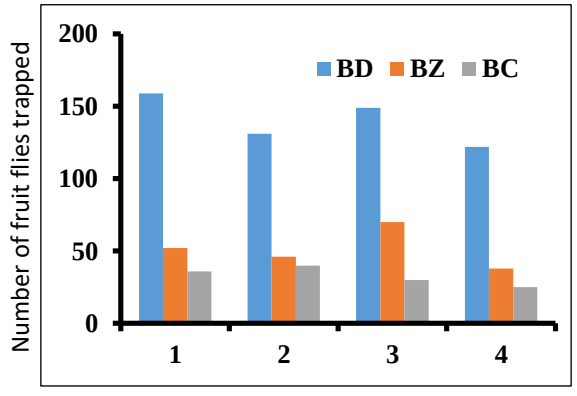


Fig 2.15. Weekly abundance of Fruit flies species during June 2019

School of Drought Stress Management

On field *in vivo* monitoring of pollen tube growth of dryland agricultural crops to identify the genotypic resilience to drought (OXX04232)

Jagadish Rane

Studies on effect of temporal variation in pollen viability of soybean genotypes under *in vitro* conditions

Soybean genotypes (Birsa soya, NRC-77, NRC-37, PUSA-24 and PRS-1) were sown in the pots and grown in controlled conditions (temperature 26°C/ RH 60%). Pollens were collected at different time intervals (1, 3 and 6 hours after anthesis) to detect temporal variation in viability of pollens. Pollen viability was assessed from the images captured by foldscope clearly indicated existence of genetic variation at different time intervals (Figs. 2.16, 2.17).

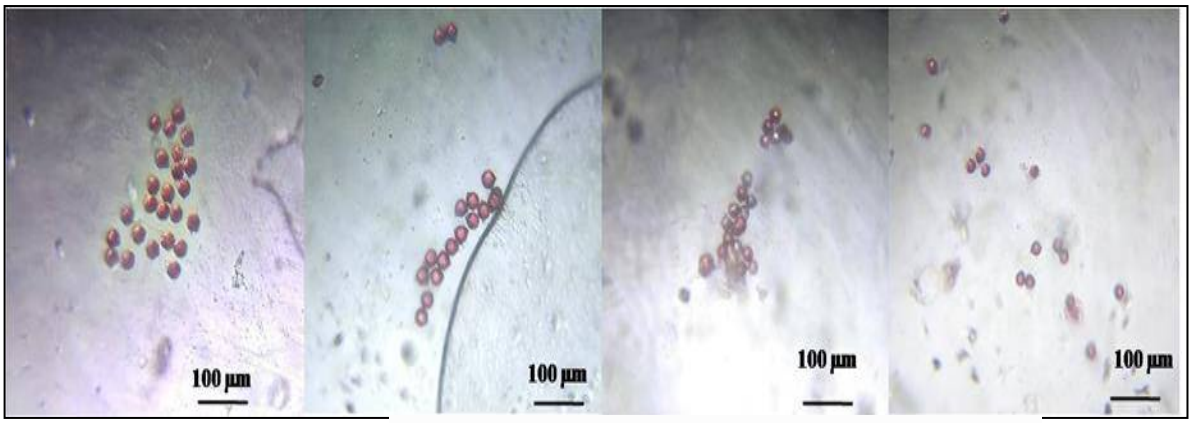


Fig.2.16. Viability of soybean pollens observed using Foldscope

Pollen viability decreased over the time in all soybean genotypes. The maximum per cent pollen viability was observed 1 h after anthesis (79% to 58%) and it gradually decreased over time. Pollen viability ranged from 41 (BIRSA SOYA) to 75% (NRC-77) after 3 h of anthesis. The 51% per cent of pollen were found viable even after 6 h of anthesis in the genotype NRC-77, whereas genotype PUSA-24 had very less pollen viability (19%).

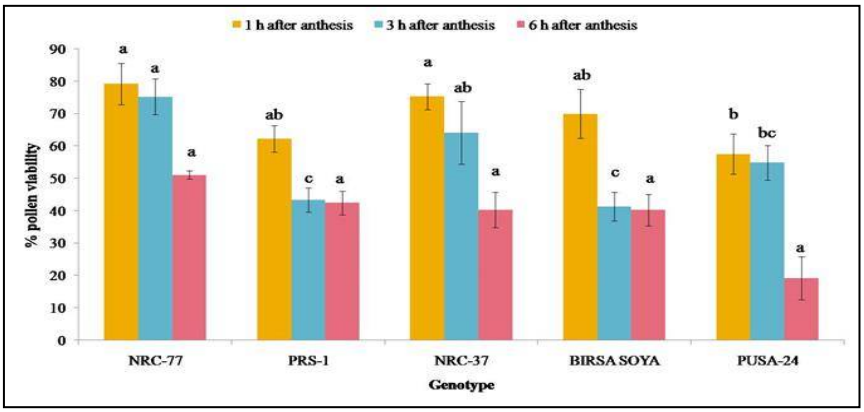


Fig. 2.17. Pollen viability in soybean at different time intervals after anthesis as calculated by using Foldscope images.

Studies on effect of low moisture stress under *in vitro* pollen germination of soybean genotypes

Four genotypes of soybean (CO-1, CO-2, PUSA-24 and JS-9752) were grown in controlled conditions in greenhouse. Water stress was imposed at V2 growth stage (First trifoliate) by restricting water to 40% of the field capacity till R1 growth stage (Flower initiation) and plants grown with well-watered (80% of pot field capacity) kept as control. Low soil moisture stress reduced the *in vitro* pollen germination rate to an extent of 56 to 74% as compared to well-watered conditions (Figs. 2.18, 2.19).

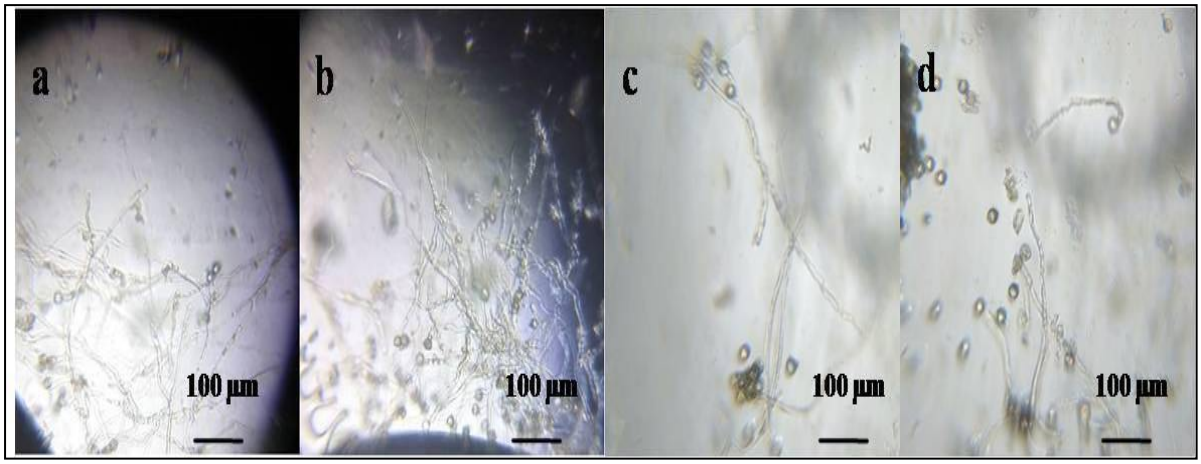


Fig. 2.18. Effect of different moisture treatment on pollen germination: (a & b) irrigated treatment, (c & d) drought treatment of soybean genotypes

The drought effect was lesser (56%) in the genotype CO-2 than others. The maximum per cent pollen germination was found in the genotypes CO-1 and CO-2 under water stress (20 and 22% respectively) as well as well-watered conditions (48 and 50% respectively) compared to drought condition (21.79% to 5%).

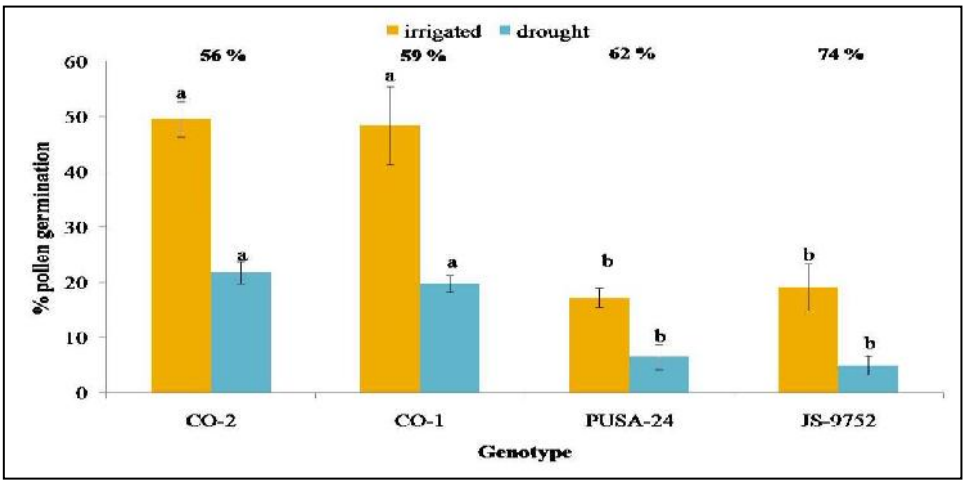


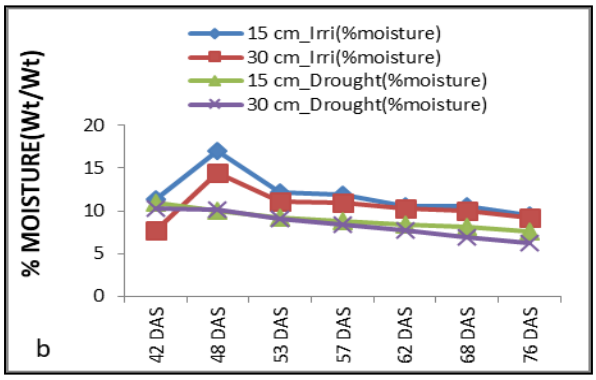
Fig. 2.19. Effect of drought on pollen germination of soybean genotypes. Percent values indicate the difference of pollen germination in irrigated and drought conditions.

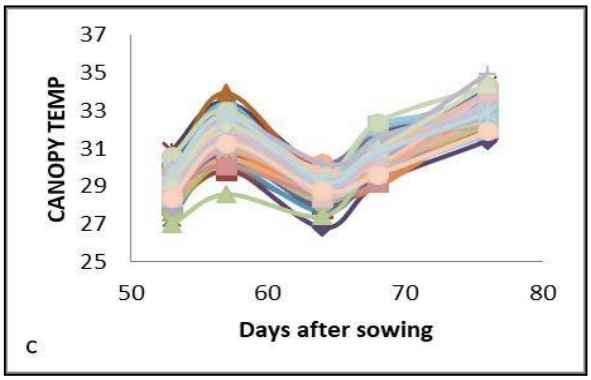
Phenotyping of pulses for enhanced tolerance to drought and heat (OXX01737)

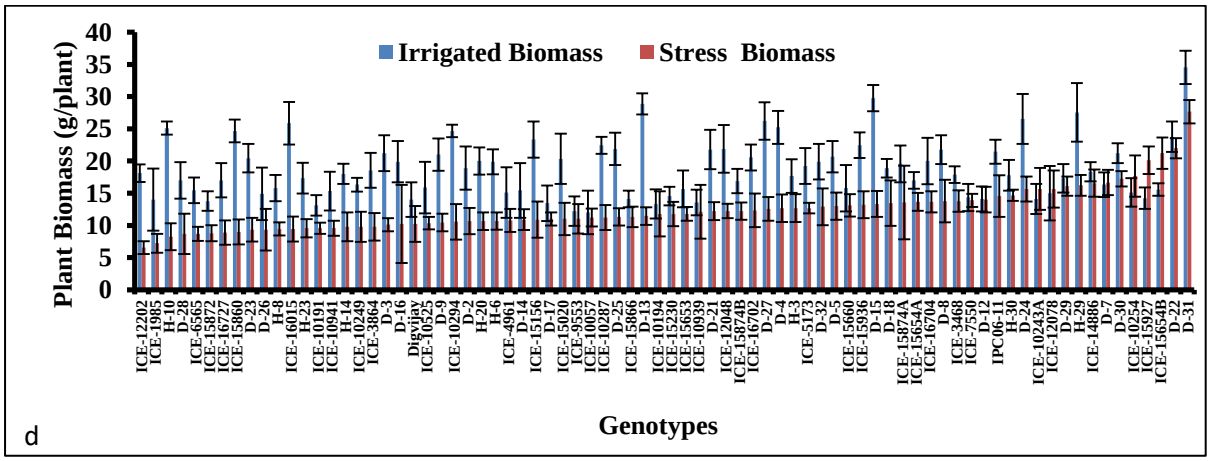
Jagadish Rane and Mahesh Kumar

Responses of chickpea genotypes to soil moisture deficit imposed under field condition

Experiment was conducted with two level of soil moisture by varying number of irrigations. Most of the time the soil up to 30 cm was dry with only about 8% moisture in stressed plots and about 10-18% moisture in irrigated plots. Genotypes such as D-24, D-31, ICE-15654B had high seed yield and maintained cooler canopy under stress condition induced by soil moisture deficit. Higher biomass accumulation was observed among D-24, D-15, D-5, D-22 and ICE-10294 under well-watered condition while D-22, D-29 and ICE-15654B under water stress condition.







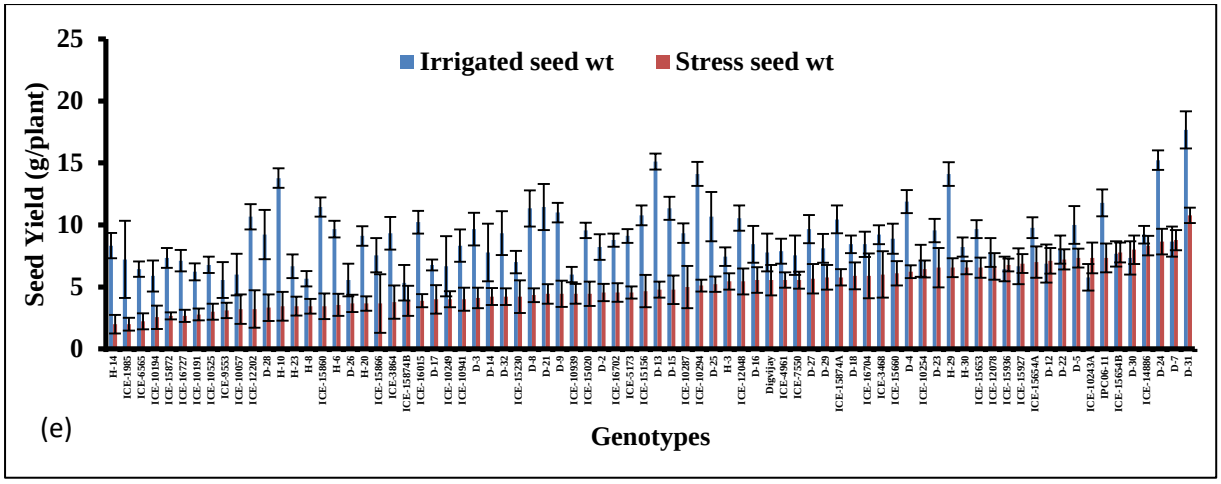
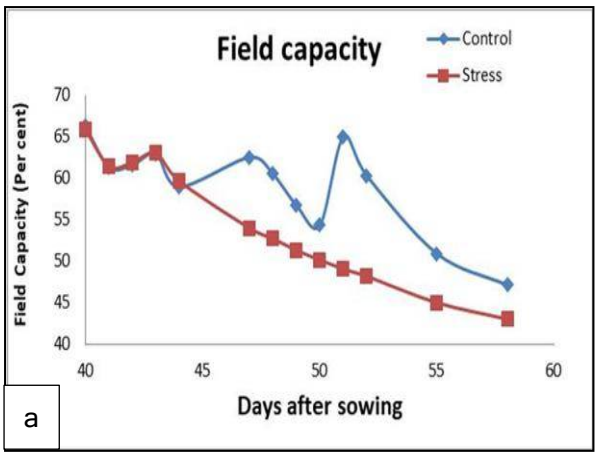
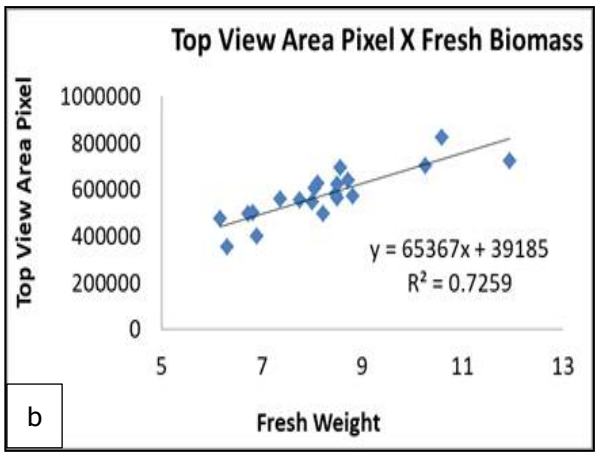


Fig. 2.20. Responses of 78 chickpea genotypes to soil moisture deficit conditions: (a) the soil moisture levels at 15 and 30 cm, (b) Variation in canopy temperature, (c) biomass, (d) seed yield per plant (e) in chickpea genotypes tested for normal and moisture stress under field conditions.

High throughput phenomics for characterizing genetic diversity drought responses of chickpea genotypes (*Cicer arietinum*)

Image-based phenotyping method was optimised to assess responses of chickpea genotypes to depleting soil moisture. The aim of this study was to identify surrogate parameters that can differentiate the responses of chickpea genotypes to drought tolerance. Twenty two genotypes of chikpea were studied to monitor the responses using Infra-Red (IR), Visible and Near Infra-Red (NIR) imaging systems that had been fixed in separate chambers in the Plant Phenomics Facility. Digital area as revealed by top view by a high resolution camera as well as NIR intensity could help in differentiating the response of chickpea genotypes to depleting soil moisture in high throughput mode. Genotype ICCV-92944 can be a promising candidate. which can be used as donor for drought tolerance as it had high biomass relative to Digvijay, the local variety and the top view area which may serve as alternate trait for large scale screening.





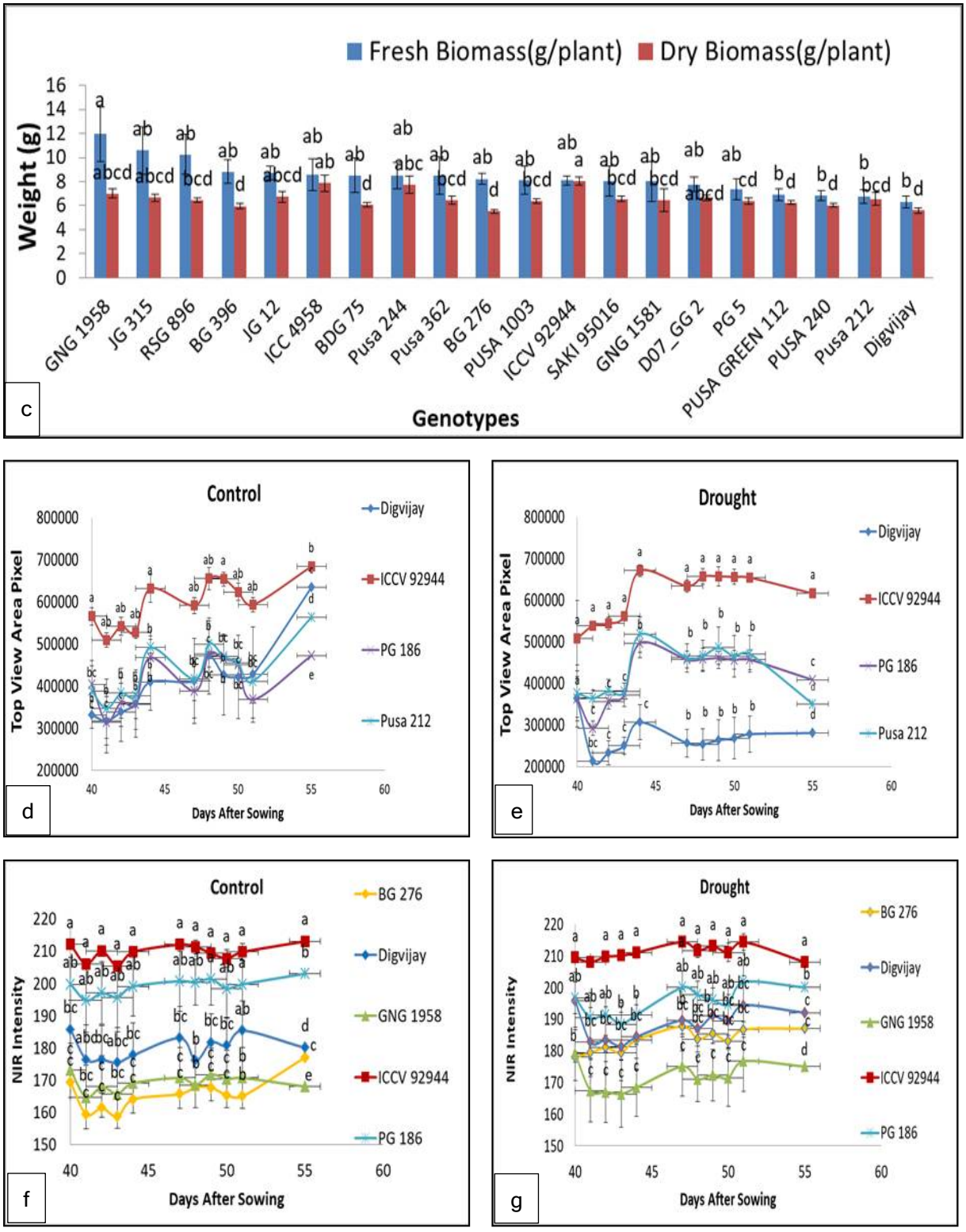


Fig. 2.21. Soil moisture trends in control and drought stress condition as field capacity per cent(a), Correlation between top view area and fresh biomass (b), Genotypic difference between fresh and dry biomass accumulation (c), Genotypic variation in top view area pixel in control condition (d), and drought condition (e), Genotypic variation in NIR Intensity under control condition (f) and drought condition (g).

Non-destructive measurement of biomass in pigeonpea genotypes through high throghput phenotyping

Plant biomass is one of the main parameter for growth analysis and yield prediction in different environmental conditions. In this experiment, we aimed at methodology to estimate biomass based on image-derived traits of 13 genotypes of pigeonpea.We proposed a linear model for estimating the plant digital biomass as a function of object extent x, object sum area, boundary points to area ratio, caliper length, convex hull circumference, roundness, digital biomass to produce the linear model. Proposed model showed 0.94 r^2 with observed biomass indicating that our model is useful for predicting plant biomass with image drived parameters with out destroying plant. To validate the approach, the generalized linear model was applied to predict biomass from each day's image parameter. Cross-validation technique to measure the generalization or estimation error of a biomass prediction model was used.

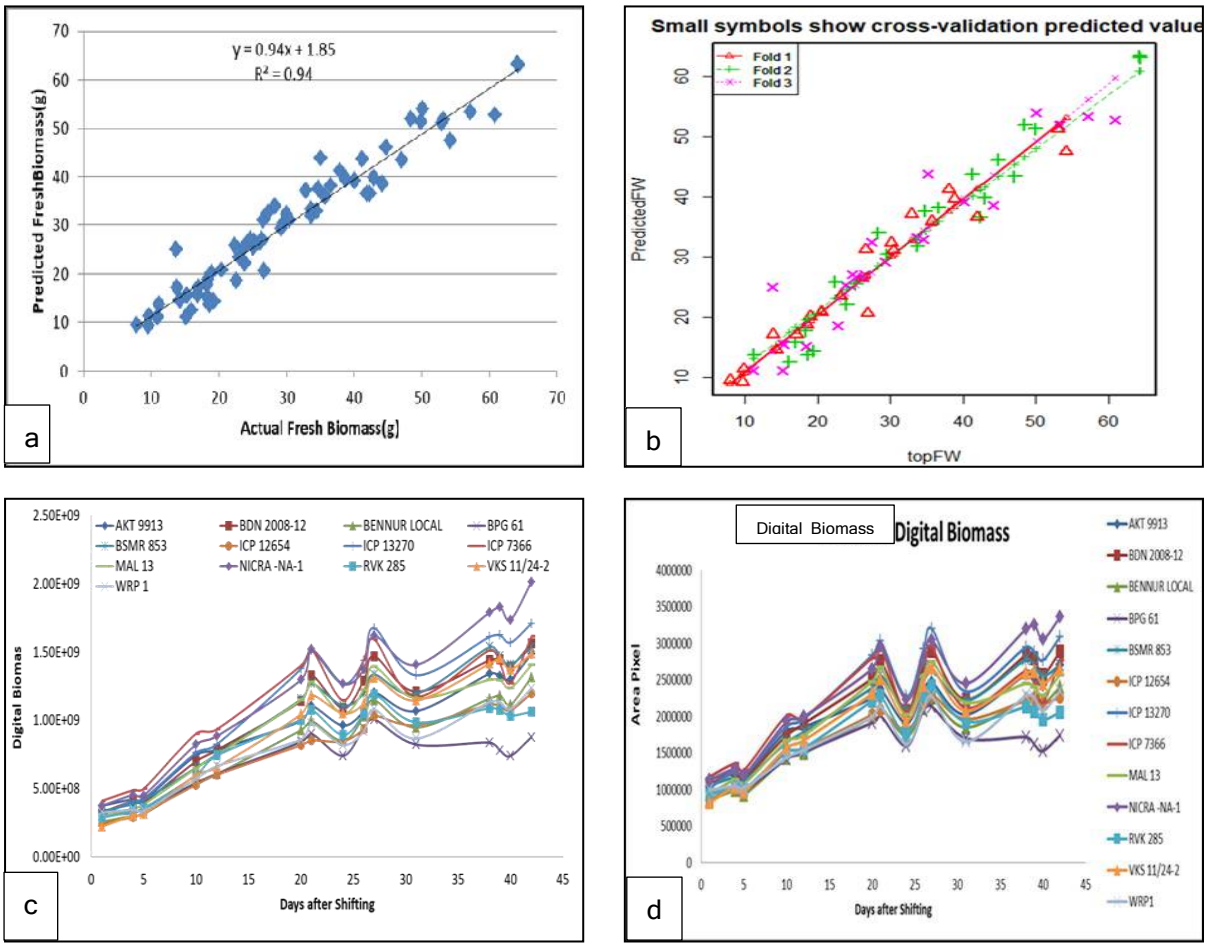


Fig. 2.22. Correlation between predicted and actual biomass: (a) Three-fold cross-validation technique where small symboll indicates cross validation prediction value, (b) Digital biomass, (c) Predicted biomass by using prediction model by using top and side area pixel (d).

Comparison of plant responses observed in plant phenomics and under field experiments conducted at different places

Attempts were made to assess efficiency of phenomics parameters to differentiate stable and unstable genotypes of pigeonpea tested under field trials elsewhere (based on data and scientific article published by other. It was observed that image parameters such as excentricity, centre of mass, circumference, trend in NIR intensity which reflects tissue moisture content could differentiate stable and unstable genotypes. This will be validated again through field and phenomics experiments. RVK-285 had higher dry biomass even with less consumption of water. Some image parameters like digital biomass, excentricity and compactness could efficiently differentiate stable group (RVK-285, AKT-9913) and unstable group (Bennur Local, BDN-2008-12, ICP-7366, WRP-1) of genotypes tested across the environments. Center mass of X showed highest difference between stable group (RVK-285, AKT-9913) and unstable group (Bennur Local, BDN- 2008-12, ICP-7366, WRP-1) of genotypes followed by Eccentricity, circumference, NIR Intensity, Roundness and sub object count.

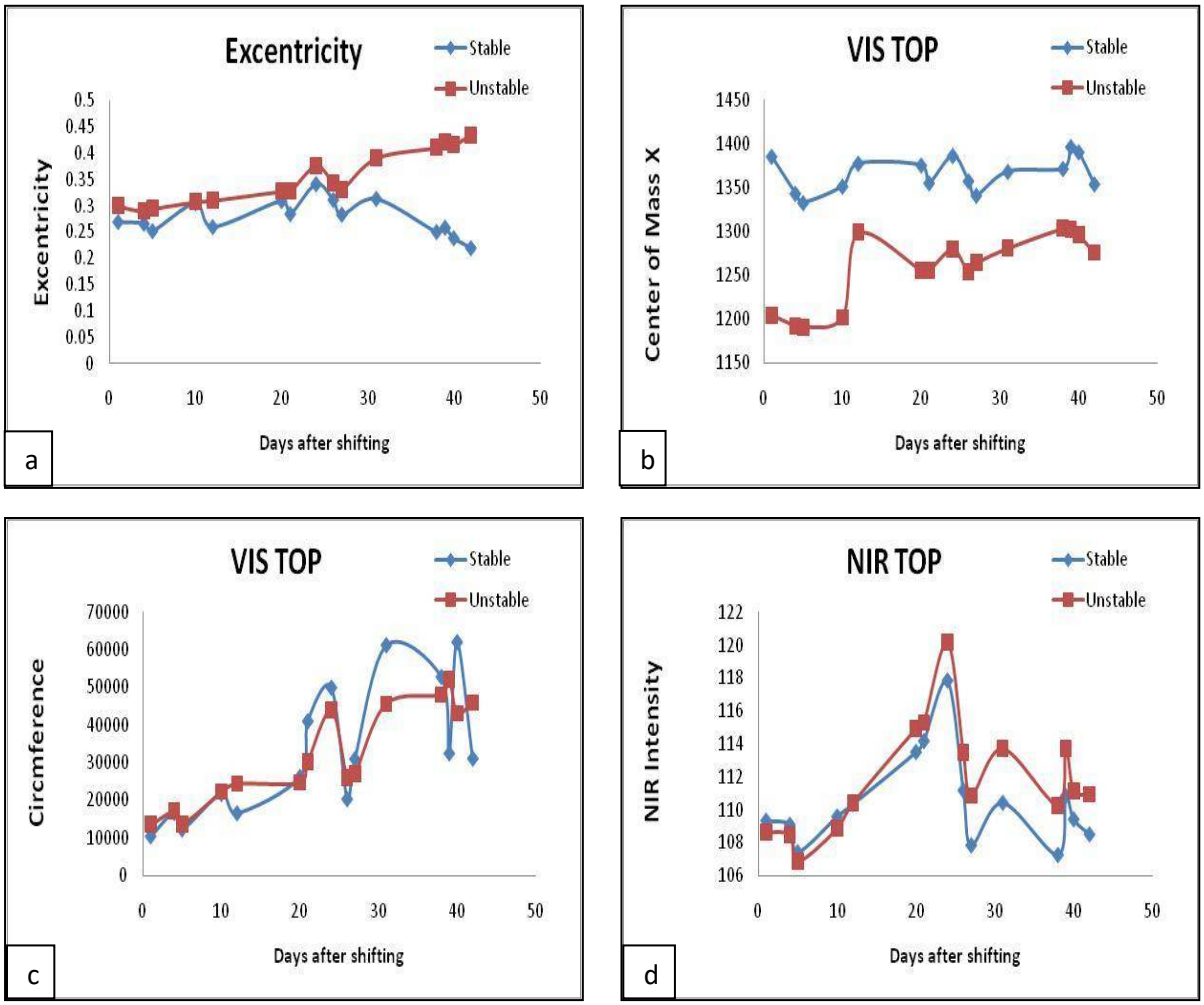


Fig. 2.23. Difference in image parameters: (a) Eccentricity, (b) Center of mass X, (c) Circumference, (d) NIR intensity between stable group (RVK-285, AKT-9913) and unstable group (Bennur Local, BDN-2008-12, ICP-7366, WRP-1) of genotypes tested across the environments.

Phenotypic response of pigeonpea genotypes to water deficit condition

An experiment was conducted for the phenotypic evaluation of 12 pigionpea genotypes under water deficit condition. Under water deficit condition, genotype SMVT-ı-1806 showed the highest digital biomass accumulation followed by SMVT-ı-1808 and SMVT-ı-1811. However, genotype SMVT-ı-1806 showed lowest NIR Intensity followed by SMVT-ı-1809 and SMVT-ı-1808 indicating higher tissue moisture. Dry weight accumulation showed good correlation with NIR intensity (0.75 r^2). Convex hull area also differentiated genotypes under water stress condition while genotype SMVT-ı-1806 showed lowest NIR Intensity followed by SMVT-ı-1802 and SMVT-ı-1810.

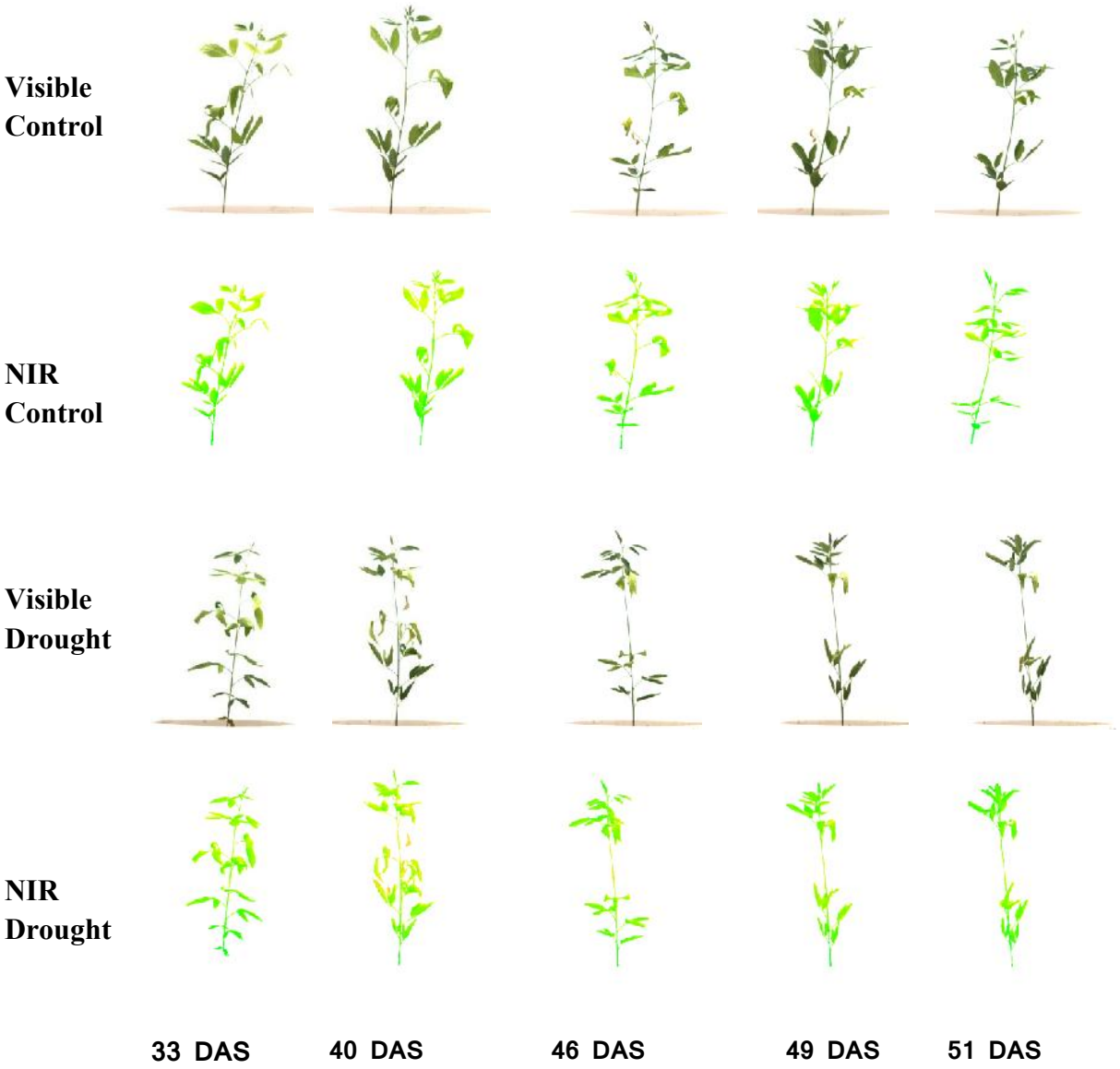


Fig 2.24. Effect of drought stress on pigeonpea genotypes

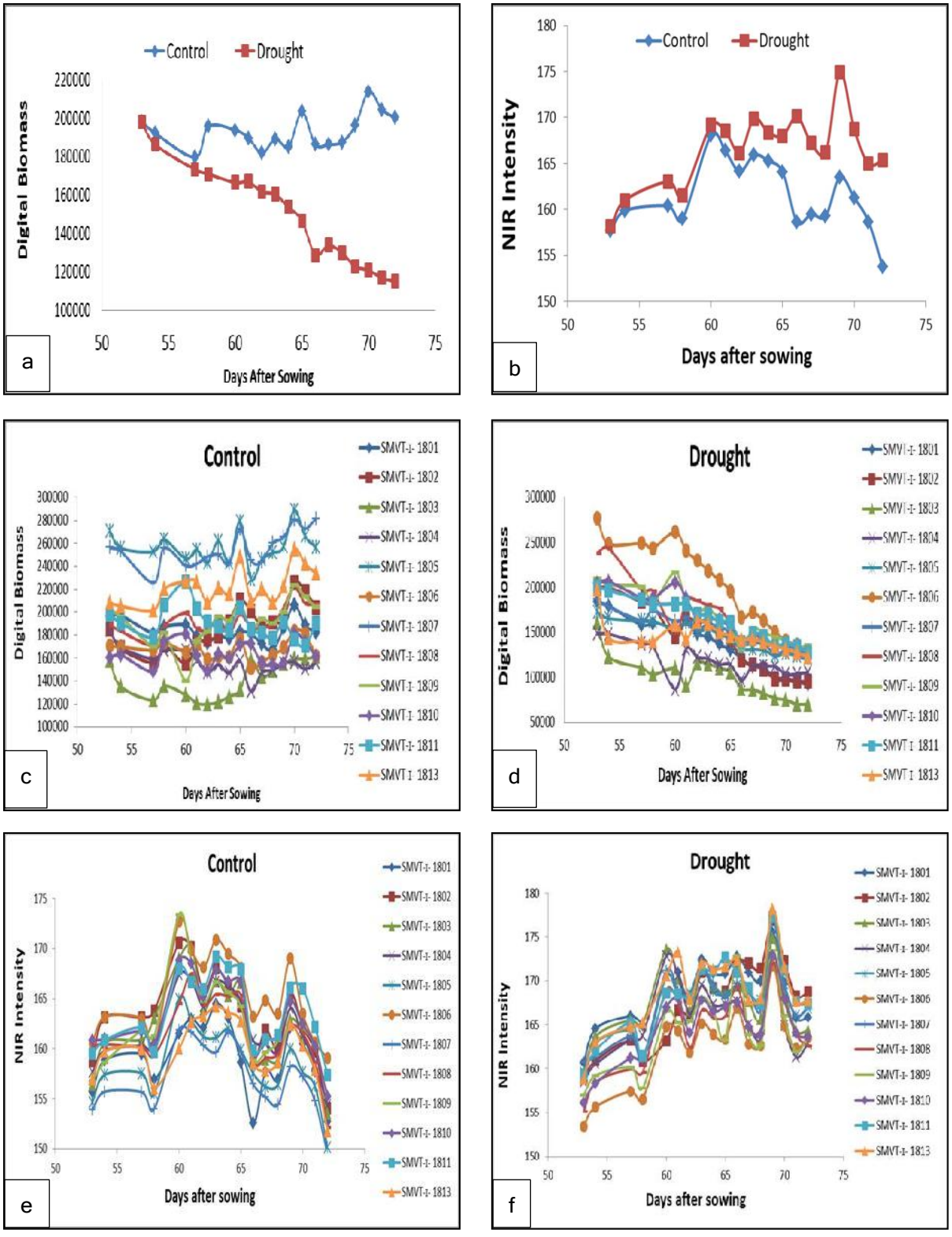


Fig 2.25. Overall variation in digital biomass (a), NIR intensity under diferent environmental condition (b), genotypic variation in digital biomass (c) and NIR intensity in different pigeonpea genotypes under control condition (e), genotypical variation in digital biomass (d) and NIR intensity in different pigeonpea genotypes under control condition (f) .

Phenotyping of Recombinant Inbred Lines (RIL) of Lentil genotypes

An experiment designed with 212 genotypes of lentil in three different batches with common parents recieved from ICAR-IIPR-Kanpur. These genotypes were planted in three different batches including parents in each of the batch at three different dates. Objectives of the experiment were to optimize image based phenotyping method, to assess responses of lentil genotypes to depleting soil moisture stress, to identify surrogate parameters that can differentiate the responses of lentil genotypes and to assess genetic variation useful for identification of QTLs/genes. Data revealed that digital top view area as viewed by high resolution camera as well as NIR intensity can help in differentiating the response of lentil genotypes to depleting soil moisture in high throughput mode. Genotypes R-19, R-20 showed significant increase in area from top view as compared to parents. Genotypes R-20, R43 and R-185 showed highest per cent incresed in convex hull area as compared to parents at 45 days after sowing. Boundary Point Count is the maximum circle that can enclose the plant.Genotypes R-43, R-20 and R-49 showed highest per cent increased in boundary point counts compared to parents at 45 days after sowing.

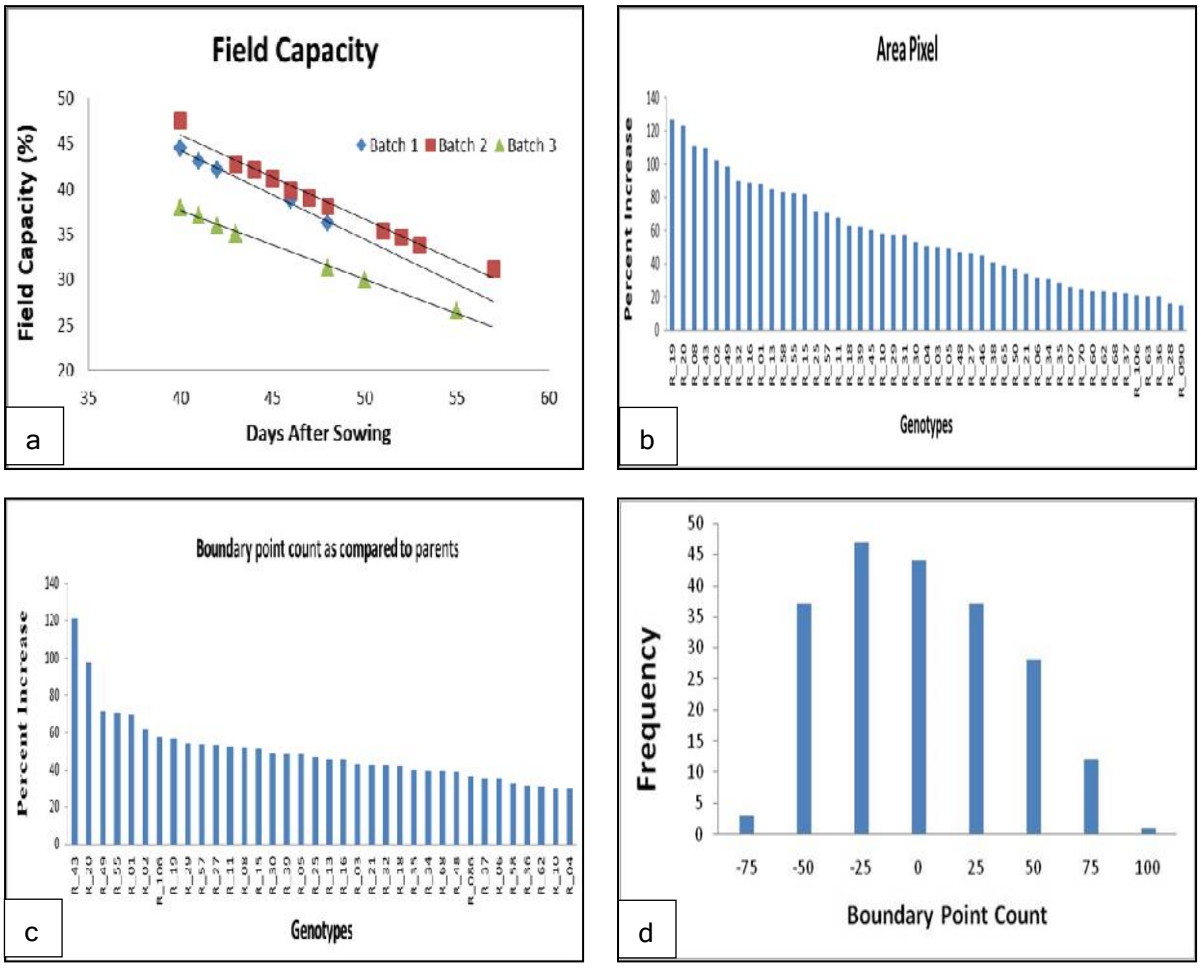


Fig. 2.26. Soil moisture trends in control and drought stress condition as field capacity per cent (a), Percent increase in area pixel at 45 days after sowing as compared to average of both parents (b), Per cent increased in boundary point countas compared to parents at 45 days after sowing (c), Frequency of boundary point count distribution in the range between -90 to 120 in the lentil genotypes as compare to parents from top view after 5 days after shifting (d).

Screening of Mungbean (*Vigna radiata* L.) for drought tolerance by high-throughput phenotyping method

The Plant Phenomics facility at ICAR-NIASM was used to differentiate the phenotypic responses of 12 mungbean genotypes BM 2002-1, BM 2003-2, IC-415144, EC-693360, Vaibhav, Harsha, VC-6372 (45-8-1), VC-3960-88, EC-693356, EC-693357, EC-693358, EC-693363 to short-term drought (11 days; 46 days after sowing (DAS) to 57 DAS). The moisture content of the soil was reduced to 32% of field capacity on the last day of stress (57 DAS). Images acquired from 42 DAS to 63 DAS in different spectral ranges (Visible and Near Infra-Red) were later processed and features were extracted using LemnaTech Software. The mungbean genotypes Harsha and EC-693357 performed better than the locally adapted cultivar i.e. Vaibhav. The biomass at the end of experiment (62 DAS) was significantly correlated with the parameters derived from images captured before harvesting the plants.

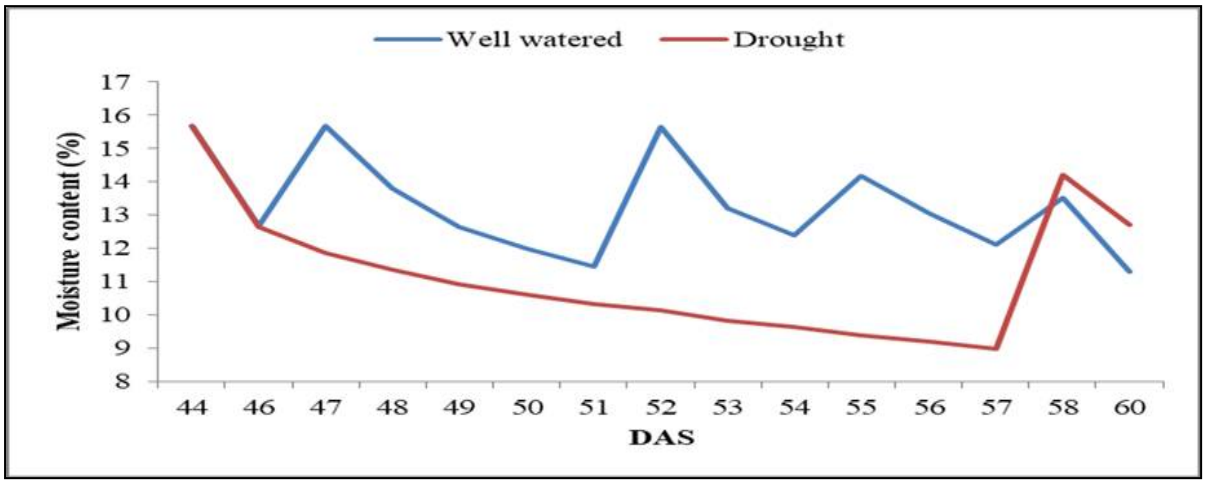


Fig. 2.27. Reduction in average soil moisture content during imposition of drought 46-57 days after sowing.

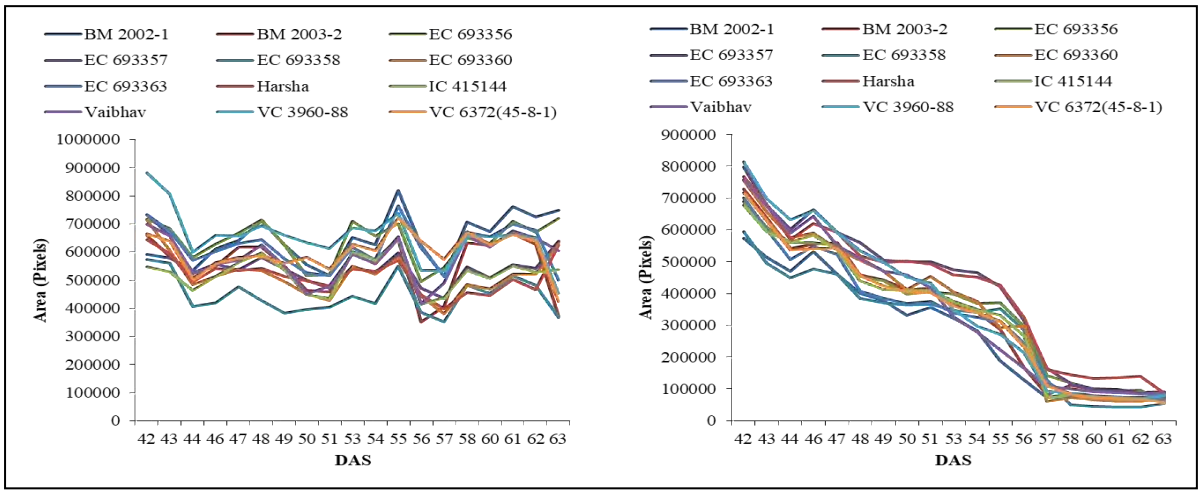


Fig. 2.28. Area of well-watered (left) and drought (right) treated mungbean plants as calculated from the visible images.

Phenomics approach for evaluation of drought tolerance genotypes in cowpea [*Vigna unguiculata* (L.) Walp]

Phenomics approach was used for evaluation of drought tolerance genotypes in cowpea to access the long-time retention of tissue water content in cowpea leaves. Traits dissection affected by high-throughput phenotyping could provide a significant new opportunity in furthering the understanding of plant responses to drought, elucidating the genetic bases for these responses, and then introgressing these traits into appropriate combinations to improve yield maintenance under a variety of drought conditions in crops. Seeds of 6 different cowpea genotypes namely Kashi Kanchan, COBVAR-2, COBVAR-3, COBVAR-3, COBVAR-4, COBVAR-5 and COBVAR-6 were obtained from AICRP-VC, IIVR, Varanasi. Water applied as 65% of field capacity after 3 days interval. After 21 days old plants were shifted to phenomics for imaging. After specified time interval visible, IR and NIR images of plants and weight of the pots has been recorded. Genotype COPBVAR-6 having greater digital volume as compared to others and had greater drought tolerance ability.

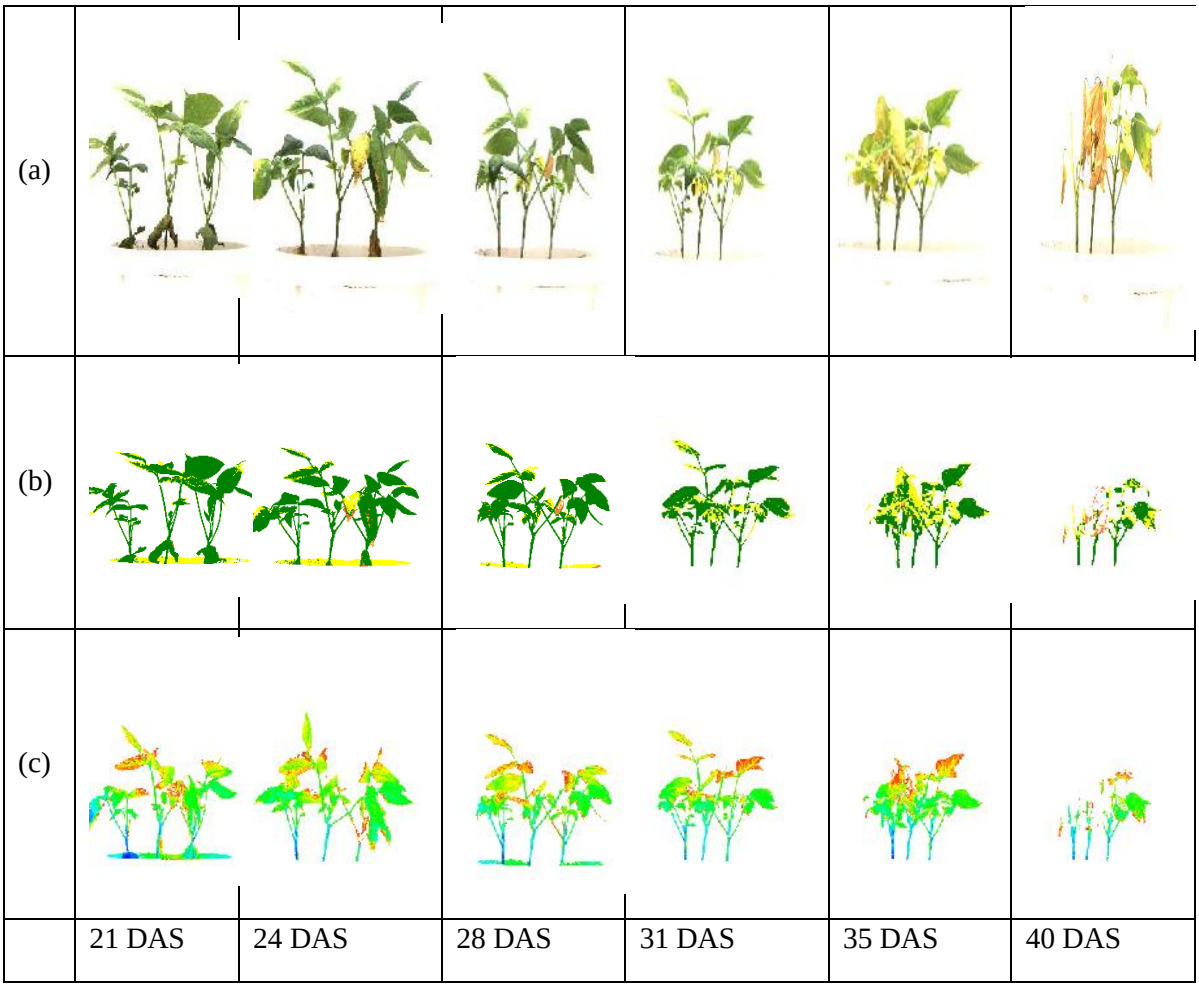


Fig.2.29. Images of Cowpea taken after 21 DAS to 40 DAS. (a) Side view original images of Cowpea plants, (b) Processed image of the same plants shown in A, where green depicts healthy leaves and yellow indicates senescent areas, (c) NIR images of the same plants shown in A.

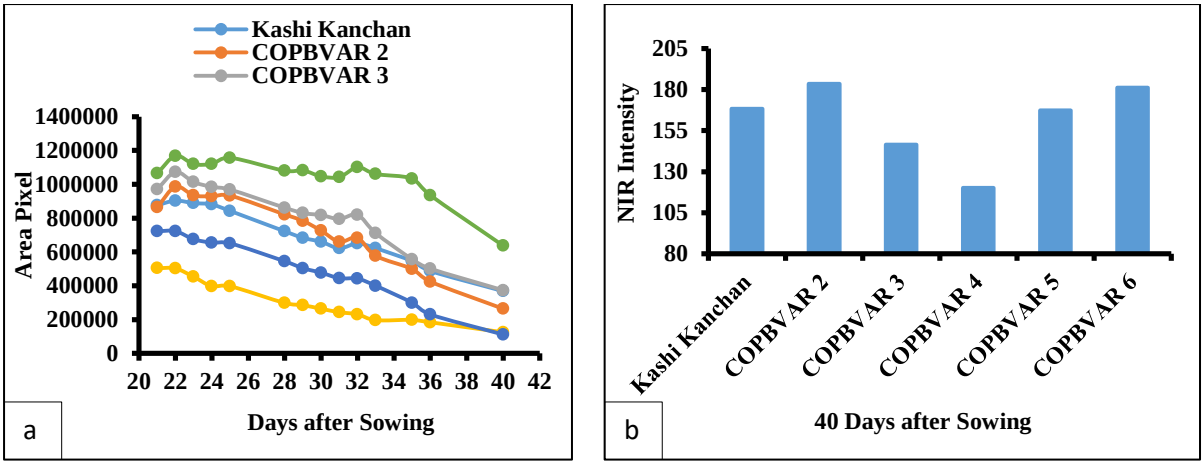


Fig. 2.30. Changes in the pattern of digital volume of cowpea genotype from 21 DAS to 40 DAS (a), NIR intensity of different cowpea genotypes at 40 DAS (b).

Abiotic stress detection from field to landscape scale in different crops using remote sensing tools (SUFALAM) (OXX04474)

Jagadish Rane

Monitoring the effect of mulching on soil moisture and temperature using moisture & temperature profiling probe

Soil moisture is critical for plant performance and its response to different environmental stimuli, which can be captured through spectral signatures. Soil moisture depletion curve in response to ambient temperature variation can be a guide for interpretation of spectral signatures. Hence, we conducted experiments to monitor the diurnal temperature variations in soil moisture at different depths of soil The soil moisture and temperatures were recorded frequently with soil moisture probe (Grow Point Lite, GPLP-8, Canada). Experiments were carried out with different irrigation and mulching treatments .. The study revealed that the soil moisture at 54 cm below the soil surface remains constant with substantially less fluctuation as compared to the top layers of soil profile particularly in the absence of crop in black soil. The soil moisture in the top layer of soil profile decreased by 29% in response to 1.5°C rise in soil temperature which was initially 30.0°C (Figs. 2.31, 2.32). Soil moisture profile determines the responses of the plants and hence the above observations have to be considered during interpretations of spectral signatures received from crops. From the present study it is evident that the mulching reduced the rate of loss of soil moisture as evident from the fact that the soil moisture reduced by 10.2%, even when the soil temperature increased by 3.0°C (30.4°C to 33.6°C) (Figs. 2.31, 2.32).

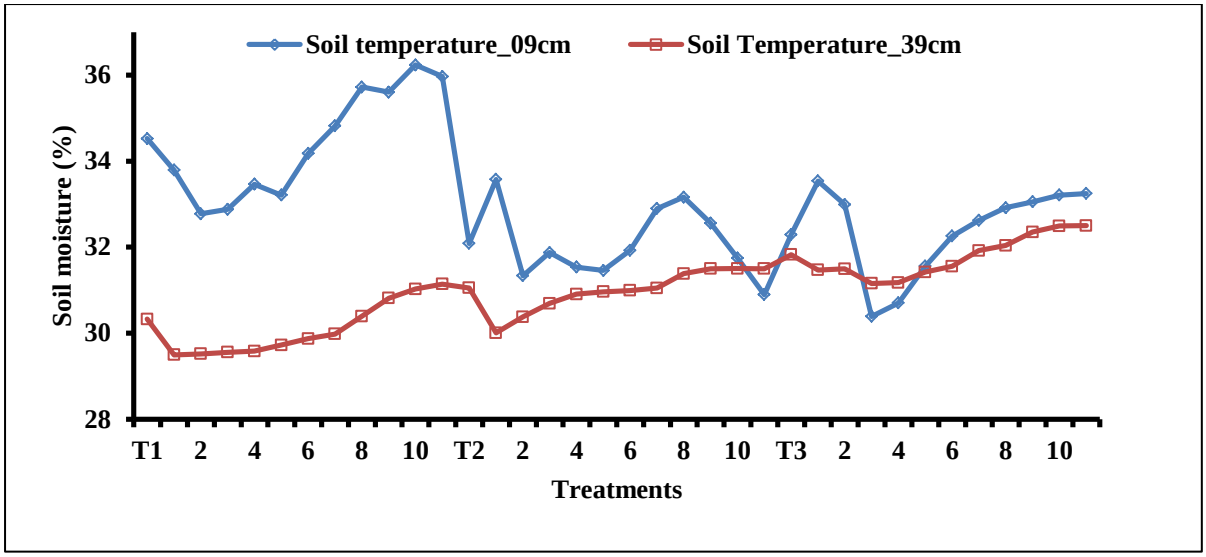


Fig.2.31. Soil temperature at different depth of soil without irrigation (T1), with irrigation without mulch (T2) and with irrigation and mulching (T3)

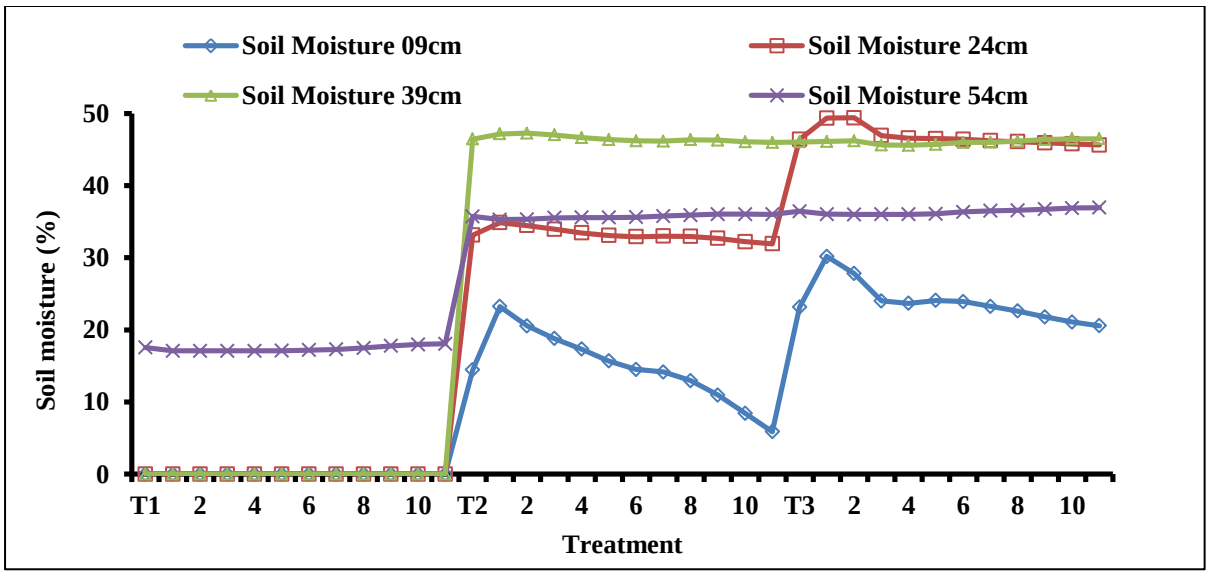


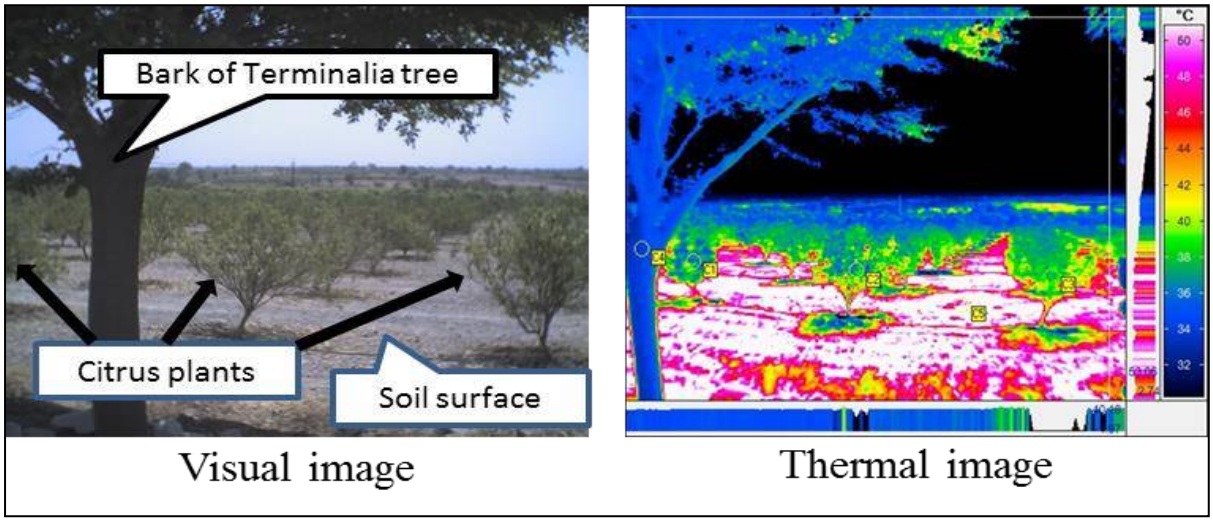
Fig. 2.32. Soil moisture at different depth of soil without irrigation (T1), with irrigation without mulch (T2) and with irrigation and mulching (T3)

Collection of in situ crop specific signatures with respect to responses of plants under various soil temperatures

Infra-Red thermal imaging is one of the remote sensing techniques commonly used for visualizing; diagnosing and quantifying plant stresses. This is a rapid method which enables simultaneous temperature measurements to assess thousands of objects or variation in temperature across the surface of the object. With the objective of collecting *in situ* crop signatures we carried out an experiment using Vario CAM IR thermal camera and the method for capturing the signature of the citrus crop in the IR region was optimized in infra red range 8-12 µ. Peaks in soil and temperatures of plant canopy were observed at 12.35 PM when the ambient temperature was 39.8°C. The peaks of soil and canopy temperatures were 61.2°C and 42.6°C, respectively. The study shows that citrus canopy temperature was varying in

phase with the ambient as well as soil temperature. In Terminalia, the bark was relatively cooler than ambient at noon as compared to evening because it was shaded by its canopy in the noon.

Fig. 2.33. Infra-Red thermal imaging camera



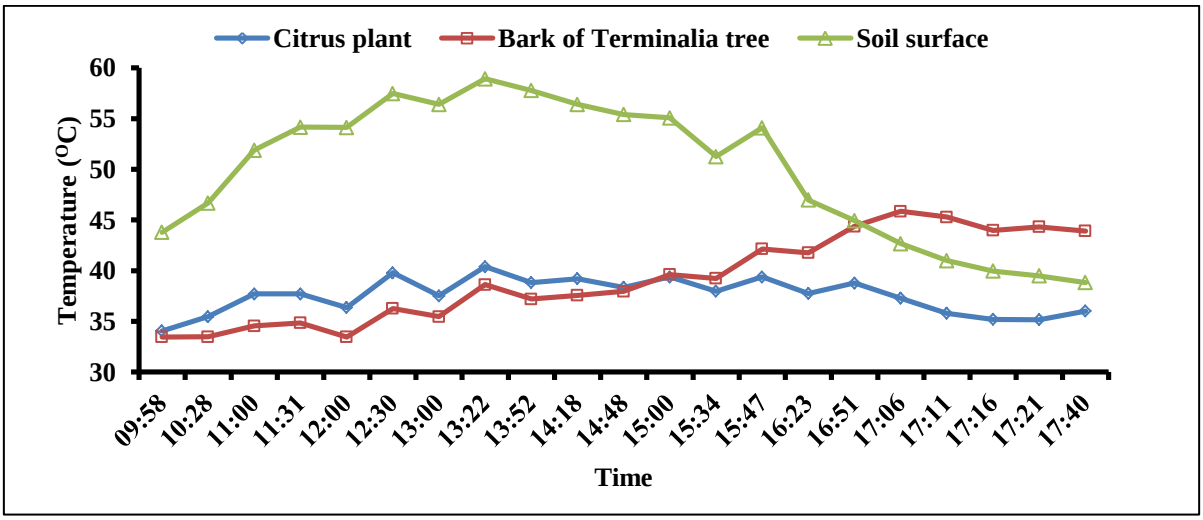


Fig. 2.34. Variation in canopy temperature in citrus (Day 1)

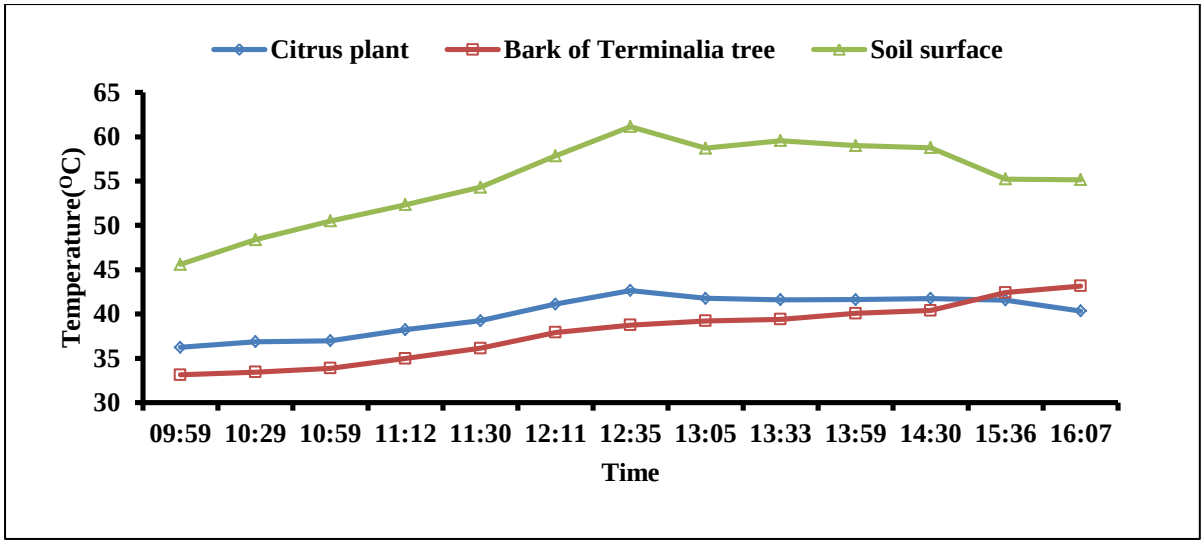


Fig. 2.35. Variation in canopy temperature in citrus (Day 2)

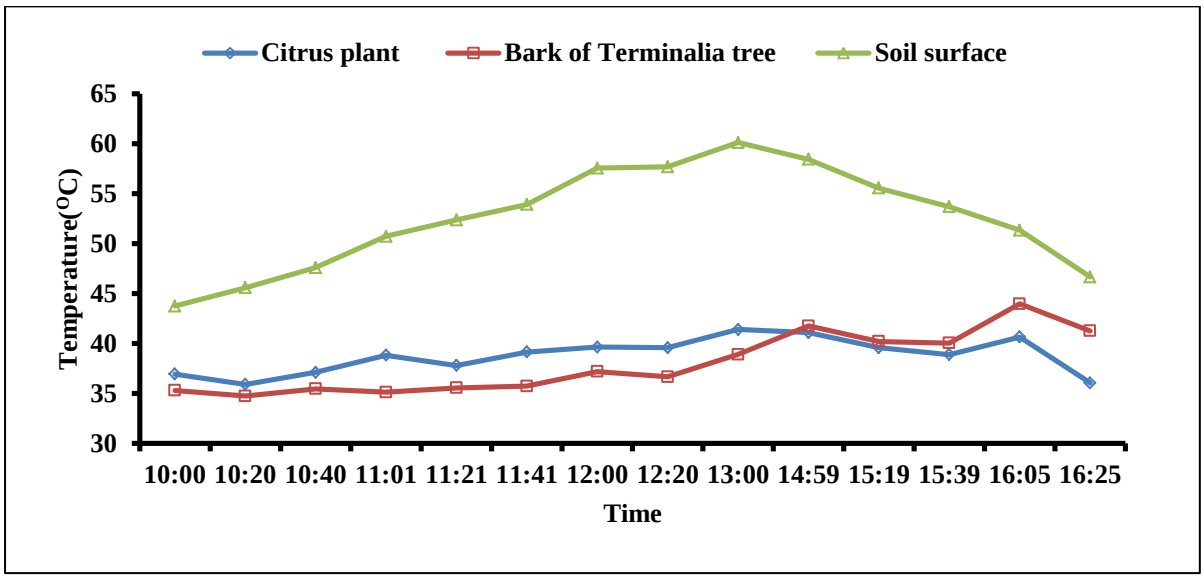


Fig. 2.36. Variation in canopy temperature in citrus (Day 3)

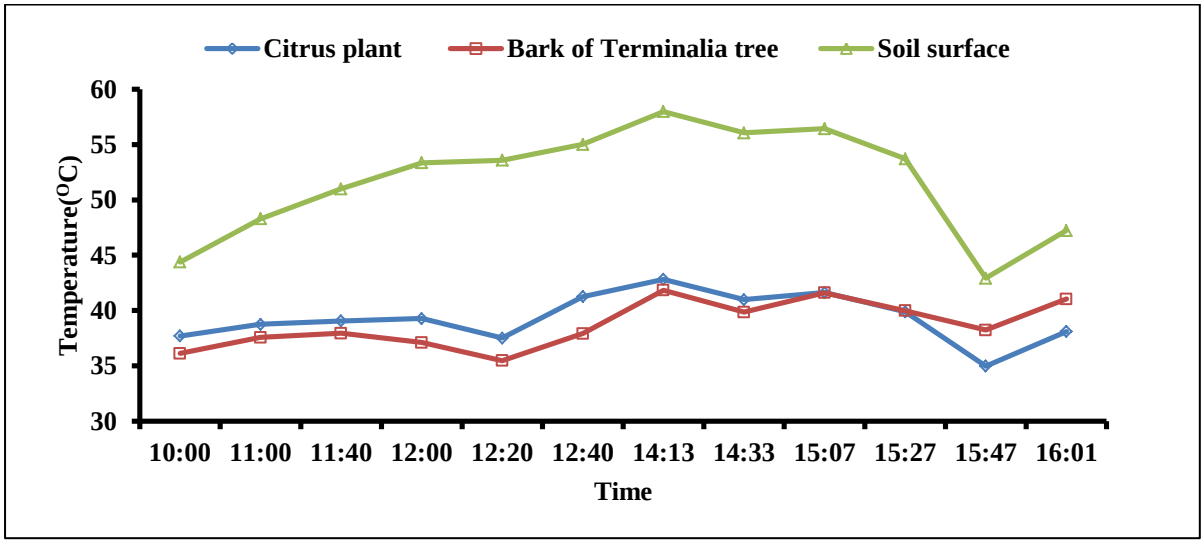


Fig. 2.37. Variation in canopy temperature in citrus (Day 4)

Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (OXX03111)

Jagadish Rane and AK Singh

To assess photosynthetic efficiency of different wheat genotypes in irrigated and soil moisture stress condition

To study genetic variation in responses of Photosystem-II under depleted soil moisture stress condition, experiments were carried out with diverse wheat genotypes under irrigated and depleted soil moisture conditions in walk-in growth chambers. These wheat genotypes were subjected to irrigated and limited soil moisture stress conditions with four replications in completely randomized block design. Soil moisture stress was imposed by withdrawing irrigation after crown root initiation stage. Chlorophyll fluorescence was measured 36 days after sowing (DAS) to assess the efficiency of PSII photochemistry (QY_max), Non Photochemical Quenching (NPQ) which reveals unutilized solar energy and Fluorescence decrease ratio (R_{fd}), which is directly correlated to the net CO_2 assimilation rate (PN) of leaves. From the present study it is evident that soil moisture stress reduces the quantum efficiency (QY_max) and R_{fd}, also the NPQ was more in soil moisture stressed plants (Figs. 2.38, 2.39, 2.40). This study revealed that genotypes NI-5439, SONARA-64, NP-404 and C-306 maintained good quantum efficiency in both irrigated and depleted soil moisture conditions. Genotype NI-5749 showed maximum non-photochemical quenching under depleted soil moisture conditions, amongst selected genotypes. This study also revealed that average NPQ under irrigated conditions was 0.62, but it increased drastically to 0.82 under limited soil moisture conditions. Hence, it can be a potential parameter to differentiate the responses of wheat plants to drought. It is possible to differentiate the drought responses of wheat genotypes by using chlorophyll fluorescence parameters such as NPQ and QY_max.

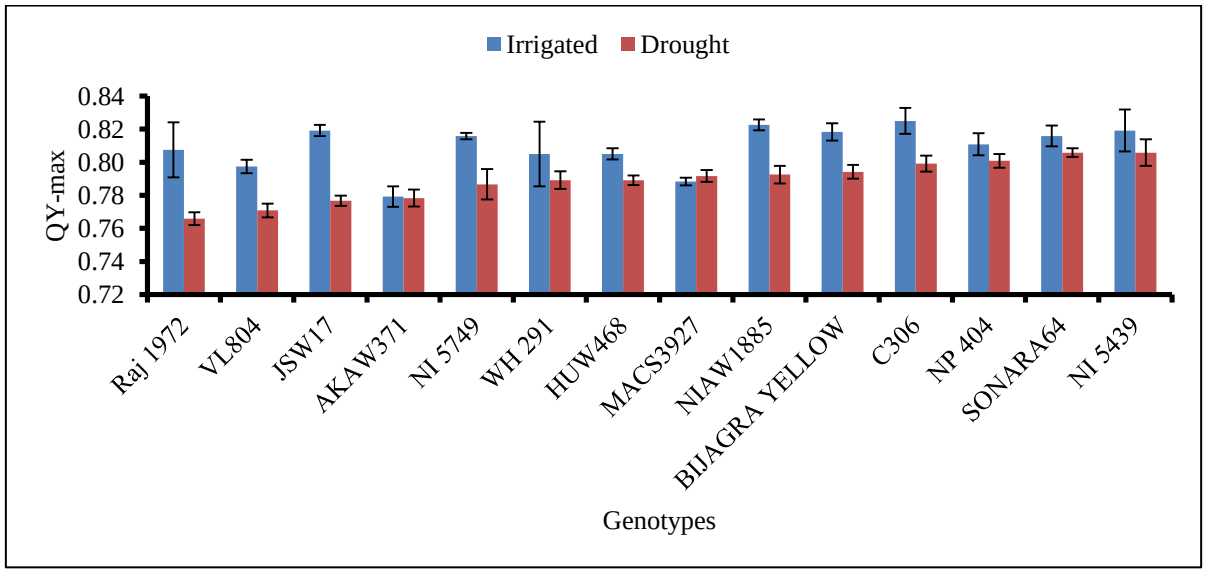


Fig. 2.38. QY-max of wheat genotypes

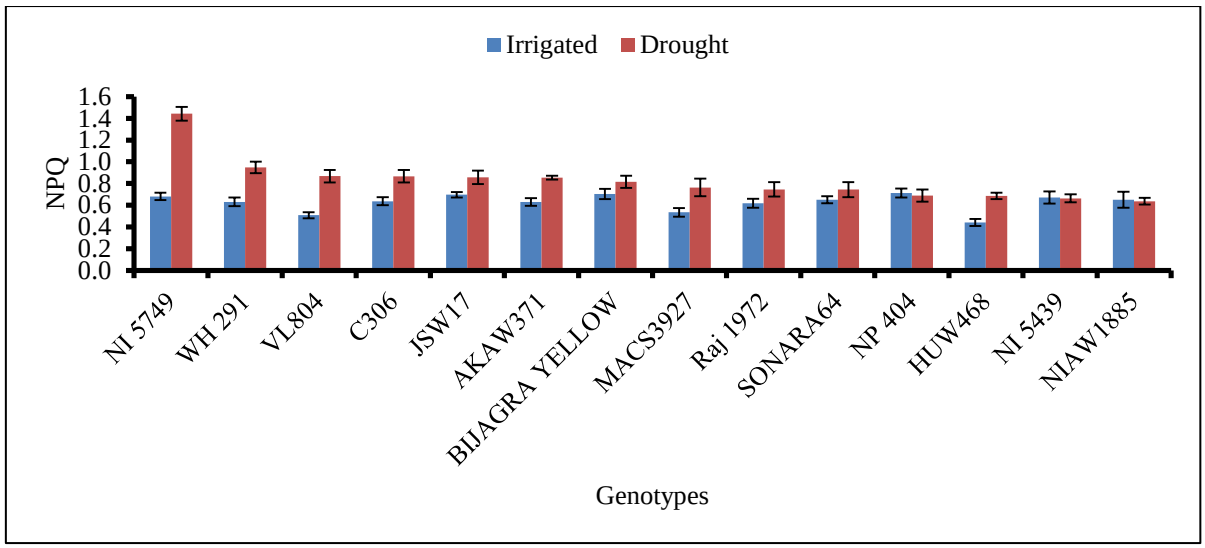


Fig. 2.39. NPQ of wheat genotypes

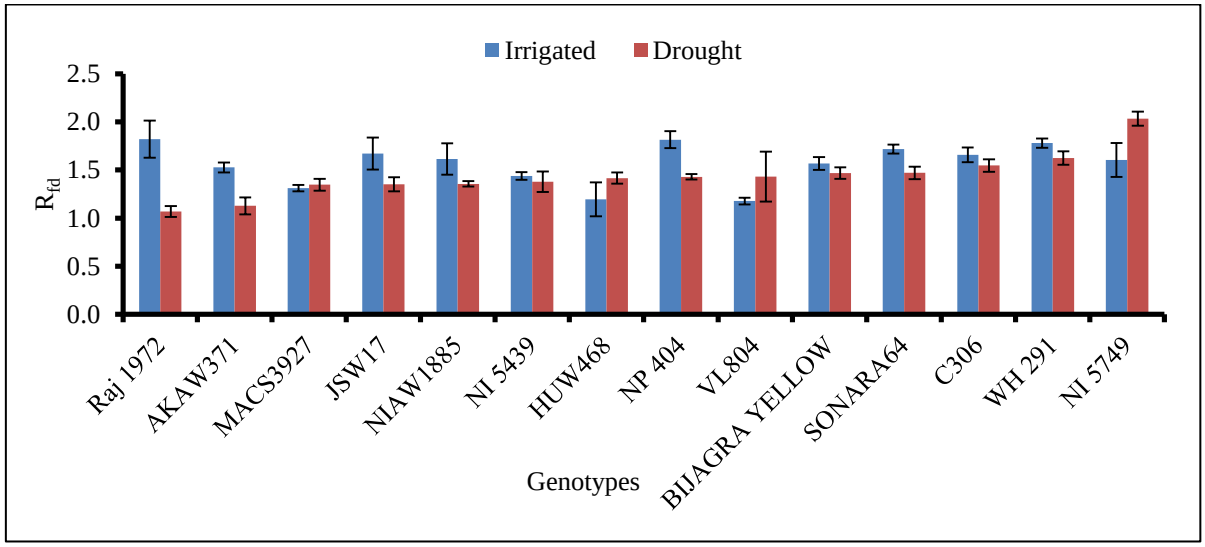


Fig. 2.40. R_{fd} of wheat genotypes

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

A K Singh, Mahesh Kumar and Jagadish Rane

A total number of 153 soybean genotypes, along with check varieties JS-9560 (drought susceptible), NRC-37 (drought susceptible), JS-9752 (drought tolerant), JS-7105 (drought tolerant), were evaluated for drought and water stagnation stress tolerance under green house conditions. Drought stress was imposed by withholding watering for 48 hour at flowering stage (R1) stage. Soybean genotypes along with check varieties were evaluated for NDVI (normalized difference vegetation index), canopy temperature, Relative water content and quantum efficiency of photosystem II. Genotypes EC-333901, EC-241995, SL-958, EC-546882, JS-2029 and EC-333859 exhibited cooler canopy under non-stress and also drought stress condition compared to check varieties JS-9752 and NRC-37. The NDVI was recorded at irrigated as well as drought stress condition. Genotypes MACS-1034, EC-333901, MAUS-

71, EC-538807, TGX- 86011-D and EC-287754 showed higher NDVI as compared to check varieties JS-9752 and NRC-37. Soybean genotypes JS- 2098, PK-308, DSB-23, MAUS-71, PUSA-37 , JS-8011 and CO-SOYA-2 showed higher relative water content as compared to check varieties JS-9752 and NRC-37.

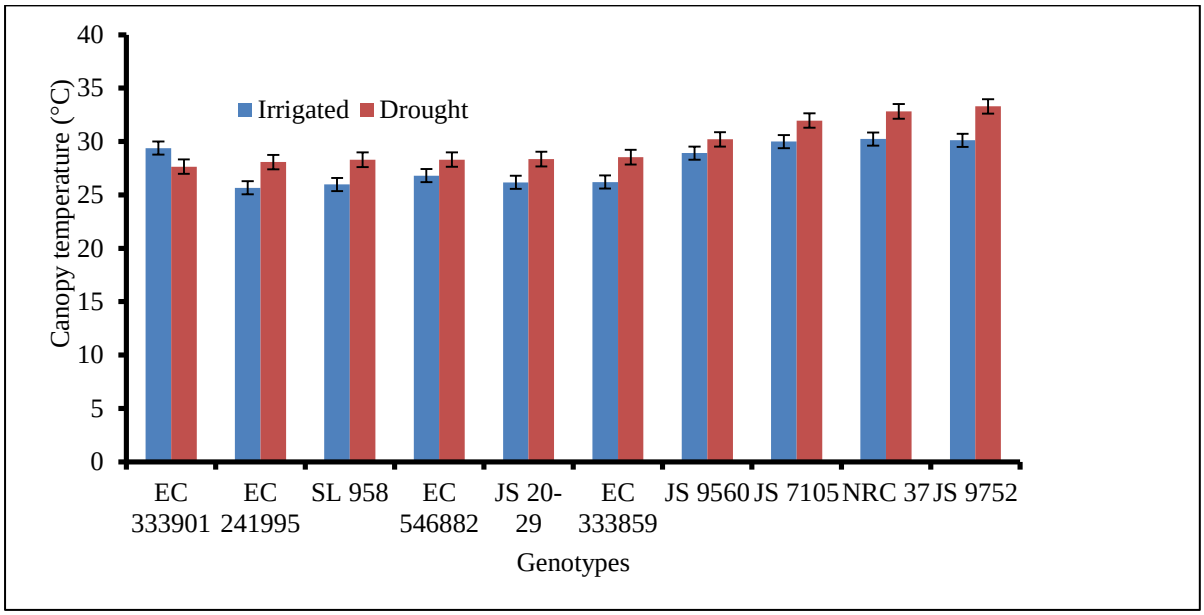


Fig. 2.41. Genetic variability in canopy temperature under drought and irrigated conditions in soybean genotypes

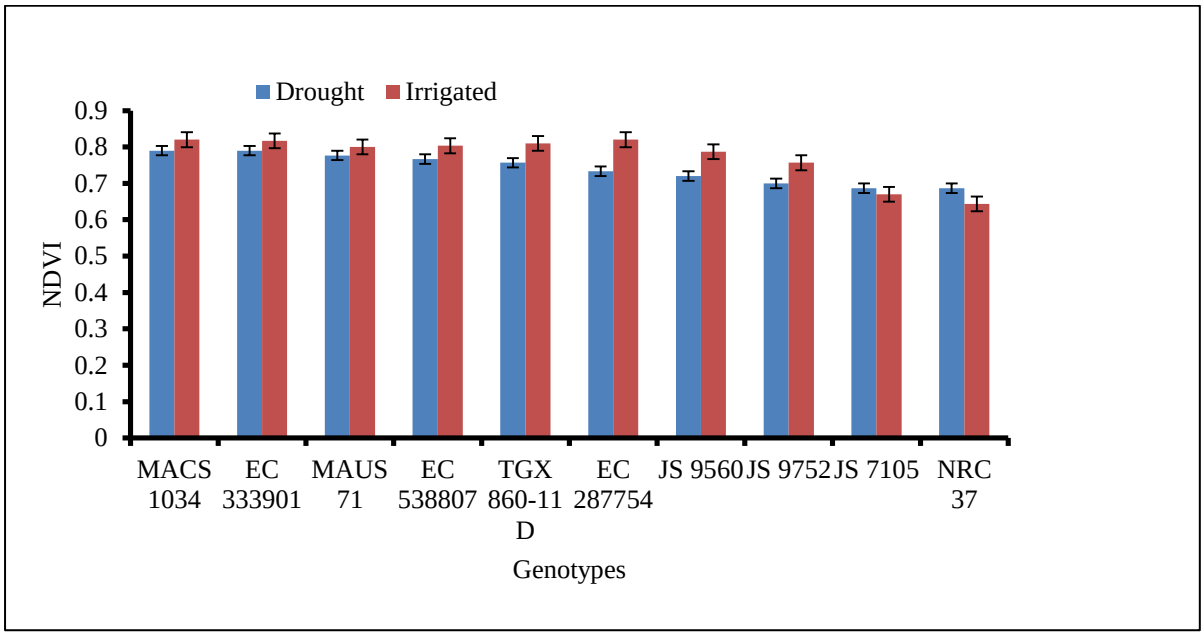


Fig.2.42. Genetic variability in NDVI under drought and irrigated conditions in soybean genotypes

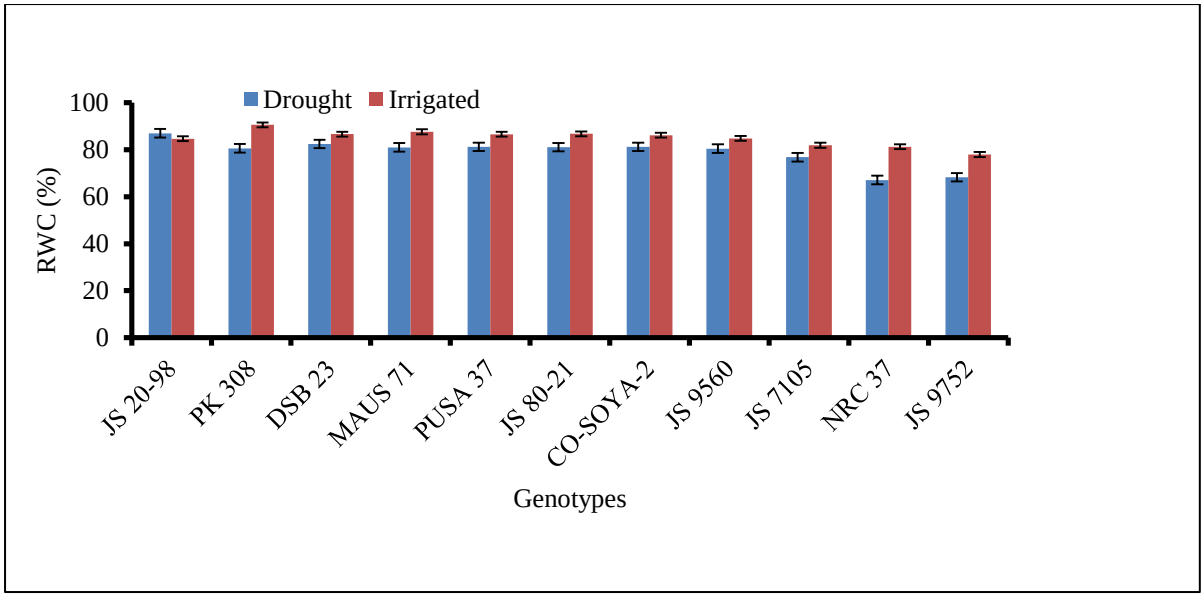


Fig.2.43. Genetic variability in relative water content under drought and irrigated conditions in soybean genotypes

Chlorophyll fluorescence variation can be used as a valuable index for evaluation of plants tolerance to environmental stresses like drought. Photo-system II photochemical capacity was calculated from the ratio of variable fluorescence to maximum chlorophyll fluorescence (Fv/Fm). The chlorophyll fluorescence of soybean genotypes against check genotype was measured under well-watered and also under drought stress condition. Genotypes BR-15, EC-241756, ICS84/86-85B-41 and AGS-142 showed higher Fv/Fm compared to check varieties JS-9752 and NRC-37.

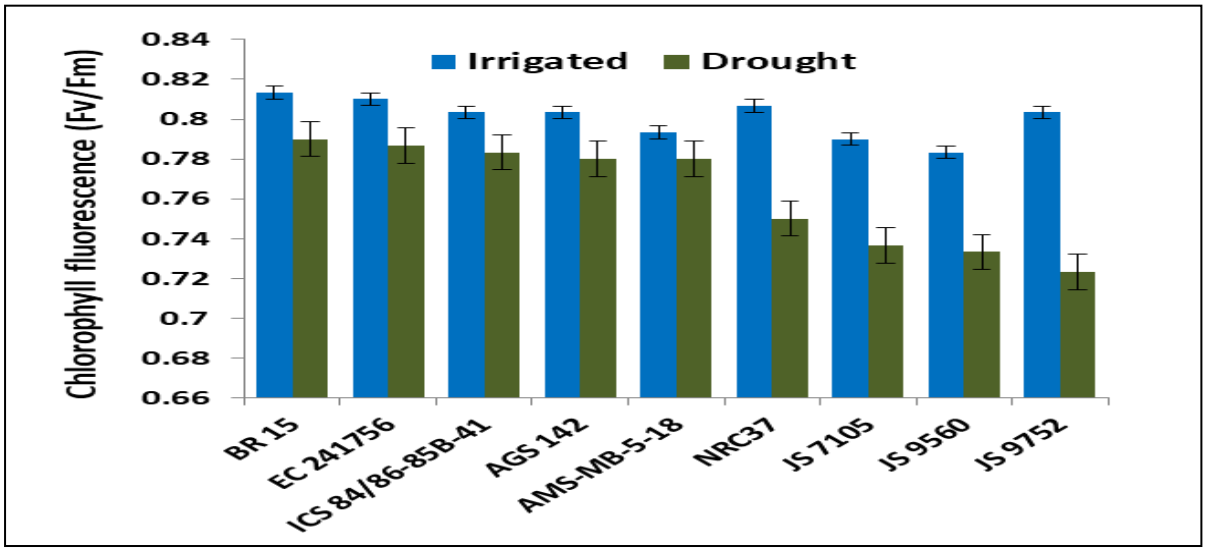


Fig.2.44. Genetic variability in chlorophyll fluorescence under drought and irrigated conditions in soybean genotypes

Screening of soybean genotypes for waterlogging stress tolerance

A total number of 53 soybean genotypes along with check varieties JS-9752 (Water logging tolerant), JS-7105 (water logging tolerant) were evaluated for water stagnation stress tolerance. The water logging condition was provided in Vegetative 2-Vegetative 3 (V2-V3) growth stage of plant for 10 days by saturating the soil with water up to 10 cm above the soil surface of plant. Soybean genotypes were evaluated for plant height enhancement, NDVI (Normalized Difference Vegetation Index), canopy temperature, Relative water content and quantum efficiency of photosystem II. Plant height was measured before the stress condition, during the stress condition and at end of the stress condition. Soybean genotypes JS-7105, EC-39376, EC-95815, MAUS- 47, JS-2034, EC-457464, BR-15A showed better plant height enhancement than the check varieties. The vegetation stress can be calculated by using the Green seeker instrument which provides the NDVI data. The NDVI data was recorded before and at end of the stress condition. Genotypes EC-95815, AMS-MB-5-18, EC-396067 and BR-19 had better NDVI than the check varieties.

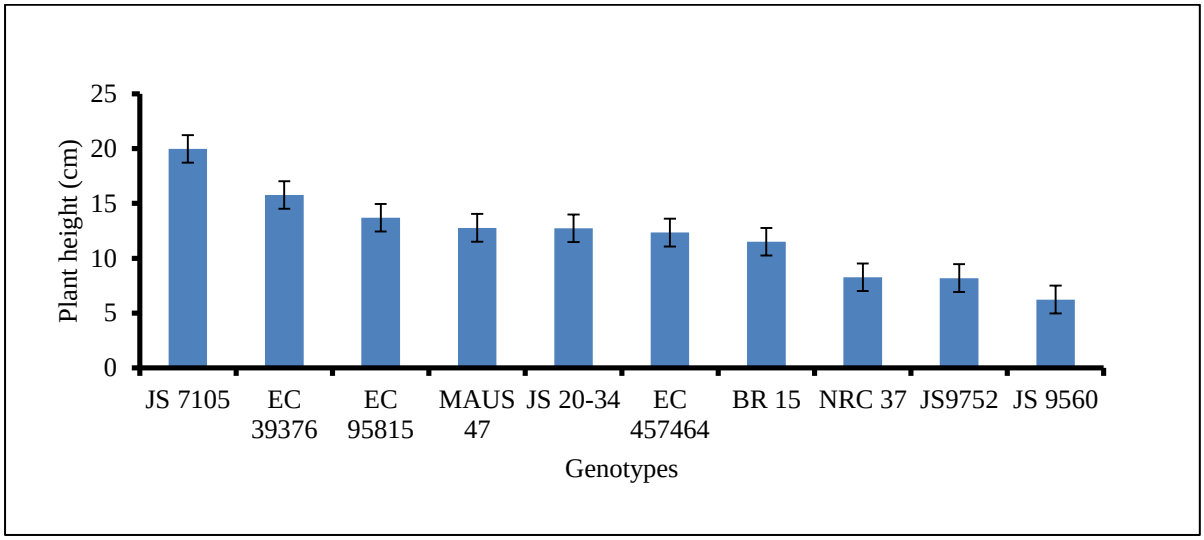


Fig.2.45. Genetic variability in plant height enhancement under waterlogging conditions in soybean.

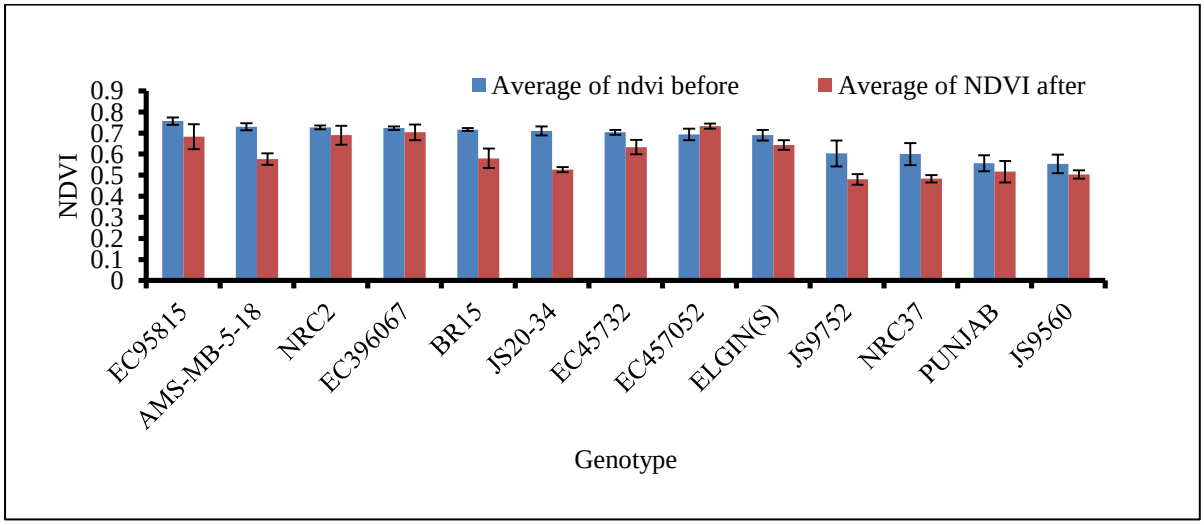


Fig.2.46. Genetic variability in NDVI under waterlogging conditions in soybean.

Evaluation of root architecture under waterlogging conditions

Plant roots play a significant role in plant growth by exploiting soil resources via the uptake of water and nutrients. Root traits such as root length, root thickness, root hairs, and root biomass are considered useful traits for improving plant productivity. Therefore, understanding interactions between roots and their surrounding soil environment is important, which can be improved through root phenotyping. A total 51 soybean genotypes were evaluated for RSA under water stagnation conditions. Soybean genotypes AGS-116, AGS-166, EC-114527, AGS-38, EC-467282, DS-321, AGS-157, AGS-150, EC-175329, EC-389154 had efficient rooting system in terms of root length. Soybean genotypes AGS-02, EC-250591, AGS-38, TGX-702-4-8 showed higher biomass compared to check variety JS-9560.

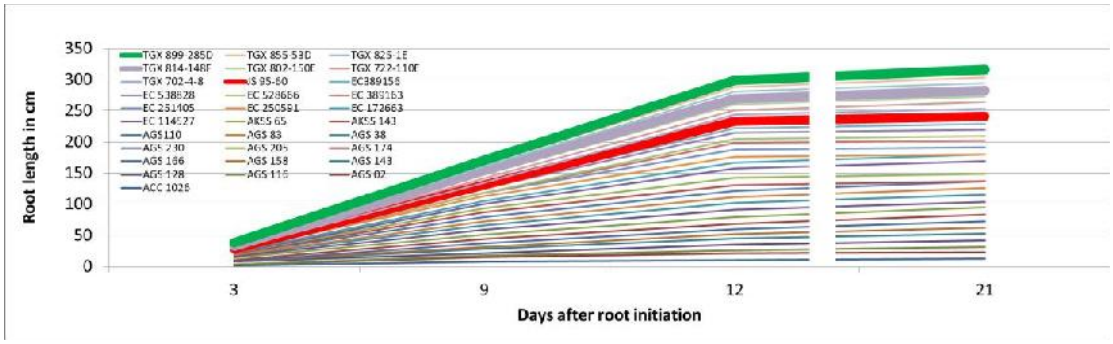


Fig.2.47. Genetic variability in root length under waterlogging conditions in soybean.

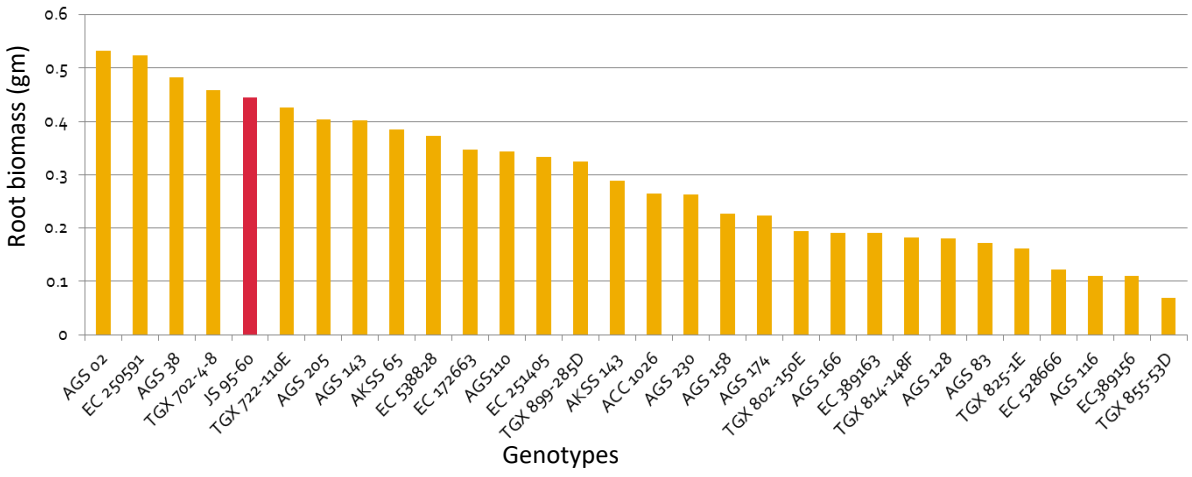


Fig.2.48. Genetic variability in root biomass under waterlogging conditions in soybean.

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

D D Nangare, Yogeshwar Singh, Mahesh Kumar, P B Taware

The physiological parameters in Pomegranate were studied under various irrigation strategies including the deficit irrigation and partial root zone drying with different irrigation levels along with the mulch and foliar spray of salicylic acid during the mid growth stage of pomegranate. It was observed that, the relative water content (RWC) varies from 70.4 to 80.2 per cent in various irrigation treatments. It was found maximum under PRD60+mulch+foliar spray of salicylic acid treatment (T14) (Fig 2.49.). The total chlorophyll content ranged from 4.38 to 6.68 mg/g of fresh weight (Fig 2.50) and was maximum in PRD60+mulch+foliar spray of salicylic acid treatment and minimum in deficit irrigation (DI40) without much and foliar spray treatment.

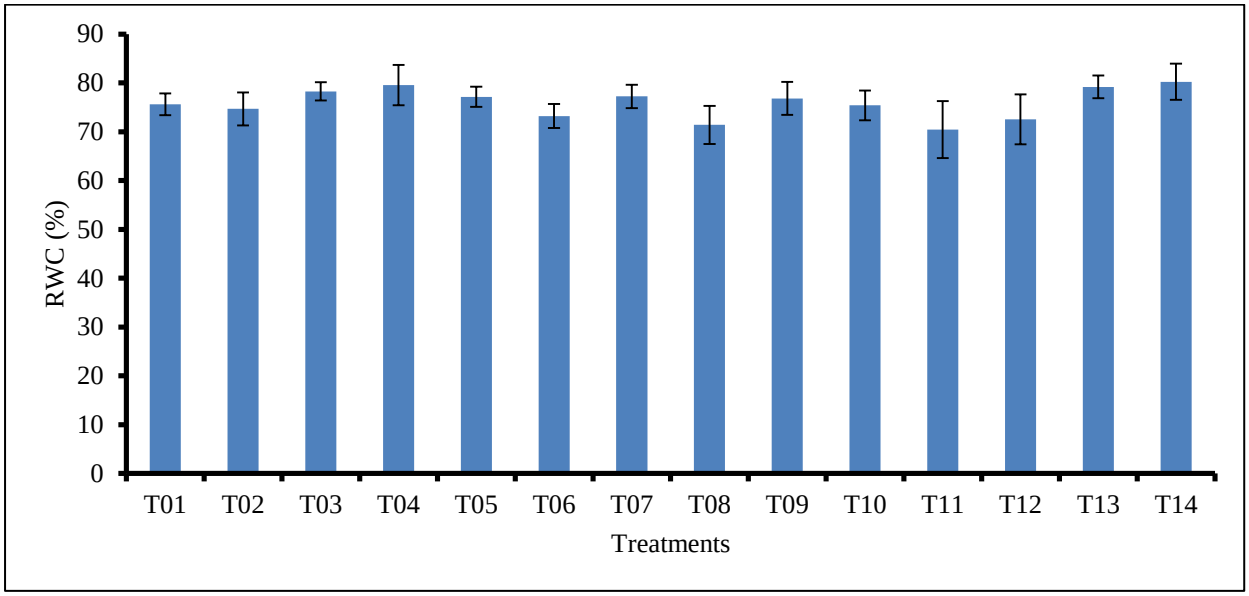


Fig 2.49. Relative water content under different irrigation treatments and strategies in pomegranate.

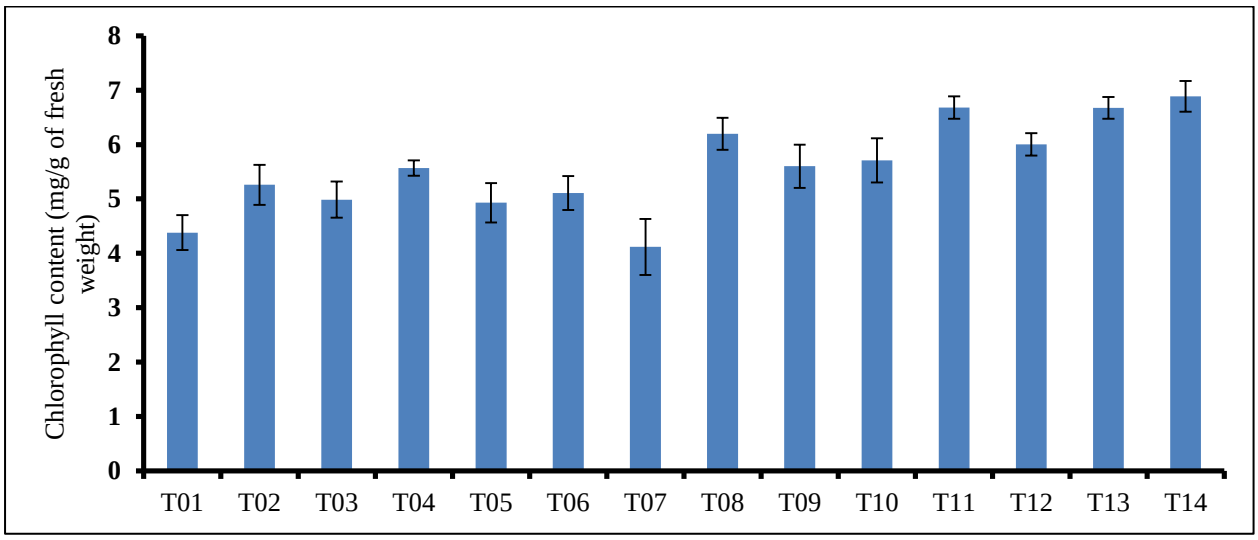


Fig 2.50. Total chlorophyll content under different irrigation treatments and strategies in pomegranate.

Techniques to obviate the edaphic stress in horticulture crops (IXX10720)

Yogeshwar Singh, D D Nangare, Jagadish Rane and P B Taware

The influence of treatments of planting methods on growth, i.e stem diameter of sapota was analysed and depicted in Fig 2.51. The stem diameter of four year old sapota trees was recorded. It was observed that the stem diameter varies from 67.8 to 84.1 mm across different treatments and the maximum diameter was observed in response to treatment of B+TP+NS treatment.

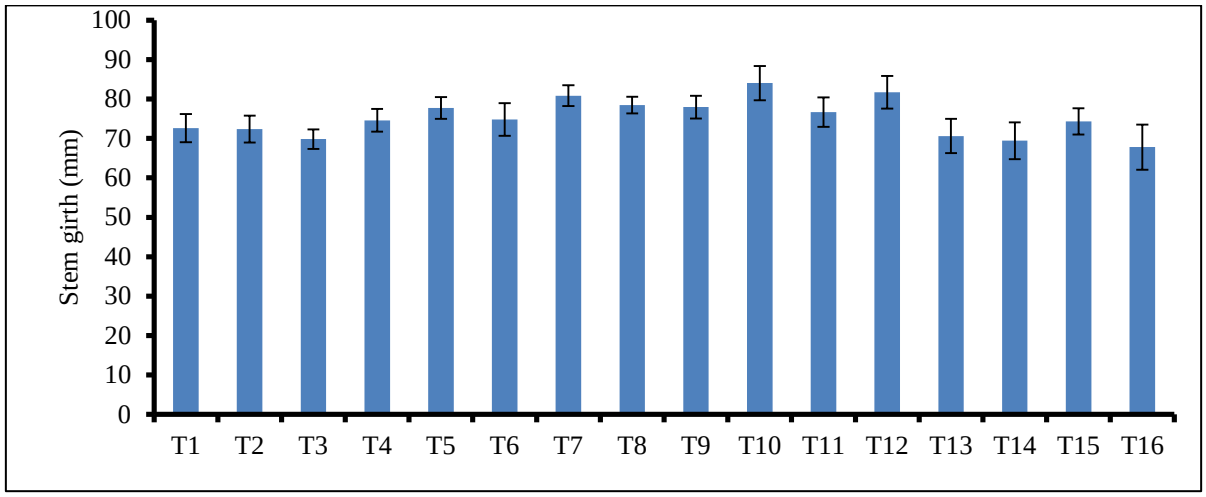


Fig 2.51. Stem diameter variation under different irrigation treatments in Sapota(x-axis as explained in Table 2.2).

Table 2.2. Post harvest quality parameters of Sapota. AP- Auger planting, TP- Trench planting, PP-Pit planting, B- Blasting, FP- farmer's practice, NS-Native soil, BS-black soil, SW-Spent wash.

Treatments	Average fruit weight, g	Average height, mm	Average diameter, mm	TSS, ^{0} brix	Pulp weight, g	Peel weight, g
AP +(BS 100 %)	78.6	54.9	50.8	22.8	60.4	6.3
AP+(NS 100%)	90.4	57.4	52.9	20.5	69.0	9.1
AP+(NS+BS)	76.2	55.2	49.5	20.7	56.9	5.7
B+AP+(BS 100 %)	80.3	53.6	50.7	21.2	61.1	6.5
B+AP+(NS + BS)	81.5	56.0	50.2	21.7	58.2	6.1
B+AP+(NS 100%)	68.7	53.8	47.1	22.2	51.2	5.2
B+PP+(NS+BS)	74.9	54.4	48.7	22.9	58.5	5.3
B+PP+NS (100%)	71.8	54.2	47.6	21.5	55.9	5.2
B+TP+(NS+BS)	79.0	55.7	49. 9	20.5	61.1	5.9
B+TP+(NS100%)	85.6	55.1	50.9	22.5	64.4	6.2
FP (45cm 3)	72.9	54.1	47.7	20.7	57.1	5.7
FP (45cm 3)+SW	68.9	52.9	46.4	22.7	53.4	6.1
PP+(NS+BS)	76.4	56.9	48.7	22.7	59.0	5.9
PP+NS(100%)	76.9	56.1	49.1	21.7	57.6	6.8
TP+(NS+BS)	66.2	51.6	46.3	22.5	49.0	7.4
TP+NS(100%)	73.3	52.7	49.0	23.2	52.8	8.2

An experiment was carried out with an objective to develop suitable production technology for introducing dragon fruit (*Hylocerus undatus*) as a new crop water scarce zone for rocky land. In an experiment, The development of fruits was assessed by measuring the furit diameter at 6 days interval in three different soils (Fig 2.63). It was observed that there was no significant variation in effects of three different soil types on diameters of fruits. The post- harvest quality parameters such as average weight of fruits, TSS, acidity, ascorbic acid, phenols and flavonoids of dragon fruits were studied under three different soil mixtures (native soil, mixed soil and black soil). These are mentioned in table. 2.3.

Table 2.3. Post-harvest quality parameters of dragon fruit during 2019.

Parameters	Black soil	Mix soil	Native soil
Total sugars (%)	9.20	9.13	9.00
Reducing sugars (%)	5.09	5.19	4.97
Non-reducing sugars (%)	4.12	3.94	4.03
Total Phenol (mg gallic acid equivalent)	10.78	12.54	12.87
DPPH (% ROS scavanging)	41.76	36.16	39.27
FRAP (µg ascorbic acid/g FW)	8.44	8.02	6.72
Titrable acidity (%)	0.28	0.20	0.23
TSS (^{0}Brix)	13.90	13.78	14.03
Specific gravity	1.06	1.17	1.15
Individual Fruit weight (g)	352.55	394.72	389.16
Peel weight (g)	128.07	139.87	130.00
Pulp weight (g)	224.48	254.84	259.15
Pulp : Peel ratio	1.75	1.82	1.99
Pulp moisture content (%)	86.29	84.56	85.36
Peel moisture content (%)	90.85	91.86	92.44
Fruit diameter (mm)	85.30	87.89	85.71
Geometric mean diameter (mm)	91.11	96.77	95.19

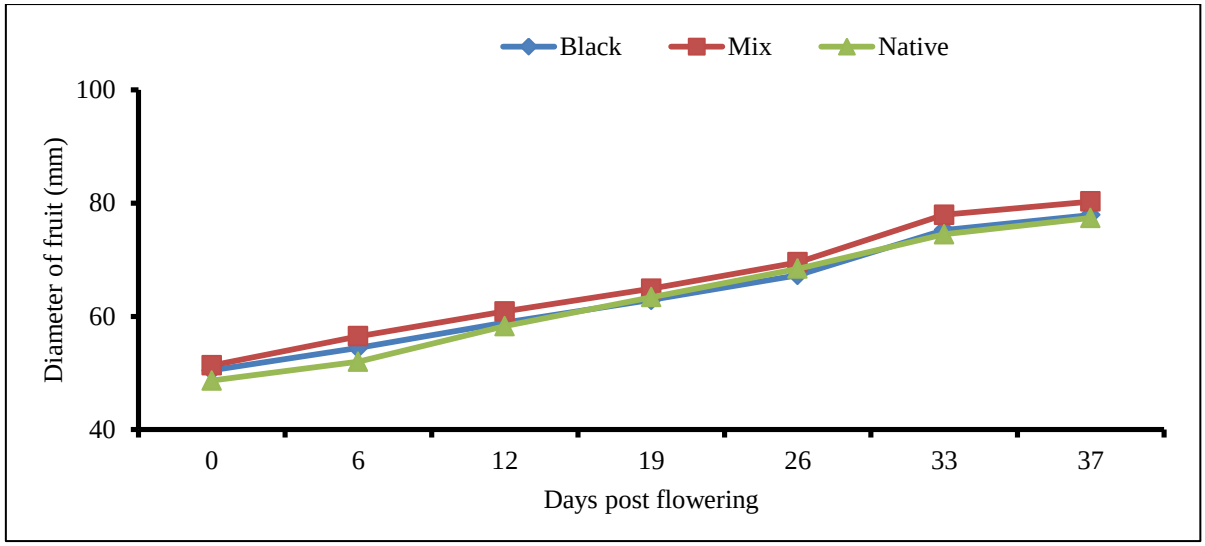


Fig 2.52. Development of fruit from flowering to harvest in different soil mixtures.

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

G C Wakchaure, B B Gaikwad and K K Meena

Onion cultivars response to water stress for enhancing post-harvest storage quality

An experiment was conducted in triplicate to investigate the interactive response of different red and white onion cultivars and water stress on post-harvest storage quality of onions. Nine onion cultivars namely *Cv.* Bhima Shubhra, Bhima Sweta, Bhima Safed, Bhima Red, Bhima red (TFL), Bhima Super, Bhima Raj, Bhima Kiran and local were raised under six levels of water stress created using line source sprinkler system. The water applied (IW) equaled 1.00, 0.80, 0.60, 0.40, 0.20 and 0.00 times the cumulative open pan evaporation (CPE), respectively. After curing of 10 days in open shed, onion bulbs of respective treatments were filled separately in nylon wire-mesh bags (1 kg capacity). These bags were thenstored in three batches at 25±1°C and 65±5%relative humidity in controlled chambers (Model: DR36VL, R−134A refrigerant, Percival Scientific, USA) for five months. The results revealed significant down fall in rehydration ratio, dry matter and total soluble sugar (TSS) of the onion bulbs during storage. Weight loss during storage was significantly affected by onion cultivars as well as the water stress levels (Fig. 2.53). In general, weight loss percentage increased with intensity of water stress and storage time. The most profound effect was observed for onion produced under severe stress(IW:CPE 0.00), where weight loss (77.2%) was about 1.5 times greater than that of no stress (IW:CPE 1.00) conditions (52.6%) after five months of storage indicating strongly negative effect on the important quality trait, as excess water loss makes the bulb shrink and sprouts. Further, minimum weight loss (48.6%) was observed in mild water stress level (IW: CPE 0.80) for period of five months. Among different onion cultivars, minimum (49.8%) and maximum (76.6%) weight loss was obtained for the local and Bhima Super cultivars, respectively. In conclusion, onion cultivars

viz., local and Bhima Kiran were identified to have better role for post–harvest storage of onion (Fig.2.54). Further mild stress could substantially reduce weight loss in long term storage by regulating physiology and metabolic activities.

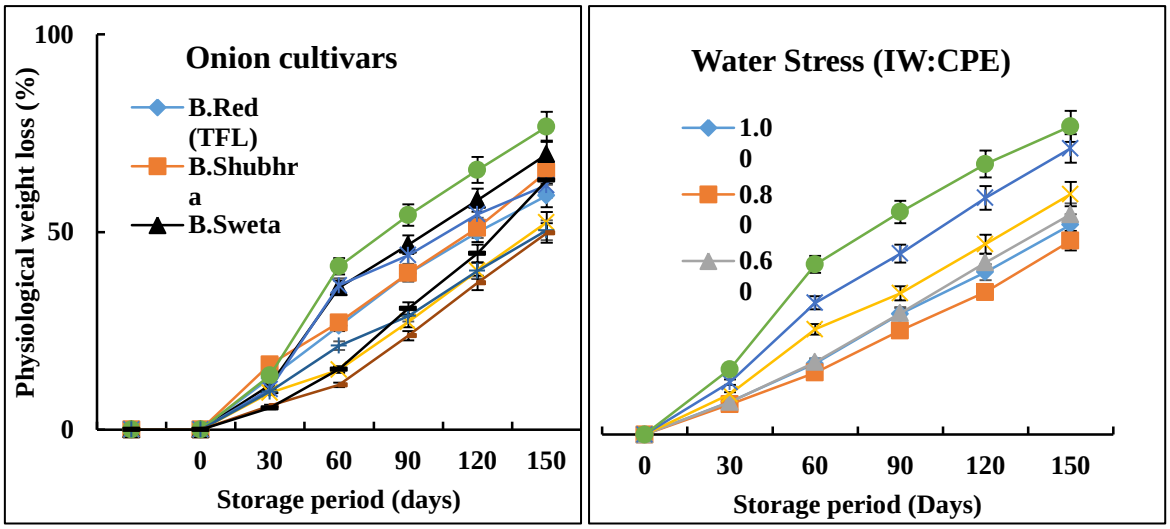


Fig.2.53. Variation in weight loss of onion cultivars in response to water stress during five months of storage.

Fig.2.54. Effect of water stress on imposed during growth on post harvest quality of different onion cultivars after 5 months of storage

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

The field trail was repeated in 2019 to validate the response of the nine onion cultivars to water stress using line source sprinkler system (*Allium cepa L.*). The onion cultivars included: *Cv.* Bhima Shubhra, Bhima Sweta, Bhima Safed, Bhima Red, Bhima red (TFL), Bhima Super, Bhima Raj, Bhima Kiran and local as main plot treatments. The line source sprinkler system (LSS) was used to maintain six levels of irrigation water (IW) i.e. 69.0, 57.44, 45.8, 34.2, 22.6 and 11 cm applied based on cumulative open pan evaporation (CPE) as subplot treatments. The results showed that the maximum bulb yield (81.70 Mg ha^{-1}) was obtained at IW, 69.00 cm for local cultivar and corresponding values were 78.14, 77.87, 77.72, 74.18, 69.21, 63.03, 58.61 and 53.01 Mg/ha for cv. Bhima Kiran, Bhima Red (TFL), Bhima Red, Bhima Raj, Bhima Sweta, Bhima Super, Bhima Safed and Bhima Shubra and, respectively (Fig. 2.55a). Among the red onion cultivars, maximum water productivity (WP) of 9.6–11.8 kg m^{-3} was obtained for local (Fig. 2.55b). Similarly among white onion cultivars, Bhima Sweta had the highest water productivity (WP) of 2.9 to 10 kg m^{-3} for. Results reconfirmed that local cultivar in Baramati area had consistently high bulb yield and quality of onion both under excess and deficit water conditions in shallow basaltic soils.

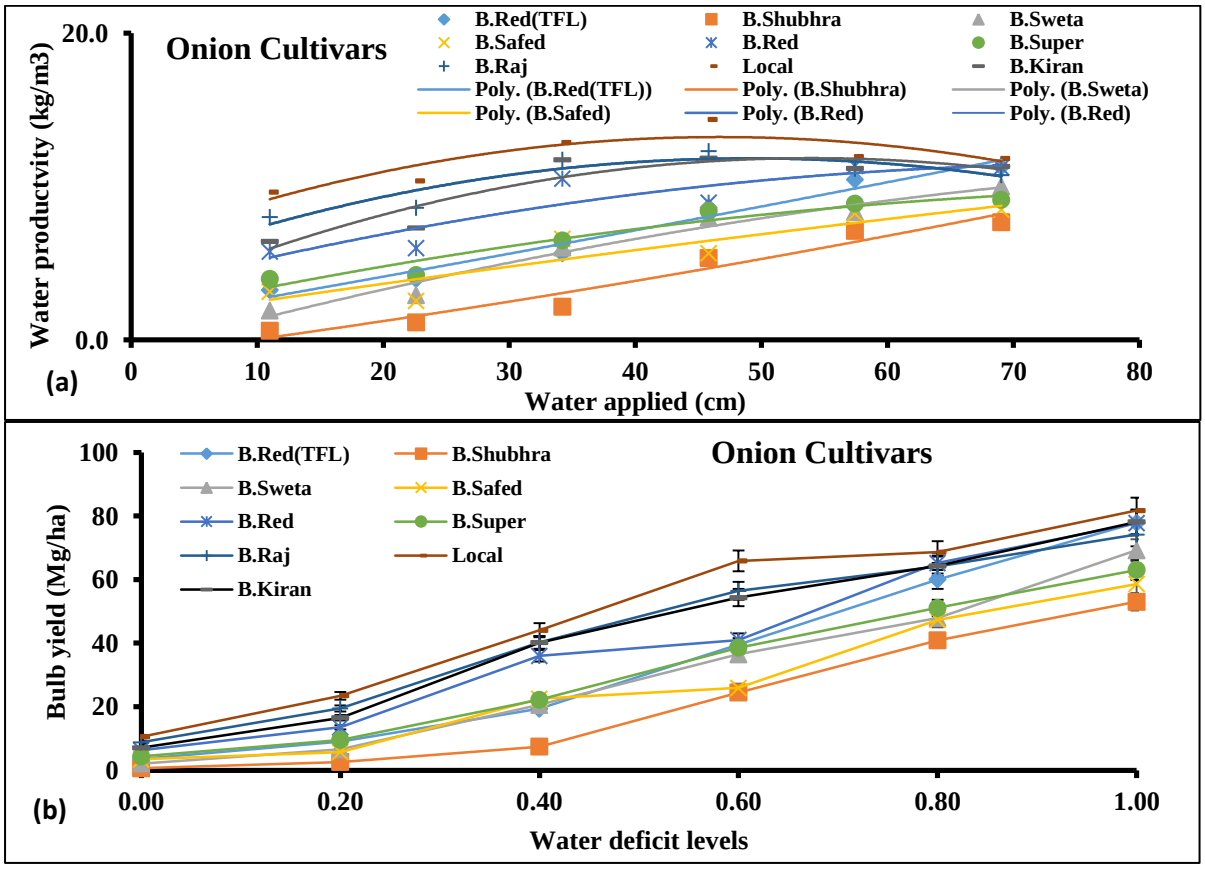


Fig.2.55. Bulb yield (a) and water productivity (b) of the potential onion cultivars under varied water deficit levels.

Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (OXX03595)

B B Gaikwad, DD Nangare and Mahesh Kumar Rajkumar

Machine learning Models for classification of growth stage of Sugarcane

Models for biophysical and biochemical characterization and abiotic stress monitoring in Sugarcane are growth stage specific, therefore determining the growth stage is prerequisite for applying stage specific prediction models. With objective to determine growth stage of sugarcane crop machine learning models viz. Artificial Neural Network (ANN), Random Forest (RF), Support Vector Machine (SVM), k-NN, Logistic Regression, Decision Trees and Naïve Bayes were fitted to hyperspectral signatures collected during the growth stages of sugarcane namely; tillering, formative, grand growth and maturity. The General workflow followed during model development is depicted in Figure 2.56.

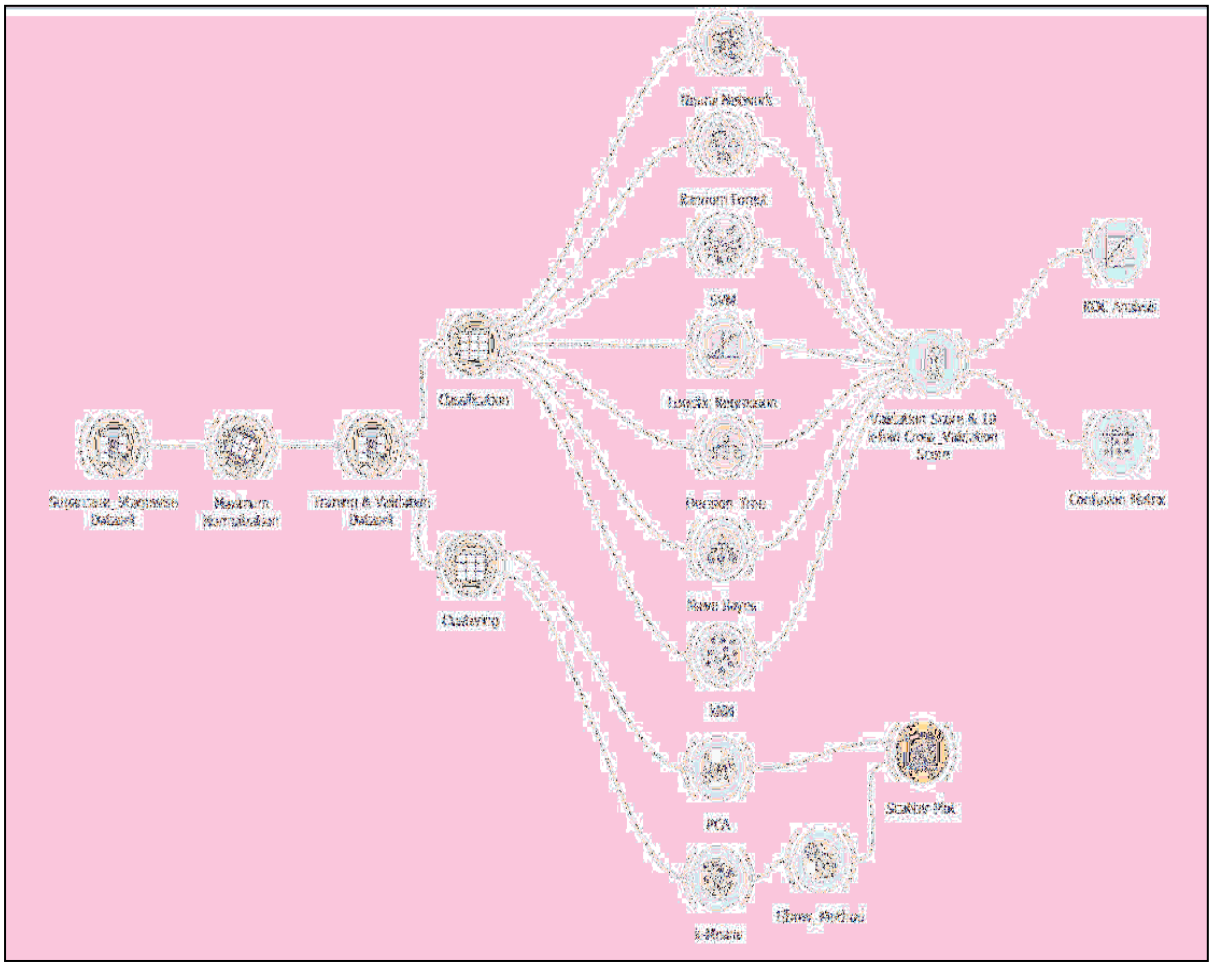


Fig. 2.56. Workflow of ML Model development.

A total dataset of 1440 signatures were used with 80% dataset for training and 20% dataset for validation of the fitted model. The Receiver Operating Characteristics (ROC) curves that illustrates the diagnostic ability of classifier system as its discrimination threshold is given in Figure 2.57.

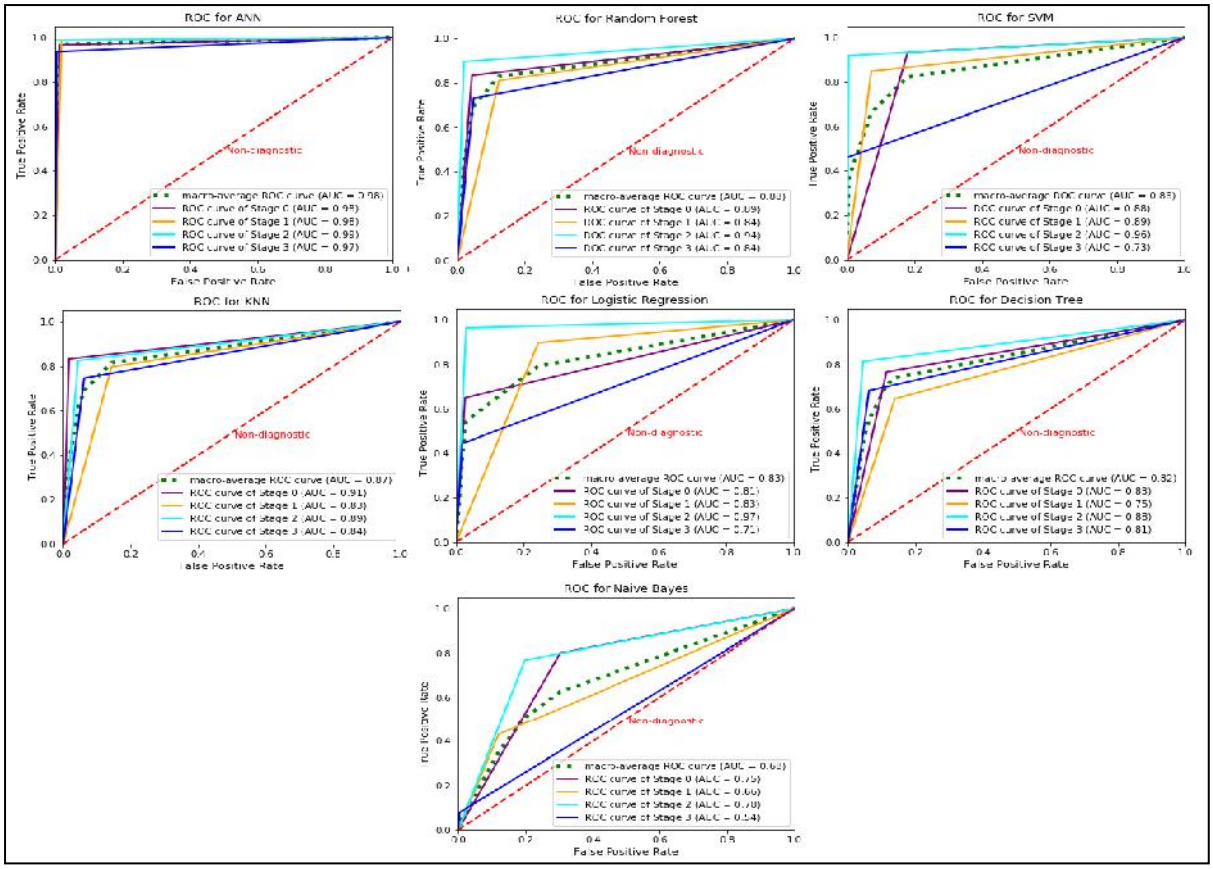


Fig. 2.57. ROC curves of the fitted models for sugarcane growth stage classification.

The performance parameters of the models are given in Table 2.4. It was found that the fitted ANN model outperformed other ML models in growth stage classification of sugarcane based on hyperspectral signatures.

Table 2.4. ANN model showing growth stage classification of sugarcane based on hyperspectral signatures

Model/ Parameters	Accuracy on Validation data (%)	RMSE	Precision (%)	Recall (%)	F1 score (%)	Mean AUC Score (%)	Variance/ Loss
ANN	95.22	0.36	97	97	97	90.36	0.011/ 0.13
Random Forest	82.29	0.78	83	82	82	83.92	0.030
SVM	80.96	0.79	90	86	86	87.50	0.11
k-NN	80.20	0.79	82	80	81	78.01	0.021
Logistic Regression	76.73	0.87	81	74	75	74.86	0.14
Decision Trees	72.91	0.97	73	73	73	76.01	0.03
Naïve Bayes	53.12	1.22	61	52	47	52.27	0.028

Software tool for generating image datasets from video for image classification using Deep learning.

A Matlab App “Video Frame Classifier v1.0” has been developed for generating image datasets from video for image classification using Deep learning algorithms. The app is useful to grab frames from videos and its classification into user defined classes. The classified image dataset can be used for training and validation of deep learning image classification algorithm.

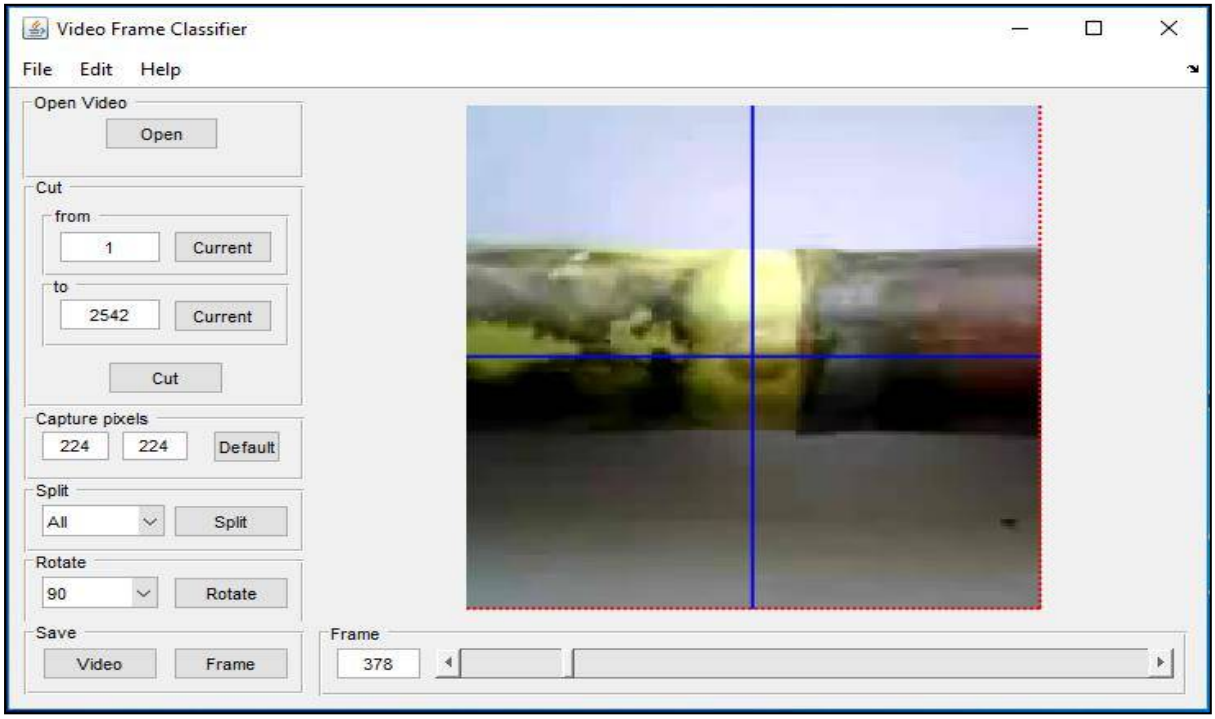


Fig. 2.58. Screen snapshot of “Video Frame Classifier v1.0” Software tool.

Sugarcane bud and node detection using efficient Convolutional Neural Networks for Mobile Vision Applications

The sugarcane bud and node detection using MobilenetV1 was attempted using hardware based on Kendryte K210 RISCV64 dual core SoC. Mobilenets is an efficient Convolutional Neural Networks for Mobile Vision Applications. The training dataset was extracted from video of sugarcane stalks using “Video frame classifier” Tool and classified into six classes as given in Table 2.5, viz "Node","Bud","Internode","Node & Root", "NodeCloseup","BudCloseup" with of 75 images each in these classes. The validation dataset of 10 different images of each class were independently selected from the additional frames captured from the video. In total 450 images were used for training and 60 images were used for validation of the fitted CNN model. The fitted CNN model performance parameters obtained were: Final Loss: 0.2173; Final Accuracy: 0.9323999881744385; Final Validation Loss: 0.0899, Final Validation Accuracy: 0.96670001745224 at Alpha: 0.7 and Depth: 1. The MobilenetV1 was found to accurately classify/detect on the fly all the classes at 8 frames per second (fps) rate on Kendryte K210 SOC hardware.

Table 2.5. Classes for sugarcane part classification using images

Classes	Representative extracted image dataset
Node	
Bud	
Internode	
Node with Roots	
Node Close up	
Bud Close up	

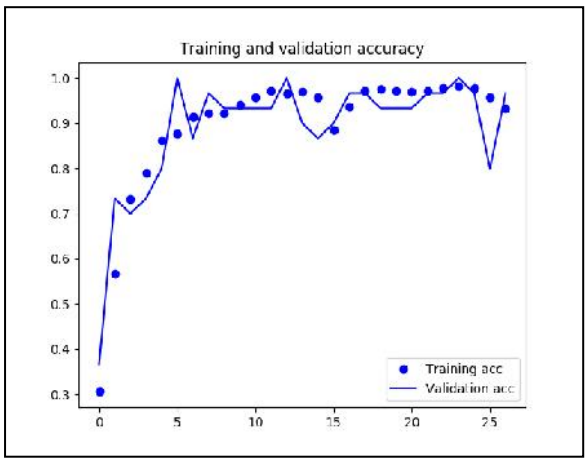


Fig. 2.59. Training and Validation accuracy.

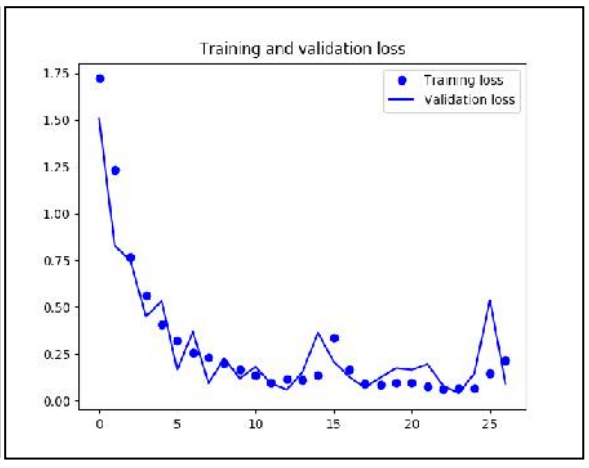


Fig. 2.60. Training and Validation Loss.

Spectral delineation of moisture and nutrient stressors in vineyards through hyperspectral spectroscopy (IXX14265)

B B Gaikwad

Determination of Relative Water Content of grapes leaves using two band indices

Determination of relative water content (RWC), a quantifying parameter of moisture stress of plant involves tedious process of measuring the weighing the water loss from excised water saturated leaves over a period of 24 hours. To determine the possibility of rapid determination of RWC using hyperspectral spectroscopy, experiment involving acquiring hyperspectral signatures using ASD FS4 Spectroradiometer for decreasing levels of moisture content was performed on 300 Grape leaf samples along with manual determination of RWC using standard protocol. Matlab app "Brute force identification of best performing two band spectral Indices" v1.0 developed for identification of two band indices in hyperspectral spectroscopy studies through co-relation analysis was used to identify the spectral bands sowing best correlation with RWC. The algorithm does recursive calculation of two band indices for all combinations of spectral values in user defined range and input parameters using Ratio (RI), Normalized difference (NDI) and pre-defined Transformations (TI). Further co-relations between these indices and Y- parameters are calculated and compared to find the Maximum R^2 obtained. The contour plot of resulting R^2 values for identification of hotspot areas suitable for band selection in the upper diagonal area and the respective calculation method used (RI/NDI/TI) in the lower diagonal area of the plot are shown in Figure 2.72 at 1nm, 5nm and 10nm spectral band averaging. The spectral averaging at 1nm, 5nm and 10nm was found to make no difference in improving the correlations, and thus RWC can be determined at 10 nm spectral bandwidth effectively at central wavelengths of 1865nm and 1395nm using transformed Normalized Difference Moisture index.

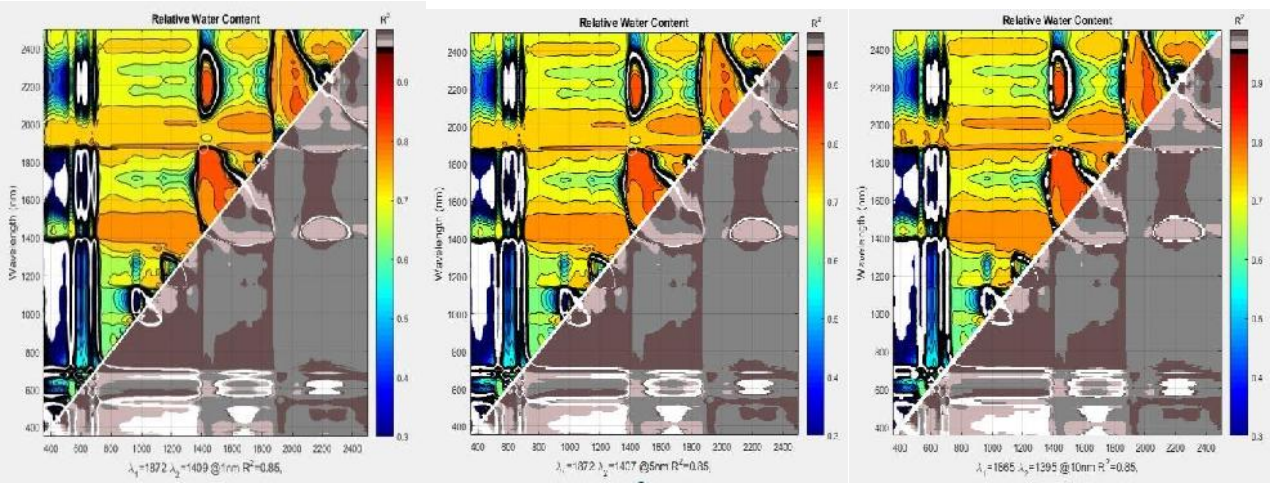


Fig. 2.61. 1 Contour Plot of Two Band Index Identification

Bioprospecting xerophytes for potential novel bio-inoculants and bio-regulators aimed at drought stress alleviation.

Satish Kumar

All the vegetative and reproductive parts of the plants such as roots, shoots, leaves, flowers, and seeds are invariably populated with microbes. These microbes live, thrive, and interact with different vegetative whorls like phyllosphere (aerial plant part), the rhizosphere (zone of influence of the root system), and the endosphere (internal transport system). In fact, every plant can be considered as a holobiont (plant + associated microbes) and plant associated microbiome is considered as the second genome of the plant. As plant and their associated microbes have co-evolved and their selection pressure for enduring the drought conditions must have had not only limited to plant but also to the associated microbes. Under selection pressure, these plants must have acquired, only those microbes which can naturally aid in the drought tolerance ability to the plant, else plants would have rejected these microbes during evolution itself. Hence, in the current project we have targeted four accessions *Opuntia ficus-indica* and one accession of *Opuntia dillenii* and *Opuntia hyptiacantha* each, for the isolation of bacterial endophytes and rhizospheric bacteria.

The *rbcL* gene based phylogenetic analysis of targeted *Opuntia* species placed *Opuntia ficus-indica* in separate clade whereas *Opuntia dillenii* and *Opuntia hyptiacantha* belonged to same clade with good bootstrap values (Fig. 2.62A-D). Using diverse microbiological culture media, we isolated 250 bacterial endophytes from the targeted *Opuntia* species. These endophytes are evaluated for their PGPA (Plant Growth Promoting Activity). So far, the *Opuntia* endophytes have been screened for their potential for siderophore production, phosphate solubilisation activity and Nitrogen fixation activity using Blue Agar CAS Assay, Pikovskaya (PVK) agar assay, and Jensen's Medium assay, respectively. So far, we have found 59 *Opuntia* leaf endophytes with siderphore production ability, 38 leaf endophytes displaying phosphate solubilisation activity and 29 leaf endophytes with showing nitrogen fixing ability. Opuntia leaf endophytes (16 Nos.) were also identified which simultaneously exhibit siderophore production, phosphate solubilisation activity and Nitrogen fixation activity. The further characterization of these leaf endophytes is in progress and these can be the potential microbes for drought stress alleviation under field conditions.

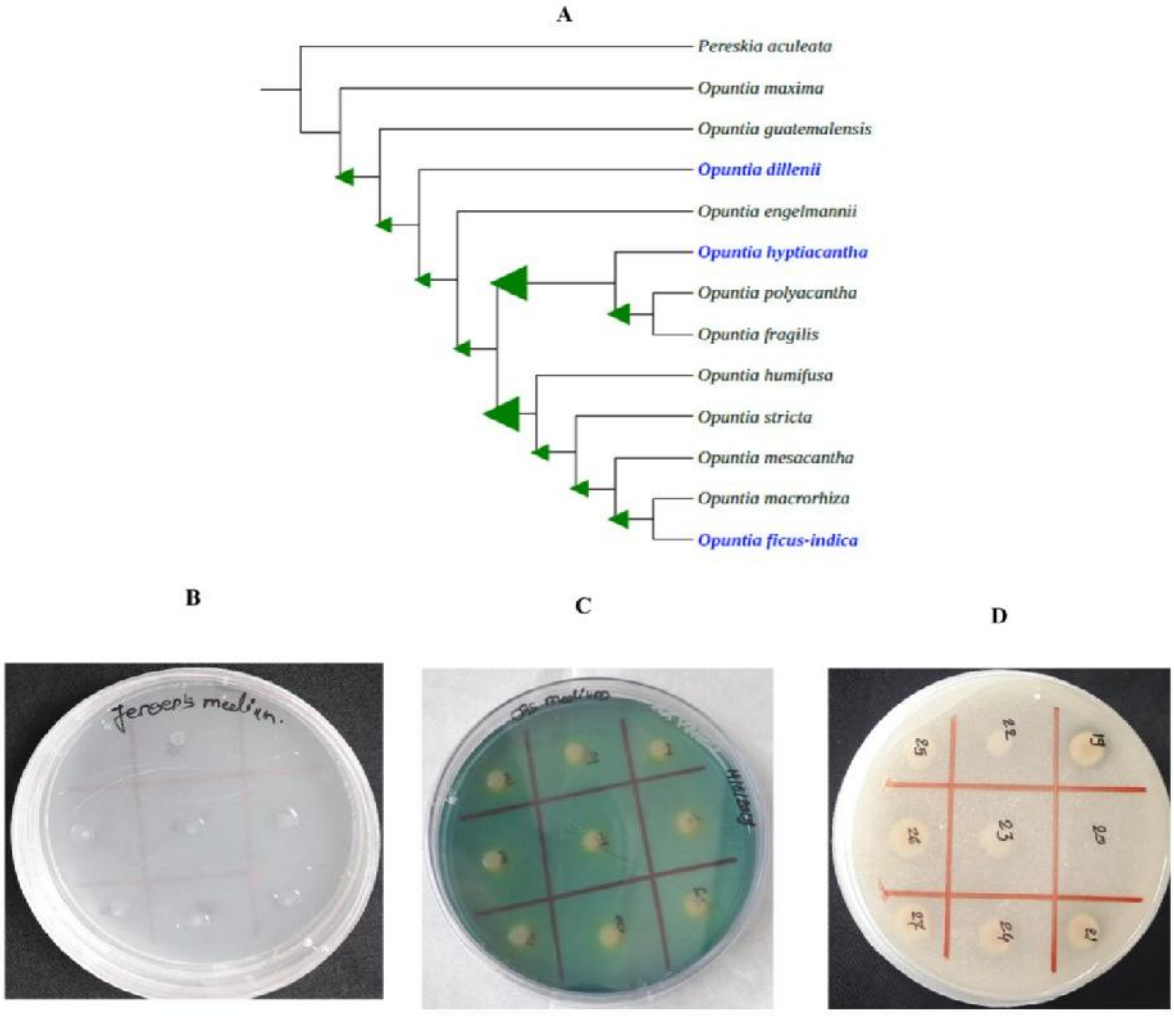


Fig. 2.62. (A) Phylogenetic tree based on the rbcL gene sequence of the *Opuntia* species used for endophytic isolation. Size of the arrow indicates the bootstrap values for the corresponding branch of the phylogenetic tree. (B) Representative Jensen medium assay plates for evaluating the nitrogen fixing ability of the endophytic bacterial plates. (C) Representative assay plates for screening siderophore production ability of Opuntia lead endophytes. (D) Representative Pikovskaya (PVK) agar assay plates for screening phosphate solubilizing activity of Opuntia leaf endophytes.

Evaluation of nutritional stressors and their indicators in cattle population in different drought prone areas (IXX11259)

N P Kurade, Neeraj Kumar, S S Pawar and AV Nirmale

Feeding experiment of all five types of silage of sugarcane tops (ST) with Jowar fodder, as 25, 50, 75 and 100% ST and 100% Jowar, completed. All data related to silage characteristics, feed intake and production parameters recorded. The mixed silage particularly 50% ST with Jowar fodder revealed better acceptance in terms of feed intake and preference by animals.

Fig. 2.63. Mixed silage of ST and Jowar.

Fig. 2.64. Bags filled with various combinations of ST & Jowar.

As there were only four lactating buffaloes were available for evaluating nutritional value of mixed silage prepared, switch over design was used. The animals were randomly fed with the silage mixtures for period of six to eight days and eight days gap was provided in between feeding of different silage mixtures. The milk production during feeding of silage was compared to gap periods subsequent to feeding of silage mixture.

Table 2.6. Comparative milk production during feeding of silage as compared to gap periods

	Average milk production (Liter)	
	During silage Feeding	**During Gap period**
T_0 (S 100)	4.26	4.04
T_1(ST 25)	2.72	2.45
T_2 (ST 50)	4.98	4.71
T_3 (ST 75)	4.74	4.70
T_4 (ST 100)	3.69	3.59
Average	4.078	3.898
SE	0.11	0.12
P value	0.0092*	

*<0.01 highly significant difference paired t-test

The acceptability of all silage mixtures of Jowar and ST was very high. The overall performance of animal during feeding of silage was comparable with normal feeding schedule. It was found that mix silage of sugarcane tops with Jowar fodder can be used for sustaining production of lactating animals during scarcity periods.

A low cost hydroponic fodder production unit is being established with collaboration with Govind dairy, Phaltan. The daily water requirement of the unit was found to be 252 liters. 5.25 liters of water is required for production of 1 kg green maize fodder. There is need

to try further options to reduce water requirement for per kg fodder production. Comparative yield performance of maize and wheat seeds, in hydroponics fodder production unit, was analyzed. Maize seeds procured from local farmers performed better as compared to wheat seeds (Lokwan variety). The per kg fodder yield was 8-10 kg of maize and 4-6 Kg for wheat.

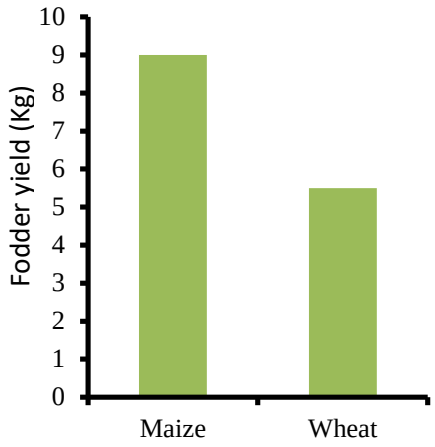


Fig. 2.65. Hydroponic green fodder

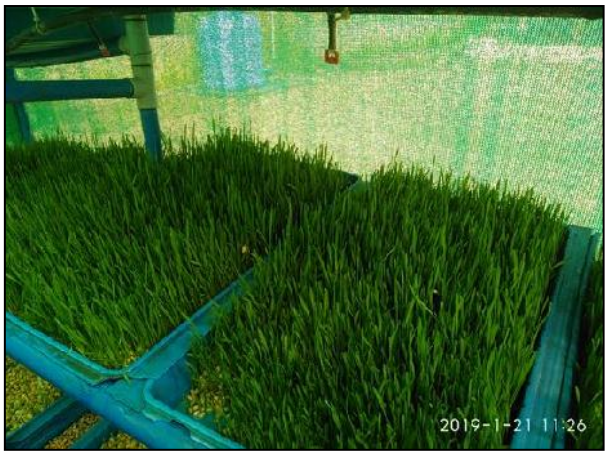


Fig. 2.66. Wheat green fodder performance

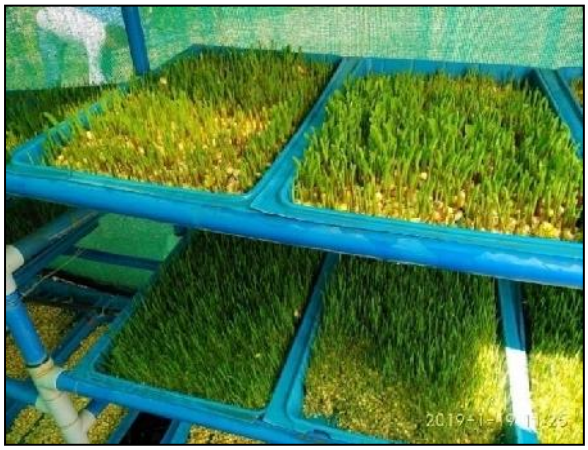


Fig. 2.67. Maize green fodder performance

Survey of livestock farmers from drought prone areas

A survey was conducted to assess nutritional stressors in livestock of the farmers from scarcity zone of maharashtra. Survey proforma was prepared and used to collect information from about 200 livestock farmers from Pune, Solapur and Osmanabad districts. It was observed that the farmers were facing severe water and fodder crisis for their livestock. None of the farmer from scarcity zone except one was using silage and hydroponics techniques for their livestock. The farmers from areas surrounding Baramati were preparing maize fodder silage for scarcity periods during summer.The farmers profile was as summarised in figure 2.68.

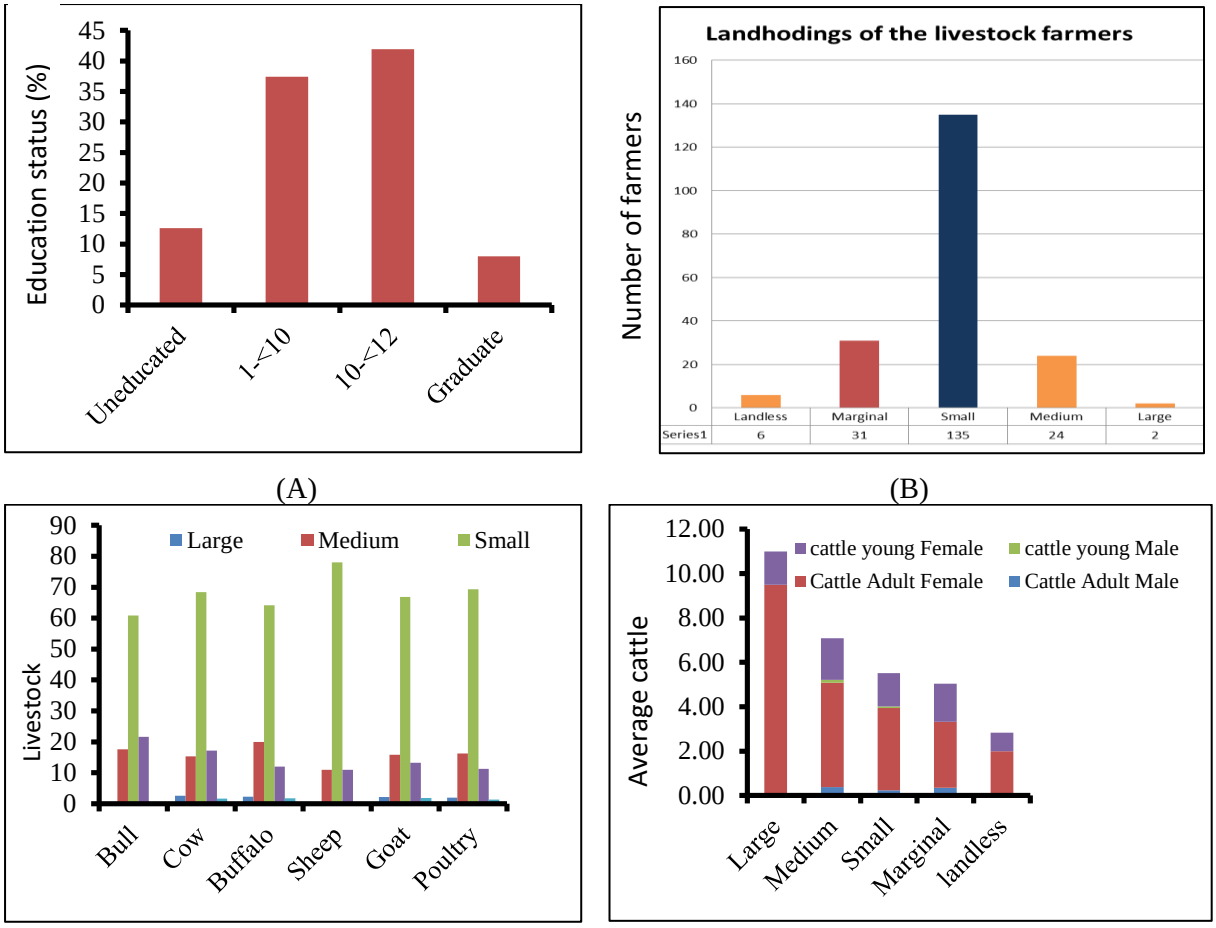


Fig. 2.68. Profiles of farmers from scarcity zone of maharashtra: (A) Education status of livestock farmers (%), (B) Farmers land holdings, (C) Livestock possession by different types of farmers, (D) Average cattle holdings by different types of farmers.

Livestock Research Facilities

The goat unit was added with a new South African breed Boer in order to evaluate comparative stress tolerant abilities with existing indigenous breeds of goat, i.e. Osmanabadi, sangamneri and Konkan kanyal. The poultry unit was with Srinidhi and Grampriya backyard parent stock was culled and it was replaced with young chicks of Vanraja and Srinidhi birds. Effects of various stressors on the birds and their growth rate will be recorded.

Fig. 2.69. Livestock research facilities

School of Edaphic Stress Management

Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (OXX03355)

K K Meena, Mahesh Kumar, Paritosh Kumar, Amresh Chaudhary and GC Wakchaure

Effect of tillage, crop residue and nutrient management practices on soil health under sugarcane cropping system

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

The results revealed that with adoption of SORF techniques along with surface retention of trash (the in treatment M3) influenced the soil properties significantly ($P \leq 0.05$) over conventional farmers' practices of trash burning and broadcast application of fertilizers. The significantly lower values of bulk density was recorded under laser land leveler + reduced tillage with surface retention of trash and SORF techniques (LLL + RT + 10% of RDF as basal, 40% through band placement and remaining 50% through fertigation) as compared to trash burnt/ removed and control treatments (farmers practices) in surface (0-5 cm) and (5-15 cm) (Fig. 2.70). However, different practices of tillage, trash, and ratoon management did not influence the soil bulk density in sub-surface (15-30 cm) soil layer.

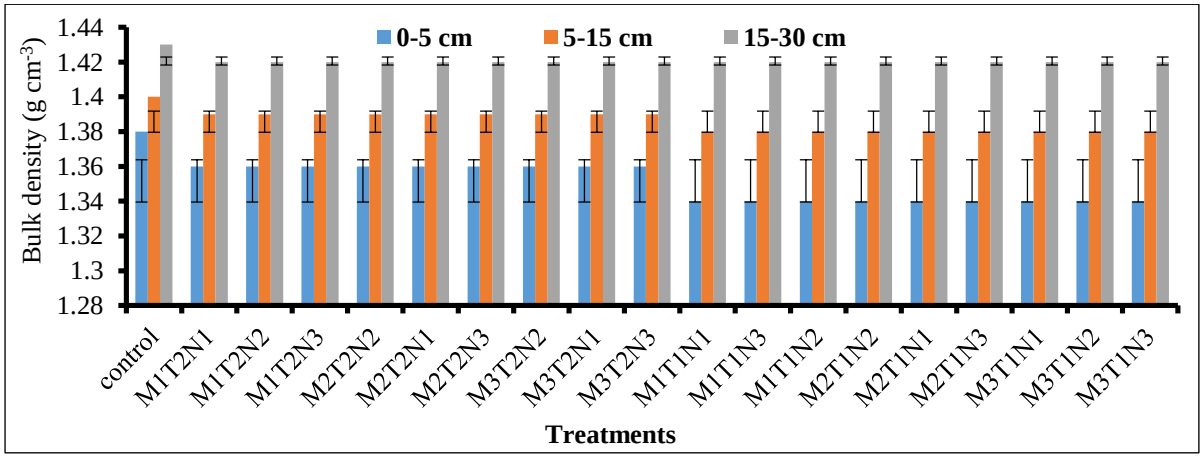


Fig.2.70. Effect of tillage, residue and nutrient management on bulk density.

Soil organic carbon storage content (SOC) in 0-5 and 5-15 cm soil layer build-up was noticed under the trash retained treatments. The maximum SOC content was recorded under (LLL + RT + 10% of RDF as basal, 40% through band placement and remaining 50% through fertigation) treatment which was closely followed by other LLL + reduced tillage (RT) by excluding deep tillage + 10% of RDF as basal and 90% through fertigation treatments. Surface retention of trash improved the SOC content by 10-17% over trash burnt treatments (Fig. 2.71). Surface retention of trash and other ratoon management practices did not influence the SOC content in 15-30 cm soil layer.

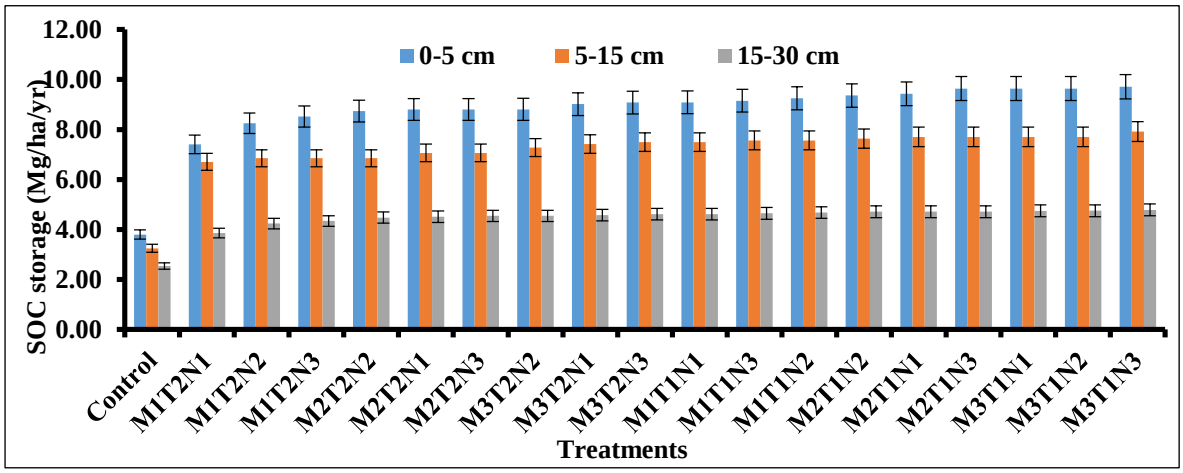


Fig. 2.71. Effect of tillage, residue and nutrient management on soil organic carbon storage.

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

K K Meena

Wheat seedlings mitigate salinity stress due to the application of phytohormone-rich extract of a methylotrophic actinobacterium isolated from soybean leaves

This study describes the response of microbial inoculation and priming of plant growth promoting biomolecules secreted by a halotolerant methylotrophic actinobacterium (*Nocardioides* sp. NIMMe6; LC140963) on wheat plants grown under saline conditions. Plant responses to salinity stress *viz.*, 0 (no-stress), 5 (moderate-stress) and 10 dS m^{-1} (high-stress) were recorded following bacterial inoculation and seed priming with bacterial culture filtrate extract (BCE) rich in indole-3-acetic-acid and salicylic acid. Results indicated improved germination, growth, biochemical status and antioxidant-enzyme gene expression of *CAT*, *MnSOD*, *POD*, and *APX* in the seedlings that sustained even at high salinity stress. High performance liquid chromatography (HPLC) and mass spectrometry (MS) based characterization revealed the predominance of salicylate and indole-3-acetate (RT 4.978 min; *m/z* 138.1 and 6.177 min; 129.1), respectively in the BCE. The study revealed that although microbial inoculation itself offers saline condition mitigation in plants, the metabolic products secreted by plant growth promoting bacteria may also have successful implications for defence against abiotic stress in crops. Therefore, priming with microbial metabolite-rich extract could also become practical approach or sustainable farming of crop plants under saline conditions. An actinobacterium *Nocardioides* sp. (LC140963) was assessed for for *in*

vitro production and secretion into the medium of bioactive compounds rich in salicylic acid and indole acetic acid. The biomolecules were extracted from the bacterial culture filterate and utilized in the form of BCE for salinity stress mitigation through wheat seed biopriming. The findings indicated that incorporation of BCE is efficient over the microbial inoculation for mitigation of salinity stress in wheat seedlings. Seed priming with BCE actively enhanced both the physicochemical status, and oxidative enzymes and helped in the modulation of gene in wheat seedlings. Therefore, the results strongly endorse strategic utilization of the BCEs rich in biomolecules secreted by plant growth promoting microbial strains for strategic management of salinity stress tolerance in crop plants. More specific work will further warrant large scale applicability under the field conditions.

Evaluation of halotolerant rhizobium and PGP- based biomolecules for alleviation of drought and salt stress (OXX04473)

K K Meena, GC Wakchaure, CB Harisha,

Foliar application of biomolecules secreted by plant growth promoting, halotolerant bacteria mitigates drought stress in coriander (*Coriandrum sativum L*)

An experiment was conducted to evaluate the response of the biomolecules secreted by plant growth promoting halotolerant bacteria under drought conditions in coriander crop. Further, the comparative evaluation was also made with the bacterial cell-lysate, and a formulation containing chemical plant growth hormones (PGHs). A consortium of 10 halotolerant plants growth promoting bacterial strains was used for production of PGH under controlled conditions in laboratory; similarly, the cell lysate was also prepared by using physical cell-disruption techniques and evaluated against chemical PGH in drought- exposed coriander crop. The treatments were delivered through foliar route at weekly intervals for 4 times. Two irrigation regimes *viz.*, full irrigation (FI), and restricted irrigation (RI) were maintained.

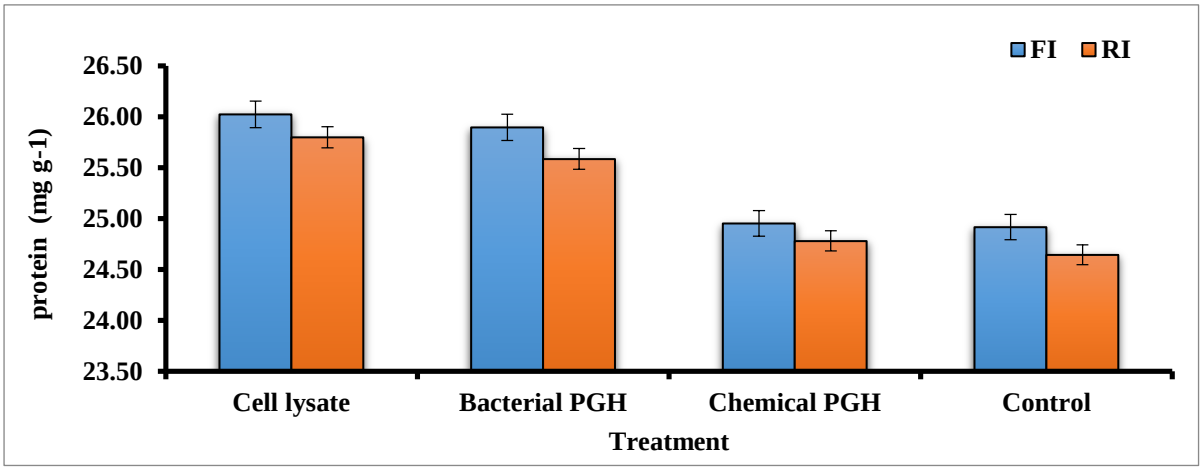


Fig. 2.72. Coriander leaf protein content under the influence of different treatment and irrigation regimes

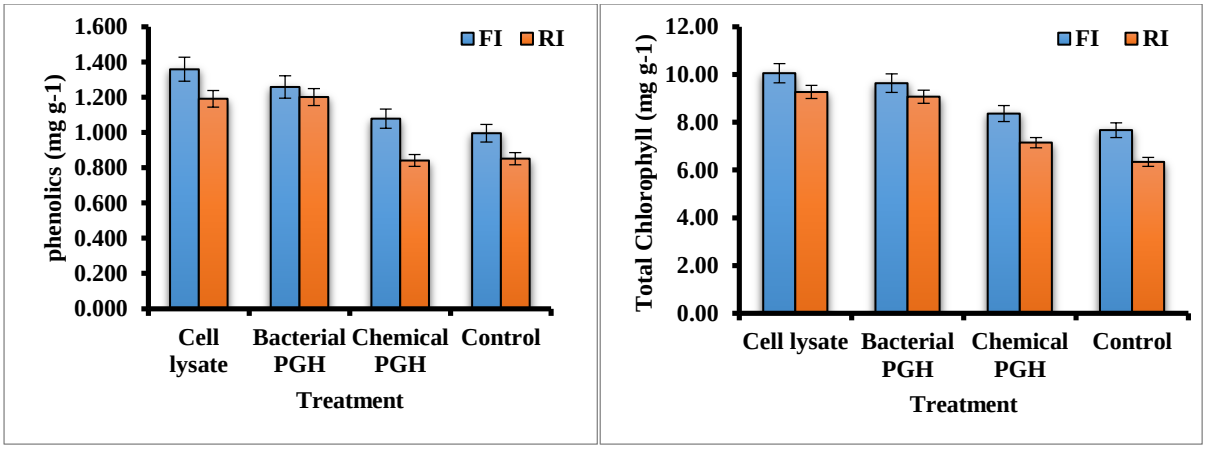


Fig. 2.73. Coriander leaf phenol and total chlorophyll content under the different treatment and irrigation regimes.

The experimental outcomes were monitored in terms of different physiochemical traits of the crop including protein, phenol and chlorophyll (Figs. 2.72, 2.73). Both the cell lysate and bacterial PGH enhanced the protein and phenol content in coriander under the both the full and restricted irrigation regimes, compared to chemical PGH and control. Chlorophyll content was enhanced in coriander treated with cell lysate and bacterial PGH, higher than chemical PGH and control. The overall results strongly endorsed the possibilities of utilizing the microbial products- the bacterial cell lysate and the biomolecules containing plant growth hormones significantly improved the plant growth, development, and mitigated the impact of drought stress.

Methylotrophic bacteria for mitigation of salinity stress in wheat

Methylotrophic bacteria from the phyllosphere region of plants were isolated and screened for salt tolerance, and plant growth hormones production. A candidate strain was selected for in-planta studies in wheat crop. Similarly, the biomolecules produced by the same strain were also evaluated at salinity levels viz. 0, 5, and 10dS m^{-1}.The microbial strain and its biomolecules were applied through seed priming. Wheat seeds primed with bacterial isolate and biomolecules were allowed to germinate under gnotobiotic conditions.

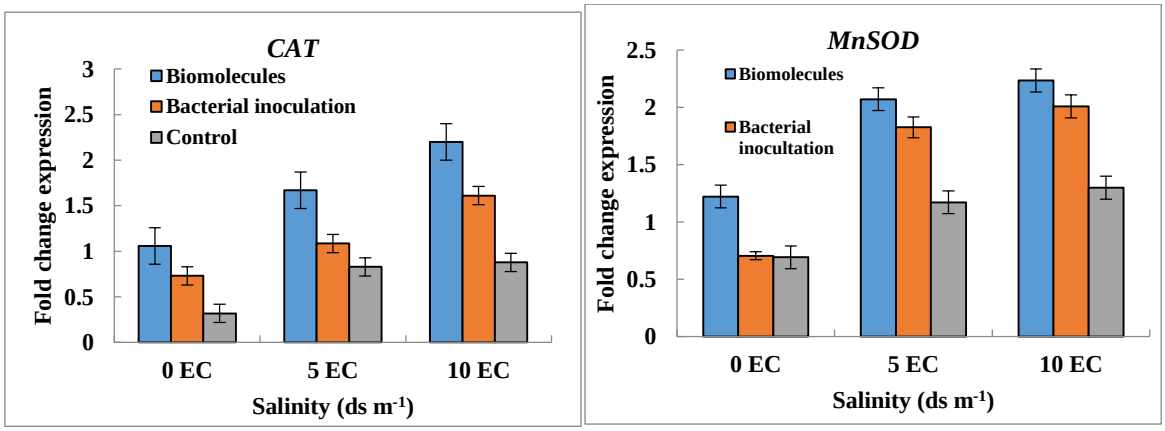


Fig. 2.74. Influence of biomolecules and bacterial inoculation on antioxidant genes *CAT* and *MnSOD* expression.

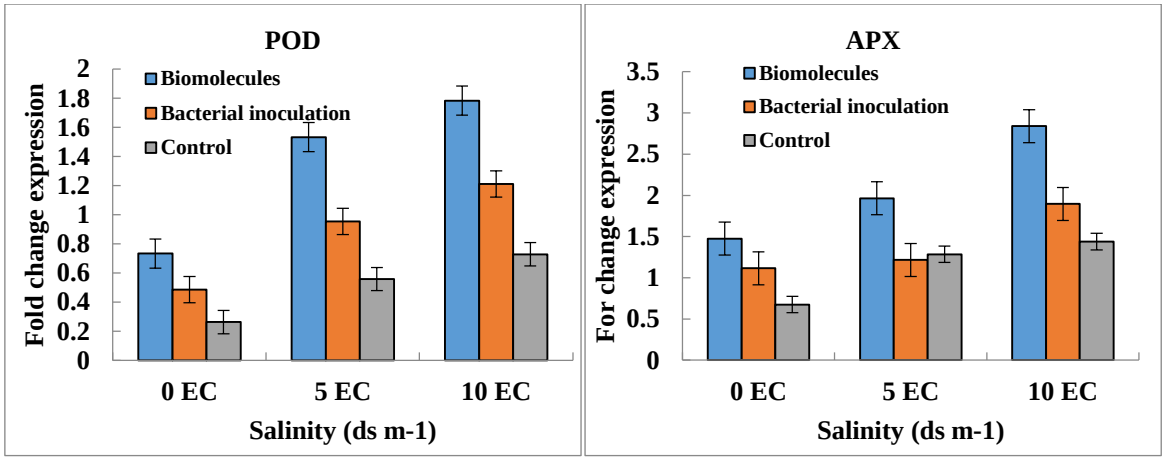


Fig. 2.75. Influence of biomolecules and bacterial inoculation on antioxidant genes *POD* and *APX* expression.

Production and accumulation of diverse phenolic compounds, antioxidative enzymes and activation of glutathione system that keenly scavenges ROS to prevent following damage to cellular components are some of the known mechanisms to overcome stresses. The antioxidant-genes expression was enhanced with the increasing stress. Although the inoculation with the bacterial strain significantly improved antioxidant gene-expression over the control, the extent of up-regulation was quite less than that induced by the seed priming with biomolecules. Expression of *MnSOD* and *POD* genes significantly raised at 5ds m^{-1} and 10ds m^{-1}. CAT gene expression sequentially enhanced with that of the stress under the influence of both the bacterial-inoculation, and biomolecules treatment at all the levels of stress. APX exhibited a specific trend in control, and the treatments, where the gene was intensely induced at 5 ds m^{-1} followed by slow rise at 10 ds m^{-1}; while in case of both the treatments steadily increased up to 5 ds m^{-1} which then revealed marked rise at 10 ds m^{-1}. The overall results determined that use of biomolecules is effective over the microbial inoculation for mitigation of salinity stress in wheat. Seed priming with biomolecules vigorously enhanced both the physicochemical status, and management of oxidative stress mechanism in wheat. The results suggested that strategic utilization of the biomolecules secreted by plant growth promoting microbial strains for inducing salinity stress tolerance in crop plants.

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

Paritosh Kumar, KK Meena, Neeraj Kumar and CB Harisha

NIASM septic tank waste water was treated through a pilot scale constructed wetland system. Septic tank wastewater unit comprised of two parallel units (i) Horizontal sub-surface flow based constructed wetland system (HSSF-CWs;Ffig. 2.76a) and (ii) Vertical sub-surface flow based constructed wetland system (VSSF-CWs; fig.2.76b) filled with different growing cum filtration media viz. Gravel + Rice hull (HGH & VGH-CW), Gravel + Coco peat (HGP & VGP-CW), Gravel + Charcoal (HGC & VGC-CW), Gravel (HG & VG-CW) and along with a media less control (MlC-CW) each with six replications. Each system has grown with

two different flowering crops viz. marigold and aster. The treated water is collected from both systems and passed through a 25 Watt UV sterilization unit and used for growing Spinach and Pangasius fish in integrated aquaponics systems. Horizontal system were grown during the first 6 months (December 2019 to May 2019) with gravel + spent mushroom compost (HGM-CW) which then replaced with gravel + Rice hull (HGH & VGH-CW) due to high turbidity and colour in treated water.

Fig. 2.76. Spinach and Pangasius-based integrated Aquaponics maintained with NIASM treated water.

Pollutant removal efficiency

As per the analysis results, in NIASM Septic tank wastewater is loaded with microbial contaminants mainly coliform bacteria (*Faecal coliform* and *Escherichia coli* etc.) and their population represented at 95% confidence level as most probable number (MPN) in 100 ml of water was >1600 and resulting their biochemical oxygen demand (BOD) was higher (~250 mg/l).

Effect of different growing cum filtration media

Among different HSSF-CWs filling medium was not found sufficient to reduce the microbial contamination to safe limit recommended by WHO for their use for irrigation i.e. Total coliform population <1000 MPN/100ml, faecal coliform and *Escherichia coli* <100 MPN/100ml and BOD < 30mg/l). Gravel + spent mushroom compost (HGM-CW), Gravel (HG-CW) and media less control system (HM-CW) system were able to reduce the total coliform population from >1600 to 1600, while Gravel + coco peat (HGP-CW) and Gravel + charcoal (HGC-CW) filled system to 910. *Faecal coliform* and *Escherichia coli* population

was also found higher than safe limit (100). However, among different filling media Gravel + Charcoal based system (HGC-CW) has performed best with total coliform population reduced from >1600 to 910, *Faecal coliform* to 240 and *Escherichia coli* 90 and their biochemical oxygen demand was also reduced from 250 to 23 mg/l.

Effect of Ultraviolet (UV) treatment

After passing through the 25 watt UV sterilization unit the microbial population of these wetland treated waters were considerably reduced further irrespective of the treatments and comes within the safe limit recommended by WHO either for total coliform (1000/100ml), *Faecal coliform* (100/100 ml) and *Escherichia coli* (100/100 ml) and their BOD was also reduced below 30 mg/l. However, among different filling media Gravel + charcoal based system has performed the best and their treatment was found consistent every month.

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

Economic yield from flower

As per earlier flowering crop performance Marigold and Aster has selected and grown in June 2019 (third crop season) on both HSSF-CWs and VSSF-CWs with plant population 5 plants and 2 plants/ system, respectively. In this crop season (June to September 2019) septic tank wastewater has spiked with multi metal mixture *viz.* Fe, Mn, Zn, Cu, Cr, Cd, Pb and Ni of 1.0 ppm concentration and evaluated further for their performance under microbial + heavy metal stress.

Among the grown flowering crops marigold has performed the best with total flower harvesting (till now) of 1851 flower number and 9.78 kg from horizontal system (HSSF-CWs) while 406 flower number and 2.61 kg from vertical systems (VSSF-CWs). However, Aster flower number was confined to 245 and 50 in (HSSF-CWs) and vertical systems (VSSF-CWs), respectively. The result also reveals that among horizontal system (HSSF-CWs) and vertical systems (VSSF-CWs) average flower yield was higher in horizontal system. However, among different growing media average marigold flower yield was found in the following order:

Horizontal sub-surface flow based constructed wetland system (HSSF-CWs):

Gravel+Charcoal (HGC-CW) > Gravel (HG-CW) > Gravel+Coco peat (HGP-CW) > Gravel+Rice hull (HGH-CW) > Medial less control (MlC-CW)

Vertical sub-surface flow based constructed wetland system (VSSF-CWs):

Gravel+Charcoal (VGC-CW) > Gravel (VG-CW) > Gravel freshwater control (GFC-CW) > Gravel+Rice hull (VGH-CW) > Gravel+Coco peat (VGP-CW)

The flower yield in all the treatments were found significantly higher (P <0.05) than media-less control system (flower number 1.10 ±0.87 and flower weight 5.63±5.65 g). Among different treatments flower yield from Gravel + Charcoal based systems was had the highest yield with average harvested marigold flowers as high as 24.60 ± 5.29 and 131.23 ± 33.21g flower weight per plant from horizontal system (HGC-CWs) while 16.40 ± 2.33 flowers and 111.30 ± 11.81g flower weight per plant were obtained from vertical system (VGC-CWs).

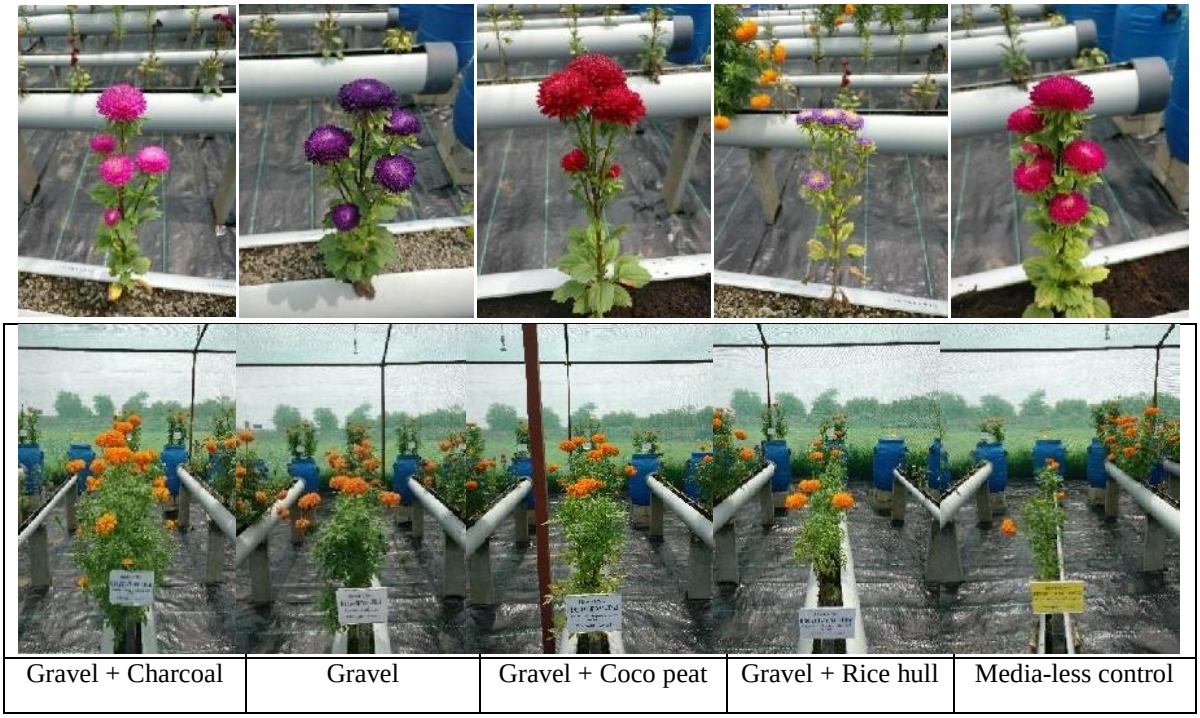


Fig. 2.77. Effect of different treatments on growth of flowering plants.

Aquaponics system

Aquaponics system was grown in one feet deep circular water tank with 90 liter capacity filled with Typha treated water (TW), Vetiver treated water (VW), Gravel treated water (GW), Gravel + Charcoal treated water (GCW), Gravel + Rice hull treated water (GHW), Gravel + Coco peat treated water (GPW) along with fresh water (FW) and Untreated septic tank metal spiked water (UW) as control; in triplicate. Each tank was grown with spinach and Pangasius fish in integrated manner with plant population 7 plants/tank and fish population 12 fish/tank.

In untreated control tanks (UW) all the 12 fish were died in seven days due to acute deficiency of dissolved oxygen (1.0 mg/l) and spiked metal pollutant load (1.0 mg/l of Fe, Mn, Zn, Cu, Ni, Cr, Pb, Cd), i.e. 100% mortality was observed. However, in metal spiked treated waters 62.80%, in nonmetal spiked septic tank treated waters 40.28% while in

freshwater tanks 50% fish died in 2 months. After two month among different treatments fish mortality was found in the order:

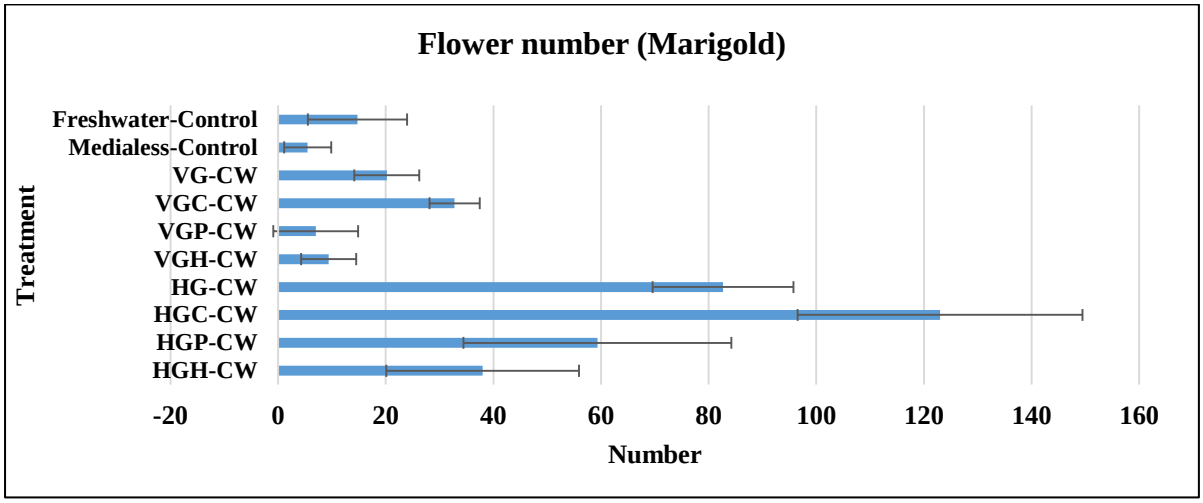
UW (100%) > GW (66.67%) > GCW (61.11%) > GPW (52.78%) > FW ~ GHW (50%)

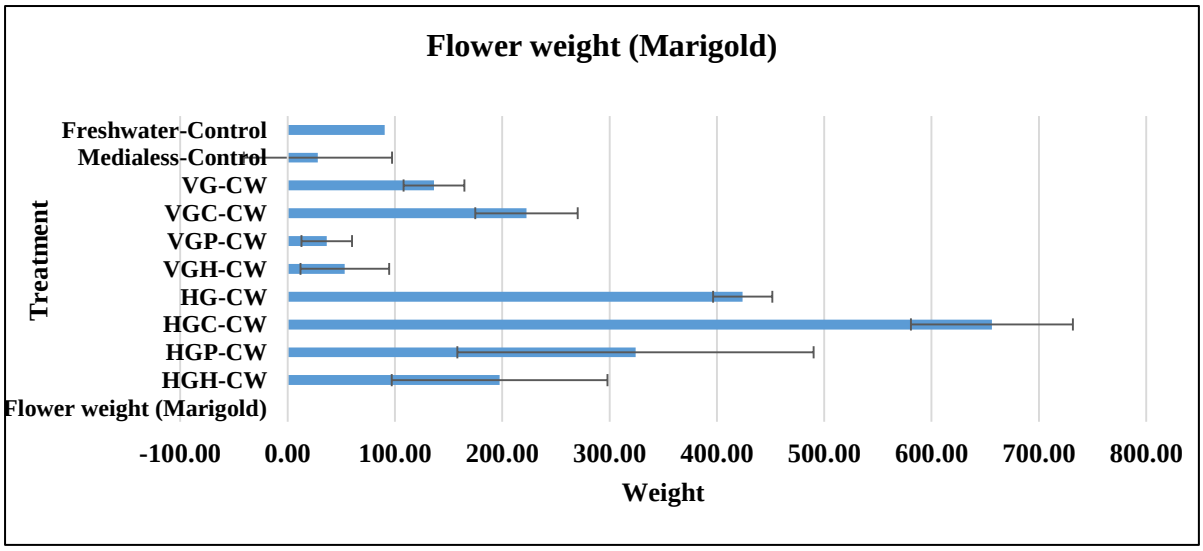
However, after two months increase in average body weight of applied fish was found in order:

GW (117.3%) > VW (111.9%) > TW (90.3%) > GPW (82.1%) > GHW (77.6%) > GCW (52.8%) > FW (51.8%) > UW (0%)

From these 30 aquaponics system of 210 plants in first harvest 4.325 kg spinach was harvested. Among different treatments the average amount of spinach harvested was found in the order:

GW (312.3g) > UW (245.0g) > GPW (204.0g) > FW (179.3g) > GHW (153.3g) > GCW (125.0g) > TW (117.3g) > VW (105.3g)





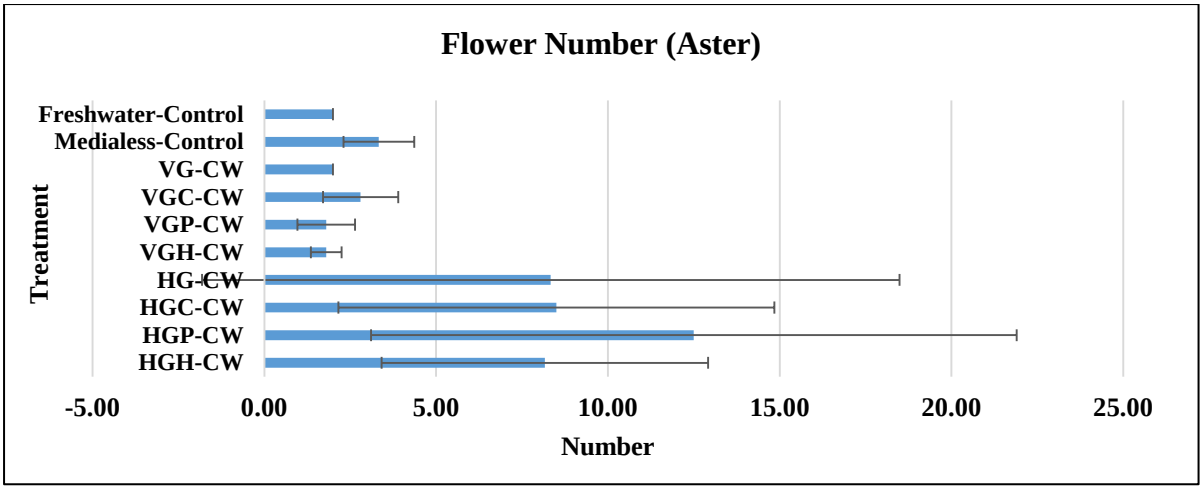


Fig. 2.78. Effect of different treatment on flower growth parameters.

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

Harisha CB and KK Meena

Effect of salinity on turmeric morphology and physiological parameter

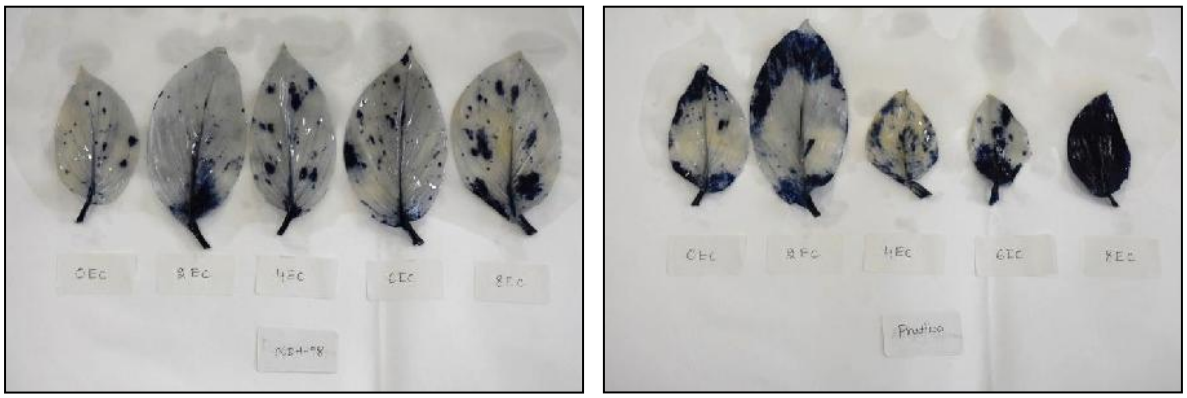
The experiment was conducted with 10 varieties/cultivars of turmeric under five salinity levels (0 dSm^{-1}, 2 dSm^{-1}, 4 dSm^{-1},6 $dSm^{-1}$and 8 dSm^{-1}) in three replications under controlled condition. Salt water is prepared using inorganic salts of NaCl, $CaCO_3$, Na_2SO_4. Irrigation water was give once in 10 days based on visual observations of water stress. The germination percentage and other morphological parameters were recorded including number of scorched leaves. It was found that scorching intensity of leaves due to salinity stress was more in Pratibha and CO-2 and was the least in Megha turmeric and NDH-98. Similarly NDH-98 recorded higher chlorophyll as compared to Pratibha which recorded lowest chlorophyll as indicated by SPAD.

Table 2.7. Effect of different treatments on physiological parameters

Treatment	Plant ht. (cm)	Scorching intensity %	SPAD reading
0 dSm^{-1}	14.02	0.0	30.9
2 dSm^{-1}	13.6	16.6	27.1
4 dSm^{-1}	12.2	25.9	28.3
6 dSm^{-1}	11.7	25.3	27.4
8 dSm^{-1}	10.8	32.3	24.7
CD @ 5%	1.83	6.61	2.37
NDH-1	11.6	24.6	27.1

Megha turmeric	10.8	7.93	25.1
R.sonia	13.5	12.3	29.8
Allepy supreme	13.9	18.9	26.6
Roma	11.0	17.6	25.8
Pratibha	10.7	22.6	23.8
Co-2	10.7	32.3	28.1
BSR-2	11.2	16.3	26.8
NDH-98	14.4	8.1	32.2
NDH-8	17.1	19.5	31.7
CD @ 5%	2.59	9.35	3.35

Saline water treated plants in nursery stage were used for histochemical detection of hydrogen superoxide (O_2^-) anion one of the most important ROS. It was found that the intensity of staining was more in Pratibha as compared to NDH-98 and Rajendra Sonia, which are tolerant to salinity up to 8 dSm^{-1}.



Most tolerant variety Most Susceptible variety

Fig. 2.79. Nitroblue tetrazolium (NBT) staining of turmeric leaves affected with salinity.

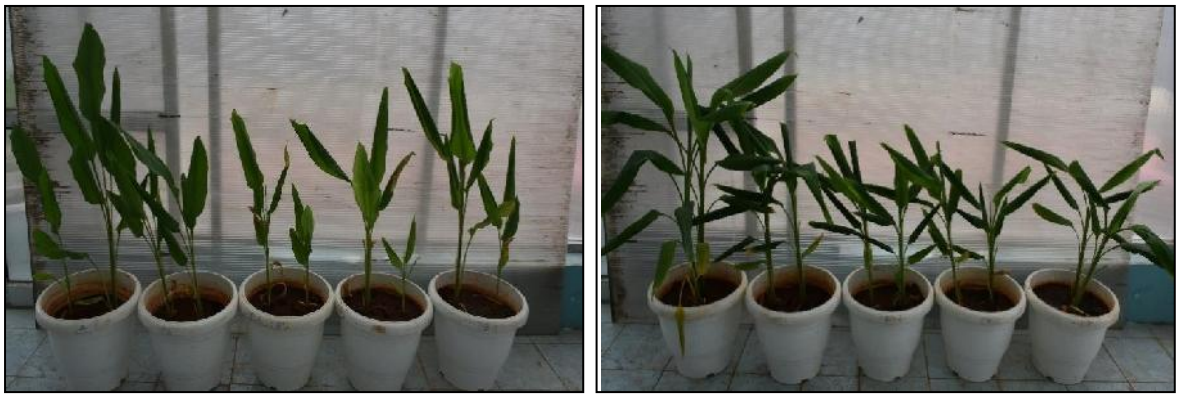


Fig. 2.80. View of Prathiba and NDH-98 at 0, 2, 4, 6, 8EC, respectively.

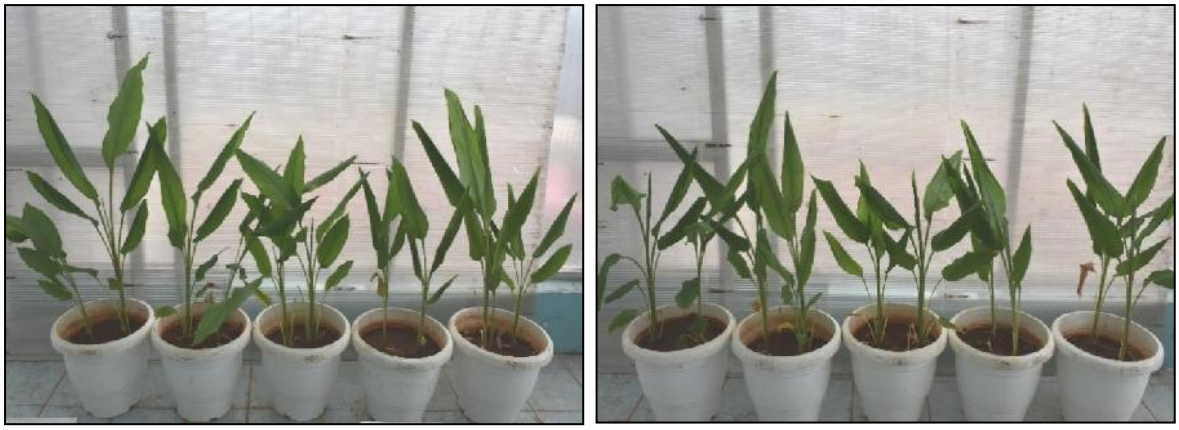


Fig.2.81. View of Allepy supreme and Roma at 0, 2, 4, 6, 8EC, respectively.

The critical symptoms of salinity in turmeric are seen in older leaves first with marginal yellowing in the young stage and become necrotic as age advanced. It was also observed that tip of leaf shows yellow, pale necrotic patches.

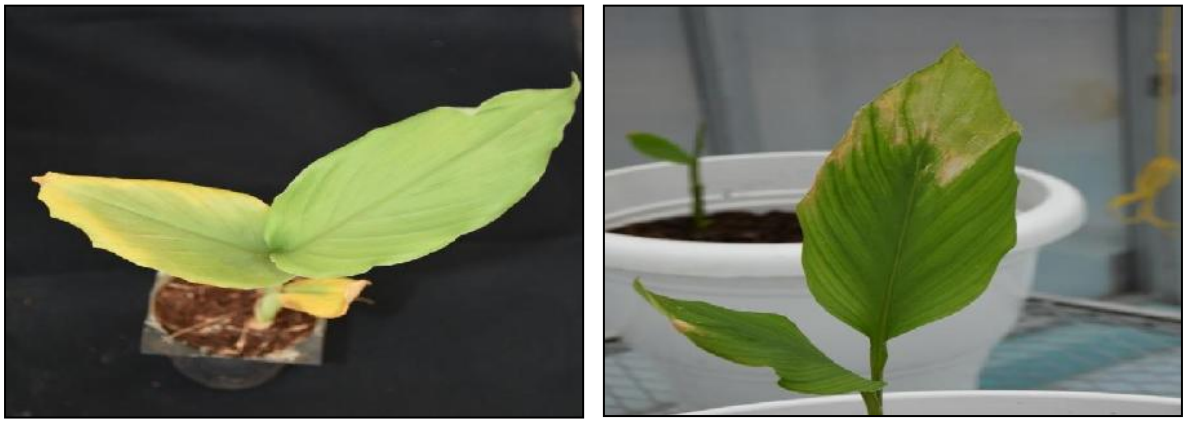


Fig2.82. Turmeric leaves showing salinity toxicity symptoms at EC of 8 dSm^{-1}.

Establishment of model herbal garden for medicinal and aromatic plants (OXX04255)

Harisha CB, Parithosh Kumar and DD Nangare

Development of herbal medicinal garden in shallow basaltic soils and its performance

Herbal medicinal garden consists of 65 species of trees, shrubs and climbers were developed at ICAR-NIASM. The bigger plant were planted in pits of 1.5m x 1.5m and small shrubs and climbers are grown in 1m x 1m. The planted trees were established well and few of them were failed to establish due to soil condition and lack of suitable climate. It was found that many of the tree species are adopted and are successfully growing in poor soil condition having shallow depth and rocks underneath. Among them neem, wood apple, *palash*, *shami*, *shivan*, *putranjeeva*, coral tree, *bael*, mahuva, *hirda*, *behda*, red sanders, eucalyptus, curry leaf, lime, kutaj, Sesbania, nirgudi, aromatic gasses etc. are performing well and they showed vigorous growth as compared to planting season. The well-established

plants had higher chlorophyll content and also cooler plant canopy.indicating their capacity to adapt to the prevailing soil and climatic conditions.

Table 2.8. Plant growth of medicinal trees in two seasons and successive growth from planting.

Sr. No	plant species	Plant height (cm)			Sr. No	Plant species	Plant height (cm)		
		Summer	Kharif	Successive growth			Summer	Kharif	successive growth
1	Ashoka	38	40	2	**21**	Henna	99	99	0
2	Neem	126	176	50	**22**	Khair	39	135	96
3	Palash	47	77	30	**23**	Shikakai	95	128	33
4	Kadamb	81	102	21	**24**	Fever nut	53	85	32
5	Simaruba	89	108	18	**25**	Agnimantha	75	90	14
6	Shami	61	76	16	**26**	Bakul	25	33	9
7	Wood apple	67	120	54	**27**	Guggal	68	118	50
8	Soap nut	98	221	123	**28**	Red Sanders	56	85	29
9	Shivan	45	106	61	**29**	Sandalwood	56	58	2
10	coral tree	37	45	8	**30**	Madhukamini	63	88	25
11	*T. chebula*	50	81	31	**31**	Curry leaf	51	91	41
12	*T. bellarica*	43	115	72	**32**	Parijatak	78	113	35
13	*T. arjuna*	72	137	65	**33**	Lemon scented gum	168	217	49
14	Beal	27	73	46	**34**	Nilgiri	115	147	32
15	Jamun	108	139	31	**35**	Champaka	103	110	7
16	Wax Apple	72	73	2	**36**	Sessbania	56	196	140
17	Mahuva	54	109	55	**37**	Kutaj	39	130	92
18	Putranjeeva	32	52	20	**38**	Danti	69	78	10
19	Mahagony	82	91	9	**39**	Nirgudi	59	110	52
20	Annato	42	74	32	**40**	Pongemia	76	88	12

In aromatic plants such as eucalyptus (two species), lemon grass (four varieties) essential oil was extracted and quantities in various seasons to find the effect of season, soil condition on oil content and also chemical constituents of volatile oil. It was found that in *Eucalyptus citrodora* oil content was increased in *Kharif* season as compared to *Eucalyptus globulus*. In case of lemon grass varieties CKP 25 and Praman shows increased oil content in *Kharif* as compared to summer. It is also observed that oil content of the herb may also vary with the age and stage of harvest.

Table 2.9. Essential oil content in aromatic plants established in shallow basaltic soils.

Plant species	Essential oil %	
	Summer	*Kharif*
Eucalyptus citrodora	1.05	1.54
Eucalyptus globulus	0.74	0.67
Lemon grass Kaveri	0.60	0.44
Praman	0.56	0.65
CKP 25	0.73	0.97
Chirharit	0.65	0.60

Native land 2018 Summer 2019

Fig 2.83. View of garden at different stages of land development and seasons.

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

Neeraj Kumar and M P Brahmane

Effect of zinc on growth performance and cellular metabolic stress of fish exposed to multiple stresses.

This study was conducted to evaluate the role of zinc to improve growth performance, cellular metabolic stress and digestive enzymes of *Pangasianodon hypophthalmus* reared under lead (Pb) and high temperature. Two hundred and seventy three fish were distributed randomly into seven treatments, each with three replicates. Three isocaloric and isonitrogenous diets with graded levels of zinc 0, 10 and 20 mg/kg diet were prepared. The lead (Pb) in treated water was maintained at the level of $1/21^{th}$ of LC_{50} (4 ppm) and maintained temperature at 34 $^{\circ}$C in exposure groups. The growth performance in terms of weight gain (%), protein efficiency ratio (PER) and specific growth rate (SGR) were found to be inhibited and the feed conversion ratio (FCR) was enhanced in Pb and high temperature exposure group whereas, zinc supplementation has improved weight gain (%), FCR, PER and SGR. The liver, gill, muscle and kidney tissues of carbohydrate metabolic enzymes (LDH and MDH), protein metabolic enzymes (ALT and AST) and liver, gill and muscle G6PDH and ATPase as well as intestinal digestives enzymes (proteases, amylase and lipase) and intestine ALP were significantly affected ($p<0.01$) by Pb and high temperature exposure to *P.*

hypophthalmus. The present study clearly revealed that, the impact of temperature and pollutant are major inhibitors for the production of aquatic organism especially, fish. The toxicity of heavy metal, lead in the aquatic ecosystem was enhanced due to temperature rise. Dietary supplementation of zinc at 10 mg/kg of diet is found to be optimum to reduce cellular metabolic stress and to maintain the whole body hemostasis during culture of *P. hypophthalmus*.

Synergistic effect of zinc nanoparticles and temperature on acute toxicity with response to biochemical markers and histopathological attributes in fish

An experiment was carried out to delineate the lethal concentration of (LC_{50}) zinc nanoparticles (Zn-NPs) alone and with concurrent to high temperature (34 °C) in *Pangasianodon hypophthalmus*. The lethal concentration of Zn-NPs alone and with high temperature was estimated as 21.89 and 19.74 mg/L in *P. hypophthalmus*. The lethal concentration was decided with the help of definite concentration via 16, 18, 20, 22, 24, 26, 28 and 30 mg/L. The Zn-NPs were significantly altered the biochemical and histopathology of different fish tissues. The stress biomarkers such as oxidative stress (catalase superoxide dismutase and glutathione-s-transferase, lipid peroxidation) was studied in the liver, gill and kidney tissue, which was noticeable ($p<0.01$) enhanced with higher concentration in both condition (Zn-NPs alone and Zn-NPs-T) in dose dependent manners. The carbohydrate (lactate dehydrogenase and malate dehydrogenase) and protein metabolic enzymes (alanine amino transferase and aspartate amino transferase) were also remarkable enhanced ($p<0.01$) with higher concentration of Zn-NPs and Zn-NPs-T. The neurotransmitter (acetylcholine esterase) activities were significant inhibited ($p<0.01$) with exposure to Zn-NPs and Zn-NPs-T and digestive enzymes such as protease and amylase were non-significant ($p>0.01$) with the exposure of Zn-NPs and Zn-NPs-T, further, lipase were significantly reduced ($p<0.01$) with exposure to Zn-NPs and temperature exposure group. The histopathological alterations were also observed in the liver and gill tissue. The present investigation suggested that, essential trace elements at higher concentration in acute exposure led to pronounced deleterious alteration on histopathology and cellular and metabolic activities in fish. The lethal concentration (LC_{50}) of Zn-NPs is also varies with temperature stress as exposure to Zn-NPs alone the LC_{50} was found to be 21.89 mg/L and with concurrent exposure to Zn-NPs and high temperature (34 °C) found to be 19.74 mg/L.

Synergistic effect of dietary selenium nanoparticles and riboflavin on the enhanced thermal efficiency of fish against multiple stress factors

An experiment was designed to delineate the efficacy of a dietary mixture of selenium nanoparticles (Se-NPs) and riboflavin (RF) on the thermal efficiency/tolerance of *Pangasianodon hypophthalmus* reared under arsenic (2.8 mg/L) and high-temperature (34 °C) stress. A green synthesis method was employed for the synthesis of Se-NPs using fish gills, which are normally discarded as by-products. Four iso-caloric and iso-nitrogenous experimental diets were used, namely, a control diet (Se-NPs and RF @ 0 mg/kg diet) and diets containing RF @ 5, 10 or 15 mg/kg diet and Se-NPs @ 0.5 mg/kg diet, and feeding was

performed for 95 days. At the end of the feeding trial, the thermal tolerance was evaluated by determination of the following parameters: critical thermal minimum (CTMin), lethal thermal minimum (LTMin), critical thermal maximum (CTMax), and lethal thermal maximum (LTMax). The anti-oxidative status in the form of catalase (CAT), glutathione-S-transferase (GST) and glutathione peroxidase (GPX) activities was significantly ($p<0.01$) enhanced upon concurrent exposure to arsenic and high temperature at LTMin and LTMax, whereas a non-significant ($p>0.05$) change in superoxide dismutase (SOD) activity was observed in the brain at LTMin and brain, gill and kidney at LTMax. Supplementation with Se-NPs @ 0.5 mg/kg diet and RF @ 5, 10 or 15 mg/kg diet significantly ($p<0.01$) improved the anti-oxidative status with or without stressors. AChE activity in the brain was significantly ($p<0.01$) inhibited upon concurrent exposure to arsenic and high temperature and improved in the treatment group supplemented with Se-NPs and RF. The results showed that the thermal efficiency/tolerance of *P. hypophthalmus* depends upon the acclimation temperature and contamination exposure (arsenic contamination). RF @ 5 mg/kg diet with Se-NPs @ 0.5 mg/kg diet has the potential to enhance thermal efficiency/tolerance and improve the biochemical attributes against multiple stress factors (thermal stress and contamination). Therefore, RF @ 5 mg/kg diet with Se-NPs @ 0.5 mg/kg diet is appropriate for the enhancement of thermal tolerance and reduced cellular metabolic stress in *P. hypophthalmus*. Overall, the results indicated that supplementation with RF @ 5 mg/kg diet and Se-NPs @ 0.5 mg/kg diet could confer protection to the fish against arsenic and thermal stress and led to enhanced thermal efficiency/tolerance of *P. hypophthalmus*.

Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)

Neeraj Kumar and Paritosh Kumar

Impacts of acute toxicity of arsenic (III) alone and with high temperature on stress biomarkers, immunological status and cellular metabolism in fish

The study has been carried out to delineate 96 median lethal concentration of arsenic alone and in combination with high temperature (As-T, 34 °C) by conducting static non-renewable bio-assay acute toxicity in *Pangasianodon hypophthalmus* (average weight 6.25 ± 0.69 g, length 5.32 cm). Effect of definitive doses such as 25, 26, 27, 28, 29 and 30 mg/L of As alone and in combination with high temperature (As-T) were evaluated on stress biomarkers and cellular metabolism of *P. hypophthalmus.* The lethal concentration (96 h LC_{50}) of As alone and in combination with high temperature was found to be 28.16 mg/L and 26.88 mg/L, respectively. The stress biomarkers in terms of catalase, superoxide dismutase (SOD) and glutathione-S-transferase (GST) in liver, gill, brain and kidney, blood glucose and NBT were remarkable higher ($p<0.01$) in comparison to unexposed group (control group). Brain neurotransmitter enzyme, AChE, immunological status (blood glucose and NBT) and cellular metabolic enzymes (lactate dehydrogenase LDH, malate dehydrogenase MDH, aspartate aminotransferase AST, and alanine aminotransferase ALT, glucose-6-phosphate dehydrogenase G6PDH and ATPase) were noticeably ($p<0.01$) altered by As and As-T

exposure. The histopathological study exhibited devastating changes with exposure to As and As-T such as bile stagnation, hepatocyte with irregular nucleus, eosinophilic granules in the cytoplasm, necrosis, melano macrophage aggregation and nuclear hypertrophy in liver and curling of secondary lamellae, hypertrophy of lamellar epithelium, blood congestion, incomplete fusion of secondary lamellae, complete fusion of several lamellae and aneurysm in gill. The results clearly indicate that acute exposure of As and high temperature led to pronounced deleterious alterations on stress biomarkers, cellular and metabolic activities of *P. hypophthalmus*. Overall, the results from this study concluded that temperature is strong elevator of acute toxicity of As. Concurrent exposure of As and high temperature led to pronounced deleterious alterations on stress biomarkers, cellular metabolic activities and histopathogy of *P. hypophthalmus*. The exposure with As and As-T enhanced bioaccumulation of As in different tissues. This is the first report to describe the effects of acute toxicity exposure of As and As-T on stress biomarker, immunological status and cellular metabolism in *P. hypophthalmus*. Therefore the data generated through this study would act as very useful biomarker of acute exposure to As alone and in combination with high temperature for utilization in aquatic ecotoxicological studies in order to formulate the suitable remedial management action plan.

Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors (IXX15014)

Neeraj Kumar

Development of concept for toxicity of manganese (Mn) and manganese nanoparticles (Mn-NPs) in fish

The study has been carried out to delineate the lethal concentration of (LC_{50}) Manganese (Mn) and Manganese nanoparticles (Mn-NPs) in *Pangasianodon hypophthalmus*. In this study we find out the lethal concentration of Mn at 111.75 mg/L and Mn-NPs at 93.81 mg/L at 96 hr. The determination of lethal concentration obtained by conducting definite concentration experiment. The concentration range trial was performed to decide the define concentration of Mn and MN-NPs. The concentrations were chosen with the help of range finding test as 10, 30, 50, 70, 90, 110 and 120 mg/L for both Mn and MN-NPs. Then we chose 85, 90, 95, 100 and 105 and 100, 105, 110, 115 and 120 for Mn-NPs and Mn respectively. Based on range finding test we have selected 91, 92, 93, 94 and 95 mg/L and 110, 111, 112, 113 and 114 mg/L for determination of Mn-NPs and Mn lethal concentration respectively. The cumulative mortality was also determined for 24, 48, 72 and 96 hr. The biochemical, immunology and histopathological attributes were also determined.

Table 2.10. Median lethal concentration (LC_{50}) of *Pangasinodon hypophthalmus* exposed to different concentrations of Mn and Mn-NPs for a period of 96 hr.

Exposure to Manganese (Mn)								
Exposure (h)	**R^2 Value**	**LC_{50} (mg/L)**	**95 % confidence interval**		**S-value**	**Safe level (C)**	**intercept**	**slope**
			Lower	**Higher**				
24	0.67	115.2	113.7	123.7	1.019	34.88	-72.13	0.67
48	0.69	114.1	112.9	121.1			-74.94	0.70
72	0.73	112.8	111.7	116.2			-77.74	0.73
96	0.79	111.7	110.1	112.9			-84.40	0.80
Exposure to Manganese NPs (Mn-NPs)								
24	0.88	96.6	95.0	105.9	1.025	29.35	-56.77	0.64
48	0.85	95.5	94.3	100.5			-68.37	0.77
72	0.77	94.7	93.6	99.8			-64.47	0.74
96	0.76	93.8	92.5	98.9			-57.53	0.67

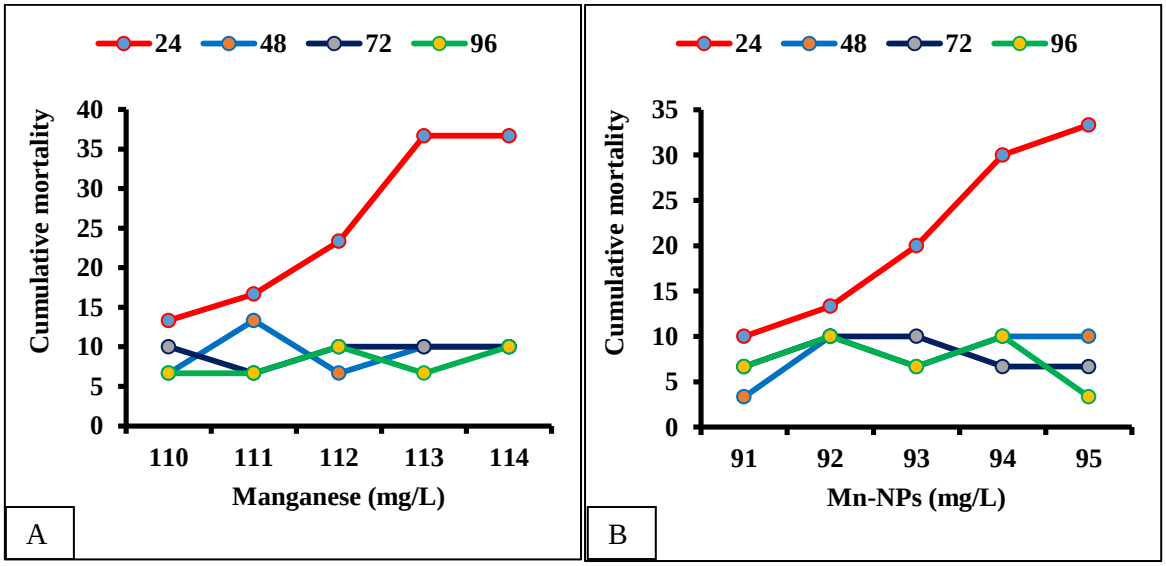


Fig. 2.84.A-B. Cumulative mortality (%) of *Pangasinodon hypophthalmus* exposed to different concentrations of Mn and Mn-NPs for a period of 24, 48, 72 and 96 hr.

3. ITMU/हिन्दी सेल

ITMU

ITMU has organized various activities relevant to IPR and institute technology commercialization during the year 2019-20. ITMU organized three times ITMC meetings for processing of Patent Application Number **3255/MUM/2012.** ITMC studied the queries raised by Patent office, Mumbai and same has been communicated to inventors. Further revised patent document was submitted to Patent office, Mumbai.

ITMU has taken initiative to register institute publications under ISSN for their wider publicity and successfully registered institute publications namely Abiotic Stress Management News, Krishi Stress Patrika and Annual Report under the International Standard Serial Number (ISSN) for Online Print Media.

ITMU made serious effort to get ISSN for above said publications in print media form. For this all online and offline application submission procedures has been completed for title verification at Office of Registrar of Newspapers for India, Ministry of Information and Broadcasting, Soochna Bhawan, New Delhi. In response to our applications RNI office issued the RNI reference number (1347075) for ICAR−NIASM.

The present IP Portfolio of ICAR-NIASM has as given below in tabular form:

IP Portfolio

IPRs	Name of Institute	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/Registration	Application Granted/ Registered**
Patent	ICAR-NIASM	3255/MUM/2012	Process for one step synthesis of bactericidal silver nano-particles from tissue extracts of Labeo rohita	09/11/2012	Application in Amended stage
	ICAR-NIASM	3127/MUM/2015	"Development of microbially-derived polymeric product for gel	Provisional filing date: 18.08.2015 Submission of Complete specification to patent office: 08.08.2016	Deemed to be Withdrawn U/S 11B(4)

			formation"		
ISSN registration of publications	ICAR-NIASM	23375	Abiotic Stress Management News (Online Print)	18.06.2019 ISSN: 2582-0915	Registered
	ICAR-NIASM	24178	Krishi Stress Patrika (Online Print)	5.9.2019 ISSN: 2582-2853	Registered
	ICAR-NIASM	24180	Annual Report (Online Print)	5.9.2019 ISSN: 2582-2861	Registered
RNI registration for Title Verification of Publications	ICAR-NIASM	1347075	Abiotic Stress Management News (Print media)	14.6.209	In Process
	ICAR-NIASM	1347075	Annual Report (Print media)	14.6.2019	In Process
	ICAR-NIASM	1347075	Krishi Stress Patrika (Print media)	18.6.2019	In Process

हिन्दी सेल की वार्षिक गतिविधियां

विगत वर्ष 2019 के दौरान राजभाषा कार्यन्वयन समिति, राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान के द्वारा, हिन्दी भाषा के प्रचार-प्रसार एवं कार्यालयीन प्रयोग को बढ़ावा देने के लिए, कई गतिविधियों का आयोजन किया गया। इस वर्ष के दौरान संस्थान में दो हिन्दी कार्यशालाओं का आयोजन क्रमश: 28-06-2019 एवं 19-09-2019 को किया गया, जिसमे संस्थान के सभी वैज्ञानिक, तकनीकी, प्रशासनिक एवं संविदात्मक सदस्यों ने हिस्सा लिया। इन कार्येशालाओं में राजभाषा कार्यान्वयन समिति अध्यक्ष तथा तत्कालीन निदेशक डा. नरेंद्र प्रताप सिंह ने हिंदी भाषा का 'प्रचार-प्रसार-संचार' इस विषय पर अपने विचार प्रकट किए। हिन्दी कार्यशाला के दौरान 'राजभाषा हिंदी : सृजन से अर्जन की और ' विषय पर मन्तव्य व्यक्त करते हुए ,सदस्य सचिव हिंदी राजभाषा कार्यान्वयन समिति श्री सतीश कुमार ने आलोचक, कहानीकार ,रचनाकार सूर्यकांत त्रिपाठी –निराला और कवि व गीतकार संतोष आनंद के जीवन के परिवेश तथा परिपेक्ष को सम्मुख रखते हुए हिन्दी भाषा को अर्जन व संचार के माध्यम के रूप में प्रस्तुत किया । डा प्रवीण तावरे ने हिंदी भाषा से मेरा अभिप्राय विषय पर अपने विचार प्रस्तुत किए।

राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने हेतु संस्थान में हिंदी सप्ताह का आयोजन 13 सितंबर से 20 सितंबर के दौरान किया गया। हिंदी दिवस तथा हिंदी सप्ताह कार्यक्रम का उद्घाटन संस्थान के वर्तमान निदेशक डा. जगदीश राणे की उपस्थिति मे संपन्न हुआ । इस अवसर पर श्री. सतीश कुमार, वैज्ञानिक एवं सदस्य / सचिव, राजभाषा कार्यन्वयन समिति ने राजभाषा हिंदी के प्रयोग को बढ़ावा देने हेतु संस्थान मे किए जा रहे प्रयासों एवं कामकाज का ब्योरा प्रस्तुत किया। हिंदी सप्ताह के दौरान संस्थान मे विविध प्रतियोगिताओं का आयोजन किया गया, जिसमे की हिंदी निबंध लेखन, वाद-विवाद प्रतियोगिता, गीत गायन/काव्यवाचन, हिंदी टिप्पण लेखन, आशुभाषण प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता आदि विशेष रूप से उल्लेखनिए हैं। संस्थान के सभी कर्मचारियों ने इन प्रतियोगिताओं मे बढ़-चढ़ कर हिस्सा लिया। हिंदी सप्ताह 2019 का पुरष्कार वितरण एवं समापन समारोह 24 सितंबर को संस्थान के बी. पी. पाल कक्ष में आयोजित किया गया। समापन समारोह की मुख्य अतिथि श्रीमती डा . इन्दु सावंत (निदेशक, राष्ट्रीय द्राक्ष अनुसंधान संस्थान, पुणे) ने प्रतियोगिता के विजेताओं को नगद पुरष्कार एवं प्रमाणपत्र देकर सम्मानित किया गया। हिंदी सप्ताह के दरम्यान सतीश कुमार, सदस्य सचिव, राजभाषा कार्यन्वयन समिति, ने हिंदी भाषा का महत्व बताते हुए संस्थान के अधिकारी एवं कर्मचारियों को हिंदी भाषा में कार्य करने के लिए आग्रह किया। हिंदी सप्ताह कार्यक्रम का समापन श्री परितोष कुमार ,सदस्य राजभाषा हिंदी कार्यन्वयन समिति के धन्यवाद ज्ञापन के साथ संपन्न हुआ।

चित्र 3.1. संस्थान के प्रधान वैज्ञानिक डॉ जगदीश राणे, हिन्दी कार्यशाला के दौरान मुख्य अतिथि डॉ नरेंद्र प्रताप सिंह का स्वागत करते हुए।

चित्र 3.2. हिन्दी सप्ताह समापन समारोह की मुख्य अतिथि श्रीमती इन्दु सावंत (निदेशक, राष्ट्रीय द्राक्ष अनुसंधान संस्थान, पुणे), विजेताओं को परितोषिक वितरण करते हुए।

4. Meetings

Meeting for inter-institutional collaboration to map abiotic stresses by employing GIS and remote sensing tools: January 03, 2019

A meeting between ICAR-NIASM, Baramati and ICAR-NBSS&LUP, Nagpur for "Inter-institutional collaboration to map abiotic stresses by employing GIS and remote sensing tools" was held on Janaury 3, 2019 at Dr Punjab Singh Meeting Room, ICAR-NIASM.

Fig 4.1. Inter-institutional meeting between ICAR-NIASM, Baramati and ICAR-NBSS&LUP, Nagpur.

Interaction meeting with schedule caste Self Help Groups (SHG) under SCSP scheme

The interaction meeting with schedule caste Self-Help Groups (SHG) was held on December 14, 2019 at Krishi Vigayan Kendra, Baramati for active participation. The total 11 SHG groups participated in the interaction meeting. The NIASM scientist Dr GC Wakchauare and Dr Neeraj Kumar interacted with self-help group groups. The discussion was made for participation in Bhimtadhi, Pune for providing market platform to 11 schedule caste SHG groups under SCSP scheme.

Fig. 4.2. Interaction meeting NIASM Staff with schedule caste self-help group under SCSP scheme.

Interaction meeting with young minds under SCSP scheme

The interaction cum brainstorming meeting was held on December 03, 2019 under SCSP Scheme at ICAR-National Institute of Abiotic Stress Management, Baramati, Pune. The agenda of the meeting was to assess the constraint in improving livelihood and income of schedule caste community from the rural/farming background including drought prone area. The Video message of Director NIASM about SCSP scheme has been displayed during inaugural session.The total 68 students participants and teachers/representative from the seven different colleges viz. Rajendra Junior College, Khandala; SPMM College Shardanagar; T.C College, Baramati; College of Agriculture Baramati; College of Pharmacy, Malegaon; Mudhoji college, Phaltan; SSCH College Phaltan. The interaction was focused on four thematic areas i.e. awareness, health safety, livelihood option and mode of implementation of the schemes by providing questionnaires.

Fig. 4.3. Interaction meeting NIASM Scientists with Young Minds under SCSP Scheme.

9th Institute Management Committee Meeting

9th Institute Management Committee Meeting held on 28 March, 2019. The meeting was chaired by Director, NIASM.

Fig. 4.4. 9th Institute Management Committee meeting held at ICAR-NIASM.

5. Linkages & Collaboration

Research institute	Areas identified for research collaboration
ICAR-NBPGR, New Delhi	Screening wheat, common bean and mungbean germplasm for drought and high temperature stress tolerance
ICRISAT, Hyderabad	Genomics in soybean for improvement of yield under drought condition
ICAR-CRIDA, Hyderabad	Phenotyping pulses for tolerance to soil moisture stress
ICAR-IARI, New Delhi	Identification of micro-organisms for drought tolerance
ICAR-NRCG, Pune	Studies on tolerance to abiotic stress in grapes
ICAR-CAZRI, Jodhpur	Plant phenotyping and evaluation of CAZRI products
ICAR-NRCP, Solapur	Fruit cracking in and aril browning in Pomegranate Screening of Pomegranate genotypes against blight and other stresses using Phenomics facility
ICAR-CIFE, Mumbai	Abiotic and biotic stress management in fishes
ICAR-NBAIM, Mau Nath Bhanjan	Functional characterization of salt tolerant bacteria using multi omics approaches & their exploitation for alleviation of salt stress in crop plants
ICAR-IIPR, Kanpur PAU, Ludhiana	Exchange of germplasm of pulse crops and evaluation for drought tolerance
ICAR-IISR, Indore	Screening soybean germplasm for drought tolerance
ICAR-IIWBR, Karnal	Screening wheat germplasm for drought and high temperature stress tolerance
MPKV, Rahuri	Conservation agriculture Collaboration in academic program and post graduate research. Genetic enhancement of crop productivity by using modern tools
VNMKV, Parbhani SKUAST, Kashmir	Collaboration in academic program and post graduate research.

UAS, Bengaluru IGKVV, Raipur	Studies on abiotic stress tolerance in crop plants and exchange of students and faculties for post graduate studies.
University of Delhi, New Delhi	RNAi and VIGS for drought and heat stress tolerance in Soybean crop.
MRDBS, Pune	Joint research activities for abiotic stress in grapes Participation in seminars and academic meetings Special, short-term academic/training programs for grape growers.
TC College, Baramati	Collaborative research with focus on drought/ water quality/salinity tolerance mechanisms in plants/fish stress mitigation.
Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli	Collaboration in academic program and post graduate research on abiotic stress tolerance in crop plants and exchange of students and faculties for post graduate studies.
UAS, Dharwad	Collaboration in academic program and post graduate research programmes on management of abiotic stress in crop plants.
PDKV, Akola	Collaboration in academic program and post graduate studies on abiotic stress management in crop plants and exchange of students and faculties for academic programme at post graduate level.

6. Publications

Research Papers

Rane J, Sharma D, Ekatpure S, Aher L, Kumar M, Prasad SVS, Nankar AN, Singh NP (2019) Relative tolerance of photosystem II in spike, leaf, and stem of bread and durum wheat under desiccation. Photosynthetica. 57:1100-1108

Raina SK, Rane J, Raskar N, Singh AK, Govindasamy V, Kumar M (2019) Physiological traits reveal potential for identification of drought tolerant mungbean [*Vigna radiata* (L.) Wilczek] genotypes under moderate soil-moisture deficit. Ind. J. Genet Plant Breed 79: 427-437.

Kumar N, Gupta S, Bhushan S, Narendra Pratap Singh (2019) Impacts of acute toxicity of arsenic (III) alone and with high temperature on stress biomarkers, immunological status and cellular metabolism in fish. Aquatic Toxicology. 214: 105233

Kumar N, Chandan NK, Wakchaure GC, Singh, NP (2019) Synergistic effect of zinc nanoparticles and temperature on acute toxicity with response to biochemical markers and histopathological attributes in fish. Comparative Biochemistry and Physiology Part C Toxicology & Pharmacology 229:108678, DOI: 10.1016/j.cbpc.2019.108678.

Kumar N, Brahmchari RK, Bhushan S, Thorat ST, Kumar P, Chandan NK, Kumar M, Singh NP (2019) Synergistic effect of dietary selenium nanoparticles and riboflavin on the enhanced thermal efficiency of fish against multiple stress factors. Journal of Thermal Biology. 85: 102417.

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Integrated Method for Minimizing Phenotyping Constraints in Wheat. Crop Science 2019; 59(5): 1973-82.

Nair RM, Pandey AK, War AR, Hanumantharao B, Shwe T, Alam AK, Pratap A, Malik SR, Karimi R, Mbeyagala EK, Douglas CA, Rane J. Biotic and Abiotic Constraints in Mungbean Production—Progress in Genetic Improvement. Frontiers in plant science 2019; 10.

Taria S, Rane J, Alam B, Kumar M, Babar R, Anuragi H, Rajarajan K, Singh NP. (2019) Combining IR imaging, chlorophyll fluorescence and phenomic approach for assessing diurnal canopy temperature dynamics and desiccation stress management in Azadirachta indica and Terminalia mantaly. Agroforestry Systems. 2019; 7:1-1.

Rane J, Singh AK, George P, Govindasamy V, Cukkemane A, Raina SK, Chavan MP, Aher L, Sunoj VJ, Singh NP. (2019) Effect of Cow Urine-Based Bioformulations on Growth and Physiological Responses in Mungbean Under Soil Moisture Stress Conditions. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences. 18:1-11.

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Telecast Programme on DD Kisan

हरीश सी बी, नरेंद्र प्रताप सिंह, योगेश्वर सिंह, प्रवीण तावरे चन्दन तथा रक्तचंदन - शुष्क भूमि का सोने का खजाना , किसान खेती अंक - २ : ५-९.

Mr Harisha CB has telecast the programme on खराब और शुष्क जमीनों में औषधीय एवं सुगन्धित फसलों का उत्पादन at DD Kisan on April 26, 2019

Dr Yogeswar Singh has telecast the programme on Benefit of Dragon Fruit at DD Kisan on April 23, 2019.

7. Participation in Meetings/ Conferences/ Workshops/Trainings /Sports Meet/Lectures Delivered

Name	Event	Organized by	Place	Date
Dr K K Meena	4th international conference on agriculture and animal husbandry	Endling Conferences	University of Hyderabad, India	August 28-30, 2019
Dr G C Wakchaure	Jalshakti abhiyan interface meeting		Pune	August 22, 2019
	MoTA project meeting		Office of Commissionerate tribal development Nasik and Jahwar, Project officer office	October 23 and November 11, 2019
	Advanced user training seminar on texture Analaysis	Scientific and Digital Systems, New Delhi.	Mumbai	November 7-8, 2019
	2nd International conference on sustainable water management under the Aegis of National Hydrology Project (NHP)	Ministry of Jal Shakti, Department of Water resources, River Development and Ganga Rejuvenation	Pune	November 6-8, 2019

Dr N P Kurade	Indian College of Veterinary Pathologist (ICVP) 2019	DGCN COVAS, CSK HPAU, Palampur, Himachal Pradesh	Department of Veterinary Pathology	September 13-15, 2019
Mr R N Singh	Training workshop for scientific staff under ICAR-HRM Programme 2019-2020 on "Advances in Simulation Modelling and Climate Change Research towards Knowledge Based Agriculture"	IARI	CESCRA, IARI New Delhi	November 13-December 03, 2019
	Collaborative training program on "Climate Smart Agriculture and Abiotic Stress Management Technologies for Enhancing Farmers' Income"	NIASM and MANAGE	ICAR-NIASM, Baramati	December 16-20, 2019
Dr A K Singh	NASF Project Principal Investigators meeting and special session on Speed Breeding	ICAR-IISR, Indore	Indore	August 25-26, 2019
	Training Programme on 'Recent bioinformatics tools for genome and proteome analysis	ICAR-NAARM	Hyderabad	September 17-21, 2019
	International conference on 'Plant Genetics and Genomics: Germplasm to Genome Engineering'	Select Bio, NASC and IRRI	NASC Complex, New Delhi	October 17-18, 2019
Dr Mahesh Kumar	Workshop on Enhancing resilience and productivity of rice based system through precision agronomy, machine learning and ICT based tools	IRRI	Chandigarh	August 24-25, 2019

	Workshop on Open Source Software KOHA and RFID	IASRI	New Delhi	May 31-June 01, 2019
	CAFT training programme on " Advances in data Science Using R"	IASRI	New Delhi	September 21-October 11, 2019
Mr Amresh Chaudhary	21 days CAFT training on Advances in Data Science Using R organized at Agricultural Statistics and Computer Applications division	IASRI	New Delhi	September 21-October 11, 2019
Dr Paritosh Kumar	4th International Conference on Agriculture and Animal Husbandry	Endling Conferences organized by School of Life Sciences, University of Hyderabad	School of Life Sciences, University of Hyderabad	August 28-30, 2019
	3-days management development training on "Improving Alternatives to Reduce, Reuse and Recycle for Waste Management and Value addition with Emerging Technology"	Vaikunth Mehta National Institute of Co-operative Management (VEMNICOM)	Pune	July 2-4, 2019
Mr Satish Kumar	Workshop on "Statistical Methods in Microbiome Research"	National Center for Cell Science (NCCS)	Pune	December 16-20, 2019.

Dr Neeraj Kumar	Workshop on Research Data Management of ICAR Repository for Knowledge Management	ICAR- IASRI, New Delhi	NAAS Complex New Delhi	December 11-12, 2019

Participation in Exhibitions/ Kisan Mela/Field visits

Participants	Programme	Place	Date
Jagadish Rane	Jalshakti Abhiyan Mela, KVK, Baramati and ICAR-NIASM stall exhibition	Jawalarjun village, Purandar Tahsil	September 03, 2019
Dr GC Wakchaure	Jalshakti Abhiyan Mela, KVK Baramati with ICAR-NIASM stall exhibition	Jawalarjun village, Purandar Tahsil, Pune	September 03, 2019

Participation in Sports meet

Name	Event	Organized by	Place	Date
Dr KK Meena, Dr Satish Kumar, Dr Paritosh Kumar, Mr Mukesh P Bhendarkar, Mr Amresh Chaudhary, Mr Anil K. Sidharth, Mrs Purnima S Ghadge, Mr Girish V Kulkarni, Mr Pravin More, Mr Rupesh K Amarghade, Mr Aniket More	"ICAR West zone Sports tournament	ICAR	ICAR-Central Sheep and Wool Research Institute (CSWRI), Avikanagar, Rajasthan, India	November 14- 18, 2019

Lectures delivered

Dr M P Brahmane

- "अनुवंश सुधारित तिलापिया मत्स्य शेती -परिचय आणि मार्गदर्शक तत्वे" at Krishi Vigyan Kendra, Baramati and National Fisheries Development Board, Hyderabad on "Shet talyatil Matsya Palan"during 27-29 August 2019.
- "अनुवंश सुधारित तिलापिया मत्स्य शेती -परिचय आणि मार्गदर्शक तत्वे" at ICAR-NIASM, Baramati and National Fisheries Development Board, Hyderabad on 10th July 2019.

Dr S S Pawar

- "Livestock and Climate Change" in Winter School on Climate smart agricultural technologies for resource conservation and increasing farmer's income" at ICAR-NIASM, Malegaon during 19th Nov – 9th Dec, 2019.

Mr M P Bhendarkar

- "गोड्या पाण्यातील मत्स्यव्यवसाय" on the occasion 19th National Fish Farmers' Day held at ICAR-NIASM on 10th July 2019.
- "शेततळ्यातील मासेमारी, उत्पनाची हमी भारी" in the one day NFDB funded training programme on "Sustainable fisheries and aquaculture development through intervention of scientific fisheries technology" held at ICAR-NIASM on 10th July 2019.
- "Management of Common Craps and Water Quality" in the three days NFDB funded training programme on "Shet Talyatil Matsya Palan" at Krishi Vigyan Kendra, Baramati on 29th August 2019.
- "Fresh Water Fish farming" in the Workshop on Care & Maintenance of Farm Pond for Fresh Water Fish Farming" held at Krishi Vigyan Kendra, Baramati on 14th October 2019.

Mr Satish Kumar

- "Advances in soil microbiology one day workshop on "Advances in assessment of soil biological diversity" held at ICAR-NIASM during 04 to 6th November 2019.
- 'Advances in microbiome research' in 21 days winter school held at ICAR-NIASM during 19th November – 9th December, 2019.

Dr D D Nangare

- 'Deficit itrrigation water management in fruit crops' as resource person in 21 days CAFT national training programme in horticulture entitled "National problems and prospects in fruit crops' organized by MPKV, Rahuri during on 14th November to 4th December, 2019
- 'Deficit irrigation strategies for management of abiotic stresses in horticulture crops' as resource person in 21 days winter school on 'Climate smart agricultural technologies for resource conservation and increasing farmer's income" at ICAR-NIASM, Baramati during 19th November to 9th December, 2019.
- 'Climate smart innovative techniques to obviate edaphic and drought stresses in Orchards grown on shallow basaltic soils of Deccan Plateau' in collaborative training programme with MANAGE on "Climate smart agriculture and abiotic stress management technologies for enhancing farmer's income" held at ICAR-NIASM, Baramati during December 16 to 20, 2019.

Dr GC Wakchaure

- Cultivation, nutraceuticals and processing of Mushrooms: an Agribusiness Activity. National Training on "Recent Advances in Functional and Nutraceuticals for Future Foods (Post Harvest-Plus-Bio-Fortification & Value addition (July 8-28, 2019)"

organized by Centre for Advanced Agricultural Science & technology on Nutritional Crops, CSA University of Agriculture & Technology, Kanpur.

- Recent advances in Post-Harvest Handling of Mushrooms. National Training on "Recent Advances in Functional and Nutraceuticals for Future Foods (Post Harvest-Plus-Bio-Fortification & Value addition (July 8-28, 2019)" organised by Centre for Advanced Agricultural Science & technology on Nutritional Crops, CSA University of Agriculture & Technology, Kanpur.
- Introductory lecture: Abiotic Stresses, climate change, food security and climate smart agriculture: challenges and prospects. Collaborative Training on Climate smart agriculture and abiotic stress management technologies for enhancing farmers income (16-20 December 2019), organized by ICAR-NIASM in collaboration with MANAGE, MoAFW, Govt. of India. Training Manual p.1-4.
- Bioregulators for raising yield, quality, d productivity and farmers income under water stress conditions. Collaborative Training on Climate smart agriculture and abiotic stress management technologies for enhancing farmers income (16-20 December 2019), organized by ICAR-NIASM in collaboration with MANAGE, MoAFW, Govt. of India. Training Manual p.30-35.
- Climate smart machinery for sugarcane ratoon management and enhancing farmers' income. Collaborative Training on Climate smart agriculture and abiotic stress management technologies for enhancing farmers income (16-20 December 2019), organised by ICAR-NIASM in collaboration with MANAGE, MoAFW, Govt. of India. Training Manual p.71-73.
- Mushroom cultivation: promising agribusiness for enhancing farmers income under climate change: prospective and challenges. Collaborative Training on Climate smart agriculture and abiotic stress management technologies for enhancing farmers income (16-20 December 2019), organised by ICAR-NIASM in collaboration with MANAGE, MoAFW, Govt. of India. Training Manual p.74-81.
- Transforming barren rocky basaltic terrain into productive land. Collaborative Training on Climate smart agriculture and abiotic stress management technologies for enhancing farmers income (16-20 December 2019), organised by ICAR-NIASM in collaboration with MANAGE, MoAFW, Govt. of India. Training Manual p.74-81.

Mr Amresh Chaudhary

- "Soil health Assessment and management framework" and given hands on training for Nitrogen analysis by using "Kjeldahl Apparatus in the Winter school on "Climate smart agricultural technologies for resource conservation and increasing farmer's income" during 19 November - 09 December, 2019.

Dr Paritosh Kumar

- "Advances in water quality assessment in the context of climate change" in the Winter school on "Climate smart agricultural technologies for resource conservation and increasing farmer's income" during 19 November - 09 December, 2019.
- "Water quality: challenges and opportunities for addressing abiotic stresses in present scenario of climate change" on 03rd November 2019.

8. Major Events

Submission of Quinquennial Review Team (QRT) report

Quinquennial Review Team (QRT) report of ICAR-NIASM, Baramati has been submitted by the Dr Gurbachan Singh, Chairman, QRT, ICAR-NIASM to the Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR in the presence of Dr K Alagusundaram, DDG (NRM), ICAR, Dr Narendra Pratap Singh, Director, ICAR-NIASM and Dr S K Chaudhari, ADG (Soil & Water Management) on 08 April, 2019 at ICAR, New Delhi.


Fig. 8.1. Submission of report by Quinquennial Review Team (QRT) report

Inauguration of 11/0.433 KV Electrical Substation

The "11/0.433 KV Electrical Substation" at ICAR-NIASM, Gat-35 Malegaon Khurd, Baramati was inaugurated by Dr Narendra Pratap Singh Director, ICAR-NIASM and the OIC (works) and Works committee members in presence of D D Nangare and others were present. Er Ramesh Rai, Assistant Engineer, Electrical CPWD and Er Vinod Ganvir Assistant Engineer, Civil CPWD were also witnessed for this event on July 30th, 2019. Er Ramesh Rai briefed the details and features of Electrical Substation.


Fig. 8.2. Inauguration of Electric sub-station on July 30th 2019.

Inauguration of Krishna Residency' (Type III & IV Quarter) at MIDC, Baramati

The 'Krishna Residency' (Type III & IV Quarter – Eight nos. each) at ICAR-NIASM residential complex MIDC Baramati was inaugurated by Dr Narendra Pratap Singh, Director, ICAR-NIASM in presence of Er Sushil Prasad, Executive Engineer (Civil), Er Vinod Ganvir, Assistant Engineer (Civil) and Ramesh Rai, Assistant Engineer (Elect.) from CPWD Pune, Dr D D. Nangare OIC (works), Shri B K Sinha, SAO, and AAO were present on this occasion on July 20, 2019.

Fig. 8.3. Inauguration of Krishna Residency' (Type III & IV Quarter) at MIDC, Baramati on July 20, 2019

Swachh Bharat Abhiyan

Under Swachh Bharat Abhiyan during April 2019 to September 2019 various Swachhata Action Plan (SAP) approved activities has carried out in the institute in which more than 150 persons including scientific, administrative, technical, young professionals, research fellows and contractual labours participated and contributed more than 50 hours.

Date	Activity	Number of participants
30th April, 2019	Cleaning of plastic waste from the premises of administrative and school building	50
07th June, 2019	Collection of plastic wastes from the premises of hostel building, labour shed and Type-IV residential quarters	35
25th July, 2019	Planting Mango and Ber in administrative block area	70
6th June, 2019	Cleaning the medicinal block area	150

For basic maintenance cleaning and sanitation activity nine workers are taking care of cleaning the toilets, office building premises, doing weeding and plantation of flowering plants in front of the office building, regularly. All the institute employee doing the dusting and cleaning the sitting areas of their office rooms, labs and farms. For development of green-belt and beautification inside the institute campus a medicinally important trees and shrubs based garden named 'Sanjivani garden' has established. In this garden more than 1500 medicinal plants has planted. In the administrative block area more than 500 mango and ber plants has planted while road sides of Type-IV residential quarters, hostel building and guest house different flowering trees and shrubs has planted.

For management of bio-degradable solid waste including crop residue, weeds, kitchen waste, animal unit waste etc. and to generate wealth from waste a vermicomposting unit of 10 tonnes/year capacities is working at waste dumping site in the institute campus. The unit consists of eight pits of 5.0×1.0×0.9 meter dimension covered with shed. In this unit two types of earthworm species has used for compost preparation Red wigger worm (*Eisenia fetida*) and African night crawler (*Eudrilus eugenia*) for rapid decomposition of green and dry farm waste. Since January 2019 more than 2.5 tonnes compost has collected from eight pits in one round and sold/used in the campus.

For management and reuse of liquid waste generated in institute campus a vertical subsurface flow constructed wetland system based wastewater treatment system of 3000 liters/day capacity is running near septic tank site and the treated water is used for vegetable and fish production and then be used in nearby horticultural orchards (like guava, fig and aonla etc.) to supplement the irrigation water demand during dry periods. To make the institute campus plastic waste and *Parthenium*-free cleaning and eradication drive conducted every month.

As per the D.O. No. 2/2/S(DWS)/19 dated 31.08.2019 by the Secretary, Government of India, Department of Drinking Water & Sanitation, Ministry of Jal Shakti and D.O. No. Secretary (DARE) & DG (ICAR)/2019/998 dated 05.09.2019 'Swachhata Hi Sewa' campaign has organized in the institute from 11th September to 02nd October 2019 on the theme "Plastic Waste Management". Swachhata Hi Sewa campaign-2019 is started with Swachhata Oath on 11th September 2019. Plastic waste collection and disposal drive was conducted in the institute campus. During this campaign plastic waste were collected from institute main gate and roads, premises of administrative building, school buildings, crop farms, guest house and medicinal garden block, hostel buildings, horticultural orchards, animal unit, fish unit, premises of Type IV, Type VII quarters. Awareness campaigns for collecting plastic waste were also conducted in the premises of Tukai temple, Karawaganj (Tourist spot) on 25th Sep. 2019. During this campaign various competitions were also organized viz. essay competition on the topic "Plastic waste management", debate competition on "plastic should be banned or managed" and elocution competition on "Plastic waste management". A Swachhata awareness programme was organized at Jilha Parishad Prathmik Shala, Malegaon Khurd to "Reduce the single use plastic and proper disposal of plastic waste", also conducted plastic waste collection and awareness drive in the premises of

Mata temple, Malegaon Khurd and conducted Swachhata awareness rally at Malegaon Khurd with the help of school's children and institute staffs on 30th Sep. 2019. One day workshop on "Innovative ideas of plastic waste management" was conducted in the institute on 1st October 2019. On 2nd October 2019 a poster competition was conducted having slogan for reducing the single use plastic and celebrated Swachh Bharat Diwas- as massive Shramdaan for plastic waste collection in the premises of Nageshwar temple, Malegaon Budruk.

Celebration of National Fish Farmer Day

The ICAR-National Institute of Abiotic Stress Management, Baramati observed the 19th National Fish Farmers' Day at Baramati on 10th July 2019. Mr. Abhay Deshpande, Reginal Deputy Commissioner, Fisheries, Pune division was the chief guest on this occasion. He emphasized on the need of learning the newer fisheries technologies for doubling farmer's income through skill development. Addressing the gathering, Dr. Jagdish Rane, ICAR-NIASM Principal Scientist and In-chare Head briefed about the achievements of the Institute. On the occasion of this event one day training programme was organized in collaboration with National Fisheries Development Board, Hyderabad. Around 150 fish farmers from different district of Maharashtra were present at the event. A scientist-farmer interaction session was also organized on the theme 'Sustainable fisheries and aquaculture development through intervention of scientific fisheries technology. The training programme was conducted by Mr Mukesh Bhendarkar, Scientist and Dr M P Brahmane, Principal Scientist.

Fig. 8.4. Celebration of National Fish Farmer Day

ICAR-National Institute of Abiotic Stress Management (ICAR-NIASM), Malegaon, Baramati organized one-day workshop on “Climate smart technologies for sugarcane cultivation"

The motto for organizing this program was to generate awareness among farmers about the climate smart ways of tackling problems of water scarcity, trash burning and controlling pest and disease problems in changing climatic scenario. About 175 farmers and 25 guests had attended this program. The inaugural session was chaired by Dr. Narendra Pratap Singh, Director, ICAR- NIASM, Dr Alaka Padhi, Deputy General Manager, NABARD, Pune, Shree Ranjankumar Taware, Chairman, The Malegaon Sahkari Sakhar Karkhana, Malegaon and Shree S V Pawar. Director, ICAR-NIASM informed the gathering about the current situation of sugarcane production and problems arisen due to climate change in this crop in this address to guests and farming community present in the workshop. Dr Alaka Padhi, Deputy General Manager, NABARD, discussed the about the role of NABARD in agricultural development by financing different programs, workshops, developmental and research projects to various organizations for the benefit of farmers. Shree RanjanKumar Taware discussed about the problems of farmers and sugar sugar industries and urged farmers to adopt new technologies generated from ICAR-NIASM for better production under multiple stress condition. There are three lectures of related to climate-smart production system of sugarcane, innovative methods of disease and pest management and new varities of sugarcane for better adoption to abiotic stress condition were delivered by experts. Two progressive farmers who are getting higher productivity of sugarcane has also shared their experiences to farmers regarding their management skills to manage sugarcane trash without burning and adopting integrated nutrient management in sugarcane cultivation. Director, ICAR-NIASM has expressed his gratitude towards sponsors of this workshop including NABARD, United Phosphorus Limited (UPL) and State Bank of India, Baramati branch for funding this workshop.

Fig. 8.5. Dr Alka Padhi (DGM, NABARD) along with Mr Rajan Kumar Taware, Chairman, MSSK sugar factory, lightening the lamp during the inauguration function

Fig. 8.6. Dr N P Singh (Director, ICAR-NIASM) addressing farmers about the workshop

73rd Independence Day Celebration

ICAR-NIASM celebrated 73rd Independence Day on August 15th 2019. All the staff including scientific, technical, administrative, SRF, JRF, YPs and contractual were present for the event. On this occasion, Dr Jagdish Rane, Director, ICAR-NIASM hoisted the national flag and addressed to the staff of ICAR-NIASM.

Fig. 8.7. 73rd Independence Day celebration at ICAR-NIASM

MoU with Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola

ICAR-National Institute of Abiotic Stress Management, Baramati, Pune signed MoU with Punjabrao Deshmukh Krishi Vidyapeeth, Akola for abiotic stress management research and PG studies including pulse, millets, cotton and citrus on 23rd October, 2019 in presence of Dr Bhale Honb'le Vice-Chancellor of PDKV, Director of Research, Dean, Registrar and Heads of the Departments. Dr Jagadish Rane, Director (A), ICAR-NIASM, Baramati delivered a talk on "NIASM a potential partner for research and education. He discussed common areas of interest for collaboration involving faculty from relevant departments and PG students.

Fig. 8.8. Signing of MoU for collaborative research between ICAR-NIASM and PDKV, Akola

MoU for collaborative research on abiotic stress management with Dr BSKKV, Dapoli

ICAR-National Institute of Abiotic Stress Management, Baramati, Pune signed MoU with Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli (MS) on October 11, 2019 in presence of Hon'ble Vice-Chancellor, Dr Sanjay D Sawant to promote research on abiotic stress in Crop Science, Animal and Husbandry Science and Fisheries Science. The both Institutes also collaborate for Master and PhD students' research.

Fig. 8.9. MoU between ICAR-NIASM and Dr BSKKV, Dapoli for collaborative research

MoU with University of Agricultural Sciences, Dharwad

ICAR-NIASM signed the MoU with UAS, Dharwad on October 4, 2019 to carry out collaborative research in the area of abiotic stress management. This MoU will provide opportunities for scientists and post graduate students of UAS Dharwad to make best use of the state of the art facilities for research at ICAR-NIASM by involving different disciplines with an aim to provide the best combination of options for areas prone to abiotic stresses such as drought, extreme temperature, waterlogging, salinity etc. The meeting for MoU was

chaired by Dr MB Chetti, Hon'ble Vice-Chancellor of UAS, Dharwad. While briefing about the genesis of ICAR-NIASM, Hon'ble Vice-Chancellor highlighted that the state of the art facilities for abiotic stress research will be useful for complementing the present research going on at the University and the staff and student should make best use of this opportunity. The MoU was signed by Dr Jagadish Rane, Director (A) of NIASM and Dr VR Kiresur, Registrar, UAS Dharwad. ICAR-NIASM and UAS-Dharwad scientists were present on this occasion.

Fig. 8.10. Signing of MoU between ICAR-NIASM and UAS, Dharwad for collaborative research on abiotic stress management

Workshop on advances in soil and water analysis

A workshop on "Advances in soil and water analysis" was organized in the Institute during November 4-6, 2019. 28 candidates from different parts of Maharashtra attended the workshop. Dr Narendra Pratap Singh (Ex. Director, ICAR-NIASM) was the chief guest in the inauguration ceremony. Various lectures and practical sessions were conducted viz. lecture on advances in soil chemical analysis, Analysis of soil physical Parameters, Water quality: challenges and opportunities for addressing abiotic stresses in present scenario of climate change, Advances in assessment of soil biological diversity, How to conduct field experiments on water stress and water productivity, Soft skills for data analysis and visualization, Advanced instrumentation facility for detection of micronutrients and heavy metals in soil and water. Practical sessions of the workshop were conducted on "Assessment on soil quality indicators" in which soil sampling, sample preparation in the lab (like air drying, crushing, sieving, extract preparation, etc.) and analysis of soil health parameters viz. soil bulk and particle density, pH, EC, NPK analysis etc. were covered. During practical session of "Analysis of water quality" water sampling method (from pond, tap and bore well, well), sample preparation in the lab (for microbial, nutrient and metal analysis) and analysis of water quality parameters like pH, Electrical conductivity (EC), Oxidation reduction potential (ORP), temperature, Dissolved oxygen (DO), salinity, turbidity, TDS, alkalinity (Carbonate & Bicarbonate), hardness (Calcium + Magnesium ion), chloride, sodium, potassium, micronutrients and metal analysis, total coliform, faecal coliform and *Escherichia coli* etc. were covered. During workshop working of Atomic Absorption Spectrophotometer

(AAS), Inductively Coupled Plasma Mass Spectroscopy (ICP-MS), Flame photometer (FES), UV/VIS-spectrophotometer have also demonstrated and also given hands on training to the participants.

Fig. 8.11. NIASM staff and participant of workshop on advances in soil and water analysis

हिंदी कार्यशाला

भारतीय कृषि अनुसंधान परिषद के दिशा निर्देशों के अंतर्गत राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान में राजभाषा हिंदी के प्रयोग को बढ़ावा देने हेतु "हिंदी सप्ताह " (13 सितंबर -20 सितंबर) का आयोजन किया गया। हिंदी दिवस तथा हिंदी सप्ताह कार्यक्रम का उद्घाटन संस्थान के निदेशक डा. जगदीश राणे की उपस्थिति मे संपन्न हुआ । संस्थान के निदेशक डा. जगदीश राणे ने सभी का स्वागत करते हुए अपने सम्बोधन मे संस्थान के दैनिक कार्यो मे राजभाषा हिंदी के प्रयोग को बढ़ावा देने का आहवान किया तथा हिंदी भाषा के प्रचार- प्रसार हेतु सुझाव भी दिए। इस अवसर पर श्री. सतीश कुमार, सदस्य सचिव, हिंदी राजभाषा कार्यन्वयन समिति ने राजभाषा हिंदी के प्रयोग को बढ़ावा देने हेतु संस्थान मे किए जा रहे प्रयासों एवं कामकाज का ब्योरा प्रस्तुत किया। हिंदी सप्ताह 2019 के दौरान संस्थान मे विविध प्रतियोगिताओं का आयोजन किया गया । हिंदी निबंध लेखन ,वाद-विवाद प्रतियोगिता ,गीत गायन/काव्यवाचन ,हिंदी टिप्पण लेखन , आशुभाषण प्रतियोगिता ,प्रश्नोत्तरी प्रतियोगिता आदि प्रतियोगिताओं का आयोजन किया गया । इसी दरम्यान हिंदी भाषा को बढ़ावा देने के लिए 19 सितम्बर को " एकदिवसीय हिंदी कार्यशाला" का भी आयोजन किया गया । इस एकदिवसीय कार्यशाला के दरम्यान हिन्दी भाषा के प्रचार –प्रसार तथा कार्यलय प्रयोग को बढ़ावा देने के तौर-तरीकों पर गहन विचार विमर्श किया गया। संस्थान के सभी कर्मचारियों ने बढ़-चढ़ के इस कार्यशाला में हिस्सा लिया । हिंदी सप्ताह 2019 का पुरष्कार वितरण एवं समापन समारोह 24 सितंबर को संस्थान के डॉ. बी. पी. पाल कक्ष में हुआ। समापन एवं पुरष्कार वितरण समारोह की मुख्य अतिथि श्रीमती डा . इन्दु सावंत (निदेशक, अंगूर अनुसंधान संस्थान ,पुणे) ने सभी विजेताओं को पुरष्कार वितरित किए। हिंदी सप्ताह के दरम्यान सतीश कुमार, (सदस्य /सचिव राजभाषा कार्यन्वयन समिति) ने हिंदी भाषा का महत्व बताते हुए संस्थान के अधिकारी एवं कर्मचारियों को हिंदी भाषा में कार्य करने के लिए निर्देशित किया । हिंदी सप्ताह कार्यक्रम का समापन श्री परितोष कुमार ,सदस्य राजभाषा हिंदी कार्यन्वयन समिति के धन्यवाद ज्ञापन के साथ संपन्न हुआ।

चित्र 8.12. समारोह में दीप- प्रज्वलन करते हुए निदेशक डा जगदीश राणे, साथ में डा अविनाश निर्मले तथा श्री अमरेश चौधरी।

चित्र 8.13. निदेशक डा जगदीश राणे संस्थान में हिंदी कार्य को बढ़ाने के लिए संस्थान के कर्मचारियों को सुझाव देते समय।

Collaborative Training with MANAGE, Hyderabad

A collaborative training program on 'Climate Smart Agriculture and Abiotic Stress Management Technologies for Enhancing Farmers Income' was organised at ICAR-National Institute of Abiotic Stress Management, Baramati during 16-20 December 2019. The training programme was sponsored by the National Institute of Agricultural Extension Management (MANAGE), Ministry of Agriculture and Farmers Welfare, Hyderabad. Total 26 extension functionaries from state agriculture development departments and state agricultural university and KVKs were participated. The training programme was inaugurated by Dr Jagadish Rane, Chief Guest and Director (A), ICAR-NIASM, Mr. Balaji Tathe, Guest of Honour and Subdivisional Agriocultral Officer, Baramati and Mr Bhausaheb Dhumal, National Coordinator MANAGE, Hyderabad. The various lectures, practical's and fields visits majorly on climate change and abiotic stress management, water and soil management strategies for

enhancing farmers income includes bio-regulators, climate smart crops, novel microbial, biotechnological and phonemics approaches, livestock and fish production technologies were delivered by the resource persons from the ICAR-NIASM. The training programme was coordinated by Dr G.C. Wakchaure, Sr. Scientist (AS&PE) and Dr. Kamlesh K. Meena, Sr. Scientist (Microbiology).

Fig. 8.14. NIASM scientists with participants of MANAGE Collaborative Training

Swachhta Pakhwada

As a part of Swachh Bharat Abhiyan 'Swachhata Pakhwada' has observed at ICAR-NIASM, Baramati on 16th – 31st December 2019. As per the action plan various activities were carried out to keep the campus plastic free and to create awareness among the staff, nearby villagers, schools involving students and teachers about the importance to shun the use of single use plastics and adopt cleanliness and sanitation in daily habit. All the staff of NIASM including scientists, technical, administrative, contractual staffs, research fellows and young professionals of institute were participated in the activities which were carried out as per the action plan.


Fig. 8.15. Activities during 'Swachhta Pakhwada' at ICAR-NIASM, Baramati

Celebration of World Soil Day

World soil Day was organized by ICAR –NIASM, Malegaon, Baramati in collaboration with Krishi Vigyan Kendra, Baramati and Maharashtra State Agriculture Department at Sangavi Village of Baramati tahshil. The program was attended by Dr. S.A. Syed, Head, KVK, Baramati, Dr. Vanita Salunkhe, Scientist, NIASM, Mr. Amresh Chaudhary, Scientist, NIASM, Dr. Vivek Bhoite, Scientist, KVK, Mr. Y. Jagadale, Scientist, KVK and Mr. Balaji Tate, SDAO, Baramati. About 250 farmers of nearby villages attended this program. The program was inaugurated by the Dr. S.A. Syed, Head and senior scientist, KVK, Baramati. Then, a series of lectures were given by scientists and officers of Maharashtra state agriculture department. Mr. Y. Jagadale delivered lectures on cultivation technologies of drumstick along with its marketing strategies under dryland agriculture. After that, Mr. Amresh Chaudhary, Scientist, NIASM delivered a lecture on importance of World Soil Day and soil health under farmers' perspective. He awared farmers about the theme of world soil day -2019 i.e. "Stop soil erosion and save your future". He also informed various techniques of controlling soil erosion which farmers can easily apply in their fields. He also talked about various management practices regarding soil health management. Mr. Vivek Bhoite, Scientist, KVK, Baramati delivered a lecture on reclamation of problematic soil and ratoon sugarcane management. He addressed farmers regarding factors of soil alkalinity and salinity in the soil and its management practices. Mr. Balaji Tate informed farmers about soil health and fertility status of Pune district and distributed soil health cards to farmers.

Dr. Sayed, Head, KVK Baramati has informed farmers about residue-free food production and innovation in agriculture by KVK, Baramati. He informed various new techniques including aquaponics, hi-tech vegetable farming and a new app "Krishak" for benefit of farmers.

A Demonstration of mole plough for subsurface drainage for reclamation of saline soils was also performed in a nearby farmers' field. At least, a formal vote of thanks was delivered by Mr. Hake and program was ended with national anthem.

Fig. 8.16. Celebration of World Soil Day at ICAR-NIASM

Celebration of Constitution Day

During the second fortnight of December 2019, ICAR-NIASM, Baramati, held a meeting-cum-Gosthi with Institute staff on fundamental duties of Indian citizens under Article 51-A of the Indian Constitution. The meeting has been graced by the presence of the Institute's Director. Institute workers have been made aware of basic Indian citizen duties. Discussion on the fundamental duties was started with cum Gosthi. The event was great moments by all the personnel including scientists, technical and administrative and project staff.

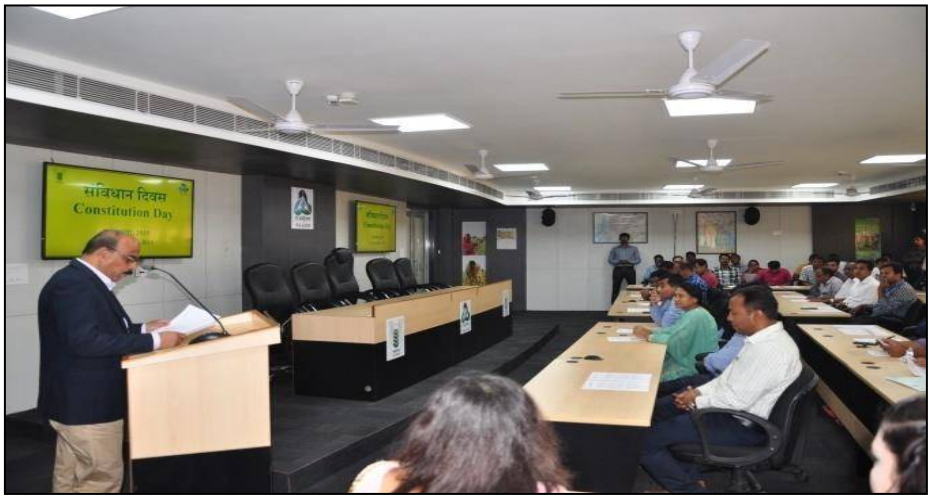

Fig. 8.17. Dr Jagadish Rane, Director (A) addressing NIASM staff during celebration of Constitutiion Day

Winter School on climate smart agricultural technologies for resource conservation and increasing farmers' income

ICAR-NIASM, Baramati organized 21 days "Winter School on Climate smart agricultural technologies for resource conservation and increasing farmer's income" during November 19th to December 9th 2019. The program was sponsored by Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare, Govt. of India. Nineteen participants includes scientists, teachers and researchers from different parts of the country participated in this training programme.

The objective of this programme was sensitizing the participants with the recent advancements in climate smart agricultural technologies. Lectures related to abiotic stress management and doubling farmers' income in abiotic stressed areas were delivered and also hands on training on use of high-end equipment related to abiotic stress assessment. The programme covered informative sessions, lectures, field visits, demo-sessions, and future perspectives in the area of climate change; food security and climate smart agriculture; abiotic stresses and their mitigation strategies using microbial resources; live demonstration of planting methods in commercial crops such as sugarcane; application of Stubble shaving, Off-barring, Root pruning and Band placement of basal fertilisers (SORF) machine for advanced cultural practices in sugarcane; measurement of root dynamics using sophisticated imaging system; Infra-Red imaging system for canopy modelling; integrated farming system for small farmers to achieve sustainable income; animal husbandry fish farming, and pest management under abiotic stress conditions; extraction of microbial biomolecules and subsequent analysis through HPLC; water and soil management technologies; novel microbial, biotechnological and plant-phenomics approaches for enhancing crop and water productivity were delivered by the various experts/resources persons.

Fig 8.18. Dr Jagadish Rane, Director (A) addressing participants during Winter School

9. RPwD

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

The Rights of Persons with Disabilities (RPwD) Act, 2016 is the disability legislation passed by the Indian Parliament to fulfil its obligation to the United Nations Convention on the Rights of Persons with Disabilities. Rights and Entitlement of Persons with Disabilities include right to equality, life with dignity and respect for his or her integrity equally with others, no discrimination on the ground of disability **(**Equality and Non-discrimination); rights to live in community (Community life); Protection of disabled person from being subjected to torture, cruel, inhuman or degrading treatment (Protection from cruelty and inhuman treatment); Protection of disabled person from incidence of abuse, violence and exploitation (Protection from abuse, violence and exploitation); rights of equal protection and safety in situations of risk, armed conflict, humanitarian emergencies and natural disasters (Protection and safety); rights to access any court, tribunal, authority, commission or any other body having judicial or quasi-judicial or investigative powers without discrimination on the basis of disability (Access to justice); No child with disability shall be separated from his or her parents on the ground of disability except on an order of competent court, if required, in the best interest of the child (Home and family) etc. ICAR-NIASM complies with RPwD Act, 2016 and various activities and the decisions have been taken for implementation of RPwD Act, 2016 during financial year 2017-18:

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

10. New Staff/Promotion/ Superannuation/Selection-transfer

New staff

- Mr Ram Narayan Singh, Scientist (Agricultural Meteorology) joined ICAR-NIASM on April 03, 2019
- Dr Vanita Navnath Salunkhe, Scientist (Plant Pathology) joined ICAR-NIASM on December 02, 2019
- Dr. Sanjivkumar Angadrao Kochewad, Scientist (LPM) joined ICAR-NIASM on December 16, 2019
- Dr. Boraiah KM, Scientist (Genetics and Plant Breeding) joined ICAR-NIASM on December 24, 2019
- Mr. Karthikeyan N, Scientist (Plant Microbiology) joined ICAR-NIASM on December 26, 2019

Joining

- Dr Jagadish Rane, Principal Scientist joined as Director (A) on August 01, 2019

Promotions

- Dr Goraksh Wakchaure, Scientist (Ag. Structure and Process Engineering) promoted to Senior Scientist level 12 as per 7th CPC, effective from February 10, 2018
- Dr Susheel Kumar Raina, Scientist (Plant Breeding) promoted to level 11 as per 7th CPC, effective from April 20, 2014
- Dr V Govindasamy, Scientist (Agriculture Microbiology) promoted to level 11 as per 7th CPC, effective from April 20, 2014
- Dr Neeraj Kumar, Scientist (Fish nutrition and Biochemistry) promoted to level 11 as per 7th CPC, effective from January 01, 2018

Superannuation

- Prof Narendra Pratap Singh, Director, ICAR-NIASM superannuated on July 31, 2019

Selection

- Dr Yogeshwar Singh, Senior Scientist was selected as Professor in Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh

11. Budget Utilization (2019-20)

(₹ Lakhs)

Head/Sub-head	Allocation	Expenditure
Grants in aid–Capital	300.00	
Works		233.53
Equipment		57.72
Information Technology		1.21
Library		1.11
Furniture and Fixures		4.57
Vehicles and Vessels		0.00
Livestock		1.86
Sub Total - 1	**300.00**	**300.00**
Grants in aid–Salary		
a) Establishment Charges	588.85	588.69
Sub Total – 2	**588.85**	**588.69**
Grants in Aid - General		
Pension & Other Retirement Benefits	76.60	76.29
Travelling Allowance	449.85	15.82
Research & Operational Expenses		115.59
Administrative Expenses		305.13
Miscellaneous Expenses		13.31
Total Grants in Aid-General	**526.45**	**526.14**
Tribal Sub Plan		
Scheduled Castes Sub Plan		
Grants in Aid –Capital	10.00	6.63
Grants in Aid –General	11.14	11.04
SCSP Total	**21.14**	**17.67**
Grand Total	**1436.44**	**1432.50**

12. Research Projects

S. No.	Project Name	PI	Co-PI
School of Atmospheric Stress Management			
1.	Quantifying thermal tolerance limits and genetic polymorphism to temperature stress in fishes from drought affected Bhima, Krishna rivers (IXX14264)	MP Brahmane	MP Bendarkar Neeraj Kumar
2.	Simulation and visualisation of potential population growth in pulse beetle, *Callosobruchus chinensis* L. (Bruchidae: Coleoptera) in pigeonpea (*Cajanus cajan* L. Millsp) under changing climatic conditions and its geographic distribution. (IXX14278)	Rajkumar	A K Singh
3.	Spawning and larval development of snakehead, channa spp, and Nile Tilapia *Oreochromis nilolicus* under abiotic stress environment (IXX14249)	MP Bhendarkar	MP Brahmane Neeraj Kumar
4.	Study of immune response and HSP genes polymorphism in relation to heat stress in poultry (IXX11251).	S S Pawar	NP Kurade
School of Drought Stress Management			
5.	Assessment of Quinoa (*Chenopodium quinoa*) as an alternate crop for water scarcity zone (IXX14286)	Jagadish Rane	NP Singh
6.	Evaluation of nutritional stressors and their indicators In cattle population In different drought prone areas. (IXX11259)	NP Kurade	Neeraj Kumar SS Pawar AV Nirmale
7.	Investigation on traits and genes associated with adaptation of wheat genotypes to local drought and heat stress environments (IXX09675)	A K Singh	Jagadish Rane Mahesh Kumar
8.	Evaluation of water saving techniques for fruits and vegetables in shallow soils of semi-arid region (IXX10721)	D D Nangare	Yogeshwar Singh Mahesh Kumar P B Taware
9.	Crop water production functions using line source sprinkler system: interaction with bioregulators, soil fertility and crop cultivar (IXX11584)	G C Wakchaure	K K Meena

10.	Exploring potential to obviate water and high temperature stress in onion (*Allium cepa* L.) for enhancing productivity and post-harvest storage quality.(IXX14250)	GC Wakchaure	B B Gaikwad K K Meena
11.	Investigation of traits and genes associated with resilience to moisture stress in soybean (IXX09645)	Mahesh Kumar	A K Singh
12.	Spectral delineation of moisture and nutrient stresses in vineyards through hyperspectral spectroscopy (IXX14265)	BB Gaikwad	--
13.	Determination of relative water content of grapes leaves using two band indices (IXX14265)	BB Gaikwad	--
School of Edaphic Stress Management			
14.	Impact of cropping systems and spent wash on soil development under irrigated and rainfed conditions (IXX10215)	Yogeshwar Singh	K K Meena G C Wakchaure
15.	Techniques to obviate edaphic stresses in orchards grown in shallow basaltic soils (IXX09671)	Yogeshwar Singh	D D Nangare, Jagadish Rane P B Taware
16.	Techniques to obviate the edaphic stress in horticulture crops (IXX10720)	Yogeshwar Singh	D D Nangare Jagadish Rane
17.	Isolation and characterization of biomolecule producing bacteria for salt stress alleviation in major crops (IXX10378)	KK Meena	--
18.	Brood stock management, breeding and seed production of important fin fishes in abiotic stressed farms (IXX09673)	Neeraj Kumar	M P Brahmane
19.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches (IXX12494)	Neeraj Kumar	Paritosh Kumar
20.	Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics (IXX14228)	Paritosh Kumar	KK Meena Neeraj Kumar CB Harisha
21.	Effect of nutritional and salinity stress on physiological, biochemical traits and yield of turmeric (*Curcuma longa L.*) (IXX13858)	CB Harisha	KK Meena
22.	Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors (IXX15014)	Neeraj Kumar	--

Externally Funded Projects

S. No	Project Name	PI	Co-PI	Funded by
1.	Genomics strategies for improvement of yield ad seed composition traits under drought stress conditions in soybean (0XX04449)	A K Singh	Mahesh Kumar, Jagadish Rane	ICAR-NASF
2.	Phenotyping of pulses for enhanced tolerance to drought and heat (OXX01737)	Jagadish Rane	Mahesh Kumar	NICRA, Hyderabad
3.	Combining field phenotyping and next generation genetics to uncover markers, genes and biology underlying drought tolerance in wheat (OXX03111)	Jagadish Rane	A K Singh	DBT, GoI-BBSRC, UK
4.	Abiotic stress detection from field to landscape scale in different crops using remote sensing tools (OXX04474)	Jagadish Rane	--	ISRO-SAC
5.	On field *in vivo* monitoring of pollen tube growth of dry land agricultural crops to identify the genotypic resilience to drought (OXX04232)	Jagadish Rane	--	DBT
6.	Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (OXX03595)	BB Gaikwad	DD Nangare Mahesh Kumar Rajkumar	(BDA-HSRS) DST
7.	Raising rice productivity through drought tolerant rice varieties and their matching management practices in Maharashtra (OXX03978)	Yogeshwar Singh (Up to July 25, 2019), Mahesh Kumar	N P Singh D D Nangare	IRRI
8.	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (OXX03355)	Yogeshwar Singh (Up to July 25, 2019), KK Meena	Mahesh Kumar ParitoshKumar, Amresh Chodahary, GC Wakchaure	CA Platform ICAR
9.	Evaluation of halotolerant rhizobium and PGPB based biomolecules for alleviation of drought and salt stress (OXX04473)	KK Meena	GC Wakchaure, CB Harisha,	AMAAS, NBAIM, Mau.
10.	Establishment of model herbal garden for medicinal and aromatic plants (OXX04255)	CB Harisha	Parithosh Kumar, DD Nangare	NMPB, New Delhi

13. Personnel

Scientific Staff*	
Dr Jagadish Rane	Director (A)
School of Atmospheric Stress Management	
Dr Jagadish Rane	Head (I/c)
Dr M P Brahmane	Principal Scientist (Biotechnology – Animal Science)
Dr S S Pawar	Scientist (Animal Biotechnology)
Mr Gopalakrishnan B	Scientist (Environmental Science) (on study leave)
Mr Rajkumar	Scientist (Agricultural Entomology)
Mr Mukesh P Bendarkar	Scientist(Fisheries resource Management)
Mr Ram Narayan Singh	Scientist (Agricultural Meteorology)
School of Drought Stress Management	
Dr Jagadish Rane	I/c Head and Principal Scientist (Plant Physiology)
Dr Nitin P Kurade	Principal Scientist (Veterinary Pathology)
Dr Ajay Kumar Singh	Senior Scientist (Agricultural Biotechnology)
Dr Dhananjay D Nangare	Senior Scientist (Soil & Water Conservation Engineering)
Dr Goraksha C Wakchaure	Senior Scientist (Agricultural Structure & Process Eng.)
Dr Mahesh Kumar	Scientist (Plant Physiology)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Dr Bhaskar B Gaikwad	Scientist (Farm Machinery)
Dr Boraiah KM	Scientist (Genetics and Plant Breeding)
Mr Karthikeyan N	Scientist (Agricultural Microbiology)
Dr Aliza Pradhan	Scientist (Agronomy)
School of Edaphic Stress Management	
Dr Kamlesh Kumar Meena	I/c Head and Senior Scientist (Agricultural Microbiology)
Dr Vanita N Salunkhe	Scientist (Plant Pathology)
Dr Sanjivkumar A Kochewad	Scientist (LPM)
Mr Rajagopal V	Scientist (Soil Chemistry/Fertility/Microbiology) (on Study leave)
Dr Neeraj Kumar	Scientist (Fish Nutrition)
Dr Paritosh Kumar	Scientist (Environmental Science)
Mr Harisha C B	Scientist (Spices, plantation, medicinal & aromatic plants) (on study leave)
Mr Amresh Chaudhary	Scientist (Soil Science)

School of Policy Support Research	
Dr KK Meena	Head (I/c)
Administrative staff*	
Shri Babul Kumar Sinha	Chief Administrative Officer
Shri Anil Kumar Sidharth	Finance & Accounts officer
Smt Purnima S. Ghadge	Assistant Administrative Officer
Mr Dayanand P Kharat	Assistant
Mr Girish V Kulkarni	Assistant
Technical staff*	
Dr A.V. Nirmale	Chief Technical Officer (Animal Science)
Dr P.B. Taware	Senior Technical Officer (Farm)
Mrs Noshin Shaikh	Senior Technical Assistant (Civil)
Mr Santosh Pawar	Senior Technical Assistant (Electrical)
Mr Pravin More	Senior Technical Assistant (Computer)
Mr M Gubbala	Senior Technical Assistant (Information Technology)
Mr Rushikesh Gophane	Senior Technical Assistant (Horticulture)
Dr (Mrs) Priya George	Senior Technical Assistant (Microbiology)
Mr Lalitkumar Aher	Senior Technical Assistant (Biotechnology)
Mr Sunil Potekar	Senior Technical Assistant (Agro-Meteorology)
Mr Patwaru Chahande	Senior Technical Assistant (Agriculture)
Mr Rupesh Kumar Amarghade	Senior Technical Assistant (Mechanical)
Mr Aniket More	Senior Technician (Farm)

*As on Decemeber 31, 2019

14. Distinguished Visitors

1. Dr A K Sikka, Ex DDG (NRM), ICAR & IWMI Representative-India visited on 3rd Jan 2019
2. Prof Pushpendra Kumar Gupta, Emeritus professor, Meerut University, Meerut visited on January 04, 2019
3. Dr Peter Carberry, DG, ICRISAT, Hyderabad, visited on January 17, 2019
4. Shri Sachindra Pratap Singh, Commissioner of Agriculture, Maharashtra, visited on January 20, 2019
5. Dr T Mohapatra, Secrtetory DARE & DG, ICAR, visited on 22 Feb 2019
6. Dr AN Rai, Ex. Vice Chancellor, NEHU, Shillong, visited on 8 March 2019
7. Dr R P Singh, Ex-Director, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, visited on 10 June, 2019
8. Dr D K Singh, Principle Scientist, Water Technology Centre, New Delhi, visited on June 19, 2019
9. Mr Suhash Joshi, Head Bayer CSRI, visited on November 21, 2019

Appendix

Institute Management Committee

1. Prof Narendra Pratap Singh, Director, ICAR-NIASM, Baramati
2. Dr Shrikant Kakde, Director (Education), Maharashtra Council of Agricultural Education and Research, Bhosale Nagar, Pune
3. Dr Naveen P Singh, Principal Scientist, ICAR-National Institute of Agricultural Economics and Policy Research (NIAP), New Delhi
4. Dr Vijay Mahajan, Principal Scientist, ICAR-Directorate of Onion and Garlic, Rajgurunagar, Pune, Maharashtra
5. Dr Ajay Kumar Upadhyaya, Principal Scientist, ICAR-National Research Centre for Grapes, Pune
6. Dr Eaknath B Chakurkar, Director, ICAR-Central Coastal Agricultural Research Institute, Ela, old Goa, Dist. North Goa, Goa
7. Dr Pawan L Kulwal, Associate Professor (Genetics and Plant Breeding) State Level Biotechnology Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra
8. Shri Ramchandra V Nimbalkar At/Po- Bhawani Nagar, Indapur Taluka , Pune
9. Shri Shyam Appa Chakor At/Po- Mandhawagan Farta, Shirur Taluka, Pune
10. Shri O P Nagar, Deputy Director (Account) II, ICAR, Krishi Bhavan, New Delhi
11. Senior Administrative Officer, NIASM, Malegaon, Baramati

Research Advisory Committee

1. Dr Alok K Sikka, Chairman, RAC and Ex DDG (NRM), ICAR & IWMI Representative-India & Principal Researcher, International Water Management Institute, Delhi Office, DPS Shastri Marg, Pusa, New Delhi
2. Dr D P Waskar, Director of Research, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra
3. Dr (Mrs) Vidya Gupta, Fellow National Academy of Science, Biochemical Science Division, CSIR-National Chemical Laboratory, Dr. Homi Bhabha Road, Pune
4. Dr J S Parihar, Ex-Deputy Director, Satish Dhawan Professor ISRO-Space Application Centre, Ahmedabad, 100, ISCON Greens, near Hari Om Villa, Ghuma, Post Office: Bopal, Ahmedabad
5. Dr Arun Varma , Former ADG (AN & P), ICAR, Uttar Pradesh
6. Dr A G Ponaiah, Former Director, ICAR-CIBA, Chennai
7. Prof Narendra Pratap Singh, Director, NIASM, Baramati, Pune
8. Dr Jagadish Rane, Head, SDSM, NIASM, Baramati, (Member Secretary)

First Quinquennial Review Team

1. Dr Gurbachan Singh, Ex-Chairman, ASRB, New Delhi & Chairman QRT
2. Dr Rajinder Singh Sidhu, Registrar, PAU, Ludhiyana & Member QRT
3. Prof Dilip Kumar, Ex-Director, ICAR-CIFE, Mumbai & Member QRT
4. Prof K E Lawande, Ex-Vice Chancellor, Dr.BSKKV Dapoli & Member QRT
5. Dr K C Bansal, Ex-Director, ICAR-NBPGR, New Delhi & Member QRT
6. Dr G G S N Rao, Ex-PC, AICRP-Agromet, ICAR-CRIDA, Hyderabad & Member QRT
7. Dr Yogeshwar Singh, Senior Scientist, ICAR-NIASM and Member secretary QRT

Institute committees

Institute Research Committee

Director (Chairman), All Scientists (Members), Dr Jagadish Rane (Member Secretary)

Prioritization, Monitoring and Evaluation Cell

Director (Chairman), Dr K K Meena, Dr Neeraj Kumar, Dr Paritosh Kumar, Mr G Madhukar, Dr Jagadish Rane (Member Secretary).

Monthly Review Committee

Director (Chairman), all heads of School, Farm Manager (Crop/ animal science), Dr K K Meena, SAO and AAO (Member secretary)

Farm Advisory Committee

Director (Chairman), All heads of School, Dr N P Kurade, Dr Yogeshwar Singh, Dr Neeraj Kumar, SAO, F&AO, AAO (Member secretary)

Works/Estate Management Committee (up to July 2019)

Dr D D Nangare (Chairman), Dr KK Meena, Dr GC Wakchaure, SAO, Mr Santhosh Pawar, Smt Noshin Sheikh (Member secretary)

Institute Technology Management Committee (ITMC)

Director (Chairman), Dr Jagdish Rane, Dr K K Meena, Dr Y Singh, Dr B B Gaikwad, Dr GC Wakchaure (Member secretary)

Consultancy Processing Cell

Dr KK Meena (Chairman), Dr D D Nangare, Dr Paritosh Kumar, Mr Rajkumar, Mr Amresh Chaudhary (Member secretary)

Academic and HRD committee

Dr Jagdish Rane (Chairman), Dr Ajay K Singh, Dr G C Wakchaure, Dr Aliza Pradhan (Member secretary, up to 31st July) Mr Satish Kumar (Member secretary, from 1st August)

Purchase Advisory Committee

Dr Ajay K Singh (Chairman), Dr Yogeshwar Singh, Dr G C Wakchaure, Dr Neeraj Kumar, SAO, FAO, AAO (Member secretary)

Local Purchase Committee

Dr Ajay K Singh (Chairman), Dr G C Wakchaure, Dr Mahesh Kumar,
Dr Parithosh Kumar, Dr P B Taware, AAO, Indentor

Germplasm and Genotypes Identification Committee

Dr Jagdish Rane (Chairman), Dr N P Kurade, Dr. M P Brahmane , Dr Yogeshwar Singh, Dr Mahesh Kumar and Dr Ajay K Singh (Member secretary)

Publication Committee

Dr Ajay K Singh (Chairman), Dr Yogeshwar Singh, Dr Mahesh Kumar, Dr Parithosh Kumar, Mr CB Harisha and Dr Neeraj Kumar (Member Secretary)

Technical Evaluation Committee

Dr Jagadish Rane (Chairman), Dr DD Nangare, Dr Neeraj Kumar, Dr K K Meena (Member secretary)

Resource Generation and Farm Produce Price Fixation Committee

Dr Yogeshwar Singh (Chairman), Dr G C Wakchure, FAO, Mr M P Bhendarkar,
Mr Satish Kumar (Member secretary)

Library Advisory Committee

Director (Chairman), All Heads of School, SAO, FAO, Dr. Mahesh Kumar (Member secretary and I/C Library)

Computer/ ARIS cell and instrumentation Committee

Dr Jagadish Rane (Chairman), Dr BB Gaikwad, Dr Parithosh Kumar,
Mr Madhukar Gubbala, and Mr Pravin More (Member secretary)

Institute Joint Staff Council

Director (Chairman), Dr Yogeshwar Singh, Dr G C Wakchaure, FAO, Member CJSC, Secretary IJSC (staff side), AAO (Member secretary)

Proprietary Items Committee

Dr Jagdish Rane (Chairman), Dr Ajay K Singh, Dr BB Gaikwad, Dr Neeraj Kumar (Member secretary)

Sports Committee

Dr Yogeshwar Singh (Chairman), Dr D D Nangare, Dr. Parithosh Kumar, Dr SS Pawar, Mr Sunil Potekar, Mr Lalithkumar Aher and Dr G C Wakchaure (Member secretary)

Rajbhasha Implementation Committee

Director (Chairman), All Heads of Division, Dr. Parithosh Kumar, Dr Aliza Pradhan, Dr A V Nirmale, Satish Kumar (Member Secretary)

Swatch Bharat Implementation Committee

Dr Parithosh Kumar (Chairman), Dr Mahesh Kumar, Dr S S Pawar, Mr Rajkumar, Dr P B Tawre, Mr Sunil Potekar, Smt Noshin Sheikh, Mr Aniket More and Mr Mukesh Bendarkarr (Member secretary)

Vehicle and Transportation Maintenance Committee

Dr Yogeshwar Singh (Chairman), Dr KK Meena, Dr P B Taware, FAO, AAO and Mr Rupesh K. Amargahade (Member secretary)

Guest House Management Committee

Director (Chairman), Dr Jagadish Rane, SAO, FAO, Satish Kumar (Member secretary I/C Guest House)

Institute Biosafety Committee

Director (Chairman), Dr. NP Kurade, Dr M P Brahmane, Dr Neeraj Kumar, Dr Mahesh Kumar, Dr Ajay K Singh (Member secretary),

Public Relation Committee

Dr G C Wakchaure (Chairman), Dr B B Gaikwad, Dr A V Nirmale, Mr Amresh Chaudhary, and Dr D D Nangare (Member secretary)

Grievance Cell

Dr Jagadish Rane (Chairman), Dr Yogeshwar Singh, Dr K K Meena, Dr Neeraj Kumar, Dr Parithosh Kumar, SAO (Member secretary)

RTI Cell

Dr K K Meena (CPIO)

Women Cell

Mr B K Sinha (Chairman), Dr Mahesh Kumar, Dr (Mrs) Aliza Pradhan, Dr (Smt) Priya George and Mrs Purnima S Ghadge (Member secretary)

Abbreviations

APX	Ascorbate Per Oxidase
BOD	Biological Oxygen Demand
CAT	Catalase
CD	Critical Difference
CT	Conventional Tillage
CTD	Canopy Temperature Depression
CTMax	Critical Temperature Maximum
CTMin	Critical Temperature Minimum
DAS	Days After Sowing
ELWL	Excised Leaf Water Loss
FAD3	Fatty Acid Desaturase 3
FCR	Feed Conversion Ratio
FP	Farmers Practice
GA	Gibberellic Acid
HPLC	High Performance Liquid Chromatography
GST	Glutathione-S-Transferase
HSP	Heat Shock Protein
THI	Temperature Humidity Index
ICAR	Indian Council of Agricultural Research
IISR	Indian Institute of Soybean Research
IIHR	Indian Institute of Horticulture Research
IIPR	Indian Institute of Pulse Research
IRC	Institute Research Council
ITMU	Institute Technology Management Unit
KVK	Krishi Vigyan Kendra
MDH	Malate Dehydrogenase
MGMG	Mera Gaon Mera Gaurav
LDH	Lactate Dehydrogenase
LLL	Laser Land Levelling

LSS	Line Source Sprinkler
NDVI	Normalized Difference Vegetation Index
MMR	Maximum Metabolic Rate
NPQ	Non Photochemical Quenching
MPKV	Mahatma Phule Krishi Vidyapeeth
NARS	National Agricultural Research System
NIR	Near Infra Red
NBPGR	National Bureau of Plant Genetic Resources
NIASM	National Institute of Abiotic Stress Management
NRC	National Research Center
NRM	Natural Resource Management
PBRs	Plant Bio Regulators
PGPA	Plant Growth Promoting Activity
PGH	Plant Growth Hormone
OBC	Other Backward Cast
PER	Protein Efficiency Ratio
PME	Priority setting, monitoring and evaluation
RAC	Research Advisory Committee
ROS	Reactive Oxygen Species
RWC	Relative Water Content
SA	Salicylic Acid
SVM	Support Vector Machine
SW	Spent Wash
SOD	Superoxide Dismutase
SCSP	Schedule Caste Sub Plan
TSP	Tribal Sub Plan
WP	Water Productivity