भाकृअनुप
ICAR

Annual Report 2020

राअस्ट्रैप्रसं
NIASM

भाकृअनुप -राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान

ICAR-National Institute of Abiotic Stress Management

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ICAR-NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT

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PREFACE

Abiotic stresses affect agriculture adversely. Evidently the frequency, occurrence, spatial extent and intensity of the abiotic stresses are increasing in the recent decades with severe implications on the national and global food production and value chain. This necessitates intensifying scientific efforts towards management of these stresses through basic and strategic research leading to timely adaptation and mitigation solutions. The ICAR-National Institute of Abiotic Stress Management, established to address the challenges posed by abiotic stresses affecting food production systems, has been aiming to achieve its mandate through its incremental scientific explorations that would lead to insights, foresights and sustainable management options in crop plants, livestock, fish and poultry. In this pursuit, the multidisciplinary team of researchers at ICAR-NIASM has been carrying out several of the scientific explorations along with the institutional building activities.

The Annual Report has highlighted the scientific work carried out by the teams of multidisciplinary researchers at NIASM along with teaching, extension, institutional building and other supporting activities during 2020. This includes the details on research findings and work progress of projects and research activities carried under major research programmes of NIASM. The institute has published 38 research papers, 4 review papers, 3 books, 9 technical bulletins, 3 training manuals and 36 popular articles and extension folders. The institute has started new initiatives such as publications of monthly Project Coordinator, monthly Farm Coordinator and fortnightly Agro Advisories. In COVID pandemics situation, the institute has successfully conducted webinars, events and meetings in virtual mode. The institute received several awards and recognitions and developed external linkages and academic collaborations.

I extend my sincere thanks to Dr Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Sanjay Kumar Singh, Additional Secretary (DARE) & Secretary (ICAR); Shri Bimbadhar Pradhan, Additional Secretary & Financial Advisor (DARE/ICAR); Dr Suresh Kumar Chaudhari, DDG, NRM (ICAR); Dr S Bhaskar, ADG, AAF & CC and Dr. Adlul Islam, ADG, SWM for their continued support and guidance. The contributions of various committees in institute development are highly appreciated. I sincerely appreciate the efforts made by the members of the Publication Committee in compiling this Annual Report.

Date: 31-12-2020

(H Pathak)
Director
ICAR-NIASM, Baramati

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
SA	Salicylic Acid
IFS	Integrated farming System
CIFS	Climate Smart Integrated farming System
IBA	Indole Butyric Acid
IISR	Indian Institute of Soybean Research
IIHR	Indian Institute of Horticulture Research
IIPR	Indian Institute of Pulse Research
IRC	Institute Research Committee
ITMU	Institute Technology Management Unit
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
MOP	Muriate of Pottash
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
SVM	Support Vector Machine
SSP	Single Super Phosphate
SOD	Superoxide Dismutase
SCSP	Schedule Caste Sub Plan
TSP	Tribal Sub Plan
WP	Water Productivity

EXECUTIVE SUMMARY

ICAR-National Institute of Abiotic Stress Management (NIASM) has been working in areas of basic and strategic research for management of abiotic stresses in crops, livestock and fisheries. Abiotic stresses like drought (less moisture), waterlogging, extreme temperature, salinity, acidity, shallow soil, mineral toxicity and nutrient deficiency that have emerged as major challenges for production of crops including horticulture crops, livestock, poultry, fisheries and other commodities. The salient findings of the research studies and activities carried during 2020 along with few other important progresses made under institute and externally funded projects are given below

- The spatio-temporal analysis of seasonal and annual rainfall of 36 districts of Maharashtra, India over 118 years (1901 to 2018) revealed that except Chandrapur, Kolhapur, Latur, Nagpur, Osmanabad, Sangli, Sindhudurg and Solapur, all other districts had significant declining trends of winter rainfall. The rainfall variability was very high in all the districts for winter, pre and post-monsoon seasons.
- During 1951-2015, decreasing rainfall trends in the Terai region of India with monsoon and annual rainfall having higher ENSO teleconnections were observed while the post-monsoon rainfall teleconnection were dominated by IOD.
- Among 22 genotypes of chickpea screened for drought tolerance with local check 'Digvijay' using image based phenotyping method, Genotype D-24 was a promising genotype based on RGB and NIR image derived parameters namely digital area, convex hull area (CHA), boundary point count (BPC) and NIR intensity.
- Soybean genotypes TGX 814-78D, TGX 885-44E, and TGX 854-60A exhibited higher NDVI, cooler canopy and efficient PS-II and higher RWC as compared to check varieties like JS-9752 and JS-7105, when evaluated across 320 genotypes in the phenomics facility for drought adaptive traits.
- Soybean genotypes EC-95815 showed higher plant height, canopy greenness and higher PS-II efficiency as compared to the check variety JS-9752, when evaluated across 100 genotypes in the phenomics facility, for adaptive traits associated with waterlogging tolerance.
- Among three intercropping combinations C1 (Sole soybean), C2 (soybean + pigeon pea), C3 (soybean + maize), soybean crop under C3 during flowering and C2 during pod filling exhibited cooler canopy temperatures whereas C2 exhibited significantly higher crop water use efficiency, soybean equivalent yield and yield attributing parameters, compared to respective rest two intercropping combinations.
- The instantaneous relative water content of a grape leaf can be found using reflectance spectroscopy and a quick model calibration method, which can also delineate the spectral bands affected by the water content of leaf.
- Spatial averaging over 15 m ground resolution improved performance of ML sugarcane growth stage classification models for AVRIS NG hyperspectral airborne sensor, wherein Ridge classifier followed by Logistic regression and XGB Classifier classification algorithms performed better
- Planning and layout of one hectare climate resilient integrated farming system (CIFS) model for semi-arid regions was carried out at ICAR-NIASM campus.
- Sugarcane trash residue retention significantly improved soil DHA activity and is significantly affected by residue burning as it caused more stress to microbial population and lowered their activity in reduced tillage plots as compared to conventional tillage plots.

- Turmeric is sensitive to saline irrigation and can tolerate levels up to 2 dS m^{-1} salinity without affecting yield and physiology of plant. Few varieties like NDH series, Alleppey supreme and Megha turmeric were found tolerant to salinity likely due to its high biomass yielding nature.
- The taxonomic diversity and phylogenetic analysis of genera under Cactacea family carried out revealed that many of the *Opuntia* endophytes screened, exhibit multiple PGPA traits specifically 55.12 % for siderophore production, 62.17% for phosphate solubilisation activity and 45.51 % for Nitrogen fixation activity.
- PBRs *viz.* KNO_3, Thiourea and Salicylic acid enhanced bulb yield (10.1-25.1%), dry matter content (15-34.4%) and reduced di-centre bulbs by 22-39.8% in cv. Bhima Kiran Onion variety.
- The preliminary results obtained in field experiment conducted to study responses of sulphur sources for enhancing storage quality of onions indicated the bensulf (100%) to be better for enhancing the yield and post-harvest storage quality of onion.
- Seeds of Quinoa and Chia (Black and white) subjected to mutation by exposing it to three levels of radiation intensity of gamma radiation viz. 150, 250 & 350 Gy and 400, 500 & 600Gy respectively, showed delayed germination, reduced seedling height, root length and leaf development with increasing irradiation dose. Further, morphological variations were observed for foliage colour, panicle shape, flower types and colour, branching habit in mutant lines.
- About 196 germplasm/ genotypes/ accessions of different crops were collected from several organizations, with objective to create the genetic garden of abiotic stress tolerant plants at ICAR-NIASM.
- The preliminary studies on floral biolgy in dragon fruit revealed that the continuos and heavy precipitation during night and day time (If antheis period coincide) causes flower and fruit drop and also reduction in fruit size due to pollen wash and insufficient pollen grains for pollination.
- Exogenous application of IBA @ 8000 ppm enhances rooting in Dragon fruit (Hylocereus undatus) cuttings with significant earliness in root initiation (23 days), higher number of roots and fresh root weight over those treated with lower concentrations, as well as untreated cuttings.
- Planting of sugarcane in zigzag paired row (225 × 75 cm) with sub-surface drip irrigation and crop residue mulching significantly enhanced cane yield (151.2 t ha^{-1}); followed by zigzag paired row (240 ×60 cm) planting with subsurface drip irrigation (142.5 t ha^{-1}) over the conventional method of planting (97.8 t ha^{-1}).
- The lower values of haemoglobin in Sangamneri goats were found associated with higher comparative prevalence of goat sucking lice (*Linognathus stenopsis*) during the period of evaluation.
- Four species of fruitfly *viz. Bactrocera dorsalis, B. correcta, B. zonata*, and *B. cucurbitae* were identified as major fruit fly in dragon fruit orchards using Methyl eugenol parapheromone traps.
- Culturing of black soldier fly (BSF), Hermetia illucens L. (Stratiomyidae: Diptera) was carried out for its exploration as novel protein source for poultry and fish.
- The theoretical design of thermal control chamber for poultry was done with goal to allow closed loop regulation of higher ambient temperature and humid conditions and induce thermal stress to the poultry for experimental investigations.
- The thermal heat stress determined using threshold at 27.8 THI for poultry was found to be moderate during February, August and November; and severe across March to July and September and October months of year at experimental site of ICAR-NIASM.

- Nile tilapia (*Oreochromis niloticus*) did not survive in the saline water and above 15 ppt salinity level treatments for a period more than 2 days.
- Arsenic pollution and high temperature reduced the growth performance, anti-oxidative status and immunity of the fish but dietary RF mitigated it in *Pangasianodon hypophthalmus.* A combination of Se-NPs and RF has the potential to mitigate the stresses of high temperature and air pollution. Dietary supplementation of Se-NPs @ 0.2 mg kg^{-1} diet and EPA+DHA @ 0.4% kg^{-1} diet enhanced the thermal tolerance and protected the fish against arsenic pollution and thermal stress.
- Study on *Anabas testudineus* concluded that the acute and chronic toxicity of Cr enhanced with low pH and high temperature and it lead to understanding the multiapproach of Cr toxicity which affect on stress biomarkers, cellular metabolic stress and thermal tolerance of *A. testudineus.*
- The metal removal capacity for Fe, Mn, Zn, Cu, Cd, Cr, Pb and Ni was obserbed to more than 90% for all the metals across all treatments of horizontal (HSSF-CWs) and vertical (VSSF-CWs) sub-surface flow based constructed wetland system. Five marigold varieties showed metal tolerance with no significant difference in yields for both HSSF-CWs and VSSF-CWs systems of constructed wetlands.
- The major abiotic stresses observed in livestock of drought prone areas were heat and nutritional stress. Anaemia in animals was found to be the significant monitorable indicator of nutritional stress in livestock, which may be used for monitoring during mitigation of drought like scenarios.
- The online survey conducted to understand the farmers sentiments during Covid Lockdown period in the state of Maharashtra revealed that lack of agriculture produce processing and storage facilities; non-availability of seeds, fertilizers, labour and consumers; temperature stress (abiotic stress) and disease and pest incidence (biotic stress) in field crops were the major challenges faced during lockdown period.
- Majority of the farmers did not plan taking next crop due to less assured produce price, profitability; credit non-availability; labour non-availability and more risk of Covid infection. Challenges of climatic uncertainties and less mechanization were also reported by the respondents as reason for not planning next crop/ taking alternate crop.
- The online survey conducted to understand the sentiments during Covid Lockdown period of people involved in fisheries as business in India revealed that lack of transportation facilities, less demand in the market, non-availability of fish seed, fish meal, other equipment, labour and technical support were the major challenges faced during lockdown period.
- The field survey conducted to access impact of heavy rain and flood during October 11-15, 2020 on crop, animal and fishery in affected villages nearby Bhigwan and Indapur areas of Pune District of Maharashtra revealed that there was considerable loss to the farmers in terms of agricultural and horticultural crop, and losses related to livestock components, infrastructure and disruption of social amenities.
- ITKs for insect pest management in maize, chickpea, wheat, mustard and rice were identified and reported.
- Under Scheduled Caste Sub Plan (SCSP) activities of Seed and fertilizer distribution to identified beneficiaries from Pune and Ahmednagar districts of Maharashtra were carried out.
- Under Tribal sub plan (TSP) activities of seed distribution and field visits were carried out in the Navapur Tehsil of Nandurbar district, Maharashtra.

कार्यकारी सारांश

भाकृअनुपराष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान-, फसलों, पशुधन और मत्स्य पालन में अजैविक तनावों के प्रबंधन के लिए बुनियादी और रणनीतिक अनुसंधान के क्षेत्रों में काम कर रहा है। अजैविक तनाव जैसे कि सूखा (कम नमी), जलभराव, अत्यधिक तापमान, लवणता, अम्लता, उथली मिट्टी, खनिज विषाक्तता और पोषक तत्वों की कमी इत्यादि से मुख्य फसलें, बागवानी फसलें, पशुधन, मुर्गी पालन, मत्स्य पालन और अन्य वर्ग के उत्पादन में कमी एक प्रमुख चुनौती हैं| 2020 के दौरान संस्थान और बाह्य वित्त पोषित परियोजनाओं के तहत किए गए शोध अध्ययन और गतिविधियों के मुख्य निष्कर्ष नीचे दिए गए हैं|

- महाराष्ट्र के सभी जिलों की 36118 वर्षो की वर्षा के विश्लेषण में पाया गया की चंद्रपुर (2018-1901), कोल्हापुर, लातूर, उस्मानाबाद, नागपुर, सांगली, सिंधुदुर्ग और सोलापुर के अलावा सभी जिलों में सर्दियों में होने वाली वर्षा में गिरावट की प्रवृत्ति है। साथ ही साथ सभी जिलों में सर्दी, मॉनसून से पूर्व और मॉनसून के उपरांत होने वाली वर्षा में परिवर्तनशीलता बहुत अधिक दर्ज की गयी।
- के दौरान भारत के तराई क्षेत्रों की वर्षा में गिरावट की प्रवृत्ति रही है। इसके साथ इस क्षेत्र की मॉनसून ऐंवम 2015-1951 वार्षिक वर्षा पर एन्सो और मॉनसून के उपरांत होने वाली वर्षा पर आईओडी का अधिक प्रभाव होता है।
- छवि पर आधारित फेनोटाइपिंग विधि का उपयोग करते हुए सूखा के प्रति सहिष्णुता के लिए वीभिन्न छवि व्युत्पन्न मापदंडों जैसे की डिजिटल बायोमास, कॉन्वैक्स हल एरिया (सीएचए), और NIR की तीव्रता के आधार पर किए गए मूल्यांकन में चने के 22 जीनोटाइप्स में से 'दिग्विजय' की तुलना में D -24 एक आशाजनक जीनोटाइप पाया गया। फिनोमिक्स का उपयोग कर 320 सोयाबीन जीनोटाइप्स का मूल्यांकन सूखे के प्रति अनुकूली लक्षणों के लिए किया गया जिसमे JS-9752 एवं JS-7105 की तुलना मे TGX 814-78D, TGX 885-44E एवं TGX 854-60A मे उच्च एनडीवीआई, कम केनोपी तापमान, अच्छी PS-II दक्षता और उच्च RWC पाया गया।
- फिनोमिक्स की सहायता से 100 सोयाबीन जीनोटाइप्स का जलजमाव सहिष्णुता के साथ जुड़े अनुकूली लक्षण के लिए किए - गए मूल्यांकन से पता चला कीEC-95815 में JS-9752 (चेक किस्म की तुलना में पौधे की ऊंचाई (, कनोपी मे हरापन और PS-II दक्षता ज्यादा पाई गई।
- तीन अंतर फसल संयोजना -; C1 (केवल सोयाबीन(, C2 (सोयाबीन (अरहर +, C3 (सोयाबीन में (मक्का +, पुष्पन अवस्था के दौरान C3 के तहत और फली भरने की अवस्था के दौरान C2 के तहत सोयाबीन फसल की कम कैनोपी तापमान देखे गए, जबकि फसल जल उपयोग दक्षता, सोयाबीन के बराबर उपज और पैदावार के लिए संबंधित पैरामीटर, C2 में बाकी दो अंतर - फसल संयोजनों की तुलना में अधिकतम पाया गया।
- अंगूर के पत्ते की तात्कालिक सापेक्ष पानी की मात्रा परावर्तित स्पेक्ट्रोस्कोपी एवं मॉडल अंशांकन विधि का उपयोग करके पाई जा सकती है। यह विधि सापेक्ष पानी की मात्रा से प्रभावित होने वाले स्पेक्ट्रल बैंडों को भी सीमांकित कर सकती है।
- एवीआरआईएस एनजी हाइपरस्पेक्ट्रल एयरबोर्न सेंसर के लिए मशीन लर्निंग आधारित गन्ना विकास चरण वर्गीकरण मॉडल के प्रदर्शन में सुधार, मीटर जमीनी विभेदन की औसत करने पर पाया गया 15, जिसमें रिज क्लासिफायर के बाद लॉजिस्टिक रिग्रेशन और एक्सजीबी क्लासिफायर वर्गीकरण एल्गोरिदम ने बेहतर प्रदर्शन किया।
- अर्ध) शुष्क क्षेत्रों के लिए एक हेक्टेयर जलवायु एकीकृत कृषि प्रणाली-CIFS) मॉडल की योजना और लेआउट आईसीएआर-एनआईएएसएम परिसर में विकसित किया गया।
- गन्ने के अवशेष मिट्टी के ऊपर रहने से मिट्टी के डीएचए गतिविधि में काफी सुधार हुआ है और अवशेषों को जलाने से मिट्टी के डीएचए काफी प्रभावित होता है| माइक्रोबियल आबादी पर इसके अधिक तनाव के कारण पारंपरिक जुताई के जमीनोंखेती की / खेतो में डीएचए गतिविधि कम पाई गई।/तुलना में कम जुताई वाले जमीनों
- हल्दी लवणीय सिंचाई के प्रति संवेदनशील है और पौधे की उपज और शरीर विज्ञान को प्रभावित किए बिना 2 डीएस एम -1 लवणता तक के स्तर को सहन कर सकती है। NDH श्रृंखला, एलेप्पी सर्वोच्च और मेघा हल्दी जैसी कुछ किस्मों को इसकी उच्च बायोमास उपज प्रकृति के कारण लवणता के प्रति सहिष्णु पाया गया।
- कैक्टेसिया परिवार के तहत जेनेरा की टैक्सोनोमिक विविधता और फ़ाइलोजेनेटिक विश्लेषण से पता चला है कि कई ओपुंशिया पादप अधि:के अंत (नागफनी)ग्रहीत फसल वृद्धि लक्षण)PGPA) दिखाते हैं, विशेष रूप से वर्तमान शोध में साइडरोफोर उत्पादन के लिए)55.12%), फॉस्फेट घुलनशीलता गतिविधि के लिए)62.17)% और नाइट्रोजन निर्धारण गतिविधि के लिए)45.51%) अंतपादप पाए गए है।:
- प्याज की भीम किरण किस्म में प्लांट बायोरेग्युलेटर अर्थात KNO_3, थायोयूरिया और सलिसिलिक एसिड से प्याज की पैदावार)10.1-25.1%), शुष्क पदार्थ की मात्रा)15-34.4%) से बढ़ी और दो- हिस्सों में तयार होने वाले प्याज में 22-39.8% तक कि घटोती पाई गई।
- प्याज के भंडारण की गुणवत्ता को बढ़ाने के लिए सल्फर स्रोतों की प्रतिक्रियाओं का अध्ययन करने के लिए किए गए क्षेत्र प्रयोग में प्राप्त प्रारंभिक परिणामों से पता चला है कि बैंसल्फ़ (%100) प्याज की पैदावार और भंडारण की गुणवत्ता को बढ़ाने के लिए बेहतर है।

- क्विनोआ और चिया के बीज को गामा विकिरण के तीन स्तर से क्रमशः (काले और सफेद)150, 250 और 350 Gy और 400, 500 और 600Gy से उजागर द्वारा उत्परिवर्तन करने उपरांत सामान्य बीजों के साथ खेत में बोया गया। इन में विलंबित अंकुरण (जंगली प्रकार), पौधों के अंकुर की ऊंचाई, अस्वाभाविक रूप से पत्ती के विकास और अंकुर की मृत्यु दर उत्परिवर्ती पोधों में देखी गई। इसके अलावा उत्परिवर्ती पौधों में फफूंद के रंग, पुष्पगुच्छी के आकार, फूलों के प्रकार और रंग, रेखाओं में रूपात्मक विविधताएं भी देखी गई।
- आई.सी.ए.आरएन-.आई.एएस.एम में अजैविक तनाव सहिष्णु पौधों के आनुवंशिक उद्यान बनाने के उद्देश्य से कई संगठनों से लगभग विभिन्न फसलों के 196 जर्मप्लाज्म / किस्मों एकत्र किए गए थे।
- ड्रैगन फ्रूट में फूलों की प्रारंभिक अध्ययनों से पता चला है कि रात और दिन के समय निरंतर और भारी वर्षा होने पर फूल और फलों की गिरावट होगा और परागकणों में हानि और अपर्याप्त पराग कणों से फलों के आकार में भी कमी आती है।
- आईबीए @ 8000 पीपीएम मात्रा का बहिर्जात अनुप्रयोग से जड़ बनने कि अवधि)23 दिनघट गई एवं जड़ो और ताजा जड़ भार में विर्धि (पाई गई। इसके साथ ये ड्रैगन फल कटिंग में जड़ को बढ़ाव देता है ।
- ज़िगज़ैग युग्मित पंक्ति)225 × 75 सेमी और 240 x 60 सेमी (में उपसतह टपक सिंचाई और फसल अवशेष के साथ - की गयी गन्ने की रोपाई में पारंपरिक विधि 97.8)टन प्रति हेक्टेयर(से अधिक उपज में वृद्धि 151.2 और टन प्रति हेक्टेयर 142.5, क्रमश : पायी गयीहै।
- संगमनेरी बकरियों में रक्तकणरंजकद्रव्य के निचले मूल्यों को मूल्यांकन की अवधि के दौरान बकरी में खून चूसने वाले जूँ लिनोग्नथस) की तुलनात्मक व्यापकता के साथ संबन्धित पाया गया। (स्टेनोप्सिस
- मेक्टाइल यूजेनॉल पैराफेरोमोन ट्रैप का उपयोग करके ड्रैगन फ्रूट के बागों में फ्रूटफ्लाईज की चार प्रजातियां फल मक्खी के रूप में बैक्ट्रोसेरा डोर्सलिस, बी सुर्खा, बी जोनाटा और बी कोकुरबिटा की पहचान की गई।
- ब्लैक सिपाही फ्लाई की खेती (बीएसएफ), हेर्मेटिया ने एल को पोल्ट्री और मछली के लिए उपन्यास प्रोटीन (डिप्टेरा :स्ट्रैटोमीडीए) स्रोत के रूप में खोज के लिए चलाया।
- मुर्गियों के लिए थर्मल कंट्रोल चैंबर का सैद्धांतिक डिजाइन उच्च परिवेशी तापमान और आर्द्र स्थितियों के बंद लूप विनियमन की अनुमति देने के लक्ष्य के साथ किया गया जिससे प्रयोगात्मक जांच के लिए मुर्गियों में थर्मल तनाव प्रेरित किया जा सके।
- मुर्गियों में गर्मी के तनाव का मापन किया गया, जिसमे टीएचआई २७८ को सीमांकित करके यह पाया गयी की फरवरी., अगस्त और नवंबर के दौरान गर्मी का तनाव मध्यम रेहता है; मार्च से जुलाई तक और सितंबर से अक्तूबर के दौरान गंभीर पाया जाता है। यह प्रयोग आईसीएआर-एनआईएएसएम की प्रायोगिक मुर्गी फार्म मे किया गया।
- नाइल तिलापिया खारा पानी और (ओरोक्रोमिस निलोटिकस)15 पीपीटी खारापन स्तर में 2 दिनों से अधिक की अवधि से ऊपर नहीं बच पाया।
- आर्सेनिक प्रदूषण और उच्च तापमान विकास प्रदर्शन, एंटीऑक्सीडेटिव स्थिति और मछली की प्र-तिरोधक क्षमता को कम करता है, लेकिन राइबोफ्लेविन आहार ईश प्रभाव को पंगासियानोडोन हाइपोफथाल्मस मछली में कम करता है। सेलेनिउम नैनोपार्टिकल्स की दर और इकोसापेंटेनोइक एसिड आहार के संयोजन से उच्च तापमान और आर्सेनिक प्रदूष (डीएचए) और डोकोसाहेक्सैनोइक एसिड (ईपीए)ण के तनाव को कम करने की क्षमता है। सेलेनियम नैनोपार्टिकल्स 0.2 मिलीग्राम किग्रा -1 और ईपीए डीएचए +0.4% किग्रा -1 आहार की दर से पूरक आहार ने थर्मल सहनशीलता को बढ़ाया और आर्सेनिक प्रदूषण और थर्मल तनाव के खिलाफ मछली की रक्षा की।
- एनाबस टेस्टुडाइनस पर किए गए अध्ययन में निष्कर्ष निकाला गया है कि क्रोमियम का तीव्र और पुराना विषाक्तता कम पीएच और उच्च तापमान के साथ बढ़ा है और यह क्रोमियम विषाक्तता के मल्टीपायरोच को समझने की ओर ले जाता है जो तनाव बायोमार्कर, सेलुलर चयापचय तनाव और एनाबस टेस्टुडाइनस के थर्मल सहिष्णुता को प्रभावित करता है।
- संस्थान में प्रयोगिक स्टार पर विभिन्न जल प्रदूषक तत्त्वोंका उपचार एवं व्यावसायिक फूल वाले पौधों के वृद्धि हेतु निर्मित क्षैतिज और ऊर्ध्वाधर आद्य भूमी की क्षमता का परीक्षण किया जा रहा है। आद्यभूमी के निर्माण के लिए भरे गए विभिन्न मीडिया द्वारा धातु मिस्तरित सेप्टिक टैंक के गंदे पाने की उपचार क्षमतासभी धातुओं जैसे लोहा, ज़िंक, मंगेनीज , तांबा, क्रोमियम निकेल, कैडमियम, लेड के लिए 90 चारकोल भरे गये आद्यभूमी की उपचार क्षमता सबसे जादा पाई + प्रतिशत से अधिक पाई गई एवं उनमे ग्रेवल और ग्रेवलगई। इन आद्यभूमि में उगाये गये गेंदों के पाँच प्रजातियों में अस्टगंधा एवं कोलकाता पीला में फूल उत्पादन सबसे अधिक पाया गया।
- सूखा प्रभावित क्षेत्रों के पशुधन में मनाया जाने वाला प्रमुख अजैविक तनाव गर्मी और पोषण संबंधी तनाव था। पशुओं में एनीमिया को पशुधन के पोषण संबंधी तनाव का महत्वपूर्ण निगरानी सूचक पाया गया, जिसका उपयोग परिदृश्य की तरह सूखे के शमन के दौरान निगरानी के लिए किया जा सकता है।
- महाराष्ट्र राज्य में कोविड लॉकडाउन अवधि के दौरान किसानों की भावनाओं को समझने के लिए किए गए ऑनलाइन सर्वेक्षण से पता चला कि कृषि उपज प्रसंस्करण और भंडारण सुविधाओं की कमी; बीज, उर्वरक, श्रम और उपभोक्ताओं की अनुपलब्धता; तापमान तनाव लॉकडाउन अवधि के दौरान किसानों के लिए प्रमुख (बायोटिक तनाव) और खेत की फसलों में रोग और कीट घटना (अजैविक तनाव) चुनौतियां रही ।

- अधिकांश किसानों ने कम सुनिश्चित उपज मूल्य, लाभप्रदता, ऋण की अनुपलब्धता; गैरउपलब्धता और कोविड संक्रमण का अधिक जोखिम - के कारण अगली फसल लेने की योजना नहीं बनाई थी| जलवायु अनिश्चितताओं और कम मशीनीकरण की चुनौतियां भी उत्तरदाताओं द्वारा अगली फसल की योजना नहीं बनाने वैकल्पिक फसल लेने क /ी कारण बताई गई थीं।
- भारत में व्यापार के रूप में मत्स्य पालन से जुड़े लोगों के कोविड लॉकडाउन दौरान भावनाओं को समझने के लिए किए गए ऑनलाइन सर्वेक्षण से पता चला कि परिवहन सुविधाओं की कमी, बाजार में कम मांग, मछली के बीज की अनुपलब्धता, मछली का भोजन, अन्य साधनों की कमी, कम श्रमिक और तकनीकी सहायता इ० लॉकडाउन अवधि के दौरान प्रमुख चुनौतियां थीं।
- भारी बारिश और बाढ़ से प्रभावित महाराष्ट्र के पुणे जिले के भिगवान और इंदापुर क्षेत्रों के आसपास के प्रभावित गाँवों का सर्वेक्षण १११५ - अक्टूबर, २०२० के दौरान किया गया| सर्वेक्षण से पता चला कि फसल, पशु और मत्स्य पालन क्षेत्र में किसानों को नुकसान हुआ| इसके साथ ही कृषि और बागवानी फसले, पशुधन घटक, बुनियादी और सामाजिक सुविधाओं के संबंधित घटकों का बहुत नुकसान हुआ।
- मक्का, हरबरा, गेहूं, सरसों और चावल में कीट प्रबंधन के लिए स्वदेशी तकनीक या ज्ञान की पहचान और रिपोर्ट की गई।
- अनुसूचित जाति उप योजना के तहत महाराष्ट्र के पुणे और अहमदनगर जिलों के उचित लाभार्थियों को बीज और उर्वरक (एससीएसपी) वितरण की गतिविधियों को अंजाम दिया गया।
- जनजातीय उप योजना के तहत बीज वितरण और क्षेत्र के दौरे की (टीएसपी) गतिविधियां नंदुरबार जिले, महाराष्ट्र के नवापुर तहसील में की गईं।

INTRODUCTION

Adverse impacts of abiotic stresses on agriculture have been increasing in the recent decades, which have affected the food production value chain. As projected by several scientific studies, these adverse conditions are likely to increase in temporal and spatial scale, which further necessitates intensifying scientific efforts tailored towards producing timely adaption and mitigation solutions. Though the pursuit to address several of these challenges need not only the scientific endeavor backed by pragmatic policy support, the hindsight of factors that resulted in these aggravations, along with insight of ground realities and foresight through pertinent simulation studies would be needed for planning current strategies of research, education and extension. Since majority of the country's area affected by abiotic stressors is also hit by socio-economic constraints, there is a dire need of a well-planned basic and strategic research for management of 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), established on February 21, 2009 as one of the national institutes under Indian Council of Agricultural Research (ICAR) has been working diligently in areas of basic and strategic research for management of abiotic stresses.

In addition to the abiotic stresses like drought, extreme temperatures, water stagnation, salinity, acidity, mineral toxicity and nutrient deficiency that have emerged as major challenges for production of crops, livestock, fisheries and other commodities, the world has been also facing the challenges arisen due to covid pandemic. Management of abiotic stress has been a greater challenge amid covid pandemic that has compelled to rethink the approaches and retailor the advances in dealing them, particularly with limited logistics and human workforce. Agriculture forestry and fisheries being the only sector registering positive growth rate during the COVID-19 pendamic year of 2020 for the Indian economy, has reaffirmed the fact that "Everything can wait but not the Agriculture". However, despite the fact, the much-needed resilience in agriculture can only be maintained and enhanced with continued research and extension efforts that are tailored to tackle the dynamic challenging situations arising particularly due to increasing climatic aberrations, shifting seasons and market price fluctuations of agriculture commodities. It is utmost important to reorient the research for abiotic stress management in agriculture and allied sectors to tackle these increasing dynamic challenges and thus ascertain resilience for sustenance and profitability. Considering the dynamic abiotic constraints facing the country, ICAR-NIASM formulated four new umbrella and four new flagship research projects, besides renaming schools with reframed objectives, restructuring of institutional committees and online surveys to understand ground scenarios as a step to reorient and strengthen research at ICAR-NIASM. This should lead to timely management solutions to few anticipated abiotic stress scenarios of the country. The challenging times of COVID lockdown enabled quick adoption of online tools for office communications, complete implementation of e-office and several scientific discussions through the series of webinar conducted online with the newly formulated research projects. A glimse of the research, teaching and extension work carried out in the Institute during the year 2020 is presented in this Annual Report.

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 implemented important research programmes in a thematic mode through four schools, namely Atmospheric Stress Management, Water Stress Management, Soil Stress Management and Policy Support Research. The institute has 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 has been taking efforts to complement the ongoing Research and Development under National Agricultural Research and Educaton System (NARES). The institute also aims 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

Managing abiotic stresses for sustainable agriculture.

Mandate

1. Basic and strategic research to manage abiotic stresses in crops, livestock and fisheries.
2. Repository of information on abiotic and biotic stresses, adoption and mitigation strategies and policies.
3. Building sustainable agriculture in multi-stressed ecosystem.
4. Serve as Centre of Academic Excellence in managing multiple stresses in agriculture.

Objectives

1. Assess the vulnerability of crops, horticulture, livestock, fisheries and microbes to abiotic stresses.
2. Develop technologies and policies for adaptation and mitigation of atmospheric, water and soil stresses with frontier science.
3. Develop respository of information on abiotic stress management for climate-smart agriculture.
4. Establish Centre of Academic Excellence for human resource development to manage multiple stresses in agriculture.

Strategy

A six-point hexagonal interlinked strategy is adopted to enhance effectiveness of research, extension and academic activities (Fig. 1.1). It includes defining of targets environments, adaptive techniques, mitigation strategies, policy support and synergies through networking.

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,

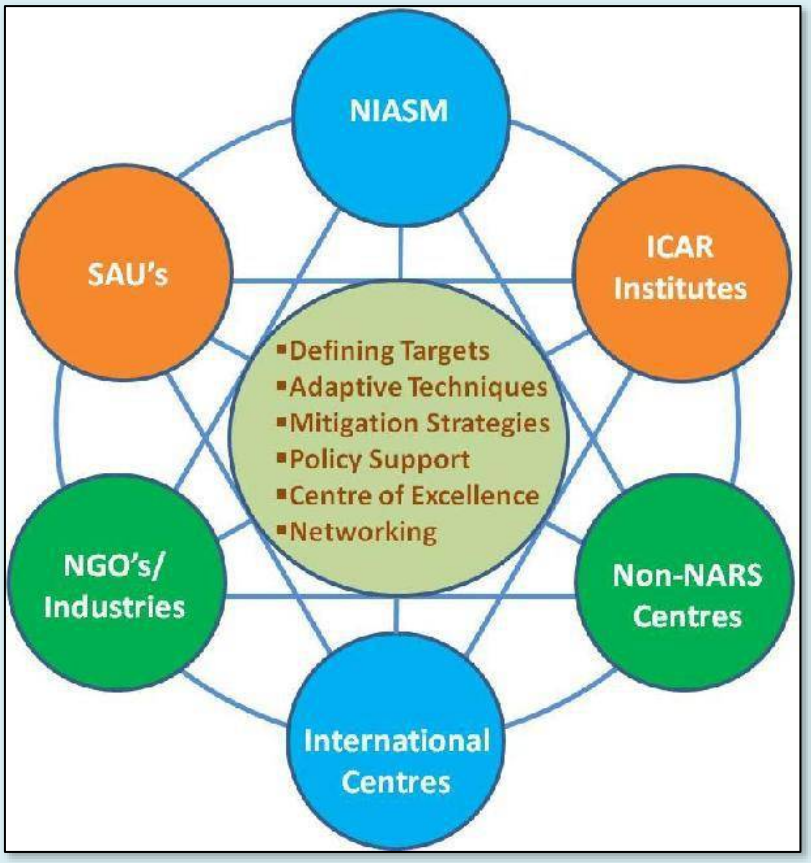


Fig. 1.1. Institute's strategy for achieving the mandate.

livestock and fisheries. This will be facilitated by continuing efforts for 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. 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

In the XI Five Year Plan, the Union Cabinet approved the proposal of Ministry of Agriculture, Govt. of India to establish "National Institute of Abiotic Stress Management (NIASM)" 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-Admin block and two school buildings. 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 30, 12 and 6, respectively. Thus the filled up cadre strength is 51 against 104 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, 2020.

Cadre	Sanctioned	Filled	Vacant
RMP	01	01	0
Scientific	50	29	21
Technical	33	12	21
Administrative	20	05	15
Grand Total	**104**	**47**	**57**

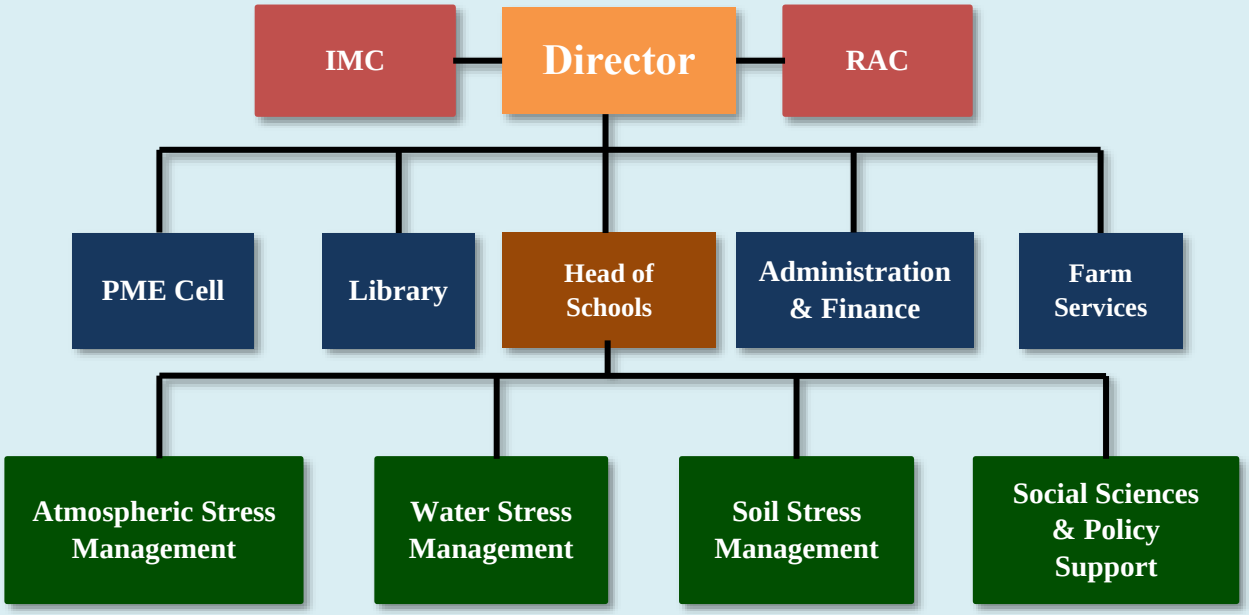


Fig. 1.2 Organogram of the institute.

Research Programmes of the Institute

School of Atmospheric Stress Management

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

School of Water Stress Management

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

School of Soil Stress Management

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

School of Social Science and Policy Support

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

2. WEATHER AT ICAR-NIASM, BARAMATI

Information on weather is of paramount importance for agriculture production. Observations of weather parameters are being recorded at Institute on regular basis since its establishment. Observations recorded during January to December 2020 are discussed below.

Temperature

The long period average of annual mean temperature of Baramati is 26.3 °C. The monthly mean temperature during different months recorded at ICAR-NIASM is presented in Fig. 1. During this year, annual mean temperature was 25.8 °C and the monthly mean temperatures varied between 21.8°C (January) to 30.8°C (May). The monthly mean temperature increased linearly from January to May followed by reduction to 25.6°C in August, due to cooling effect of the monsoon winds. A slight increase was also observed in the month September (26.7°C), after which it started decreasing and attained a value of 22°C in December. Monthly maximum temperature reached its peak in May (39.0°C) and dipped to 29.5°C in January. For minimum temperature, May recorded the maximum (22.5°C) and December recorded the minimum (14.1°C) values (Table 1).

Relative Humidity

Relative humidity measured, at standard hours in the morning (0700 LMT) and afternoon (1400 LMT), during the year 2020 were used for computation of monthly statistics. Monthly mean relative humidity during the different months has been depicted in Fig. 1. Relative humidity at morning varied between 64% (April) and 92% (August and October). On the other hand, variation in afternoon relative humidity was between 20 % (April) to 69 % (July and August). 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 64 % and ranged between 42 % to 80 %. Higher diurnal ranges (more than 40%) in RH were observed in January, February, April, May and November. The lowest diurnal range was observed in July (21%) followed by August (23%).

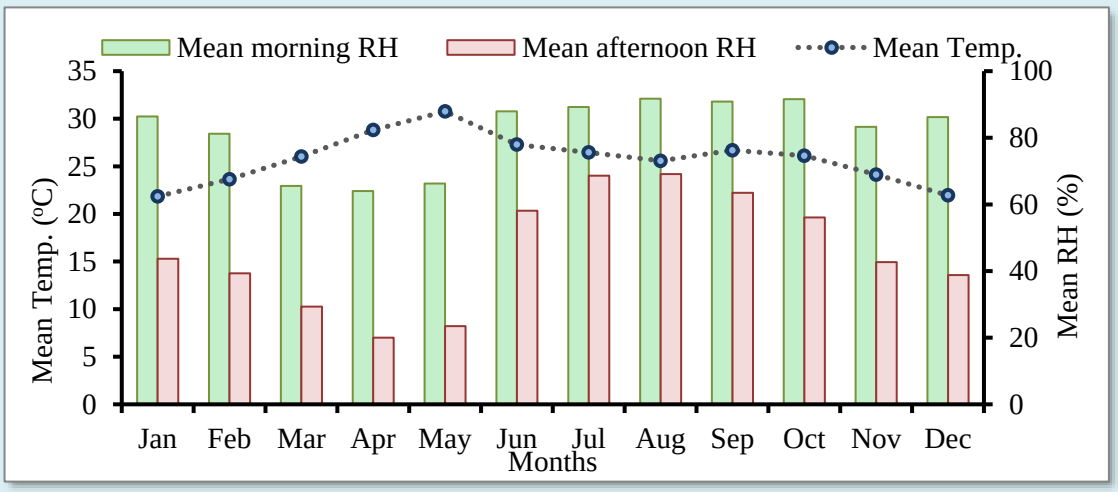


Fig. 1.3 Variations of monthly mean temperature, mean morning and afternoon relative humidity during 2020 at ICAR-NIASM Baramati.

Rainfall

The long period average annual total rainfall of Baramati is 576.0 mm with an average of 34 rainy days per year. This year, Baramati received about 177% of its average annual rainfall, distributed among 55 meteorological rainy days, which yielded 1017.4 mm of total rainfall in 2020. The monthly cumulative rainfall during different months recorded at ICAR-NIASM, Baramati has been given in Fig. 2. During the monsoon season the maximum rainfall was received in October (283.0 mm), followed by September, June and July (Table 1). In the monsoon season, there were 40 rainy days with total rainfall of 653.4 mm, which is164% of normal rainfall of the region during the monsoon season. Late withdrawal of monsoon resulted in incessant rains during October. In the post-monsoon season, highest rainfall occurred in October (283.0 mm) and during the summer season, 81 mm of rainfall was received (Fig. 1.4).

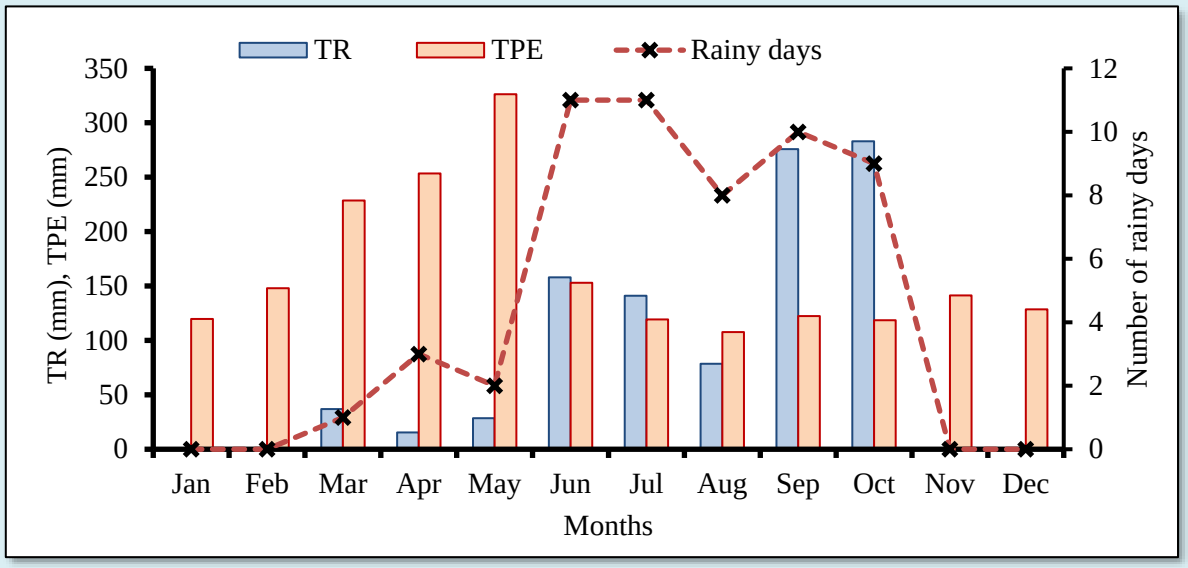


Fig 1.4. Variations of monthly total rainfall (TR), total pan evaporation (TPE) and number of rainy days during 2020 at ICAR-NIASM Baramati.

Wind speed, Pan Evaporation and Sunshine Duration

Monthly averages of the wind speed, pan evaporation and bright sunshine hours recorded in this year at ICAR-NIASM are presented in Fig. 1.5. Monthly average wind speed values have been found to vary from 4.4 (January and February) to 9.1 km h^{-1} (June), and the annual average for the daily wind speed stood at 6.3 kmph. It is observed that wind velocity was higher during May-August (>7.5 kmph) compared to the rest of the months (Table 1). Annual total open pan evaporation (TPE) aggregates to 1967 mm, which was around 2 times of the total rainfall of this year. The evaporative demand gradually increased from January and achieved its highest value in May (10.5 mm d^{-1}). It declined thereafter to 3.5 mm d^{-1} in August and from July to December average daily pan evaporation varied between 3.5 to 4.7 mm d^{-1} (Fig. 1.5). The lowest evaporation rate was recorded in August (3.5 mm d^{-1}). The annual average of daily PE was 5.4 mm. During the year, the daily average of bright sunshine duration remained 6.8 hrs and monthly average values have been found to vary between 2.7 hrs (August) and 10.2 hrs (April) (Fig. 1.5).

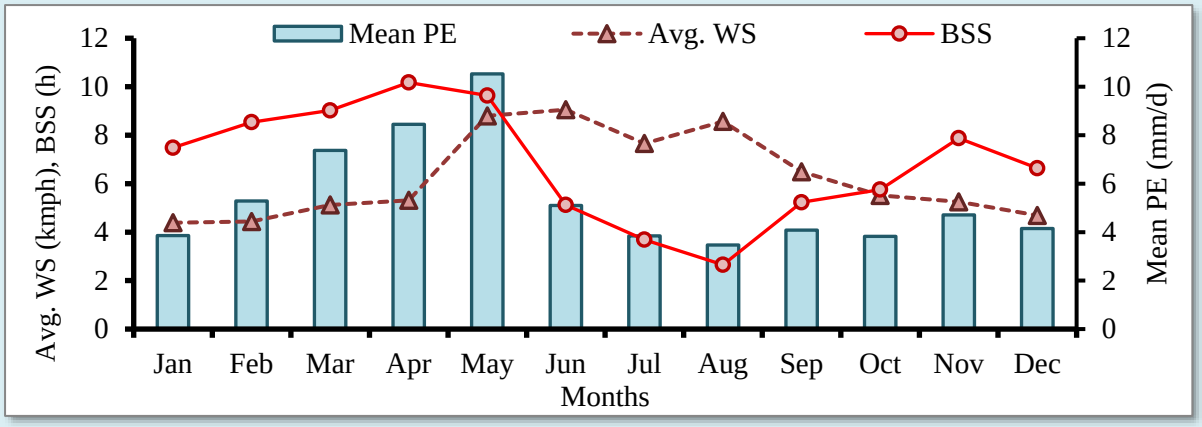


Fig. 1.5. Variations of monthly mean pan evaporation (PE), average wind speed (WS) and mean bright sunshine hours (BSS) during 2020 at ICAR-NIASM, Baramati.

Table 1. Mean monthly weather parameters recorded at ICAR-NIASM from Jan to Dec, 2020

Parameter	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tmax (°C)	29.5	31.5	34.6	37.9	39.0	32.3	30.6	29.6	31.4	31.3	30.9	29.8
Tmin (°C)	14.2	15.8	17.5	19.7	22.5	22.3	22.3	21.6	22.0	20.9	17.4	14.1
RH I (%)	86	81	66	64	66	88	89	92	91	92	83	86
RH II (%)	44	39	29	20	23	58	69	69	63	56	43	39
Avg. WS (kmph)	4.4	4.4	5.1	5.3	8.8	9.1	7.7	8.6	6.5	5.5	5.2	4.7
BSS (h)	7.5	8.5	9.0	10.2	9.6	5.1	3.7	2.7	5.2	5.8	7.9	6.6
Total rain (mm)	0.0	0.0	36.9	15.5	28.6	158.0	141.0	78.6	275.8	283.0	0.0	0.0
Total rainy days	0	0	1	3	2	11	11	8	10	9	0	0
Mean PE (mm d^{-1})	3.9	5.1	7.4	8.5	10.5	5.1	3.8	3.5	4.1	3.8	4.7	4.1

Extreme Weather Observation Recorded in 2020

The extreme weather observations recorded during the year 2020 have been listed in Table 2

Table 2. Extreme meteorological events of the year 2020.

Particular of weather parameter	Value	Date
Highest daily mean temperature (°C)	33.5	26 May 2020
Lowest daily mean temperature (°C)	18.0	23 December 2020
Highest daily maximum temperature (°C)	42.2	26 May 2020
Lowest daily minimum temperature (°C)	8.3	23 December 2020
Highest monthly mean temperature (°C)	30.8	May 2020
Lowest monthly mean temperature (°C)	21.8	January 2020
Highest daily rainfall (mm)	120.4	15 October 2020
Highest monthly cumulative rainfall (mm)	283.0	October 2020
Highest monthly cumulative PE (mm)	326.3	May 2020
Highest rate of daily PE (mm)	13.3	27 May 2020
Highest daily wind speed (km h^{-1})	18.3	4 June 2020

Research Programme-1

2.1 Atmospheric Stress Management

The increasing weather aberrations caused primarily due to atmospheric changes has direct impact on production and productivity of crops, livestock and fisheries and also indirectly due to associated population dynamics of biotic factors such as pest and diseases. The research programme on atmospheric stress management has therefore focused its research activities broadly on understanding the effects of atmospheric stress and developing adaption and mitigation strategies for its management in crops, livestock and fisheries. Thermal stress and monsoons being the most affecting atmospheric phenomenon in arid and semi-arid regions of India, this research programme has its major activities tailored for its assessment and or management. This includes areas of investigating thermos-tolerance in goats, studies on immune response, heat shock proteins and acoustic thermal distress modelling in poultry, spatio-temporal rainfall variability trends, survey studies in drought prone areas and other associated studies. The major research findings emerging out and the progress made under this programme during the past one year is summarized below.

2.1.1 Comparative evaluation of growth, reproduction and thermo-tolerance in different breeds of goats

An experiment was initiated for assessment of comparative growth, production and thermo-tolerance of four breeds of goats (Osmanabadi, Konkan kanyal, Sangamneri and Boer) in different seasons through physiological, haemato- biochemical and genetic parameters.

The lower values of haemoglobin in Sangamneri goats were found associated with higher comparative prevalence of goat sucking lice (*Linognathus stenopsis*) during the period of evaluation (Fig. 2.1). The behavioral, physiological, haematobiochemical parameters and meterological paramaters viz. mean monthly temperature and humidity are being recorded monthly along with the bodily growth parameters at fortnightly interval.

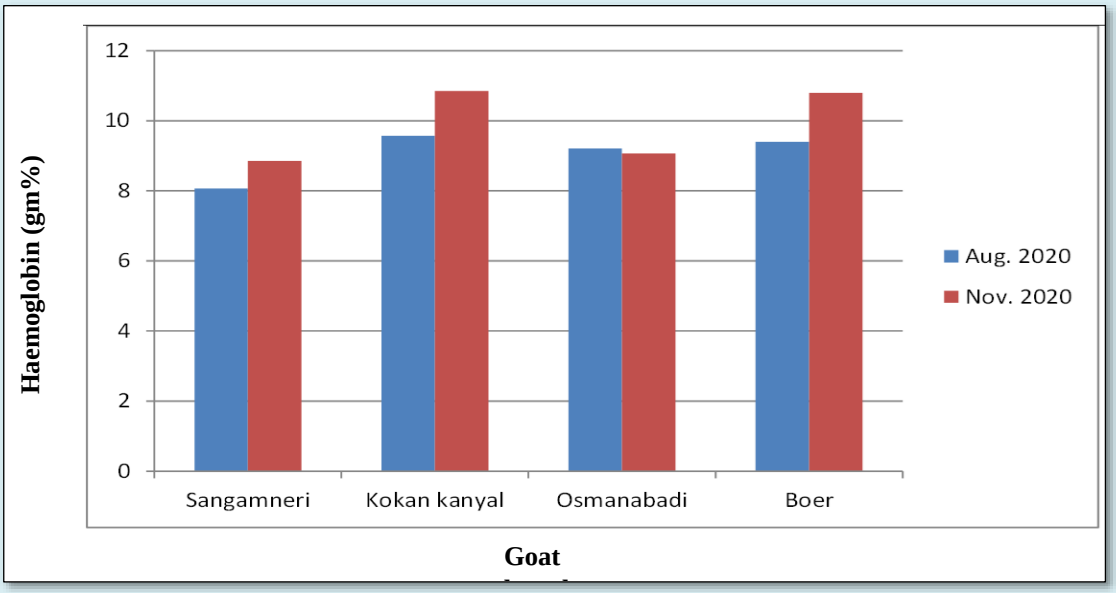


Fig. 2.1. Comparative haemoglobin (gm%) in different breeds of goats.

2.1.2 Studies on Fruit fly dynamics in dragon fruit orchard in relation to climatic variations

B. dorsalis is the major fruit fly in dragon fruit orchards. Study of fruit fly population dynamics in dragon fruit in relation to weather parameters is being carried out, to understand the parameters responsible for its high prevalence. 10 Parapheromone (Methyl eugenol) traps were erected for monitoring of fruit flies (FF) in the dragon fruit orchard during fruiting period (July and August-2020). Four species of FF were recorded i.e. *Bactrocera dorsalis, B. zonata, B. correcta* and *B. cucurbitae*. *B. dorsalis* was found in abundant followed by *B. correcta* and *B. zonata*. Generally *B. cucurbitae* melon fly, is a pest of vegetables *and* is attracted to "Cuelure" but not the "Methyl eugenol", but traps impregnated with "Methyl eugenol" recorded good number of *B. cucurbitae* during July-2020.

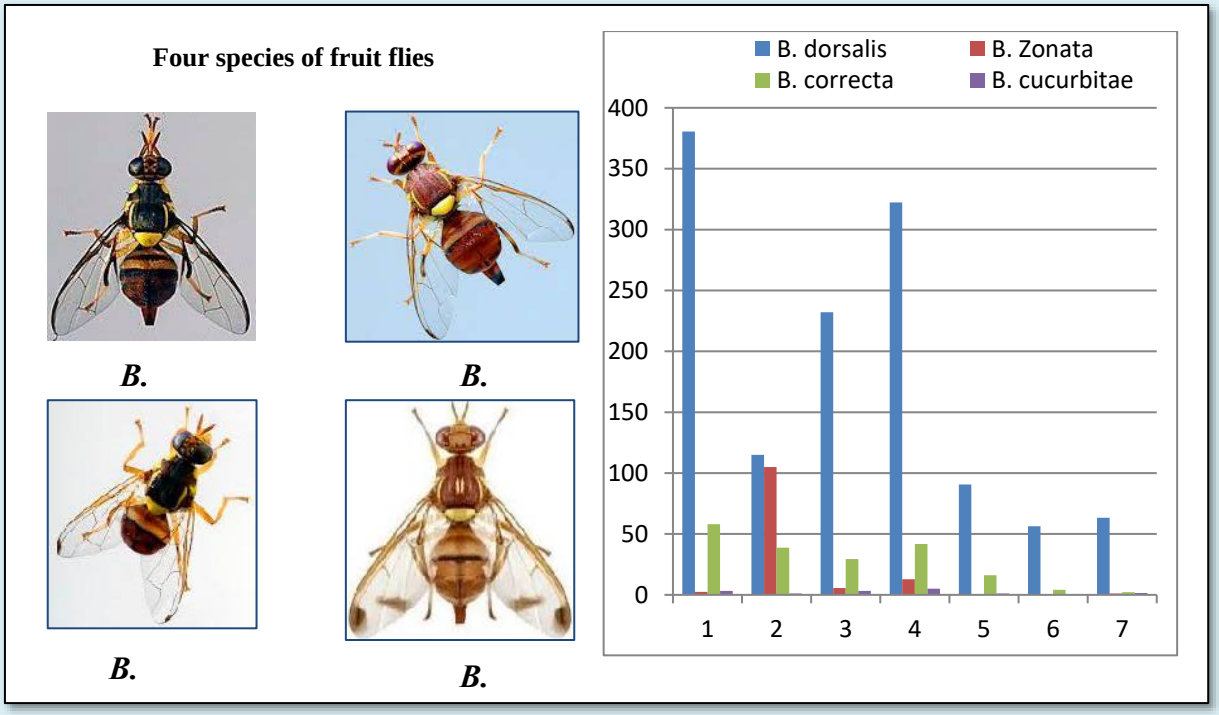


Fig. 2.2: Mean trap catch of different species of dragon fruit

2.1.3 Culturing Black soldier fly (BSF), *Hermetia illucens* L. (Stratiomyidae: Diptera) for its exploration as novel protein source for poultry and fish

The BSF is a harmless insect indigenous to the warm tropical and temperate zones and has ability to convert "food waste" (Fruits, vegetables, Agri-waste and animal tissues) into "high quality protein". The BSF larvae/pupae contain "Protein-40% and Lipids-30%". Therefore BSF has potential to serve as an alternative "Protein" source for animal feed (poultry and fish) and help in convert organic wastes into "fortified, complete manure" for agriculture, However BSF culture on large scale needs standardization in order to serve its perceived potential and make an impact on a larger scale. As part of the goal to achieve standardization of BSF culture, laboratory culture on an experimental basis was taken up. The culture of BSF carried in laboratory conditions is depicted in Fig. 2.3.

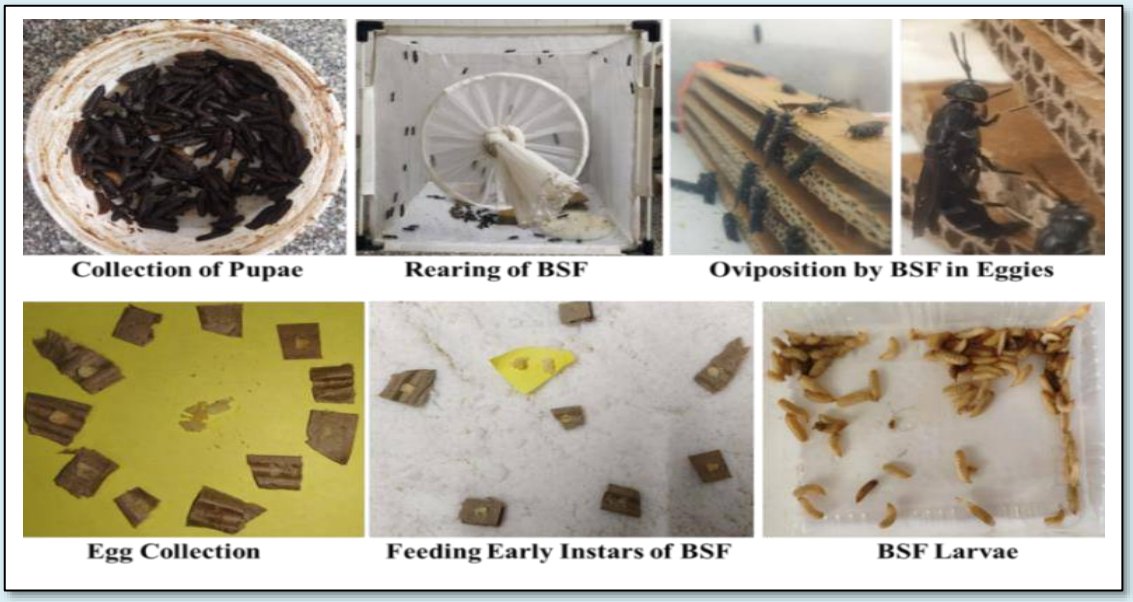
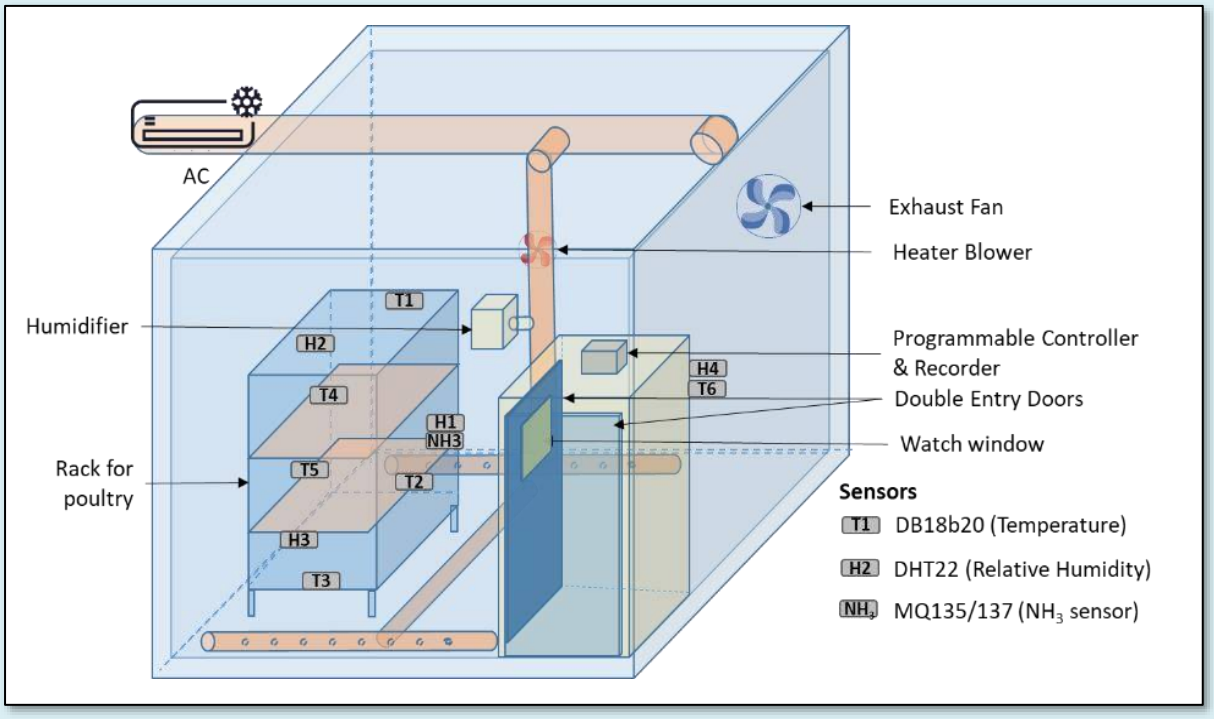


Fig. 2.3: Mass culturing of BSF under laboratory condition.

2.1.4 Experimental layout for modelling of thermal distress sound calls in poultry

The theoretical design of thermal control chamber for poultry was done with goal to allow closed loop regulation of higher ambient temperature and humid conditions and induce thermal stress to the poultry. The hardware (sensor, controller board) and layout have been worked out to allow the closed loop control of ambient temprature and humidity conditions during the growth period of broilers along with recording their sound calls and its ambient environmental parameters viz. temperature, relative humidity and ammonia gas concentration. Poultry birds will be subjected to various levels of temperature and humidty stress combinations and their distress sound calls will be recorded and modelled for its classification into various distress signals through pattern matching.



2.1.4.1 Thermal stress assessment in poultry birds during different months

In sub-tropical country like India where summer is severe and with recent increase in extreme heat wave events, enhancing poultry productivity remains a major challenge. Earlier development of modern poultry genotypes for higher production at optimal temperature is becoming a major concern for poultry production during summer. A study was carried out to evaluate the level of thermal stress risk in poultry birds during the entire year. Temperature humidity index (THI) was taken as the indicator for thermal stress assessment. 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 different months of the year. The stress threshold was determined at 27.8. The THI of 27.8-28.8 is considered as moderate, 28.9-29.9 as severe and ≥30 was determined as very severe heat stress. The recommended normothermia zone for poultry is 18-22 °C. In the present study, it was observed that during January and December there was absence of heat stress. During February, August and November the heat stress was moderate. June, July, September and October witnessed severe heat stress. During summer months namely, March, April and May the heat stress remained very severe (Fig.2.4). Based on the level of heat stress in the poultry, various mitigation measures needs to be implemented to avoid major production losses.

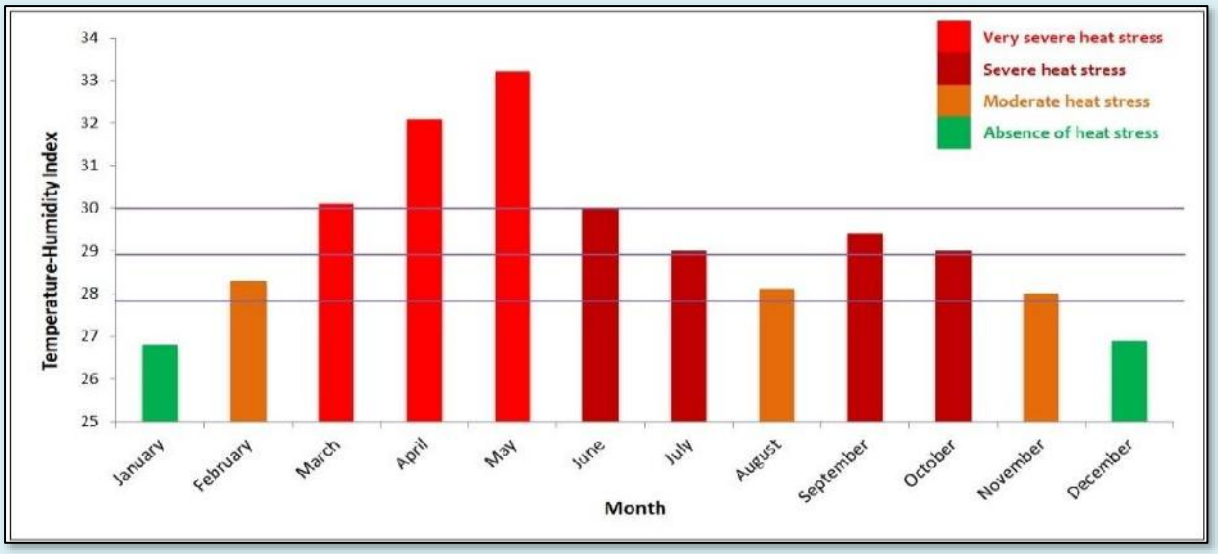


Fig. 2.4. Assessment of the thermal stress risk in poultry during the year.

2.1.5 Effect of multiple salinity levels on growth response and survival of Nile tilapia (*Oreochromis niloticus*)

An experiment to investigate the effect of different salinity levels on survival of Nile tilapia (Oreochromis niloticus) was carried out at fisheries wet lab in rectangular aquarium tanks. Experimental treatments with varying levels of salinity viz. 15 ppt, 10 ppt, 5 ppt along with freshwater 0 ppt (control) and saline water (control) were used in the study. Fish of an average initial weight of 10 ±2.0 g were randomly placed in each aquarium tank with 3 fishes per tank. Fish were fed with 28% protein diet feed equivalent to 8% of average wet body weight on daily basis. It was observed that no fish survived in the saline water (control) and in the 15 ppt salinity level treatments for a period more than 2 days.

Characterization of fish samples: The COXI and Cytochrome b genes amplified using PCR to amplify 650 and 360 bp, respectively, from the fin samples for the species and stock identification of *Hypselobarbus kolas* through DNA sequencing.

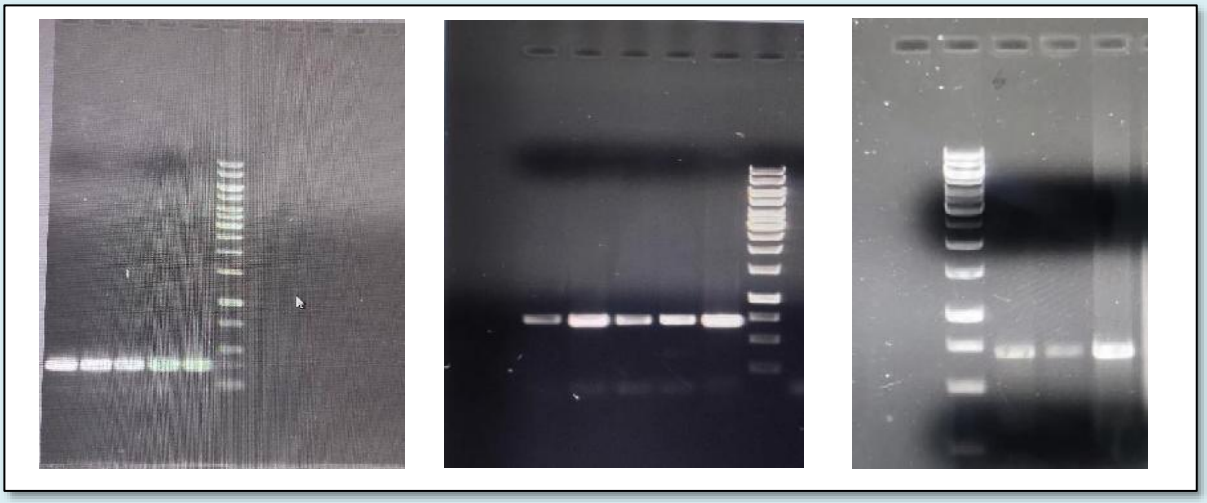


Fig. 2.5. The amplification of fish samples of Bhima river using 650 bp Cytochrome- c oxidase.

2.1.6 Survey of Livestock farmers from drought prone areas

During the last decade (2011 to 2020), three droughts were recorded in the scarcity zones of Maharashtra surveyed during the study. The information collected during the field surveys of the selected drought prone areas and experiments conducted on livestock has been compiled in the technical bulletin on "Impacts and Management of Abiotic Stresses on Livestock in the Drought Prone Areas of Maharashtra". The major abiotic stresses observed in livestock were heat and nutritional stress. Anaemia in animals was found to be the significant monitorable indicator of nutritional stress in livestock which may be used for monitoring during mitigation. It was observed that the farmers were facing severe water and fodder crisis for their livestock during the survey period. None of the farmer from scarcity zone except one was using silage and hydroponics techniques for their livestock. Very few farmers from areas only nearby Baramati were found preparing maize fodder silage to overcome fodder scarcity during summer.

The details of the cattle camps during the droughts years declared in Maharashtra were also compiled and presented in Table 1.

Table 1: Details of cattle camps, districts and livestock in different drought year.

Sl. No.	Drought year	No. of Districts in which camps opened	Total No. Livestock camps	No. of Livestock
1.	2018-19	14	1646	11,15,975
2.	2014-15	6	421	4,34,665
3	2012-13	11	1327	9,80,818
4	2003-04	6	812	7,02,216
5	1994-95	5	732	5,42,632
6	1988-89	4	415	387411
7	1983-84	2	327	210217
8	1978-79	Information not available		
9	1972-73	Information not available		

The frequency of drought and drought like situation has increased during the last decade and therefore require urgent attention for planning adaption and mitigation measures for future drought events.

2.1.7 Investigations of the trends, variability and teleconnections of long term rainfall in the Terai region of India.

This study examined the long term (1951-2015) spatio-temporal trends, variability and teleconnections of rainfall of 15 districts in the Terai region of Uttar Pradesh, India. Gridded rainfall data of India Meteorological Department (IMD) were analyzed using both parametric and non-parametric approaches and teleconnections of seasonal and annual rainfall with Indian Ocean Dipole (IOD) and El Niño/Southern Oscillation (ENSO) were investigated. Lag-1 autocorrelation coefficient was calculated and tested at 5% level of significance. The analysis revealed significantly declining trends in monthly rainfall for most of the districts in all the months, except February, April, May and December which had increasing trends. Monthly rainfall values of the region as a whole had significantly decreasing trends in January, July, August and October, while February and April had significantly increasing trends. In seasonal and annual rainfall data, only decreasing trends were significant. Monsoon, post-monsoon and annual rainfall were decreasing in 6, 9 and 7 districts, respectively. The study area as a whole had a significant decrease in monsoon, post-monsoon and annual rainfall with significantly negative Sen's slope (-2.7, -0.39 and -3.75), Spearman's rho (-0.25, -0.21 and -0.30) and slope of simple linear regression (-2.67, -0.98 and -3.49).

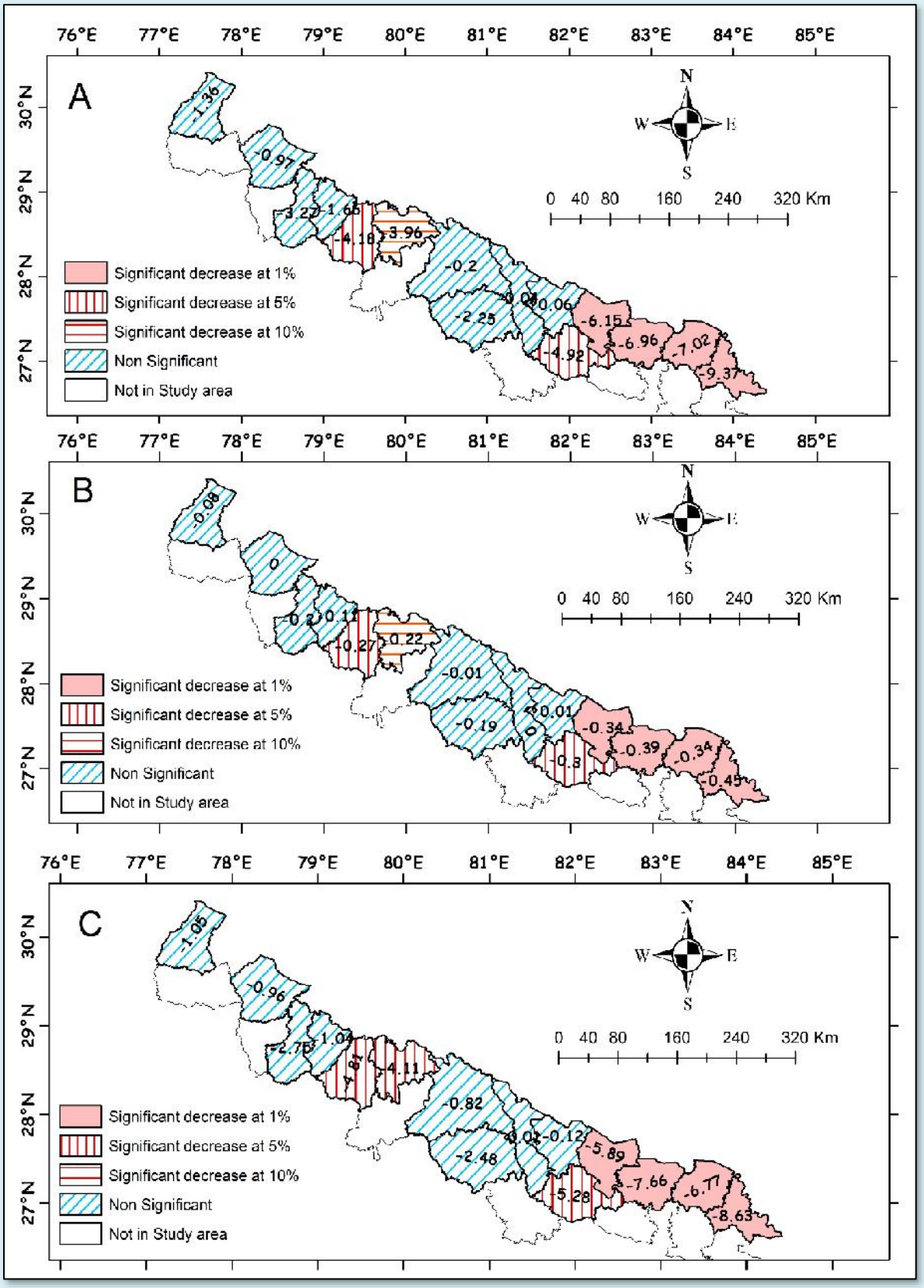


Fig. 2.6. Spatial variation of annual rainfall trends and magnitude based on A. MK/MMK test (values are SS) B. SRC test, (values are ρ (SR)) C. SLR (values are slope, SL) CV for annual rainfall of the whole region was 19% with maximum variability recorded in post-monsoon rainfall (CV = 99.81%). The results also revealed that the monsoon, post-monsoon and annual rainfall of the whole region had significant teleconnections with both IOD and ENSO events.

Table 2. Correlation analysis of seasonal and annual ENSO and IOD with rainfall.

Rainfall	Winter	Pre-monsoon	Monsoon	Post-monsoon	Annual
DMI					
Monsoon	-0.15	-0.14	-0.33**	-0.50***	-0.39**
Post-monsoon	-0.21	-0.47***	-0.41***	-0.28*	-0.45***
Annual	-0.19	-0.26*	-0.41***	-0.52***	-0.48***
Niño 3.4					
Monsoon	0.02	-0.31*	-0.64***	-0.61***	-0.57***
Post-monsoon	0.07	-0.04	-0.27*	-0.22	-0.19
Annual	0.05	-0.27*	-0.66***	-0.62***	-0.57***
Niño 3					
Monsoon	0	-0.32**	-0.59***	-0.60***	-0.57***
Post-monsoon	0.06	-0.06	-0.25*	-0.25*	-0.21
Annual	0.04	-0.29*	-0.61***	-0.61***	-0.57***
Niño 4					
Monsoon	-0.05	-0.33**	-0.63***	-0.61***	-0.54***
Post-monsoon	-0.02	-0.12	-0.25*	-0.21	-0.2
Annual	-0.03	-0.32**	-0.64***	-0.60***	-0.53***
SOI					
Monsoon	-0.13	0.32**	0.62***	0.46***	0.49***
Post-monsoon	-0.13	0.15	0.25*	0.2	0.19
Annual	-0.19	0.34**	0.62***	0.47***	0.48***

* significance at $p \leq 0.1$; ** significance at $p \leq 0.05$; *** significance at $p \leq 0.01$

The results herein suggests decreasing rainfall trends in the Terai region of India with monsoon and annual rainfall having higher ENSO teleconnections while the post-monsoon rainfall teleconnection dominated by IOD.

2.1.8 Spatio-temporal trend and variability of rainfall in Maharashtra, India: Analysis of 118 years

This study examined the spatio-temporal trends and variability of seasonal and annual rainfall of 36 districts of Maharashtra, India over 118 years (1901 to 2018) with gridded rainfall data of India Meteorological Department (IMD) using parametric and non-parametric tests. Auto-correlation coefficient was calculated at lag-1 and tested at 5% level of significance. Mann-Kendall (MK), Modified Mann-Kendall (MMK), Spearman's rank correlation (SRC) tests were used to analyze the trends of rainfall, whereas Sen's slope (SS), Spearman's Rho (SR) and simple linear regression (SLR) were used to quantify the magnitude of trends at 5% and 1% levels of significance. Rainfall variability was examined using the coefficient of variation (CV). The analysis revealed that except Chandrapur, Kolhapur, Latur, Nagpur, Osmanabad, Sangli, Sindhudurg and Solapur, all other districts had significant declining trends of winter rainfall. Post-monsoon rainfall was significantly increasing only in Mumbai city. Bhandara,

Gondiya, Nagpur, Pune, Thane and Wardha had decreasing while Kolhapur, Mumbai city, Nandurbar, Ratnagiri, Sindhudurg had increasing trends of monsoon and annual rainfall. Dhule and Nashik had increasing rainfall trends in monsoon. Solapur had very high monsoon rainfall variability. Ahmednagar, Jalna, Pune and Satara had very high monsoon and annual rainfall variability. Rainfall variability was very high in all the districts for winter, pre and post-monsoon seasons. The trend and variability analysis along with their maps would be useful for local stakeholders for planning efficient use of water resources.

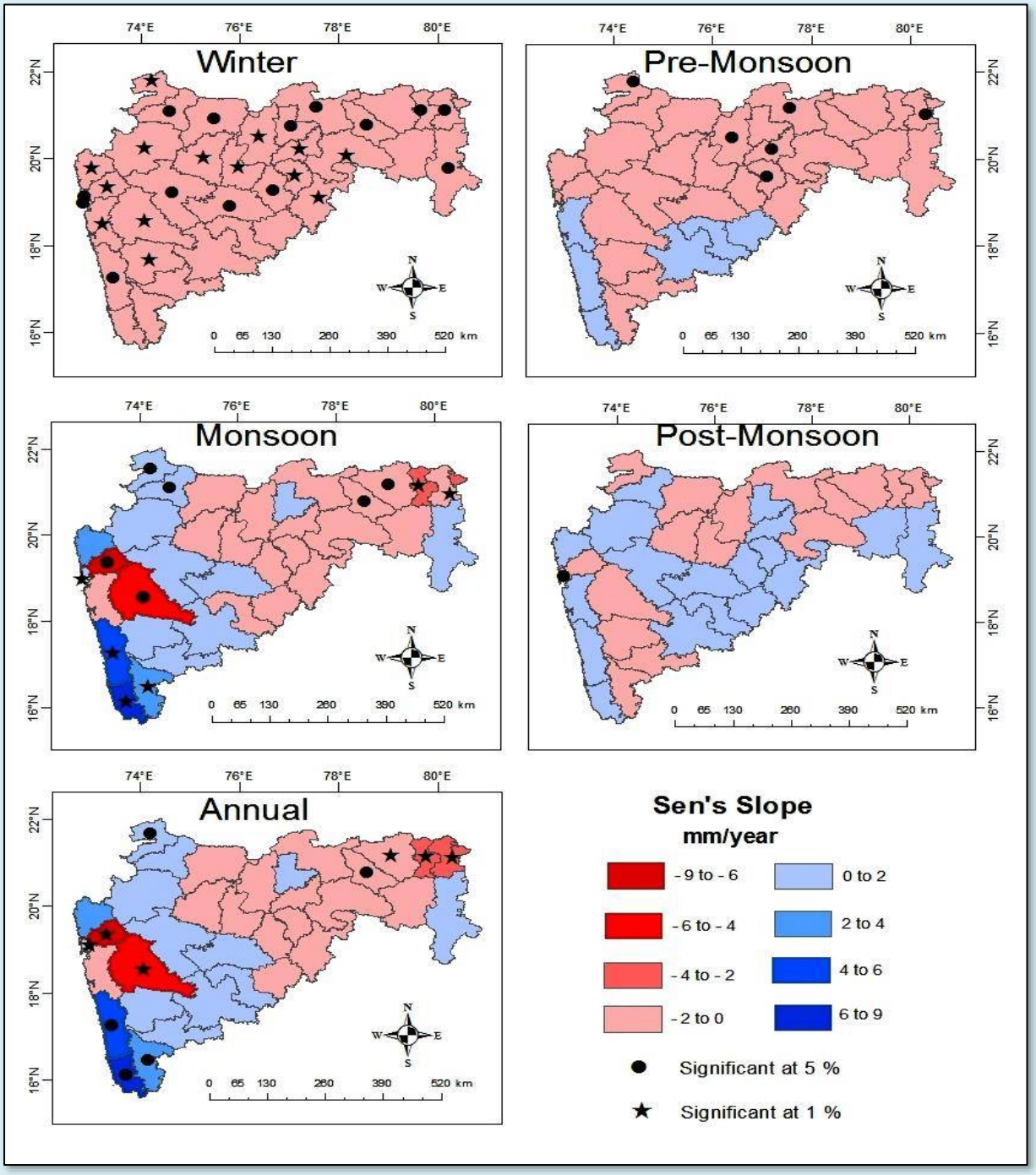


Fig 2.7. Spatio-temporal trend and variability of rainfall in Maharashtra

2.1.8 Quick method for spectral delineation and model calibration for prediction of instantaneous relative water content in leaves of vineyard

The changes in spectral signatures of leaf sample caused due to loss of water content can correlate strongly, however establishing such correlations require larger datasets and takes significant longer time, due to manual methods involved. Moreover since the calibration of such models are generally genotype specific, a quick method to generate sufficient datasets capturing variability in a genotype would be required to be useful for practical utility. An experiment was therefore conducted to explore if the instantaneous relative water content of a grape leaf can be found using reflectance spectroscopy and a quick model calibration method, which can also delineate the spectral bands affected by the water content of leaf. This involved setup (Fig. 2.8) for instantaneous heating and synced acquisition of leaf spectra and weight using spectroradiometer and digital weighing scale, respectively. The measurement of spectra was carried out using ASD Fieldspec4 Hi-res spectroradiometer in a dark room setup. This setup has provision to provide sufficient illumination using two ASD illuminator reflectance lamps which was geometrically arranged to cause gradual heating of target sample and subsequent loss of water content. The target placement plane was calibrated using white spectralon reference with bare OFC (250 FOV) placed vertically above the target for every sample run. The reflectance spectra thus obtained was correlated with the instantaneous relative water content. The λ / λ contour plot (Fig.2.9) of spectral bands combinations delineated on basis of R2 values show sufficient performance (R^2= 0.94) of two-band indices for practical use. However the generation of larger datasets also allowed improving correlations by fitting several machine learning models and its comparison of performance, which is shown in Fig.2.10 in order of its increasing RMSE.

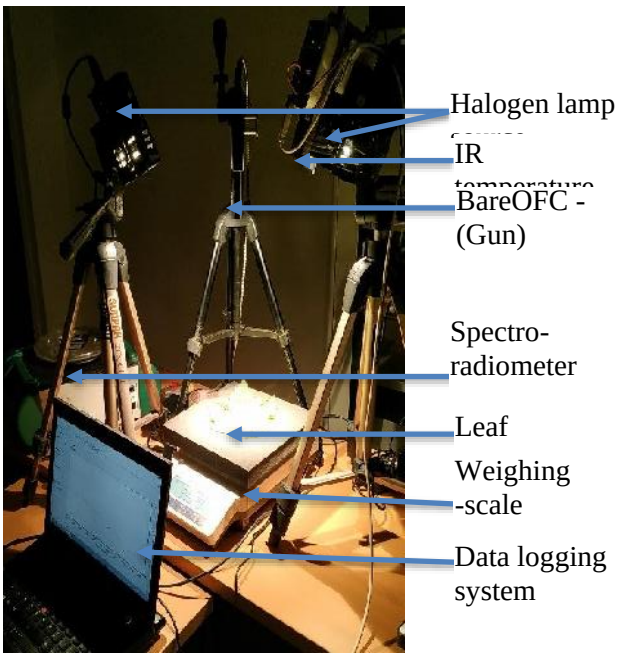


Fig. 2.8. Experimental Layout

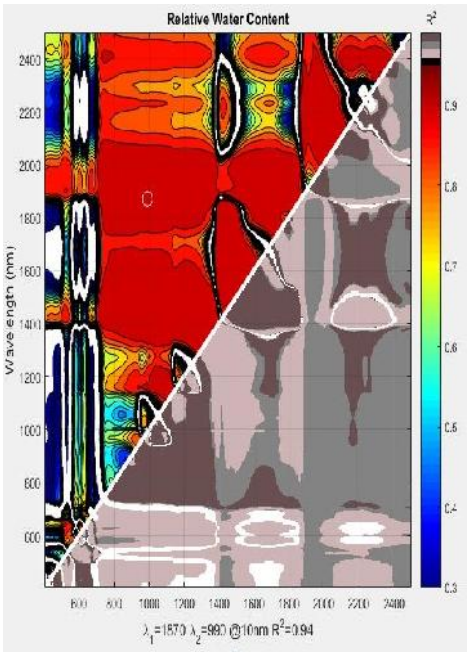


Fig. 2.9. λ / λ contour plot

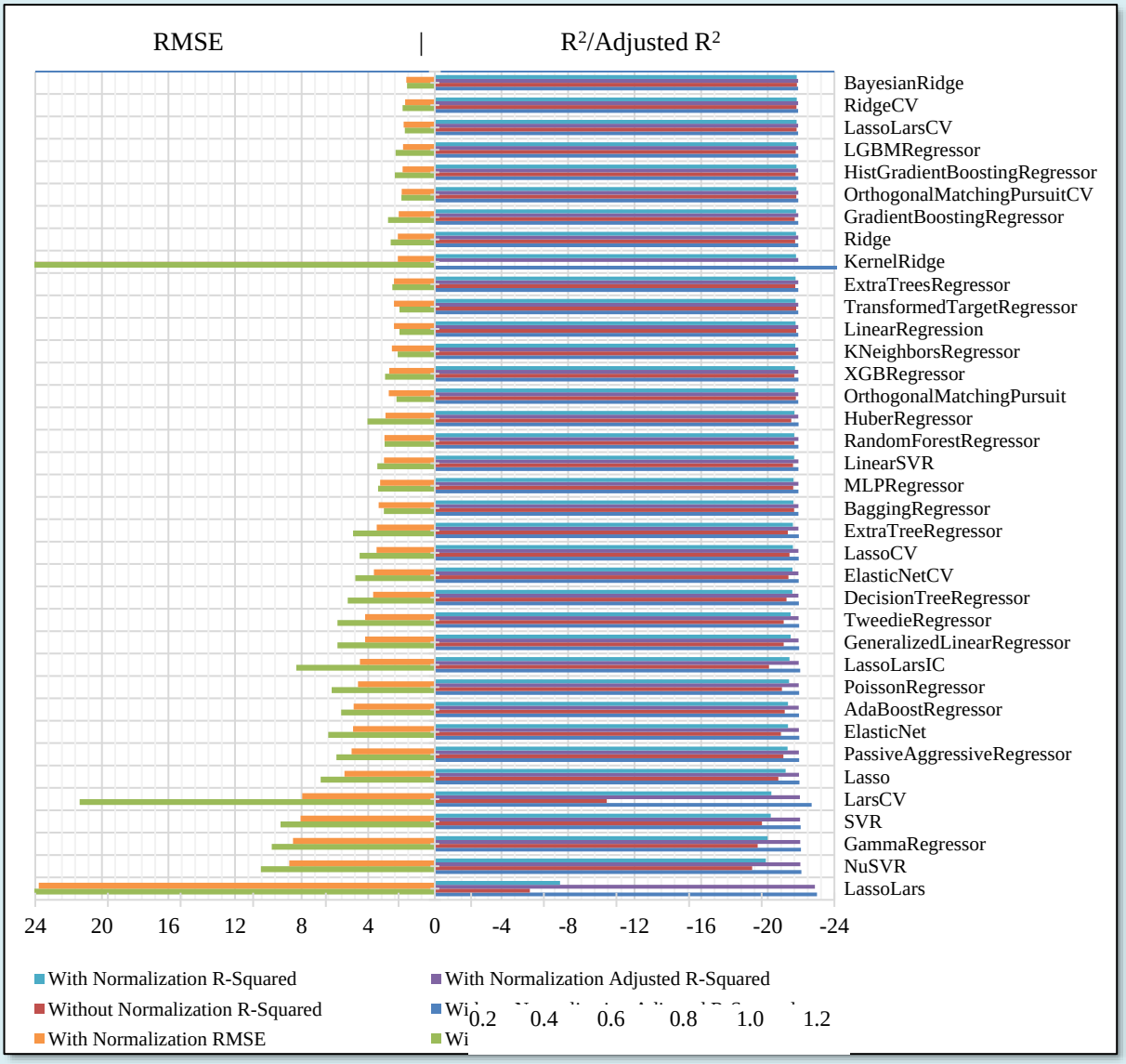


Fig. 2.10 Performance of ML models.

2.1.9 The ML models for growth stage classification in sugarcane using AVRIS NG dataset

The earlier field experimental studies conducted at NIASM concluded that the hyperspectral data based models for biophysical and biochemical characterization and abiotic stress monitoring in Sugarcane are growth stage specific, therefore determining the growth stage of crop is prerequisite for applying stage specific prediction models. The hyperspectral imagery of AVRIS NG Phase II campaign for site id 220 covering sugarcane crop was preprocessed and pixel signatures corresponding to known classified locations of sugarcane variety and its growth stages were extracted for 3, 6 and 9 m spatial resolution. Maximum Normalization method was used to normalize this spectral dataset and several machine learning classification techniques namely, Random Forest (RF), Artificial Neural Netwrok (ANN), Decision Tree, K-Nearest Neighbour (KNN), Logistic Regression and Support vector machine (SVM) were trained with 80% datasets and cross-validated for 20% datasets to get the best classification accuracy. The significant findings are

a) Spatial averaging over 15 m ground resolution improved performance of ML classification models

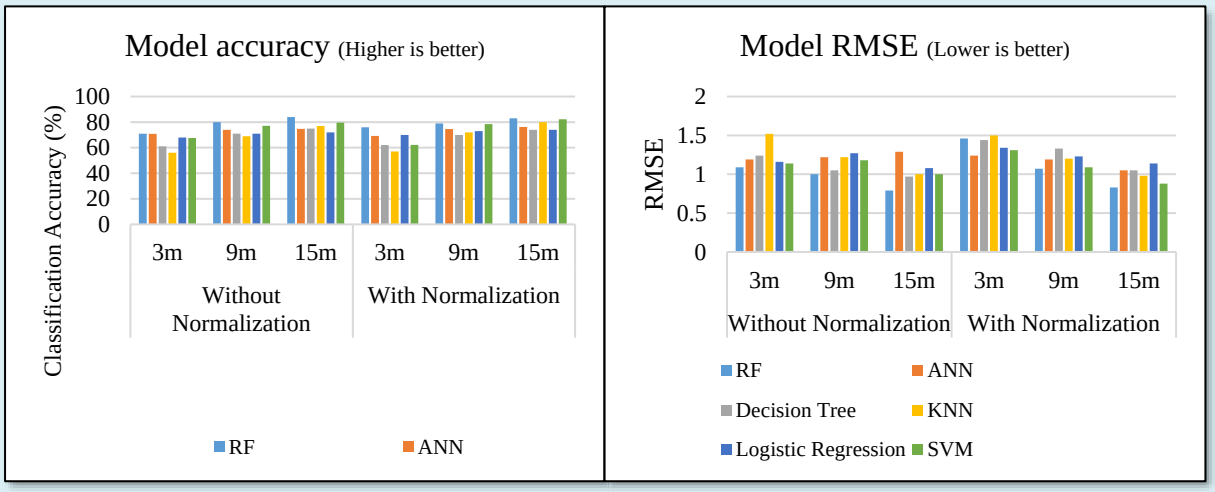


Fig. 2.11. Performance of ML models for classification

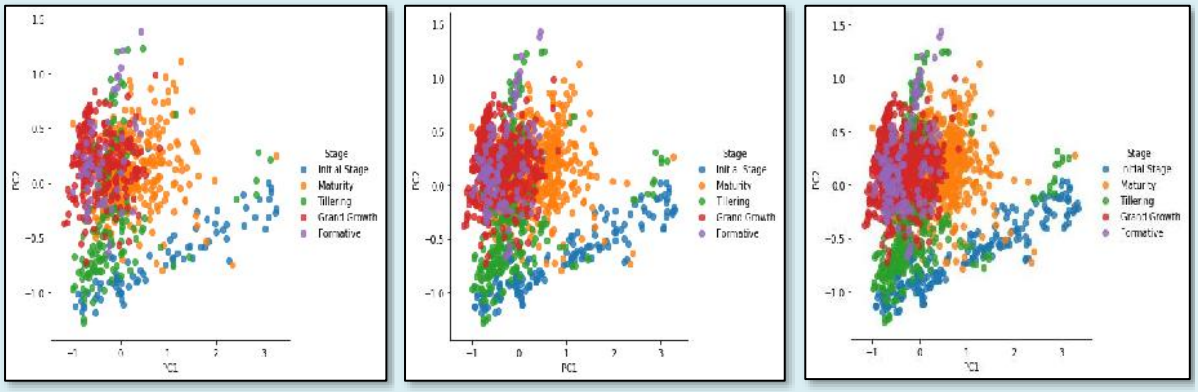
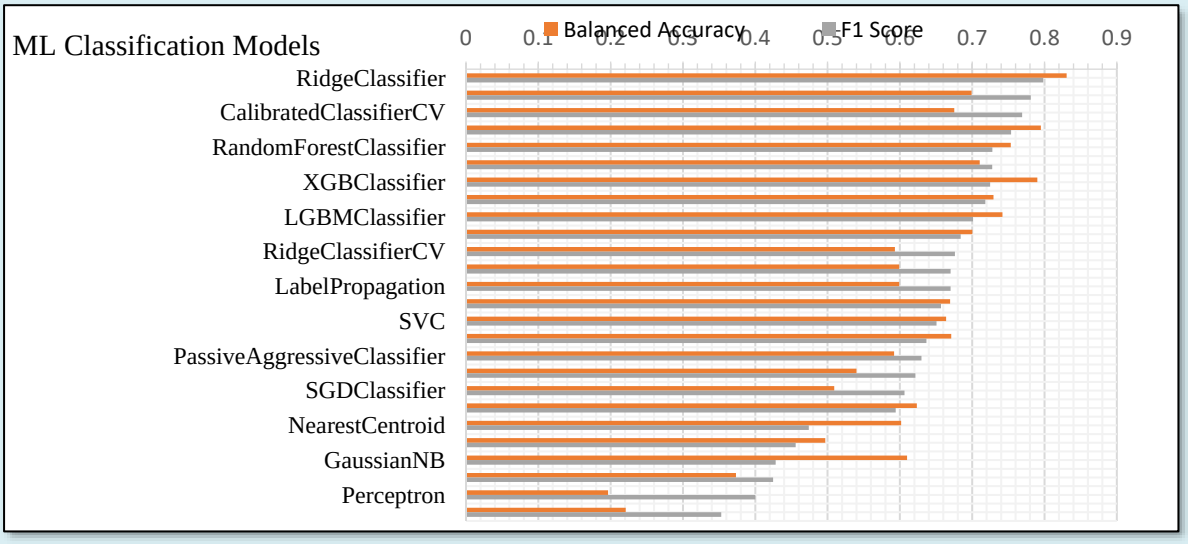


Fig. 2.12. Principal Component Analysis of AVRIS NG spectral at 3m, 9m and 15m spatial resolutions

b) Among the machine learning algorithms fitted the Ridge classifier follower by Logistic regression and XGB Classifier performed better using composite classification metrics namely F1 score and balanced accuracy (Fig. 13).



Research Programme-2

2.2 Soil Stress Management

Soil-born stresses like salinity, acidity, mineral toxicity and nutrient deficiency have emerged as major threats to global crop production, livestock, fisheries and other commodities. With the main goal of advancing basic and strategic research in the area of managing soil related stresses in crop plants, livestock and fisheries, the research programme on the Soil Stress Management has been operating with its work in areas of soil health, soil salinity, crop residue management, heavy metal pollution along with two new initiatives on bio-saline agriculture and climate resilient integrated farming system. Additionally, under the programme, supporting research activities related to conservation agriculture, sustainable water management technologies, biotechnology, nanotechnology, remote sensing, polymer science, dynamics of soil nutrients under different cropping systems, and nutrient and gene interaction approaches for management of multiple stresses in fish, medicinal garden are being conducted. The major research findings emerging out and the progress made under this programme during the past one year is summarized below.

2.2.1 Planning and layout of climate resilient integrated farming system (CIFS) model for semi-arid regions

In view of the constraints faced in semi-arid regions and the growing climate vagaries, the CIFS project initiated to optimize the components of IFS for enhancing productivity, profitability, sustainability and climate resiliency, and to develop decision support system for optimizing and upscaling climate-smart IFS. The Farming system components suitable for climate resilience have been selected and are being optimized for 1 hectare IFS model. Plantation of abiotic stress tolerant horticultural crops & agroforestry with crop rotation of climate resilient crops has been implemented. Other activities viz. development of farm pond, micro irrigation system which runs through solar energy has been implemented. Observation pertaining to field input and output data are being recorded timely and construction of structure for multilayer/multitier farming system is under progress. The selected components and size of CIFS model for 1 hectare are Crop-6250 sq.m; Horticulture-3000 sq.m; Livestock- (Indigenous cow-02, Goats-10); Native poultry birds-50 nos; Fisheries-400 sq.m; Apiary-5 boxes and boundary plantations. The initial soil chemical analysis has been done (Table 3).

a) Chickpea crop

b) Jowar Crop

c) Custard apple

d) Farm pond development

e) Gir Cow

f) Review of CIFS Project

Table 3. Chemical properties of field plot under different cropping pattern in IFS

Soil type	Cropping system	Soil depth (cm)	pH	EC (ds m^{-1})	POXC* (mg kg^{-1})	N (kg ha^{-1})	S (kg ha^{-1})
Black soil	Pearl millet - Chickpea	0-15	8.55±0.04	0.16±0.01	322.99±40.75	75.26±2.56	22.83±7.51
Black soil	Pearl millet - Chickpea	15-30	8.63±0.06	0.13±0.01	317.54±38.44	67.42±4.71	10.60±1.43
Black soil	Green gram-Sorghum	0-15	8.67±0.05	0.17±0.02	297.54±31.27	75.26±3.01	9.02±4.22
Black soil	Green gram-Sorghum	15-30	8.77±0.02	0.15±0.02	271.18±42.85	72.13±7.46	8.79±4.51
Native soil	Pomegranat, Custard apple	0-15	8.98±0.01	0.13±0.01	170.28±38.62	59.58±11.16	3.35±1.84
Native soil	Pomegranat, Custard apple	15-30	8.99±0.02	0.09±0.01	121.19±9.01	28.22±3.13	1.54±0.91

2.2.2 Effect of tillage, residue and nutrient management practices of ratoon crop in sugarcane on soil dehydrogenase enzyme activity

To study the activity of soil dehydrogenase enzyme soil samples from depths of 0-5 cm and 5-15 cm were collected and analysed for soil dehydrogenase DHA activity. The experiment is laid out with main plots of three tillage practices *viz*. M1 (laser land levelling (LLL) + conventional tillage (CT) + 10% of recommended dose of fertilizers applied as basal and remaining 90% dose of fertilizers through fertigation); M2 (LLL+RT+10% of RDF as basal, 40 % through band placement and remaining 50% through fertigation) and M3 (40 % of RDF was band placed with SORF machine rather than broadcasting). Two subplots of residue managements practices: T1 (Mulching with sugarcane trash) and T2 (Without residue) and three sub subplots of three nutrient management practices in ratoon sugarcane *viz.* N1: SORF with placement of 25% of RDF through SORF and 75% through fertigation; N2: SORF with placement of 50% of RDF through SORF and 50% through fertigation and N3: SORF with placement of 70% through SORF and 25% through fertigation were imposed. The soil biological health was estimated through measuring a sensitive indictor, soil dehydrogenase (DHA) activity of the soil samples taken after completion of four cycles of use of SORF machine and harvesting of third ratoon crop in 2020. DHA activity was analysed by using Casida et al., (1964). The distribution of DHA activity in 0-5 cm soil depth is shown in Fig.

2.13 indicating that residue burning had decreased the DHA activity in top 0-5 cm soil layer irrespective of nutrient management in sub subplots. The analysed results shows that residue retention has significantly improved soil DHA activity whereas it was found non-significant among the treatments of main plots and subplots in 0-5 cm soil depth (Fig.2.14). There was no significant effect of treatments on soil DHA activity at 5-15 cm soil depth but there is slight improvement in soil DHA activity from top 0-5 cm soil depth (Fig.2.15). The analysis of variance (ANOVA) revealed interaction between main plot and subplot along with main plot: subplot: sub subplot to be significant in 0-5 cm soil depth, indicating the effects of treatments imposed can significantly change DHA activity, however was non-significant in 5-15 cm soil depth). Higher concentration of DHA was found at 5-15 cm soil depth (Fig. 2.16), however when analysed statistically it was observed that the interaction between main plot, subplot and depth possessed significant differences (Fig. 2.17). The highest DHA activity was found in M2:T1: D2 which was at par with M1:T1: D1 and lowest under M3:T1: D1 and M3:T1: D2. Therefore, it was concluded that DHA activity was greatly affected by residue burning causes more stress to microbial population and lowering their activity in reduced tillage plots as compared to conventional tillage plots. Residue retention has improved microbial population which can be observed through DHA activity. The surface layer (0-5 cm) is greatly affected by residue burning as compared to 5-15 cm soil depth.

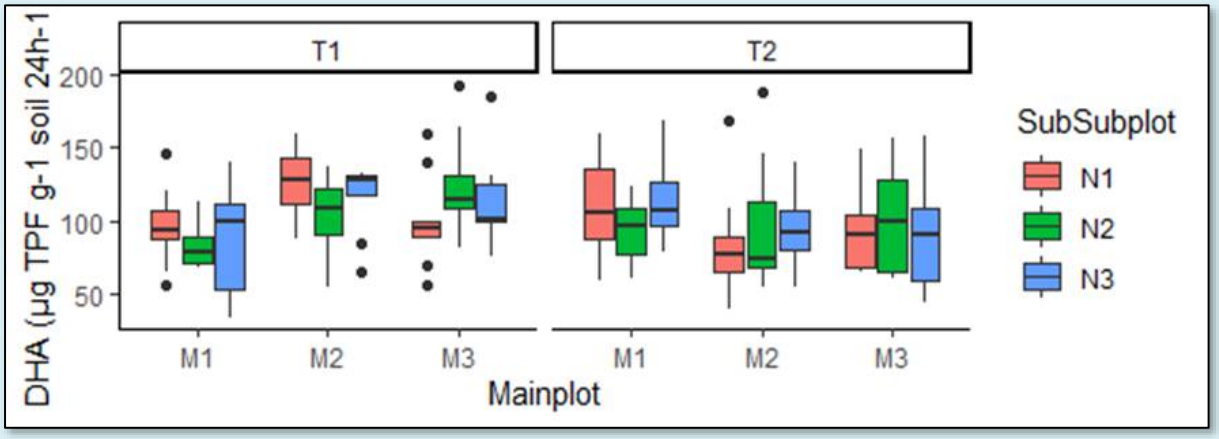


Fig. 2.13. Boxplots showing soil dehydrogenase activity at 0-5 cm of soil depth under different treatments of tillage, residue management and nutrient management of sugarcane ratoon

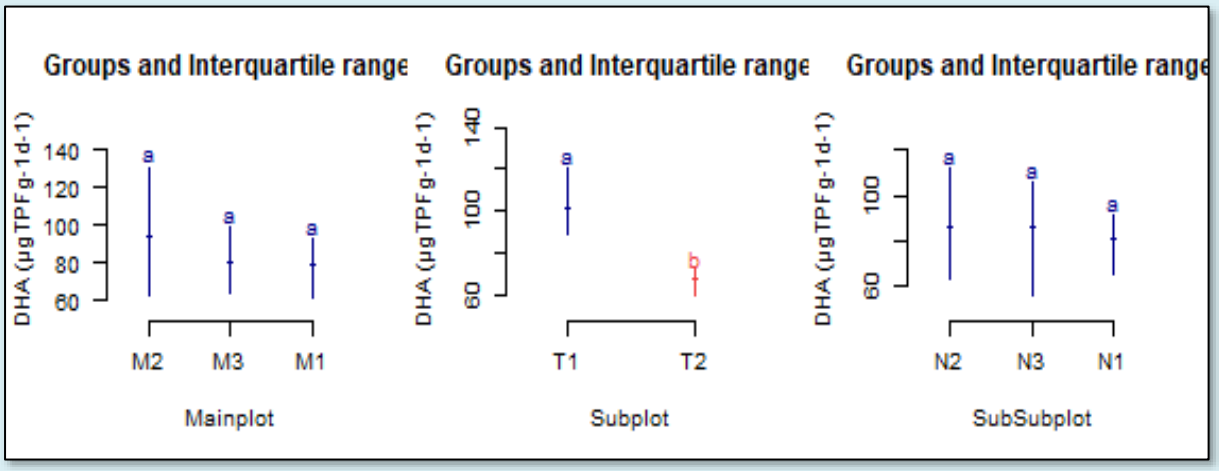


Fig. 2.14. Effect of treatments on soil DHA activity at 0-5 cm soil depth.

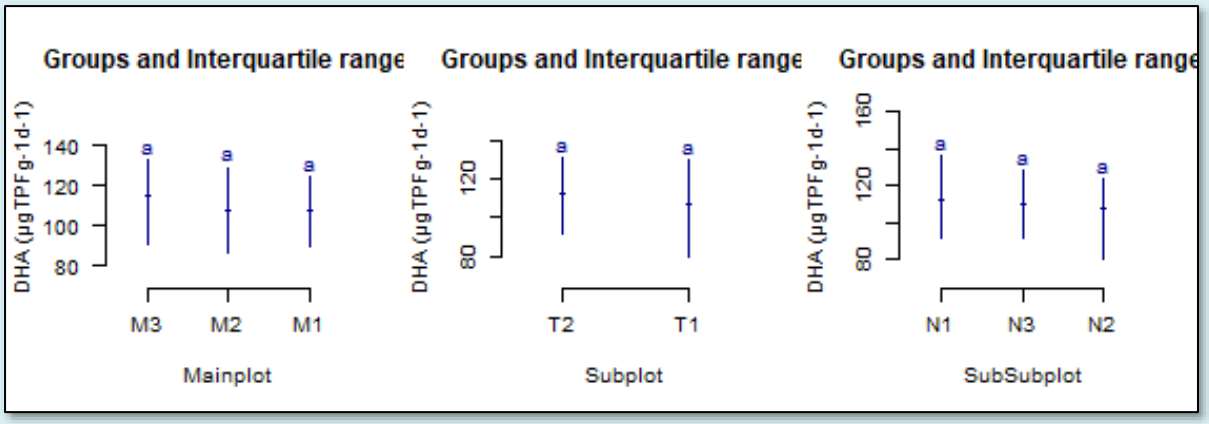


Fig.2.15: Effects of treatments on soil DHA activity at 5-15 cm soil depth

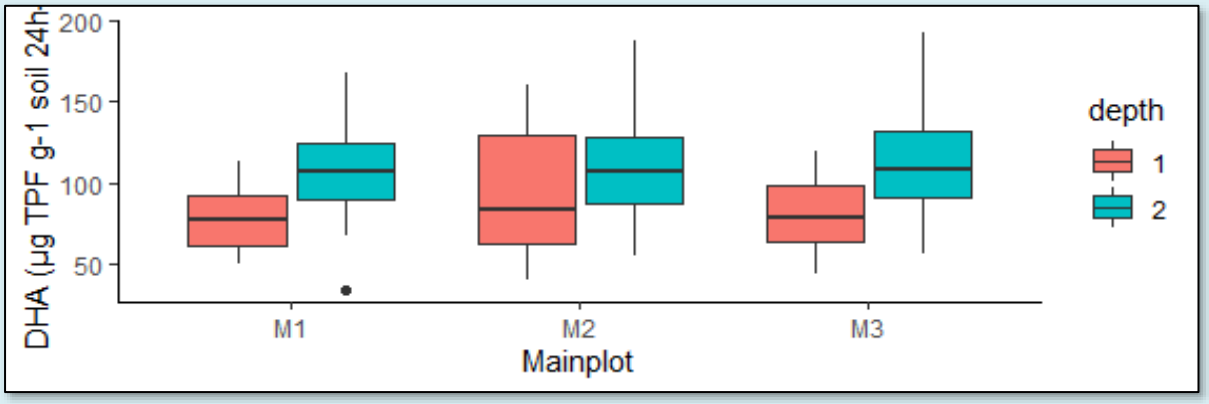


Fig. 2.16. DHA activity among different main plots in depth 1 (0-5 cm) and depth 2 (5-15 cm) soil depths.

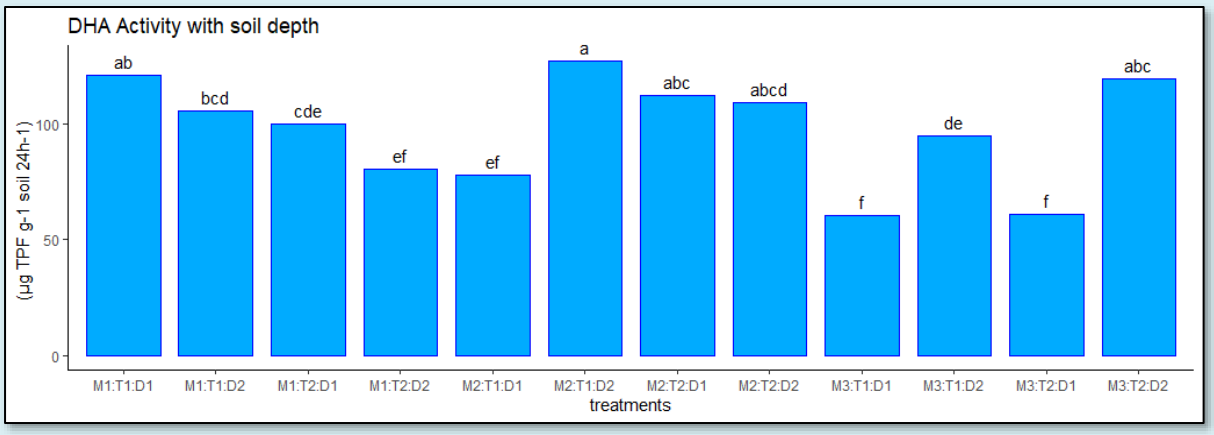


Fig. 2.17: Histograms showing the interaction effects of main plot, subplot and depth

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

Turmeric is sensitive to saline irrigation and can tolerate levels up to 2 dS m^{-1} salinity without affecting yield and physiology of plant. It was found that few varieties like NDH series, Alleppey supreme and Megha turmeric are tolerant to salinity likely due to its high biomass yielding nature. The fresh rhizome yield of turmeric decreased as the salinity level increased in all the varieties of turmeric. Percent yield reduction was lowest in case of NDH-8 (60.4%) followed by NDH-98 (62.2%), Megha turmeric (75.5%) and Alleppey supreme (76.0 %) at

highest level of salinity (Fig. 2.18 and Fig. 2.19). In case of NDH-8 and 98 varieties 50 percent yield reduction was noticed at EC of 6 dS m^{-1}. But looking to the importance of yield and health of plant it may be recommended that more than 2 EC is detrimental to the crop. Scorching intensity was recorded very high in CO-2 and Prathiba indicating higher susceptibility. However, it was less in Megha turmeric, NDH 98, Rajendra sonia and Alleppey supreme, (Table 4). With respect to salinity levels scorching intensity varied from 0 to 32% in 8 dS m^{-1}. Leaf area of plant was found highest in tolerant varieties, which gave more area against salt accumulation compare to susceptible ones resulted in to reduced scorching. Canopy temperature of plants was influenced significantly by salinity levels. Cooler canopies were recorded in normal water irrigated plants as compared saline. Similarly, among varieties cooler canopy was observed in case of susceptible varieties such as Prathiba, Co-2, Roma, etc.

Table 4. Effect of salinity stress on chlorophyll, leaf area and canopy temperature of various turmeric varieties.

Treatment	Plant ht. (cm)	Scorching intensity (%	)SPAD reading	No. of leaves	Leaf area /plant (cm^2)	Canopy temperature
0 dS m^{-1}	37.2	0.0	30.9	7.6	1919.6	28.3
2 dS m^{-1}	33.6	16.6	27.1	6.1	1333.5	28.3
4 dS m^{-1}	38.3	25.9	28.3	6.7	1219.5	28.3
6 dS m^{-1}	36.9	25.3	27.4	5.1	977.1	28.6
8 dS m^{-1}	22.9	32.3	24.7	5.0	850.6	28.7
CD @ 5%	3.7	6.61	2.37	0.66	162.2	0.17
Varieties						
NDH-1	36.8	24.6	27.1	6.08	1469.4	28.8
Megha turmeric	30.6	7.93	25.1	6.9	1731.5	28.6
Rajendra sonia	33.8	12.3	29.8	5.1	1063.8	28.9
Alleppey supreme	33.1	18.9	26.6	5.9	1203.7	28.5
Roma	25.9	17.6	25.8	6.0	867.8	28.5
Pratibha	29.6	22.6	23.8	6.3	1071.3	27.9
Co-2	36.6	32.3	28.1	5.8	977.6	28.2
BSR-2	30.8	16.3	26.8	6.7	1023	28.4
NDH-98	40.0	8.1	32.2	5.5	1387	28.4
NDH-8	41.2	19.5	31.7	6.9	1804	28.2
CD @ 5%	37.2	9.35	3.35	0.94	229.0	0.24
S x V	33.6	20.5	7.4	2.10	513.2	0.54

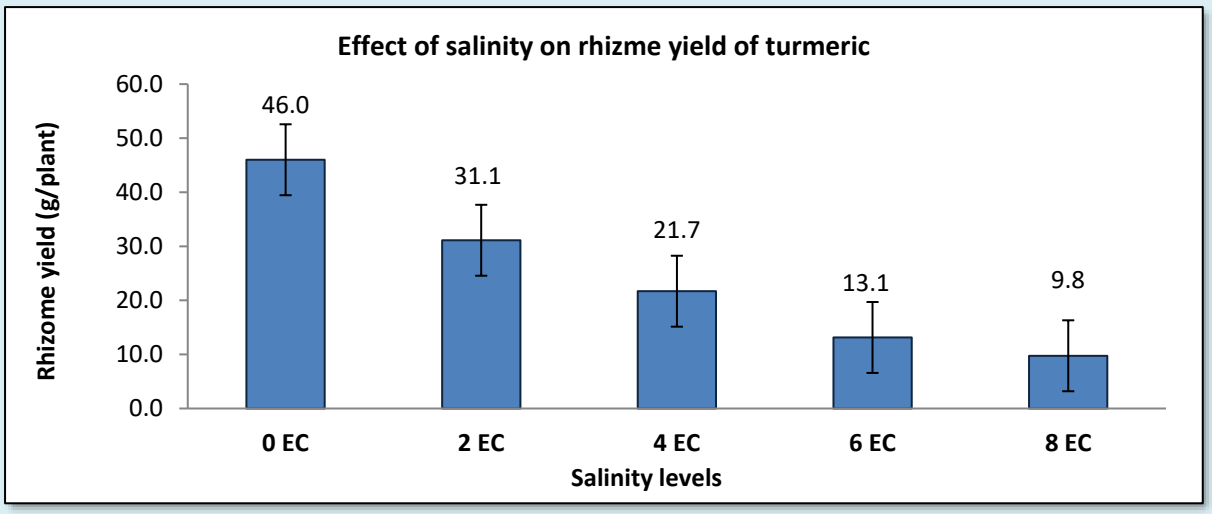


Fig 2.18: Effect of salinity on rhizome yield of turmeric

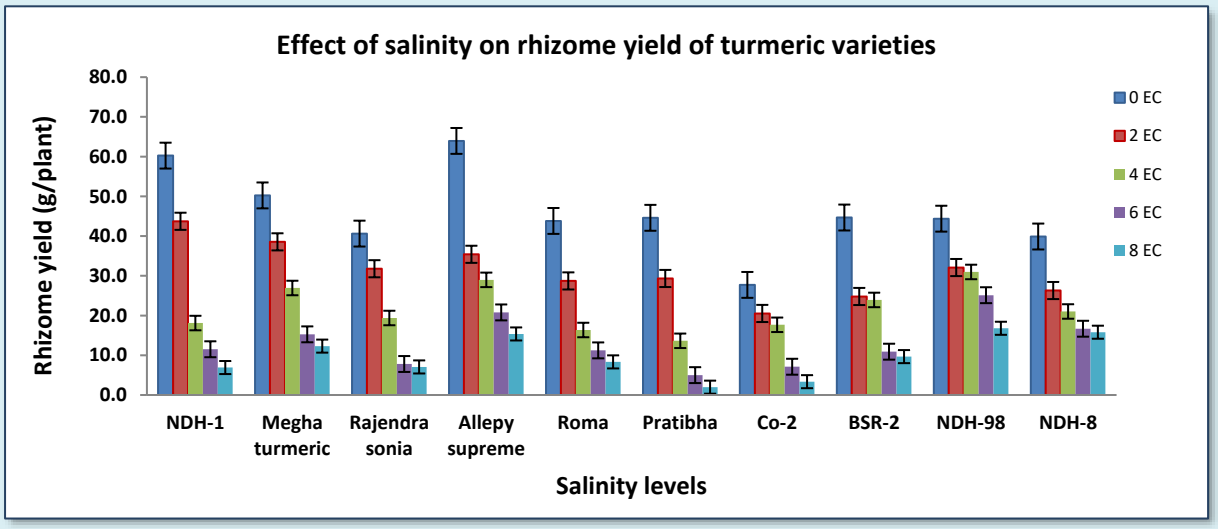


Fig. 2.19. Effect of salinity levels on fresh rhizome yield of various turmeric varieties.

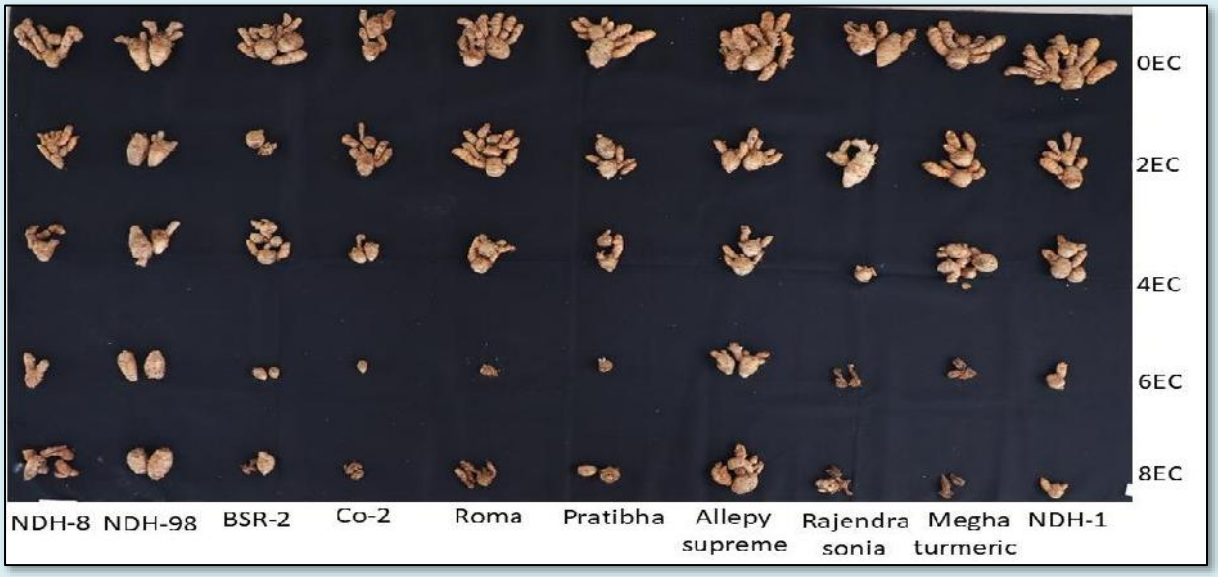


Fig 2.20: Rhizome size of different turmeric varieties under varying salinity levels

2.2.4 Dietary riboflavin enhances immunity and anti-oxidative status against arsenic and high temperature in *Pangasianodon hypophthalmus*

The study revealed that arsenic pollution and high temperature reduced the growth performance, anti-oxidative status and immunity of the fish but dietary RF mitigated it. Four diets containing RF at 0, 5, 10 and 15 mg kg^{-1} were fed to fishes reared under low dose of arsenic (2.68 mg L^{-1}) and temperature (34 °C) stresses for 90 days. Growth index viz. weight gain percentage, feed conversion ratio, FCR; protein efficiency ratio, PER; and specific growth rate, SGR significantly enhanced ($p<0.01$) with supplementation of dietary RF at 10 mg kg^{-1} diet, whereas growth index of fish treated under stressors (As+T) and fed with control diet drastically reduced ($p<0.01$). Anti-oxidative status viz. catalase, superoxide dismutase, glutathione-s-transferase and glutathione peroxidase was significantly improved ($p<0.01$) with supplementation of dietary RF at 10 mg kg^{-1} diet. Moreover, the immunological status viz. total protein, albumin, globulin, albumin globulin ratio (A:G ratio), respiratory burst activities, myeloperoxidase, total immunoglobulin were significantly improved with supplementation of dietary RF in fish reared under stressors and non-stressors. The biochemical stress markers as blood glucose and HSP 70 was drastically reduced with dietary RF at 10 mg kg^{-1} diet, however, the level of glucose and HSP 70 were elevated with arsenic and high temperature for fish fed with control diet. *Aeromonas hydrophilla* was inducted to fishes to observe the immunological status of fishes fed with dietary RF. The protective role of dietary RF was observed in the histopathological study of liver and gill. Arsenic bioaccumulation in different fish tissues reduced ($p<0.01$) with dietary supplementation of RF. *(For more information please refer: Aquaculture 533:2021:736209:https://doi.Org /10.1016/j.aquaculture.2020.736209.*

2.2.5 Mitigation potential of selenium nanoparticles and riboflavin against arsenic and elevated temperature stress in *Pangasianodon hypophthalmus*

The Se-NPs were synthesized using fish gill employing green synthesis method. Four diets i.e., Se-NPs (0 mg kg^{-1}) + RF (0 mg kg^{-1} diet); Se-NPs (0.5 mg kg^{-1}) + RF (5 mg kg^{-1}); Se-NPs (0.5 mg kg^{-1}) + RF (10 mg kg^{-1}); and Se-NPs (0.5 mg kg^{-1}) + RF (15 mg kg^{-1}) were given in triplicate in a completely randomized block design. The fish were treated in arsenic ($1/10^{th}$ of LC_{50}, 2.68 mg L^{-1}) and high temperature (34 °C). Supplementation of the Se-NPs and RF in the diets significantly ($p<0.01$) enhanced growth performance, anti-oxidative status and immunity of the fish. Stress biomarkers such as lipid peroxidation in the liver, gill and kidney, blood glucose, heat shock protein 70 in gill and liver as well as serum cortisol reduced ($p<0.01$) with supplementation of Se-NPs and RF, whereas, acetylcholine esterase and vitamin C level in both brain and muscle significantly enhanced ($p<0.01$) as compared to control and stressors group (As+T) fed with the control diet. The fish were treated with pathogenic bacteria after 90 days of experimental trial to observe cumulative mortality and relative survival for a week. The arsenic concentration in experimental water and bioaccumulation in fish tissues was also determined, which indicated that supplementation of Se-NPs and RF significantly reduced ($p<0.01$) bioaccumulation. The study concluded that a combination of Se-NPs and RF has the potential to mitigate the stresses of high temperature and As pollution in *P. hypophthalmus*. *(For more information please refer: Scientific Reports* volume *10, Article number: 17883 (2020).*

2.2.6 Arsenic reduced the thermal tolerance of the fish augmented by dietary selenium nanoparticles and omega-3 fatty acid

An experiment was conducted to delineate the effect of selenium nanoparticles (Se-NPs) along with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) for enhancement of thermal tolerance and reduced the cellular metabolic stress in *Pangasianodon hypophthalmus* reared under arsenic and high temperature for 112 days. Green approach was used for synthesis of Se-NPs using fish gill. Four experimental diets (isocaloric and iso-nitrogenous) viz. control diet (no Se-NPs and EPA+DHA), Se-NPs @ 0.2 mg/kg diet and EPA+DHA @ 0.2, 0.4 and 0.6 % were formulated and prepared and fed for 112 days. At the end of the 112 days experiment the thermal tolerance viz. critical thermal maxima (CTmin), lethal thermal maxima (LTmax) and critical thermal minima, lethal thermal minima (LTmin) were determined. Dietary supplementation of Se-NPs and EPA+DHA noticeably improved ($p<0.01$) the thermal tolerance of the fish reared under arsenic and high temperature (As+T). Oxidative stress, catalase, superoxide dismutase (SOD), glutathione-s-transferase (GST), glutathione peroxides (GPx) and LPO were enhanced by stressors (As+T), whereas dietary Se-NPs and EPA+DHA @ 0.4 % reduced the oxidative stress and LPO. The higher concentration of EPA+DHA @ 0.6 % elevated the oxidative stress. Further, acetylcholine esterase (AChE) were inhibited by arsenic alone and concurrent with temperature but dietary supplementation significantly enhanced ($p<0.01$) the activities in brain. Exposure to arsenic alone and concurrent with temperature significantly reduced ($p<0.01$) the ATPase and dietary supplementation (Se-NPs and EPA+DHA @ 0.4 %) and enhanced the ATPase in liver and gill. The bioaccumulation of arsenic was also reduced with application of dietary supplements (Se-NPs and EPA+DHA @ 0.4 %). The present investigation concluded that dietary supplementation of Se-NPs @ 0.2 mg/kg diet and EPA+DHA @ 0.4 %/kg diet enhanced the thermal tolerance and protected the fish against arsenic pollution and thermal stress in *P. hypophthalmus*.

2.2.7 Acute and chronic toxicity of chromium (VI), pH and temperature on integrating multiple biomarkers, genotoxicity and thermal tolerance of Anabas testudineus

We conducted three separate experiments to determine the acute (96 h) and chronic (72 days) toxicity of Cr in combination with low pH (6.5) and high temperature (34 °C) in *Anabas testudineus*. Lethal concentrations of Cr in neutral pH and normal temperature was 55.02 mg L^{-1}. Lethal concentration of Cr at low pH and normal temperature was reduced to 48.19 mg L^{-1} and at low pH and high temperature, it further reduced to 47.16 mg L^{-1}. The second experiments were performed to determine the chronic toxicity of Cr, low pH and high temperature. The low dose of Cr, low pH and high temperature ($1/10^{th}$ and $1/20^{th}$ of LC_{50}) has been selected for chronic test.. All the biochemical attributes were significantly ($p<0.01$) altered with exposure to Cr alone with low pH and high temperature except gill SOD. Further, Thermal tolerance significantly reduced with Cr alone exposure and Cr and low pH exposure in *A. testudineus*. The present study revealed that, the acute and chronic toxicity of Cr enhanced with low pH and high temperature and it lead to understanding the multiapproach of Cr toxicity which affect on stress biomarkers, cellular metabolic stress and thermal tolerance of *A. testudineus*.

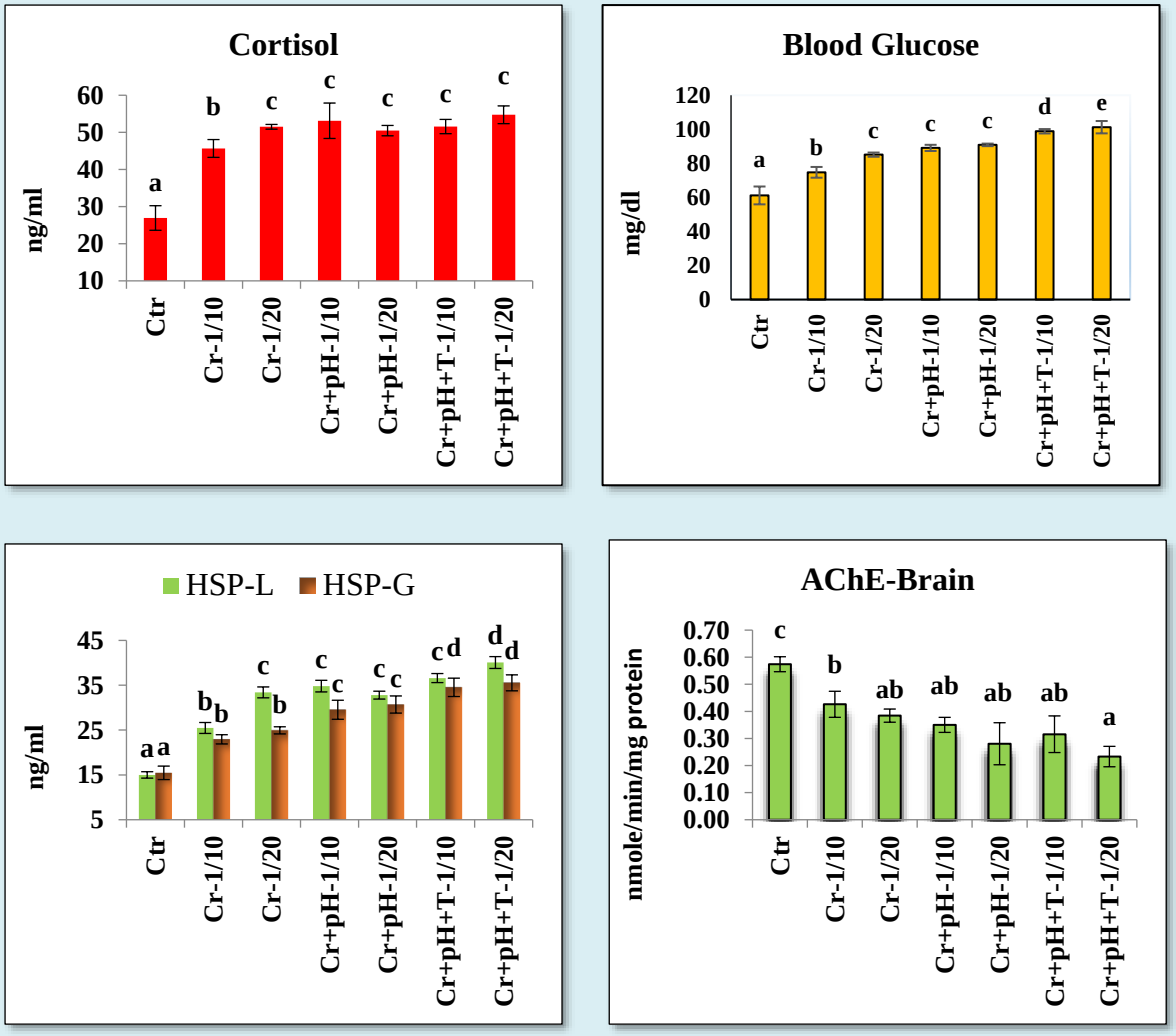


Fig 2.21 (A-D): Acetylcholine esterase (AChE), heat shock protein (HSP), cortisol and blood glucose of *Anabas testudineus* exposed to chromium alone and concurrently with low pH (6.5) and high temperature (34 °C) during 72 days.

2.2.8 Wastewater treatment synergizing with integrated approach of constructed wetland and aquaponics

Under the in-house project "Wastewater treatment through multi-approach based constructed wetland and use in integrated aquaponics", NIASM septic tank wastewater is treating through a pilot scale constructed wetland system (Fig. 1). The system comprised of two parallel units (i) Horizontal sub-surface flow based constructed wetland system (HSSF-CWs) and (ii) Vertical sub-surface flow based constructed wetland system (VSSF-CWs) 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 or planted, unplanted and freshwater control (HPC-CW, VUC-CW & VFC-CW) and grown with in commercial floricultural plants. During Sep. 2020 – Dec. 2020 unit were tested for their potential removal of for different metallic pollutants as well as comparative flower yield of different marigold varieties. For this metal mixtures of Fe, Mn, Zn, Cu, Cd, Cr, Pb, Ni each with 1.0 mg/l and 5.0 mg/l concentrations were prepared by spiking in fresh water and then fortnightly applied in these systems in three replications and five different marigold varieties *viz* Ashtagandha red, Gold spot yellow, Kolkata red, Kolkata yellow, and Pusa Narangi were grown (two plants of each varieties in each system).

Fig. 2.22 Pilot scale Constructed wetland system at NIASM for Septic tank wastewater treatment

In this crop season about 3.85 kg marigold flower were harvested out of which 2.09 kg from horizontal system while 1.76 kg from vertical system (Fig. 2 and 3). Harvested marigold flower yield in different treatments was observed in the order as.

Horizontal system (HSSF-CWs):

Gravel+Coco peat (HGP-CW) > Gravel+ Charcoal (HGC-CW) > Gravel (HG-CW) > Gravel+ Rice hull (HGH-CW) > Media less or planted control (HPC-CW)

Vertical system (VSSF-CWs):

Gravel+Coco peat (VGP-CW) ~ Gravel+ Charcoal (VGC-CW) > Gravel+ Rice hull (VGH-CW) ~ Gravel (VG-CW) > Fresh water control (VFC-CW)

In this crop season marigold yield was reduced compared to last season may be due to the use of freshwater wastewater (low nutrient content) at the place of septic tank wastewater, compaction of media in constructed wetland system (due to three year continuous operation) as well as metal stress. However, among different treatments Gravel+Coco peat based system has shown highest flower yield of 0.826 kg in horizontal system while 0.72 – 0.79 kg Gravel+Coco peat and Gravel + Charcoal based vertical system. Among different marigold varieties flower yield was observed in the order as

Kolkata yellow < Ashtagandha red < Gold spot yellow < Kolkata red < Pusa Narangi

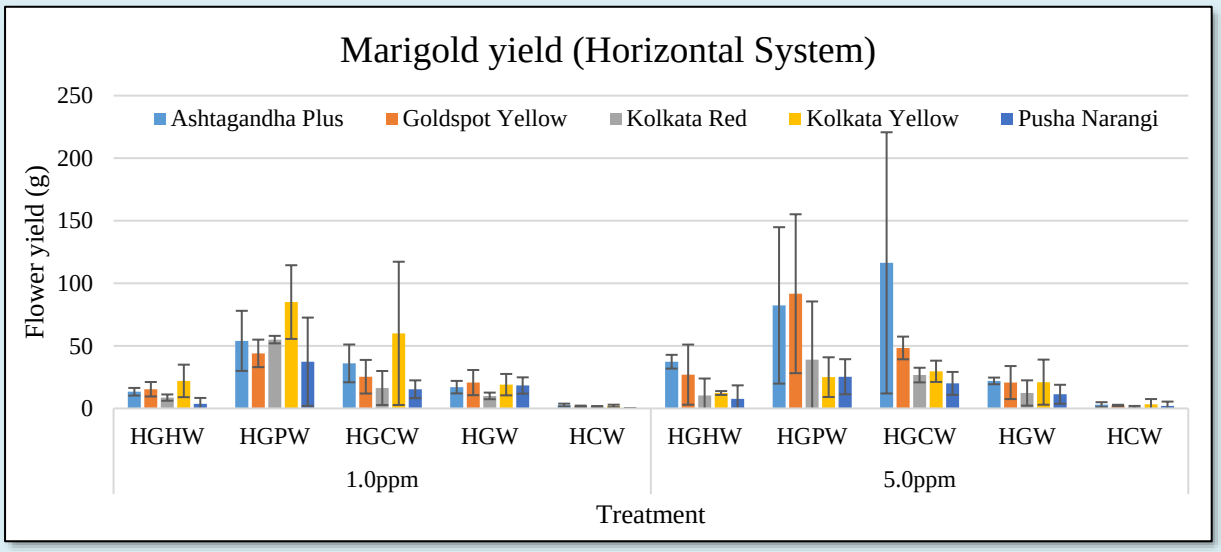


Fig. 2.23. Marigold flower yield in different Horizontal sub-surface flow

based constructed wetland system (HSSF-CWs).

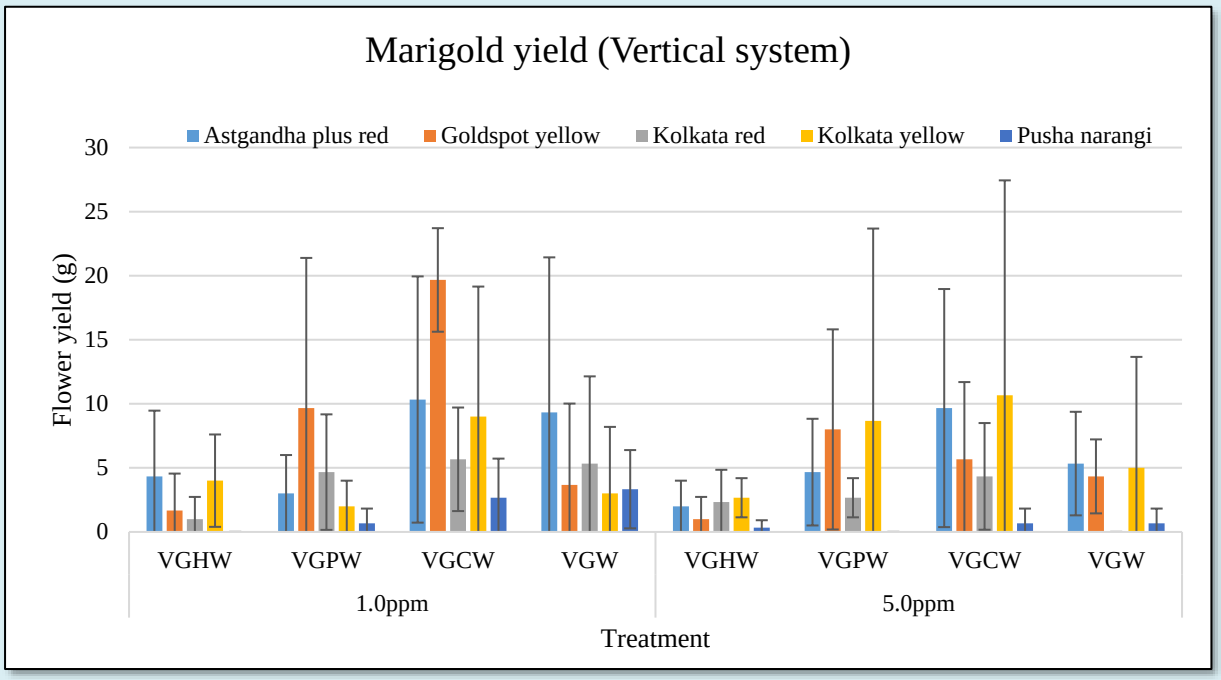


Fig. 2.24. Marigold flower yield in different Vertical sub-surface flow based constructed wetland system (VSSF-CWs).

There is no significant difference in flower yield in both horizontal as well as vertical appled with 1.0 mg/l and 5.0 mg/l of metal concentration was observed which indicates metal tolerance of marigold plant. Metal removal capacity was obserbed >90% for all the metals. However, among different treatments metal removal capacity was observed in the order as

Gravel+ Charcoal (GC-CW) > Gravel (VG-CW) > Gravel+Coco peat (VGP-CW) > Gravel+ Rice hull (GH-CW) > Unplanted control (UC-CW) > Media less or planted control (PC-CW)

Research Programme-3

2.3 Water Stress Management

Water is one of the major requirements for life to sustain and therefore managing stresses related to water has been a priority area of research being carried out at NIASM. The research programme on water stress management has broadly focused its activities to evolve adaptation and mitigation options for management of water related abiotic stresses. These include unravelling the mechanisms and traits contributing to water stress tolerance in plants for generation of climate smart crops; characterization of genes and understanding mechanisms for designing crops for adaptation and mitigation to water stress by utilizing molecular and genomic and physiological tools; optimizing novel genetic improvement approaches for enhancing resilience of crops to water stress and exploring alternative crops suitable for deficit or excess soil moisture situations. The major research findings emerging out and the progress made under this programme during the past one year are summarized below.

2.3.1 Optimization of high throughput phenotyping for drought tolerance in chickpea

An experiment was conducted to optimize image based phenotyping method for assessing plant responses to depleting soil moisture stress and to identify promising traits and potential genotype for drought tolerance using 22 genotypes of chickpea along with local check 'Digvijay'. Plants were grown under natural condition in pots upto 25 days then were shifted to plant phenomics facility for phenotyping. Two treatments were set, first was water stress in which withholding water was done after 30 DAS and other was control in which optimum water was applied regularly. Imaging system including high resolution visible (400-700 nm) and NIR (700-1700 nm) sensors were used to capture plant images. Parameters namely, digital area, convex hull area (CHA), boundary point count (BPC) and NIR intensity could differentiate the responses of chickpea genotypes more efficiently under depleting soil moisture. Genotype D-24 was found to be a promising genotype, which can be used as donor for drought tolerance as it had high biomass relative to Digvijay.

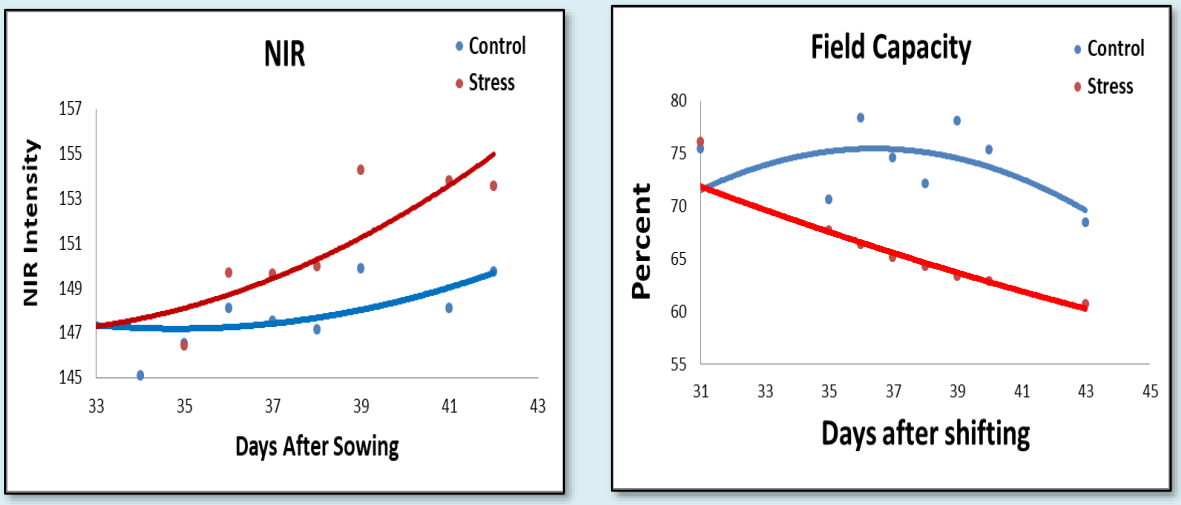
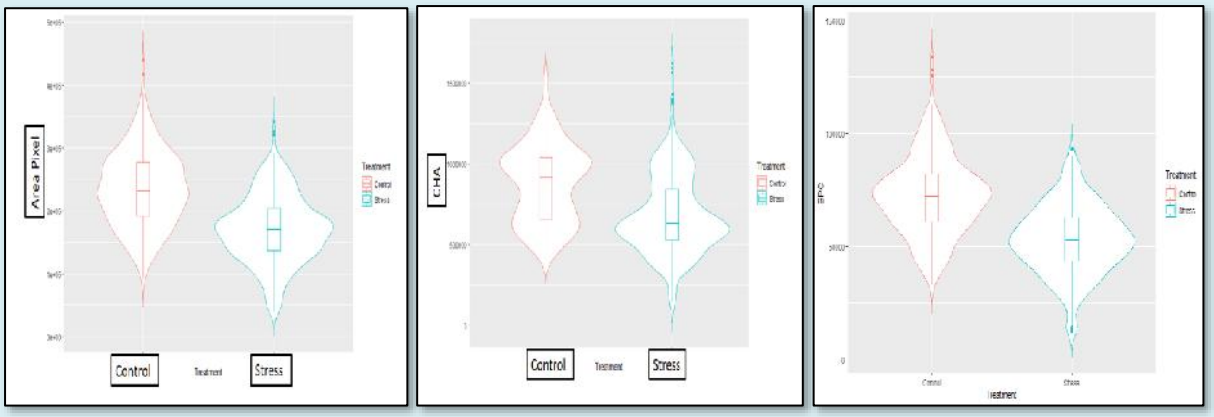


Fig. 2.25. Soil moisture trends and NIR intensity during the experiment in cotrol and drought stress treatment.



(a) (b) (c)

Fig. 2.26. Mean values of Digital Area (a), Convex Hull Area (b) and Boundary Point Count (c) of shoots of chickpea plants in drought and control condition.

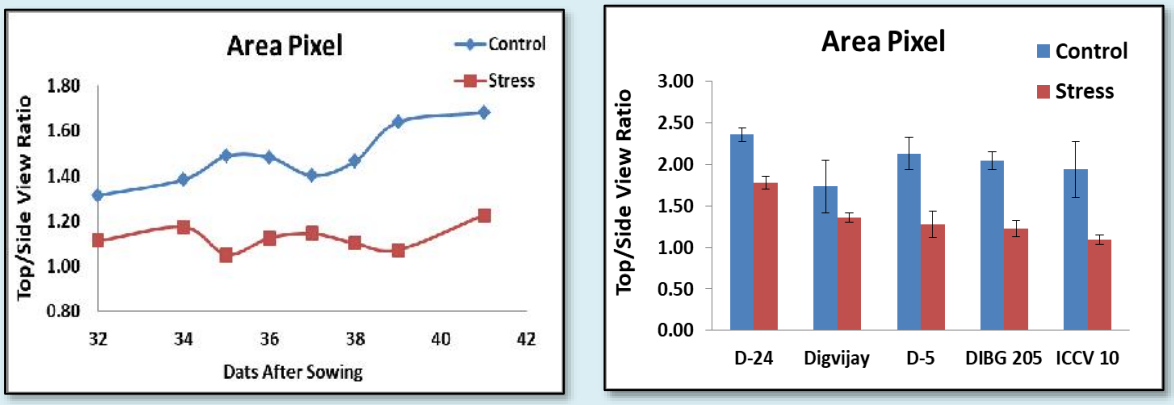


Fig 2.27. Top and Side View Ratio of digital Area Pixel ; Genotypic variation und ercontrol and drought condition.DAS 40)

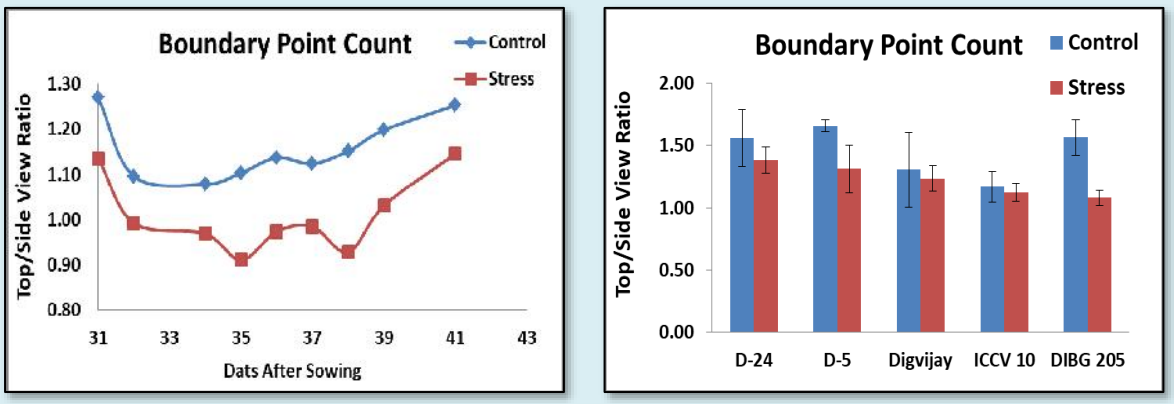


Fig 2.28 Top and Side View Ratio of Boundary Point Count; Genotypic variation under control and drought condition(40 DAS).

2.3.2 Phenotypic evaluation of soybean genotypes for drought adaptive traits

The plant RGB images obtained through the imaging unit were analyzed using the Lemna Grid (LemnaTec, Germany) by retrieving from the Database. The number of pixels of one single object (plant region) was quantified in each view (Side0, Side90 and Top) and the pixels from each view were used for quantification of the digital biomass. In the present study

soybean genotypes EC 456556, TGX 984-18 E and TGX 802-150 E showed higher digital biomass as compared to the check varieties JS-7105 and JS-9752. Soybean genotypes EC-456556 had lower Boundary Point to Area Ratio (BPAR) as compared to check varieties JS-7105 and JS-9752 when analysed using visible camera in phenomics.

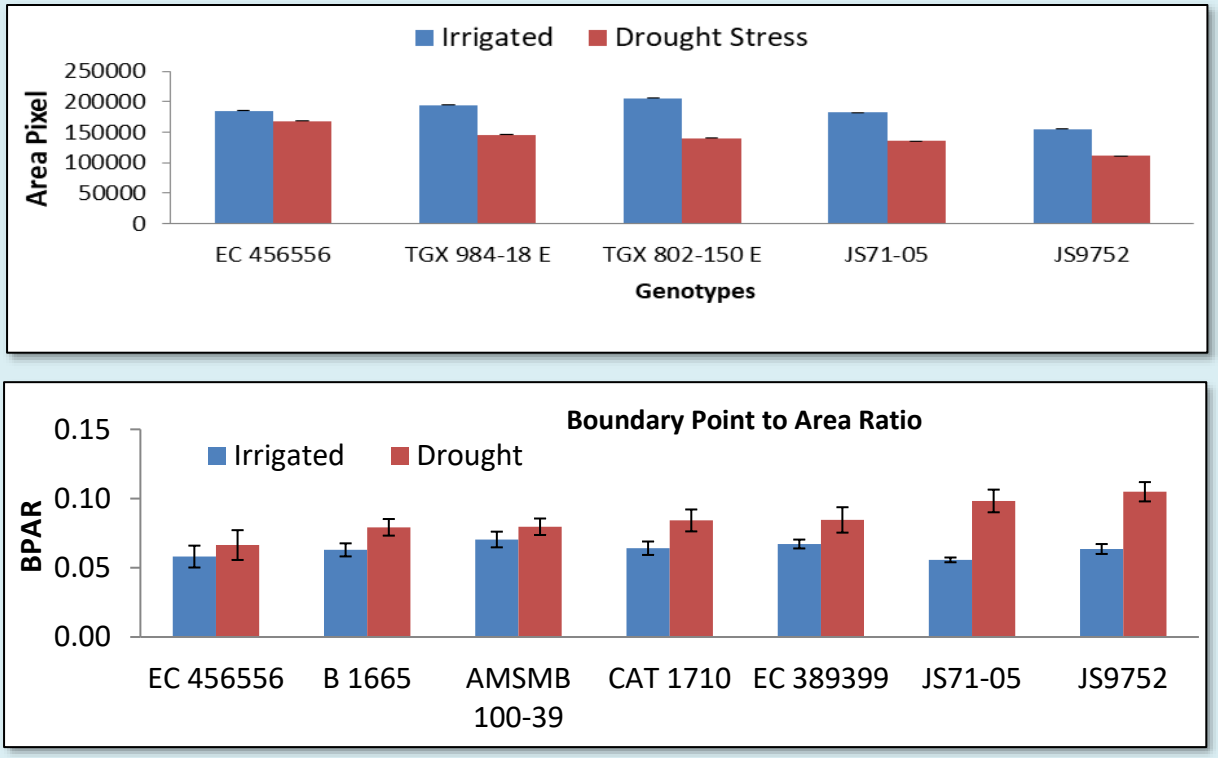


Fig. 2.29. Digital biomass and Border point to area ratio of soybean genotypes under drought and well watered conditions in soybean

2.3.3 NIR imaging to determine water status in soybean genotypes

Soybean genotypes along with check varieties i.e., JS-9752, JS-7105 (tolerant) and JS-9560, NRC-37 (sensitive) were evaluated in plant phenomics facility for drought tolerance traits.. NIR values obtained after image analysis are inversely proportional to the tissue water content as NIR is absorbed by water molecules. Genotypes JS-8021, Kaeri-651-6 and EC-589400 exhibited lower NIR intensity relative to the check varieties indicating higher potential to retain tissue water content in the drought stress condition.

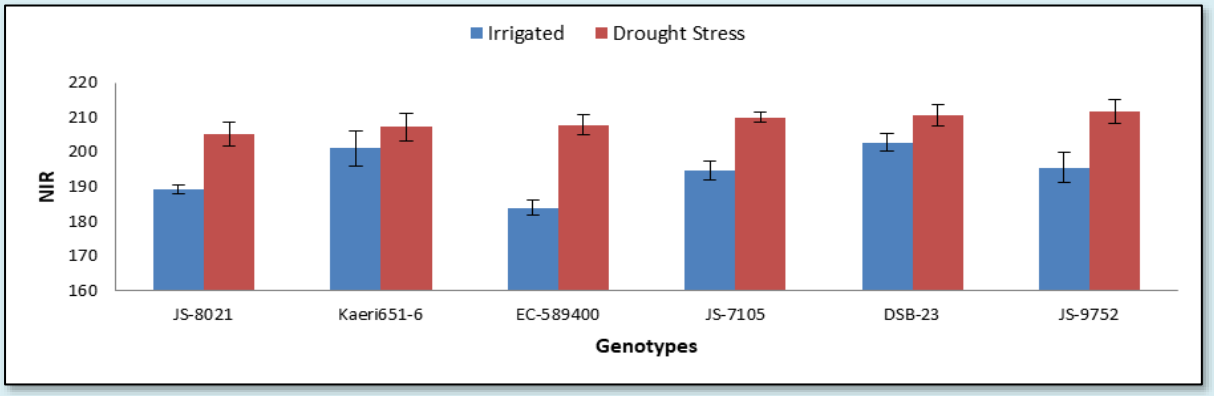


Fig. 2.30. Plant tissue water status under drought stress and non-stress conditions in soybean genotypes via NIR imaging.

To assess the responses of soybean genotypes to water stress at flowering stage, traits such as canopy temperature, canopy greenness (NDVI value), Photosystem-II (PS-II) efficiency and water status of plant (RWC) were analysed in 320 Soybean genotypes for drought adaptive traits. Genotypes TGX 814-78D, TGX 885-44E, and TGX 854-60A exhibited higher NDVI, cooler canopy and efficient PS-II and higher RWC as compared to check varieties like JS-9752 and JS-7105. Promising soybean genotypes revealed adaptation to water stress and could be suitable to grow under limited soil moisture conditions.

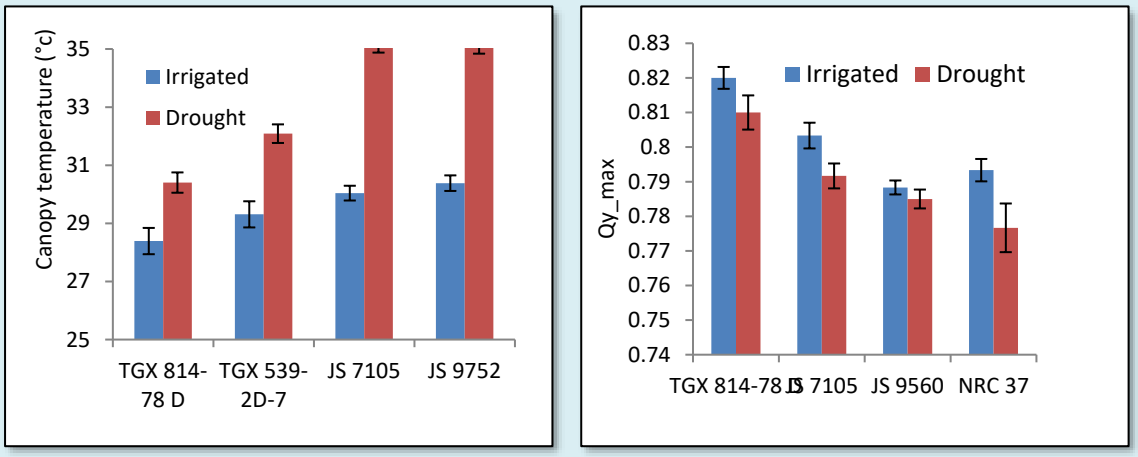


Fig. 2.31. Genotypic variation for adaptive traits associated with drought stress tolerance under greenhouse conditions in Soybean germplasm.

2.3.4 Evaluation of soybean genotypes for adaptive traits associated with waterlogging tolerance in greenhouse conditions

Traits such as plant height enhancement, PS-II efficiency and canopy greenness were evaluated to identify water logging tolerant soybean genotypes. A total 100 soybean genotypes along with check varieties JS-9752 were evaluated for water logging tolerance. The water logging condition was imposed at vegetative 2-vegetative 3 (V2-V3) growth stage of plant for 15 days. Soybean genotypes EC-95815 showed higher plant height, canopy greenness and higher PS-II efficiency as compared to the check variety JS-9752.

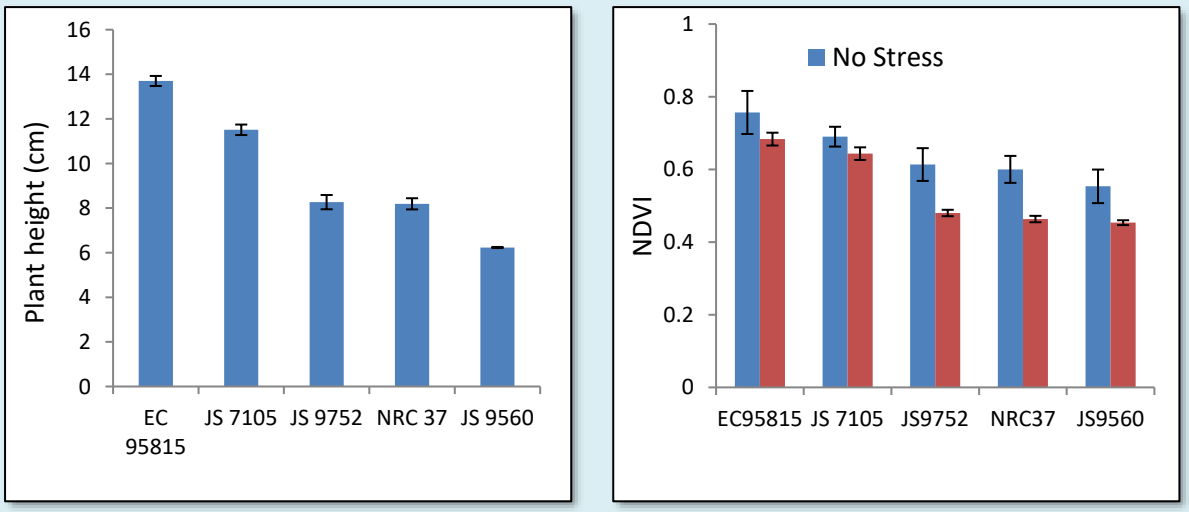


Fig. 2.32. Genotypic variation for plant height and NDVI under water logging stress and non-stress condition in soybean.

2.3.5 Evaluation of soybean genotypes for traits associated with Root System Architecture under in vitro conditions

Soybean genotypes (100 in number) were evaluated for Root System Architecture **(**RSA) under *invitro* condition. The soybean genotypes *viz*., EC-291397 and AGS-142 found efficient RSA in terms of higher root hairs, root number and root biomass as compared to check varieties such as JS-9752 (drought tolerant), JS-7105 (drought tolerant), JS-9560 (drought susceptible).

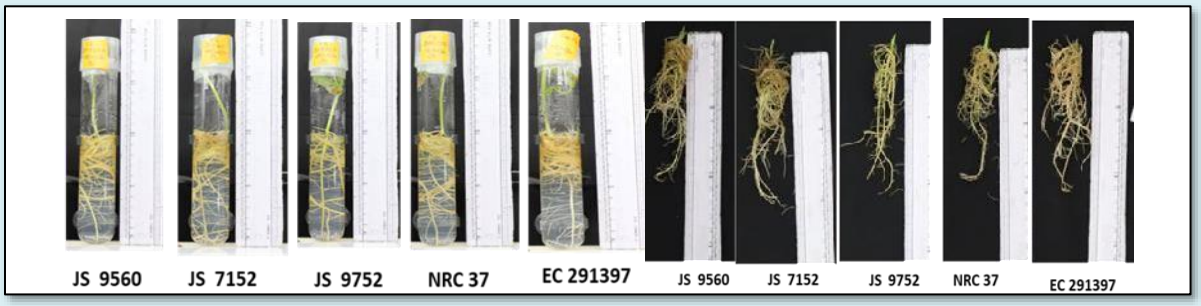


Fig. 2.33. *Invitro* root system architecture in soybean.

2.3.6 Soybean based intercropping systems for better productivity and optimum resource use efficiency

Intercropping is widely used to increase the utilization efficiency of resources such as light, heat, water, and fertilizer to effectively improve the primary production of land per unit area. A field experiment on soybean based intercropping systems was carried out in *Kharif* 2020. Three crop combinations C1 (Sole soybean), C2 (soybean + pigeon pea), C3 (soybean + maize) were established in a randomized block design. The results showed that soybean crops under soybean + maize intercropping exhibited cooler canopy compared to sole soybean and Soybean + pigeon pea during flowering whereas during pod filling, soybean plants under soybean + pigeon pea intercropping showed the coolest canopy temperature. Further, with respect to crop physiological parameters, yield attributing parameters, soybean equivalent yield and crop water use efficiency, soybean pigeon pea intercropping had significantly higher values than soybean + maize and sole soybean.

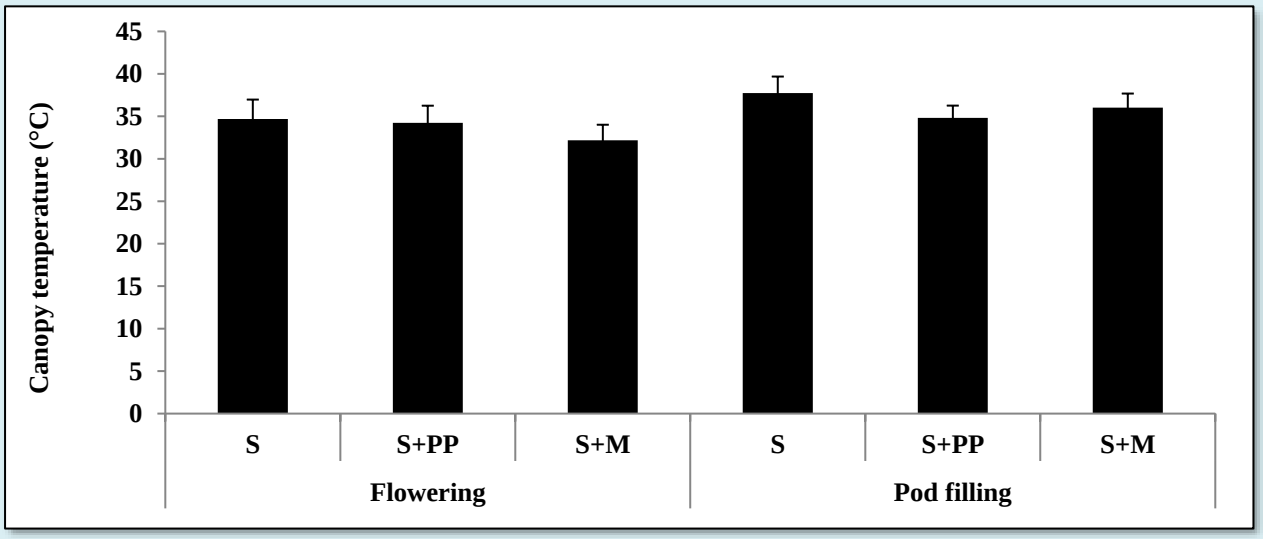


Fig 2.34. Effect of intercropping on canopy temperature of soybean at different growth stages (Note: S: sole soybean; S+PP: soybean pigeon pea (2:1); S+M: soybean +maize (2:1).

Table 5. Effect of intercropping on growth and physiology of soybean.

Treatments	Leaf Area Index			SPAD value			Dry root weight (g plant $^{-1}$)	Nodules plant $^{-1}$	Nodule weight plant^{-1}
	Tr	Fl	P	Tr	Fl	P			
Sole Soybean	3.01 b	1.98 a	1.23 b	43.8 b	40.0 b	37.5 b	2.99 c	16.1 c	134.5 c
Soybean + Pigeon pea (2:1)	3.15 b	2.03 a	1.53 a	44.1 ab	43.1 a	41.8 a	3.35 a	18.9 a	148.8 a
Soybean + Maize (2:1)	3.43 a	1.67 b	1.21 c	45.3 a	43.6 a	41.2 a	3.22 b	17.4 b	141.7 b

Different letters in a single column show statistically significant differences for P < 0.05.
Note: Tr-trifold stage; Fl-Flowering stage; P-Pod filling stage

Table 6. Effect of intercropping on yield attributing parameters and equivalent yield of soybean.

Treatments	Total dry matter (g plant $^{-1}$)	No. of pods plant^{-1}	No. of Seeds pod^{-1}	1000 seed weight (g)	Soybean equivalent yield (kg ha^{-1})	Crop water use efficiency (kg ha^{-1} mm^{-1})
Sole soybean	14.6 b	78.22 a	2.05 b	108.75 c	2201 c	7.71 c
Soybean + pigeon pea (2:1)	17.7 a	108.98 a	2.23 a	170.87 a	3067 a	8.17 b
Soybean + maize (2:1)	16.3 a	82.88 c	2.11 ab	137.19 b	2638 b	9.67 a

Different letters in a single column show statistically significant differences for P < 0.05.

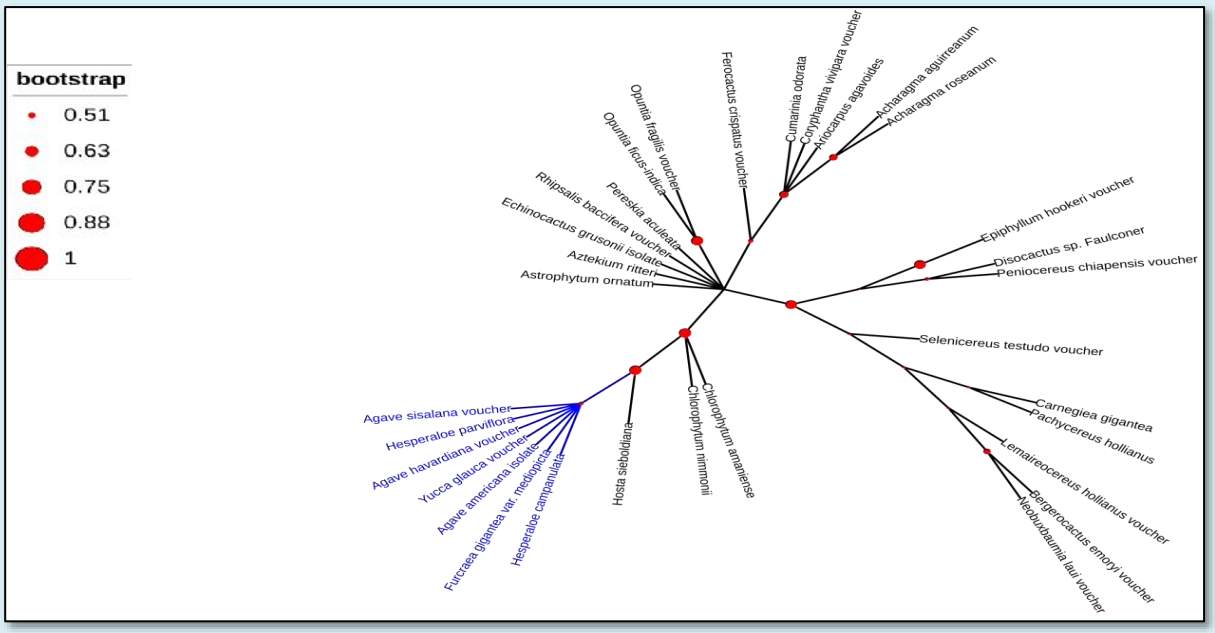
Fig. 2.35. Field view of the soybean intercropping experiment.

2.3.7 Taxonomic diversity and phylogenetic analysis of genera under Cactacea family

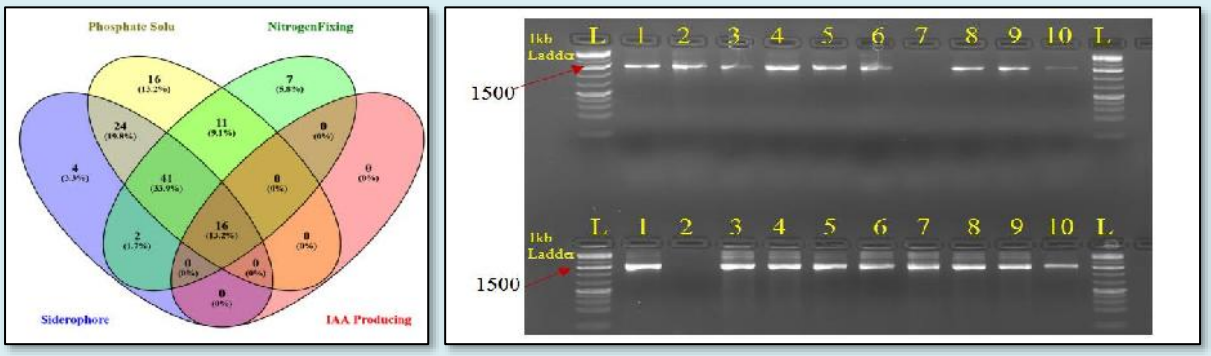
In line with the goal of the project to exploit the microbial diversity of the naturally drought tolerant xerophytic plants to augment the desiccation tolerance in agricultural crops, taxonomic diversity and phylogenetic analysis of genera Cactacea family was carried out. Cactacea family which is placed under order Caryophyllales is comprised of more than 125 genera distributed across the globe. A literature survey of the prominent genera under Cactacea family was conducted. The publically accessible gene sequences of rbcL gene were retrieved for phylogenetic analysis. A bootstrap consensus phylogenetic tree was generated. The bootstrap values are shown in the form of the colored circle at the respective node. The larger size of the colored circle indicates the higher bootstrap value. The bootstrap tree of the

different cactus genera indicated polyphyletic origin of the cactus genera. The prominent genera of the *Agavacea* family which have evolved the same morpho-physiological features as that of the cactacea were also included for phylogenetic analysis. All genera of agaves formed a separate clade as indicated with blue color showing different evolutionary lineages of the two families.

2.3.7.1 Cactus endophytes exhibiting Multi-PGPA trait



Cactus endophytes were isolated from six accessions of *Opuntia* and were screened for PGPA traits. 55.12% of the endophytes isolated from cactus leaf exhibited siderophore producing ability, 62.17 % phosphate solubilizing ability, 45.51 % showed ability to grow in N2 –free culture media indicative of N2 ability of the isolates. Cultured endophytes were also screened for IAA production using Salkowski reagent assay and Out of 9.2% endophytes tested, 16 were positive for IAA producing activity. Many of the Opuntia endophytes exhibit multiple PGPA traits of siderophore production, phosphate solubilisation activity and Nitrogen fixation activity. The 16S rRNA gene have been amplified for the identification of the cactus endophytes. The multi-PGPA traits cactus endophytes were also screened for their ability to tolerate different concentration of NaCl. Two of the Multi-PGPA endophytes (Cac-5-NA44 and Cac-5-NA79) tolerated the salt concentration of >5% NaCl. The further characterization such multi-PGPA trait endophytes is in progress.



(a) (b)

Fig 2.36. (a) Venn diagram summary of the PGPA traits exhibited by cactus endophytes. (b) Agarose gel images of 16S rRNA gene amplified from cactus endophytes.

2.3.8 Onion responses to plant bioregulators (PBR) under water logging stress conditions

A second year 2019-2020, field reconfirm the onion (cv. Bhima Kiran) responses to plant bio-regulators (600 ppm thiourea, 200 mg L^{-1} sodium benzoate, 20 g L^{-1} KNO_3, 15 µM salicylic acid and control) under growth stage specific water logging conditions (30, 60 and 90 DAT). The maximum bulb yield reduction of 9.2-13.9% was reported in bulb initiation stage (60 DAT) and identified as most sensitive growth stage to water logging. PBRs like KNO_3, thiourea and salicylic acid enhanced bulb yield (10.1-25.1%), dry matter content (15-34.4%) and reduced di-centre bulbs by 22-39.8%. PBRs (PN and TU) significantly improved bulb yield and quality attributes by alleviating yield attributes.

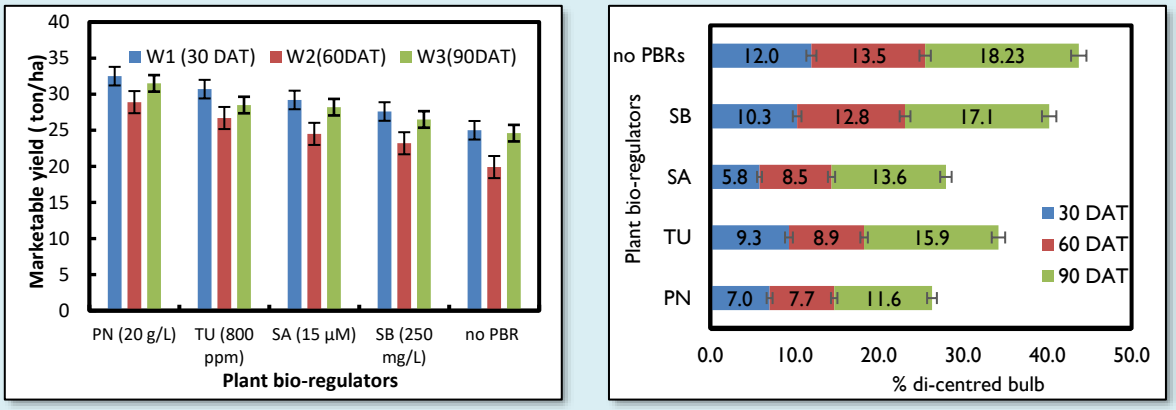


Fig. 2.37. Dry matter and di-centred bulbs as affected by PBR and water logging stress.

2.3.9 Onion responses to sulphar sources for enhancing storage quality of onions

A field trial was conducted to study the interactive effect of sulphar sources on yield and post-harvest storage quality of onion using line source sprinkler system. The main treatment included three different of sulphar sources *viz*., bensulf, single super phosphate (SSP) and sulphate of potash (SOP) with 25, 50 and100% doses of soil application. The subplots included five irrigation levels of IW: CPE 1.00, 0.75, 0.50, 0.25 and 0.0, respectively. The preliminary results indicated the bensulf (100%) to be better for enhancing the yield and post-harvest storage quality of onion. The significant changes in TSS, protein, pyruvic acid, phenol, rehydration ratio, flavonoids and ascorbic acid were observed in five month of storage.

2.3.10 Flowering and quality of dragon fruit affected by excess rainfall

During August 2020, problem of excess flowering followed by flower dropping, yellowing and rotting of fruit was observed at orchard of ICAR−NIASM. The recorded field observations indicates about 40−70% fruits were of tiny size (36−49 mm dia.) having yellow to pinkish colour, 15−20% small size fruits (63−68 mm) and remaining 8−10% medium size fruits (79−84 mm) having light to dark pink colour. The tiny fruit cannot be used for any purpose. While, small and medium grade fruits can be used for value addition and fresh consumption, respectively. Flower density management followed by covering of flower into plastic bags to avoid contact of rain water can be the solution of this problem.

Fig. 2.38. Changes in fruit size due to excess rainfall occurred during rainy season.

2.3.11 Preliminary studies on floral biolgy in dragon fruit

In order to find out the cuases of flower and fruit drop and reduction in fruit size in dragon fruit a preliminary study on floral biolgy was conducted. The study on anthesis (opening of flower), pollen viability and stigma receptivity reveled that, the flower opening starts at 6.00 PM onwards and open completely between 8-10 PM in most of the flowers. It was observed that the continuous or heavy precipaition during antheis period (particularly night and next day) cuases drastic pollen wash and thus it effects the pollination and consequently the fruit set and development. Further, continuous rains during night followed by cloudy weather in day time favors absorbtion of moisture by elongated corolla which leads to decay of developing fruit. Further, from the preliminary studies based on manual pollination in different matured flowers (stigma) it was found that stigma receptive upto 3 days after anthesis which was confirmed by fruit set (Fig 2.39). However, the large and uniform fruit deveopment was noticed in stigma pollinated on the day of anthesis (from 6.00 PM upto next day forenoon). From the pollen viability study, it was found that pollens remain viable up to 18 hr after antheis (i.e next day morning). So that supplementary pollination can be carried out even next day morning after antheis (preferably before 12 PM). Therfore, understanding the floral biology helps to plan management practices like bagging flowers and supplementary pollination (including timing of pollen collection, storage and hand pollination) to avoid losses due to rainfall and also to improve fruit size and quality in dragon fruit.

Fig. 2.39. Initiation of antheis (A); Bagging different matured flowers (stigma) after pollinated manuually (B); variation in fruit size upon pollnation in differnerent matured stigma (C); Viable (D) and non-viable pollen (E) after 18 and 40 hr after anthesis.

2.3.12 Creation of genetic novel variability in Quinoa and Chia through mutation

For any crop improvement programme existence of genetic variability is pre-requisite for selection to be effective. With the objective of generating novel variation in existing germpalsm, seeds of Quinoa and Chia (Black and white) were subjected to mutation by exposing it to three levels of radiation intensity of gamma radiation viz. 150, 250 & 350 Gy and 400, 500 & 600Gy respectively, at the Gamma Chamber facility, ICAR-IIHR, Bengaluru. Under lab condition mutation effect noticed in terms of changes in germination rate and morpho-physiological traits were affected by mutation doses. It was observed that process of germination was delayed with increasing irradiation dose in both the crops. Further, seedling height, root length and leaf development were also reduced with increasing dose. In case of Quinoa, seedlings at 350Gy did not survive after 30 DAS. Genetic variations were observed for foliage color, panicleshape, flower types and color, branching habit in mutant lines.

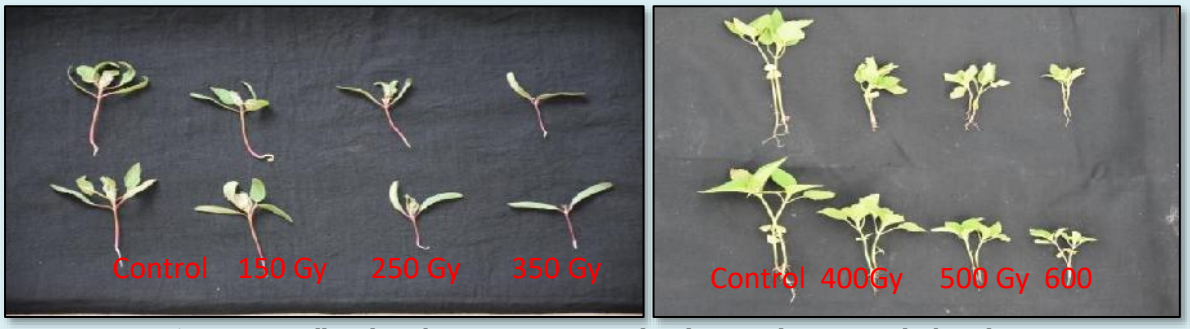


Fig. 2.40. Seedling length variation in control and mutated Quinoaand Chia plants with different dose of radiation.

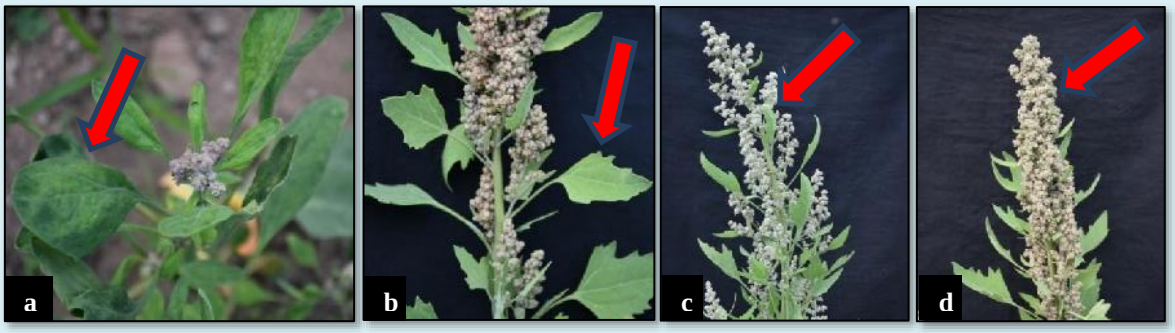


Fig. 2.41. .Morphological variations in M_1 generation of Quinoa. (a) non serrated leaf in mutant plant (b) serrated leaf in wild/ normal plant (c) loose panicle in mutant plant (d)compact panicle in wild plant.

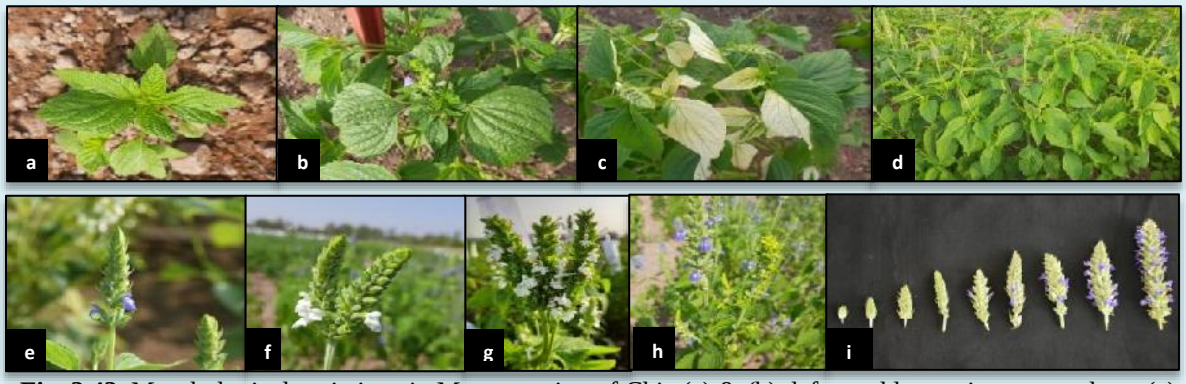


Fig. 2.42. Morphological variations in M_1 generation of Chia.(a) & (b) deformed leaves in mutant plants (c) chorosis in mutant palnt (d) normal foliage in wild type plants (e) single panicle in wild panicle (f), (g)

2.3.13 Collection, multiplication and evaluation of the germpalsm/ genotypes/ accessions of different crops

With objective to create the genetic garden of abiotic stress tolerant plants, the germplasm/ genotypes/ accessions of different crops have been collected from different organizations. The seed materials of collected materials were properly stored in cold storage. Further, germplasm of crops were also sown in the genetic garden.

Table 7. The list of collected germplasm/ genotypes/ accessions of different crops.

Sl. No.	Crops	Germplasm/ genotypes	Abiotic stress tolerance	Source
1	Safflower	NARI-6, NARI-96 & GMU-2369	Drought	NARI, Phaltan
2	Sorghum	Madhura-2, Madhura-3 &Revati	Drought	
3	Stylo	Stylohamata&Stylosebrana	Drought	
4	Subabul	Wonder graze &Taramba	-	
5	Wheat	KRL 210, KRL 213, KRL 283, KRL 3-4, KRL 99, KRL 19, KRL 1-4 &Karchia 65	Salinity	ICAR-CSSRI, Karnal
		10 promising lines	Drought	ICAR-NIASM, Baramati
6	Chickpea	72 Genotypes	Evaluation under progress	IIPR, Kanpur & SWSM,ICAR-NIASM, Baramati
7	Lentil	32 Genotypes	Evaluation under progress	IIPR, Kanpur
8	Pigeon pea	4 Genotypes	Water logging	ICRISAT, Hyderabad
9	Soybean	JS-7105, JS-9752, EC-456556, TGX 814-78D, TGX 885-44E, TGX 854-60A	Drought	ICAR-IISR, Indore
		JS-9752, EC-95815	Water logging	
10	Quinoa	15 Genotypes	Evaluation under progress	MPKV, Rahuri and ICAR-IISS, RS, Bengaluru
11	Turmeric	16 Genotypes	Evaluation under progress	-
12	Fenugreek	17 Genotypes	-	NRCSS, Ajmer

2.3.14 Information on daily rainfall events (heavy rain >100 mm and between 50-100 mm in a day) occurred in last 35 years (1986-2020) at ICAR-NIASM, Baramati

The data of daily rainfall (heavy rainfall>100 mm and 50-100 mm in a day) occurred at NIASM during last 35 years were collected. The data will help in design and planning of the soil and water conservation structures and drainage network in the farm. The number of events of daily rainfall occurred in last 35 years is depicted in Fig. 2.43.

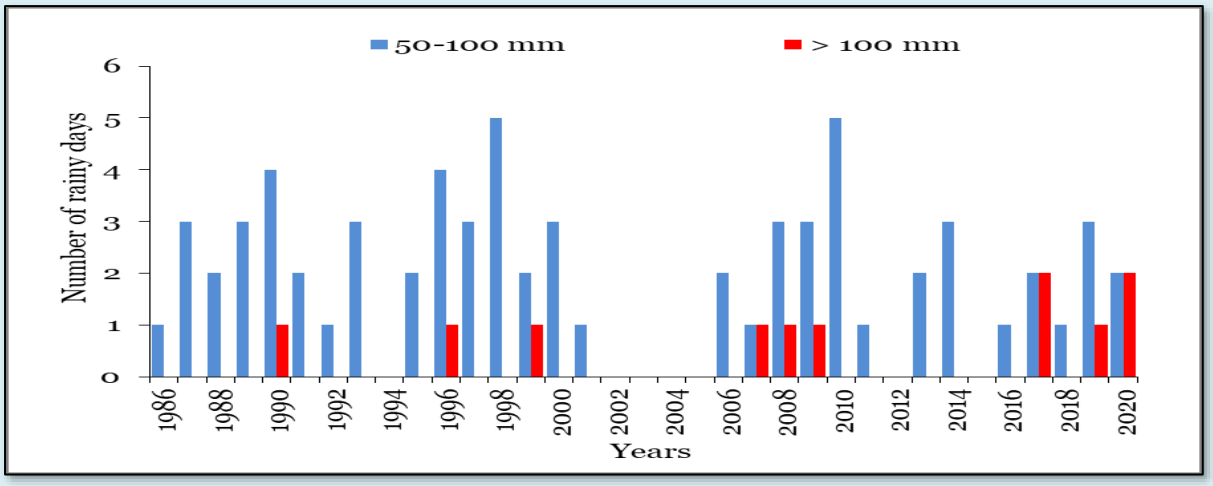
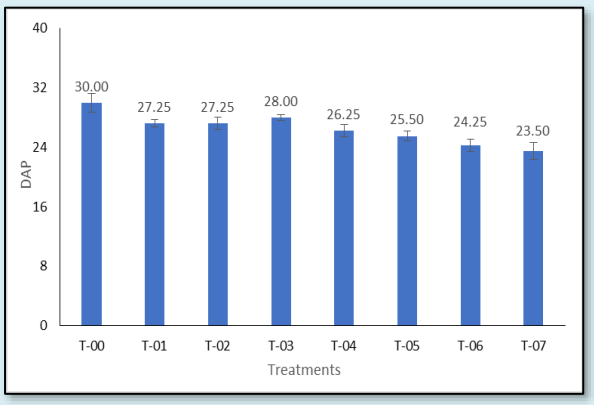


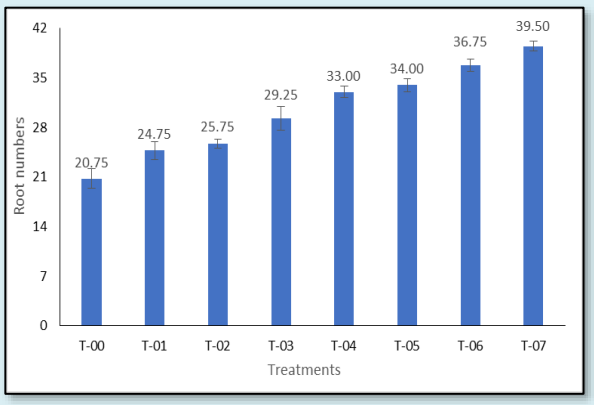
Fig 2.43. Events of daily maximum rainfall occurred in last 35 years at ICAR-NIASM, Baramati

2.3.15 Exogenous application of IBA enhances rooting in Dragon fruit (*Hylocereus undatus*) cuttings

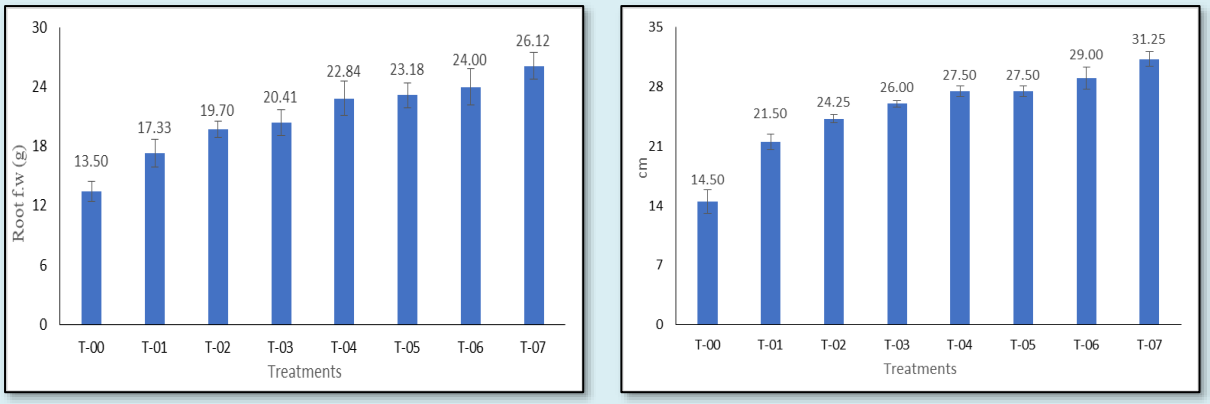
A field experiment was conducted at the experimental farm of ICAR–NIASM, Baramati in January to June 2020 to study the influence of exogenous Indol3 Butyric acid (IBA) on rooting behaviour of dragon fruit cuttings. The treatment consists of different concentrations of IBA *viz*: T1:100 ppm, T2:200 ppm, T3:500 ppm, T4:1000 ppm, T5:2000 ppm, T6:4000 ppm, T7:8000 ppm and a T0: Control with No IBA treatment. Planting materials were selected from mother orchard, cuttings that appeared healthy and were approximately 30 cm long. The influence of exogenous application of IBA concentrations was observed with parameters like days required for root initiation, number of roots, length of root, root fresh weight. The results clearly endorsed a positive performance of IBA @ 8000 ppm towards rooting behaviour in dragon fruit cuttings. Treatment with IBA @ 8000 ppm exhibited significant earliness in root initiation (23 days) over treated with lower concentrations, as well as untreated cuttings (30 days). Along with early rooting, same treatment was also found responsible for emergence of maximum number of roots (39.00) and higher fresh root weight (26.12 g). Cuttings treated with IBA @ 8000 ppm, produced roots with longest length (31.25 cm) however untreated cuttings reported shortened and weakened root system at 100 days after planting. Based on the results it is evident that the IBA @ 8000 ppm would be used for better rooting and establishment of dragon fruit cuttings.



Initiation of roots in days after planting



Root numbers



Root weight Root length

Fig. 2.44. Effect of IBA on root traits in dragon fruit cuttings.

2.3.16 Sugarcane yield and quality as affected by micro irrigation, planting techniques and residue management practices

During the year 2019-2020 second year field trial was conducted to examine the interaction effect of modified planting geometry, trash residue retention, and micro-irrigation on soil health, yield, productivity and quality of sugarcane. The main treatment included planting system *viz.* zigzag paired row (210× 90 cm), parallel-single row (150 cm), parallel-paired row (210 × 90 cm) with surface and zigzag paired row (225 × 75 cm), zigzag paired row (240 × 60 cm) with subsurface micro-irrigation regimes and sub-treatment consisting crop residue burning and retention, respectively. Planting of sugarcane in zigzag paired row (225 × 75 cm) with sub-surface drip irrigation and crop residue mulching significantly enhanced cane yield (151.2 t ha^{-1}); followed by zigzag paired row (240 ×60 cm) planting with subsurface drip irrigation (142.5 t ha^{-1}) over the conventional method of planting (97.8 t ha^{-1}). Retention of sugarcane crop residue on soil surface also improved cane yield (130.6 t ha^{-1}) over the field burning (112.3 t ha^{-1}) under the different planting system and micro-irrigation combinations. Quality parameters such as brix, sucrose content, purity and commercial cane sugar content remained almost unaffected with the changing crop geometry and irrigation techniques. The results showed the potential of integrating micro-irrigation, planting geometry and conservation agriculture for enhancing yield sustainable sugarcane farming in India.

Research Programme-4

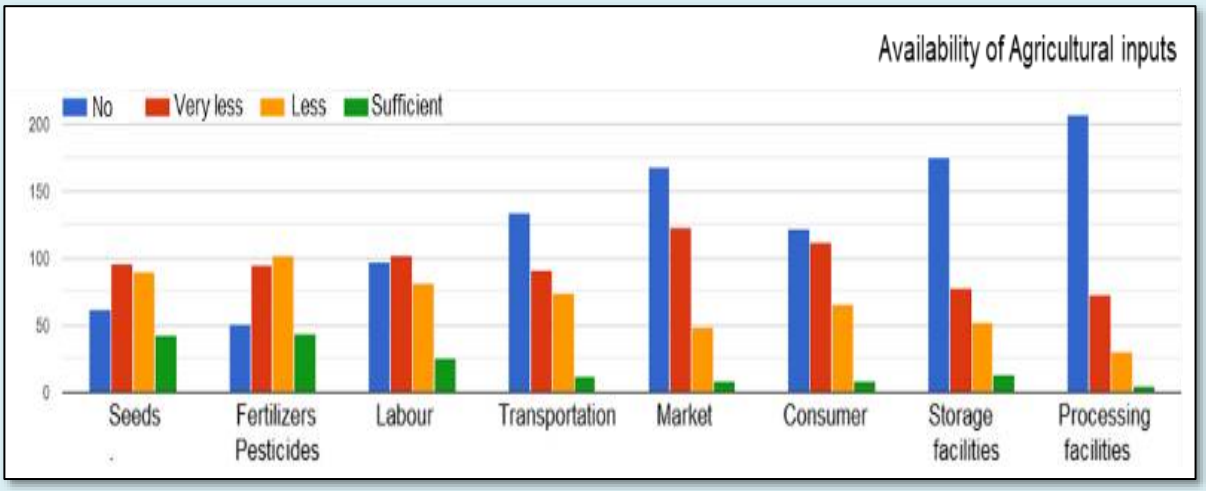
2.4 Social Science and Policy Support

The research programme on social sciences and policy support has been focusing on understanding the socio-techno-economic factors pertinent to adoption of strategies and technologies for management of multiple abiotic stress scenarios. Under the programme, the information and communication technologies are being used for assessment and dissemination of technologies; policy support related studies related to assessment of abiotic stresses even under exceptional scenarios like covid pandemic. The progress made under this programme during the past one year is summarized below.

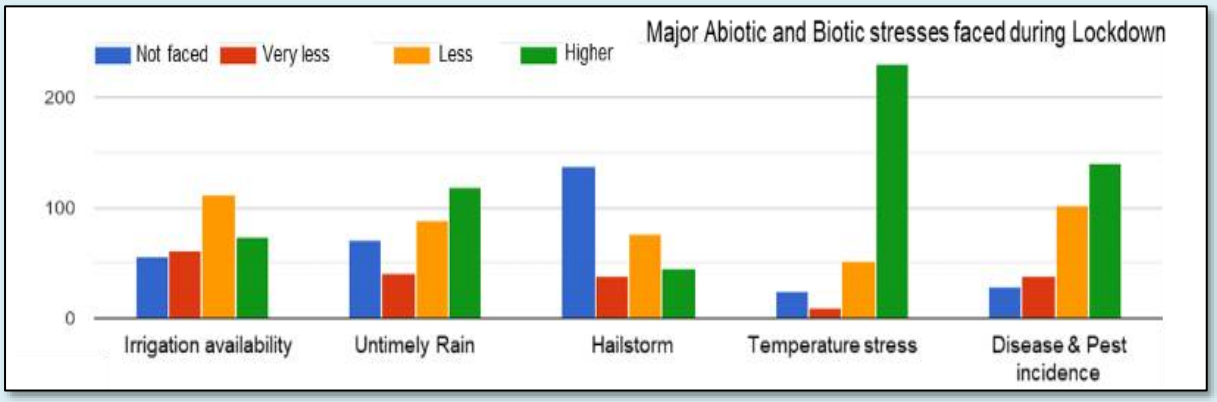
2.4.1 Online survey of farmer's sentiments during Covid Lockdown

An online survey was conducted to understand the farmer's sentiments during Covid Lockdown period in the state of Maharashtra. A questionnaire form was created using google form in Marathi language. Responses of 392 farmers were collected using the snowball sampling technique by circulating questionnaire on several online social networking platforms during May 19-25, 2020. 375 responses were filtered after removing partially answered responses. 43.9% of respondents were from the red zone, 41.7 % from the orange zone and remaining (14.4%) from the green zone. The inferences deduced from the response of the farmers are as following:

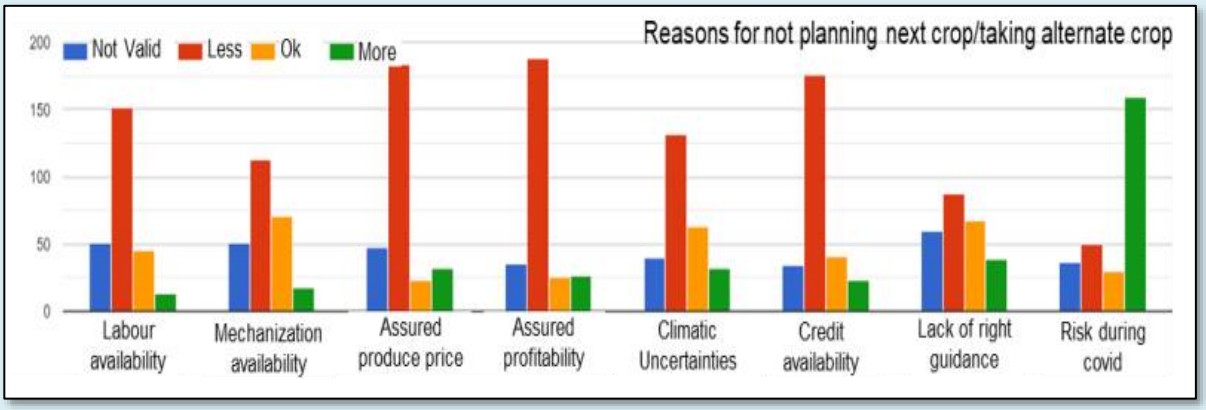
i) Majority of farmers had no agriculture produce processing and storage facilities, had no market and transportation available during lockdown. Challenges of non-availability of seeds, fertilizers, labour and consumers were also faced by majority of the respondents.



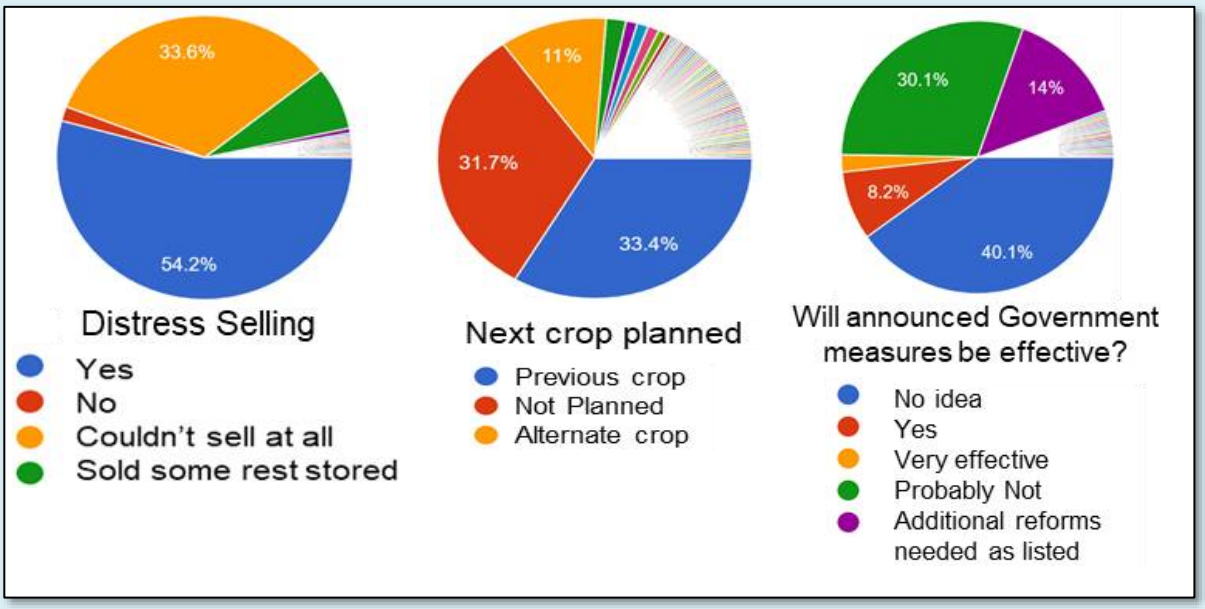
ii) Temperature stress, Disease and pest incidence were the major abiotic and biotic stresses faced during lockdown period. Challenges of Irrigation unavailability and untimely rains were also faced by the respondents.



iii) Majority of the farmers did not plan taking next crop due to less assured produce price, profitability; credit non-availability; labour non-availability and more risk of Covid infection. Challenges of climatic uncertainties and less mechanization were also reported by the respondents as reason for not planning next crop/ taking alternate crop.



iv) Majority of respondents (40.1%) had no idea of the government measures taken to facilitate agriculture during covid lockdown. Also 30% responded felt that the measures taken will be not be effective in addressing the challenges faced by agriculture sector.



v) The strategies used by farmers to cope up with the lockdown situation in Maharashtra were a) Sale of farm produce at the local level at whatever price was offered, b) Reliable income

generation through selling milk and milk products for livelihood, c) Involving family members including children for all agricultural activities.

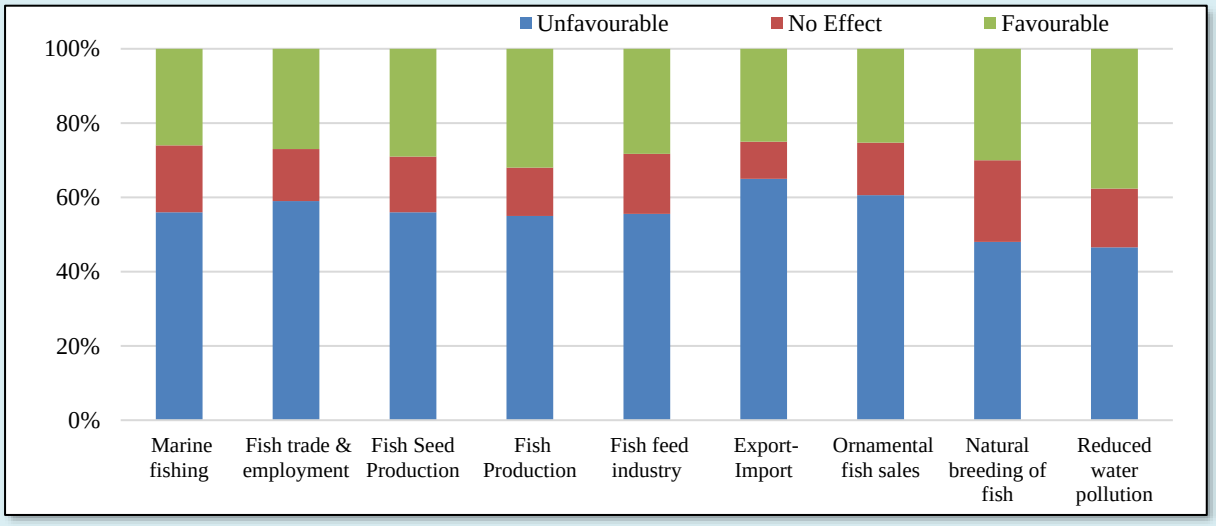
Several suggestions were also received for State/Central Govt. and research organizations as listed a) Further facilitate the sale of produce or Government should buy directly from the farmers b) Issue mobile-based agricultural advisory for adverse conditions, c) Agri-input shops should be kept open or given free of cost, d) APMC local market/Vegetable mandis should be kept open with proper covid containment measures e) Natural disaster package should be given upon survey for various commodities, f) Make provision for processing of commodities near villages to minimize the monetary loss, g) Govt. officials seldom visit the farmer's field to advise on various issues, h) Research institutes to find an immediate solution in managing recent viral disease outbreak in tomato, i) Extension of Agricultural research should be further strengthened.

2.4.2 Online survey of sentiments of fisheries businesses during Covid Lockdown

An online survey was conducted to understand the sentiments during Covid Lockdown period of people involved in fisheries as business in India. A questionnaire form was created using google form in Hindi and Marathi language. Responses of 586 farmers were collected using the snowball sampling technique by circulating questionnaire on several online social networking platforms during July 11-31, 2020. 568 responses were considered for analysis after removing duplicate and largely unanswered responses. 28.5% of the respondents were from the red zone, 35.7 % from the orange zone, 33.2% from the green zone and remaining did not answer it. 51.3 % respondents were from Maharashtra, 11.5% from Jharkhand, 8.8% from Gujarat, 8.2% from Chhattisgarh are remaining from 16 states of India. The inferences deduced from the response of the respondents are as following:

i) Major problems reported were a) Lack of transportation facilities (91%), b) Less demand in the market (89%), c) non-availability of fish seed (88%), d) non-availability of fish meal & other equipment (86%), e) labour unavailability (84%), and f) technical support not available (83%).

ii) Majority of the respondents (56%) anticipated negative impact as against positive (29%) or no impact (15%) on Fisheries sector after the lockdown to be lifted. The anticipated unfavourable, favourable and no effect of lockdown lifting on fisheries sector is given in graph below.



2.4.3 Survey findings of the impact of heavy rain and flood during October 11-15, 2020 on crop, animal and fishery in affected areas of Pune district of Maharashtra

The return monsoon caused damage to ready to harvest crops across western Maharashtra and Marathwada region during 11-15th October, 2020. In Pune district, Baramati and Indapur tehsil has received more than 150 mm of rainfall within 24 hours which further caused flood and excessive crop loss, soil loss and some extent livestock mortality. Ground survey and assessment was carried out by the team of scientists from ICAR-NIASM 17.10.2020 in the nearby villages of Bhigwan (Village: Madanwadi, Nimbodi and Shetphalgade) and Baramati (Village: Karavagaj, Karahate and Jalgaon- Supe) and Indapur to understand the nature and extent of damage, assess the crop loss and farmers conditions to cope up with the sudden disaster.

During the survey it was observed that there was considerable loss to the farmers in terms of agricultural and horticultural crop, and losses related to livestock components, infrastructure and disruption of social amenities.

Bajara field

Fodder maize field

Severely damaged sugarcane crop (almost uprooted) during flood

Maize cob sprouting

Sorghum crop field

Kharif onion-yellowing & stunted growth

Waterlogging in Vineyard

Fruit-shedding in grapes affected due to heavy rainfall and waterlogging

Waterlogging in citrus orchard

Wilting of Brinjal

Water stagnation in Banana orchard

Attack of army worm on sunflower

Bud initiation and sprouting problem in vineyard

Soybean field at harvesting stage

2.4.4 ITKs for Insect Pest Management

1. For insect control, spraying of diluted onion or garlic juice is used by tribes to control grasshopper and other leaf inhabiting insects on Maize crop.
2. Management of pod borers in gram crop through whey (lassi) + *Aloe barbadensis and* (Gwarpatha) + *Nicotiana tabacum* (tobacco).
3. Management of insect pests of wheat through cow urine + *Vitex negundo* (Nirgundi) + *Ferula asafoetida* (Hing).
4. Management of insect pests of mustard crops through *Aloe barbadensis (Gwarpatha) + Nicotiana tabacum (tobacco) + Azadirachta indica (neem) + Sapindus trifoliatus Linn. (Aritha).*
5. Fermented solution of 5 kg cow dung, 5 litre of cow urine, 150 gm lime + 100 litre of water is sprayed to control aphids, bacterial and viral diseases.
6. *Bhelama* (*Anacardium* spp.) stem twigs are being adopted by the tribal in transplanted rice for protecting the incidence of rice gundhi bug.

2.4.5 Scheduled Caste Sub Plan (SCSP) activities

The SCSP implementation committee carried out detailed survey of the target area for selection of individual beneficiaries and self-help groups (SHGs) of scheduled caste farmers. For the current financial year i.e., 2020-21, districts *viz.* Pune, Ahmednagar, Solapur and Satara were identified. A list of more than 1500 beneficiaries and 12 SHGs was prepared. The list of farmers below poverty line was obtained from Grampanchayat authorities, Sarapanch/Gramsevak and also from authorised ration shop in the village. Beneficiary farmers with their Aadhaar card number, caste certificate and ration card were identified from 38 villages from six tehsils.

2.4.5.1 Seed distribution in Pune and Ahmednagar districts

The detailed survey of Schedule Castes beneficiary farmers form Karhawagaj, Anjangaon and Belwandi was carried out by the SCSP committee. The seed requirement for the Rabi season in respect of Wheat, Sorghum and Bengal gram was identified after interacting with the beneficiary farmers. The seed distribution programme was carried out in Karhawagaj and Anjangaon (Baramati tehsil, Pune district) on 25th November, 2020, following all the necessary COVID-19 precautionary measures. The seed distribution was extended to Belwandi (Karjat tehsil, Ahmednagar district) on 3rd December, 2020 wherein different agriculture seeds were distributed.


Seed distribution programme in Karhawagaj


Seed distribution programme in Anjangaon


Seed distribution programme in Belwandi

2.4.5.2 Distribution of fertilizers in Pune and Ahmednagar districts

Schedule Castes beneficiary farmers form Karhawagaj, Anjangaon (Baramati tehsil, Pune district) and Belwandi (Karjat tehsil, Ahmednagar district) were identified based on the survey carried out by SCSP committee. The fertilizer requirement of individual beneficiary for the Rabi season in respect to Urea, MOP and SSP was identified after interacting with the beneficiary farmers and quantity of wheat/jowar/Bengal gram seeds sown. The fertilizers were distributed to the Scheduled Caste beneficiaries following all the necessary COVID-19 precautionary measures.

Distribution of fertilizers to beneficiaries from Karhawagaj, Anjangaon and Belwandi

2.4.6 Tribal sub plan (TSP) activities at Nandurbar district

ICAR-NIASM has successfully implemented the scheduled TSP scheme during the year 2020 at Nandurbar district.

The list of the activities conducted the year is listed below.

- Surveyed and selected more than 10 villages for implementation of TSP activities at Navapur Tahsil of Nandurbar District.
- Arranged more than 20 farmers corner meeting at selected villages for creating awareness among tribal farmers about improved package of cultivation practices, dairy and poultry for sustainable agriculture.
- Provided the seeds of improved varieties of wheat, chickpea and groundnut seed to the 383 tribal farmers for enhancing their income and livelihood
- Organized two Kisan Gostis at Navapur, Nandurbar during 27-28 December 2020. About 300 farmers were participated.
- Organised field visits to tribal farmers' fields for assessing the present farming situation and identifying the interventions to be adopted in future.
- Visited to state development departments and KVK of Nandurbar for their guidance and seeking their help for seeking their help for implementation of TSP in hilly and water scarce regions.

Photo 5: Distribution of inputs to farmers in Nandurbar district under TSP activities

Institue Technology Management Unit (ITMU) has done various activities during the year 2020 in ICAR-NIASM. ITMU conducted ITMC meeting for ISSN and ISBN for publications. The ITMU has taken initiative to register publications of institute under ISSN and ISBN for these publications for wider publicity. ITMU has successfully registered institute publications like Abiotic Stress Management News, Krishi Stress Patrika and Annual Report under the International Standard Serial Number (ISSN) for Online Print Media and ISBN for Dragon Fruit Cultivation in India: Scope, Marketing, Constraints and Policy Issues and NIASM- A Decade of Service (2009-2019) regarding details are mentioned in Table 1.

The ITMU completed all online and offline application submission procedure 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 issues the RNI reference number (1347075) for ICAR-NIASM. During the said period ITMU staff attended online trainings/workshops on Intellectual Property Rights and Technology Commercialization.

Table 1. IP Portfolio.

IPRs	Name of Institute	Application/ Registration No.	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/ Registration	Grant Status/ Registered
Patent	ICAR-NIASM	3255/MUM/2012	Process for one step synthesis of bactericidal silver nano-particles from tissue extracts of Labeorohita	09/11/2012	Examination completed Application in Amended stage
	ICAR-NIASM	3127/MUM/2015	"Development of microbially derived polymeric product for gel formation"	Provisional 18.08.2015 Complete 08.08.2016	Deemed to be Withdrawn U/S 11B(4)
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	Title is Verified
	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
ISBN registration of books	ICAR-NIASM	-	Dragon Fruit Cultivation in India: Scope, Marketing, Constraints and Policy Issues	978-81-949091-4-9	Registered
	ICAR-NIASM	-	NIASM- A Decade of Service (2009-2019)	978-81-949091-5-6	Registered

5. हिन्दी सेल

हिन्दी दिवस तथा हिन्दी पखवाड़ा कार्यक्रम

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान मे हिंदी भाषा को बढ़ावा देने के हेतु से 14 सितंबर 2020 को हिन्दी दिवस और 14 से 28 सितंबर 2020 तक हिन्दी पखवाड़ा ऑनलाइन तरीके से मनाया गया। हिन्दी दिवस तथा हिन्दी पखवाड़ा कार्यक्रम की शुरुआत 'आईसीएआर गीत' तथा 'नियासम गीत' से की गयी। राजभाषा कार्यान्वयन समिति के सदस्य डा एलिजा प्रधान ने सभी सदस्यों का स्वागत और कार्यक्रम का सूत्रसंचालन किया। संस्थान के अधिकारियों ने हिन्दी भाषा को बढ़ावा देने हेतु अपने विचार रखें। संस्थान के निदेशक तथा राजभाषा कार्यान्वयन समिति के अध्यक्ष डा. हिमांशु पाठक जी ने संस्थान के विविध विभागों को दिशा निर्देश देते हुए हिंदी भाषा में अधिक से अधिक कार्य करने का आवाहन किया। डा प्रवीण तावरे (सदस्य सचिव, राजभाषा कार्यान्वयन समिति) ने समिति के पिछले वर्ष के उपलब्धियों का ब्योरा दिया तथा हिंदी भाषा के प्रचार–प्रसार हेतु भविष्य की योजनाओं को प्रस्तुत किया। हिन्दी पखवाड़े मे आयोजित किए जानेवाले कार्यक्रमों का संक्षिप्त विवरण देते हुए सभी के सहभाग की अपेक्षा रखी। हिन्दी पखवाड़ा 2020 के दौरान कई कार्यक्रमोंका ऑनलाइन तरिकोंसे आयोजन किया गया। जिसमे हिन्दी निबंध लेखन, घोष वाक्य तथा काव्य वाचन और वादविवाद प्रतियोगिताओं का आयोजन किया गया। निदेशक की अनुरोध से इन प्रतियोगिताओं में संस्थान के वैज्ञानिक, कर्मचारी, राजभाषा कार्यन्वयन समिति के सभी सदस्य तथा यंग प्रोफेशनल, एस आर एफ, अन्य सभी कर्मचारियों ने अपने परिवार जनों के साथ बढ़ चढ़कर हिस्सा लिया। हिन्दी पखवाड़े का समापन का आयोजन गांधी जयंती समारोह के अवसर पर किया गया। प्रतियोगिताओं के पुरस्कारों का आबंटन भी ऑनलाइन तरीके से ही किया गया और सभी कर्मचारी कार्यक्रम में उत्साह से शामिल हुए।

राजभाषा कार्यान्वयन समिति की संस्थागत बैठक

राजभाषा कार्यान्वयन समिति की संस्थागत बैठकों का आयोजन 31 अगस्त 2020 और 20 अक्तूबर 2020 को किया गया। जिसमें संस्थान में हिन्दी को बढ़ावा देने हेतु चर्चा की गयी।

हिंदी एकदिवसीय कार्यशाला

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान मे हिंदी भाषा को बढ़ावा देने के हेतु से "राजभाषा कार्यान्वयन समिति" द्वारा संस्थान में 20 अक्तूबर 2020 को एकदिवसीय कार्यशाला का ऑनलाइन आयोजन किया गया। कार्यशाला का विषय था- "ई-ऑफिस में हिन्दी का प्रयोग।" इस समय संस्थान के निदेशक डा. हिमांशु पाठक ने संस्थान के विविध विभागों को दिशा निर्देश देते हुए हिंदी भाषा में अधिक से अधिक कार्य करने का आवाहन किया। डा प्रवीण तावरे (सदस्य सचिव, राजभाषा कार्यन्वयन समिति) ने कार्यालयीन कामकाज में हिन्दी को बढ़ावा देने हेतु 'ई-ऑफिस" में हिन्दी का प्रयोग करने पर आवश्यकता को देखते हुए आयोजित इस कार्यशाला की रूपरेखा का विवेचन किया । संस्थान के ई-ऑफिस से संबन्धित वरिष्ठ तकनीकी सहायक श्री प्रवीण मोरे तथा श्री मढ़कर गुब्बाला ने 'ई-ऑफिस' में आवती भेजने में तथा ग्रीन नोट पर टिप्पणी लिखने में हिन्दी का प्रयोग आसानी से कैसे कर सकते है, इसका प्रात्यक्षिक दिखाया। एकदिवसीय कार्यशाला में संस्थान के वैज्ञानिक, तकनीकी तथा प्रशासनिक कर्मचारी, राजभाषा कार्यान्वयन समिति के सभी सदस्य और अन्य सभी बड़े उत्साह से उपस्थित रहे।

एकदिवसीय कार्यशाला के दरम्यान निदेशक एवं राजभाषा कार्यन्वयन समिति सदस्य एवं उपस्थित कर्मचारियों ने निम्नावत सुझाव दिए :

आम प्रयोग में आनेवाले पदबंध संकलित करने का जो प्रयास समिति ने किया है, उसे संशोधित करने हेतु सभी अधिकारी/कर्मचारी इनपुट दे। संकलित पदबंध सभी कर्मचारियों को परिचालित किए जाएँ। सभी कर्मचारी प्रस्ताव से ही हिन्दी का प्रयोग शुरू कर दें ताकि फ़ाइल के हर पग पर हिन्दी का प्रयोग होता रहे। संस्थान में हो रहे सभी कार्यक्रम का ब्योरा संस्थान के वेबसाइट पर हिंदी में प्रस्तुत किया जाए।

हिंदी एकदिवसीय कार्यशाला: 20 अक्तूबर 2020

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान मे हिंदी भाषा को बढ़ावा देने के हेतु से "राजभाषा कार्यान्वयन समिति" द्वारा संस्थान में 20 अक्तूबर 2020 को एकदिवसीय कार्यशाला का ऑनलाइन आयोजन किया गया। कार्यशाला का विषय था- "ई-ऑफिस में हिन्दी का प्रयोग।" इस समय संस्थान के निदेशक डा. हिमांशु पाठक ने संस्थान के विविध विभागों को दिशा निर्देश देते हुए हिंदी भाषा में अधिक से अधिक कार्य करने का आवाहन किया। डा प्रवीण तावरे (सदस्य सचिव, राजभाषा कार्यन्वयन समिति) ने कार्यालयीन कामकाज में हिन्दी को बढ़ावा देने हेतु 'ई-ऑफिस" में हिन्दी का प्रयोग करने पर आवश्यकता को

देखते हुए आयोजित इस कार्यशाला की रूपरेखा का विवेचन किया । संस्थान के ई-ऑफिस से संबन्धित वरिष्ठ तकनीकी सहायक श्री प्रवीण मोरे तथा श्री मढ़कर गुब्बाला ने 'ई-ऑफिस' में आवती भेजने में तथा ग्रीन नोट पर टिप्पणी लिखने में हिन्दी का प्रयोग आसानी से कैसे कर सकते है, इसका प्रात्यक्षिक दिखाया। एकदिवसीय कार्यशाला में संस्थान के वैज्ञानिक, तकनीकी तथा प्रशासनिक कर्मचारी, राजभाषा कार्यान्वयन समिति के सभी सदस्य और अन्य सभी बड़े उत्साह से उपस्थित रहे। डा एलिजा प्रधान, सदस्य, राजभाषा कार्यान्वयन समिति के धन्यवाद ज्ञापन के साथ एक दिवसीय कार्यशाला संपन्न हुई।

हिंदी दिवस एवं हिन्दी पखवाड़ा: 14-28 सितंबर 2020

राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान मे हिंदी भाषा को बढ़ावा देने के हेतु से 14 सितंबर 2020 को हिन्दी दिवस और 14 से 28 सितंबर 2020 तक हिन्दी पखवाड़ा ऑनलाइन तरीके से मनाया गया। हिन्दी दिवस तथा हिन्दी पखवाड़ा कार्यक्रम की शुरुआत 'आईसीएआर गीत' तथा 'नियासम गीत' से की गयी। राजभाषा कार्यान्वयन समिति के सदस्य डा एलिजा प्रधान ने सभी सदस्यों का स्वागत और कार्यक्रम का सूत्रसंचालन किया। संस्थान के अधिकारियों ने हिन्दी भाषा को बढ़ावा देने हेतु अपने विचार रखें। संस्थान के निदेशक तथा राजभाषा कार्यान्वयन समिति के अध्यक्ष डा. हिमांशु पाठक जी ने संस्थान के विविध विभागों को दिशा निर्देश देते हुए हिंदी भाषा में अधिक से अधिक कार्य करने का आवाहन किया। डा प्रवीण तावरे (सदस्य सचिव, राजभाषा कार्यान्वयन समिति) ने समिति के पिछले वर्ष के उपलब्धियों का ब्योरा दिया तथा हिंदी भाषा के प्रचार–प्रसार हेतु भविष्य की योजनाओं को प्रस्तुत किया। हिन्दी पखवाड़े मे आयोजित किए जानेवाले कार्यक्रमों का संक्षिप्त विवरण देते हुए सभी के सहभाग की अपेक्षा रखी। हिन्दी पखवाड़ा 2020 के दौरान कई कार्यक्रमोंका ऑनलाइन तरिकोंसे आयोजन किया गया। जिसमे हिन्दी निबंध लेखन, घोष वाक्य तथा काव्य वाचन और वादविवाद प्रतियोगिताओं का आयोजन किया गया। निदेशक की अनुरोध से इन प्रतियोगिताओं में संस्थान के वैज्ञानिक, कर्मचारी, राजभाषा कार्यन्वयन समिति के सभी सदस्य तथा यंग प्रोफेशनल, एस आर एफ, अन्य सभी कर्मचारियों ने अपने परिवार जनों के साथ बढ़ चढ़कर हिस्सा लिया। हिन्दी पखवाड़े का समापन का आयोजन गांधी जयंती समारोह के अवसर पर किया गया। प्रतियोगिताओं के पुरस्कारों का आबंटन भी ऑनलाइन तरीके से ही किया गया और सभी कर्मचारी कार्यक्रम में उत्साह से शामिल हुए।

6. MEETINGS

10th Pre-Institute Research Meeting (IRC)

10th Pre-IRC meeting was held on April 08-10, 2020 through video conferencing. The meeting was started with a brief presentation by the Director followed by presentation of achievements during 2019-2020 by Heads of Schools. All the scientists of the ICAR-NIASM presented their research work on April 09-10, 2020. Director NIASM strongly recommended for one flagship research project and a few (3-4) focused research projects for every School. He urged the scientists for submission of Research Project Proposals for external funding. He also suggested for technology and product development in collaboration with other Institutes, private organizations and farmers.

Review Meeting of ICAR-NIASM Research Programmes by DDG (NRM)

The achievements and proposed future programmes of ICAR-NIASM, Baramati was reviewed by Dr. S.K. Chaudhari, DDG (NRM), ICAR in presence of the Directors of all the research Institutes in the NRM Division of ICAR and other Institutes through video conferencing on May 22, 2020. Dr. H. Pathak, Director Presenented overview of the mandate, objectives and the progress achieved by institute during the previous plan 2017 to 2020. He presented the future plans of the institute projects comprising of 4 Umbrella and 4 Flagship Projects for the period from 2021 to 2025. He highlighted the plan for the academic activities including teaching and training of the Institute. Dr. S K Choudhary in his concluding remarks appreciated the efforts of all the staff in establishing the institute with excellent facilities and demonstrating the technologies in abiotically challenged site. He emphasized that the institute should focus on basic and strategic research to support ongoing research at other institutes to address abiotic stress management.

8th Research Advisory Committee Meeting

Research Advisory Committee (RAC) meeting was held on June 12, 2020 through video conferencing. The meeting was chaired by Dr. A.K. Sikka, Ex-DDG (NRM), ICAR & IWMI Representative-India & Principal Researcher along with other RAC members Dr. J.S. Parihar, Ex-Deputy Director, Space Applications Centre- ISRO, Ahmedabad; Dr. A.G. Ponniah, Ex-Director, CIBA & NBFGR, Chennai; Dr. (Mrs.) Vidya Gupta, CSIR-National Chemical Laboratory; Dr. Adlul Islam, ADG(I/C), Soil and Water Management, NRM, ICAR; Dr H. Pathak, Director, ICAR-NIASM, Baramati, Pune; Dr. Jagadish Rane, Head and Principal scientist ICAR-NIASM. Dr H Pathak, Director briefed the progress and achievements of the institute during the last year. The Dr AK Sikka appreciated the efforts and achievements by the institute and also initiatives being taken in research and academic activities. He emphasized the need of including water, energy and agri-input dimensions in the context of climate resilient agriculture and abiotic stress management.

10th IRC Meeting of ICAR-NIASM

The 10th IRC meeting was held on June 18, 2020 through video conferencing. The meeting was chaired by Dr H Pathak, Director. The meeting was started with a brief discussion about 8th RAC suggestion and recommendation which was held on June 12, 2020. All the Heads of the Schools presented the institute Flagship projects and subsequently the Principal Investigators presented the Umbrella projects. The institute have 3 level of projects as Flagship, Umbrella and In-house. Director ICAR-NIASM emphasised the need of doing in-depth studies in all the projects to generate basic and strategic information.

7. AWARDS & RECOGNITION

- Dr. Basavaraj P S received First Best Oral Presentation Award in the International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity' organized by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru during 24-27th November, 2020.
- Dr. Basavaraj P S received First Best Oral Presentation Award in International E-Conference on "Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture" from 6-9th October, 2020, organized by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru.
- Dr. Boraiah, K. M. and Dr Aliza Pradhan are recognized/inducted as PG Faculty Member by IARI, New Delhi.
- Dr. Boraiah, K. M. recognized/inducted as PG Faculty Member by MPKV, Rahuri.
- Mr. Mukesh Bhendarkar, Scientist (Fisheries Resource Management) was awarded 'Netaji Subhas ICAR International Fellowship-2020'.
- Mr. Mukesh Bhendarkar, Scientist (Fisheries Resource Management), School of Atmospheric Stress Management, NIASM, Baramati, Pune received 'Young Scientist Award-2020' from Society of Fisheries and Life Sciences for Outstanding contribution in the field of Fisheries and Aquaculture.
- Dr. Neeraj Kumar Awarded as Dr Hiralal Chaudhary Young Scientist Award 2020 from Central Institute of Fisheries Education, Mumbai.
- Dr. Neeraj Kumar Awarded as Lal Bahadur Shastri Young Scientist Award 2020 from Indian Council of Agriculture Research.
- Dr. P.S. Khapte received Best oral presentation award on the oral presentation in National Conference on Agriculture Resource Management for Atmanirbhar Bharat by CAU, Imphal during 17-19th July, 2020.
- Dr. Vanita N Salunkhe was recognized as a Faculty member, IARI, New Delhi.
- Dr. Vijaysinha Kakade received second prize for Best article award.
- Dr. H Pathak was selected as Editorial Board Member, Agricultural Systems, Elsevier (NAAS Score: 10.21).
- Dr. H Pathak was selected for Dr. NS Randhawa Memorial Award, National Academy of Agricultural Sciences, New Delhi.
- Dr. H Pathak was selected as Convener, Pune Chapter, National Academy of Agricultural Sciences, New Delhi.
- Dr. H Pathak was selected as Member, Senior Officers Committee, Indian Council of Agricultural Research, New Delhi.
- Dr. H Pathak was selected as Member, Scientific Advisory Committee, Tea Research Association, Jorhat, Assam.
- Dr. H Pathak was identified among the top 2% of Indian scientists in the global ranking by Stanford University of USA in the field of agriculture.

8. LINKAGES & COLLABORATIONS

9. PUBLICATIONS

Research Papers

1. Basavaraj PS, Gireesh C, Muralidhar B, Manoj A, Anantha MS and Raju CD (2020) Genetic analysis of backcross derived lines of *Oryza rufipogon* in the background of Samba Mahsuri a for yield enhancing traits in rice. Electronic Journal of Plant Breeding 11(04):1120–27.
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10. Dubey R, Pathak H, Chakrabarti B, Singh S, Gupta DK and Harit RC (2020) Impact of terminal heat stress on wheat yield in India and options for adaptation. Agricultural Systems 181:102826. doi: 10.1016/j.agsy.2020.102826.
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18. मनीषा जगदाळे, महेश जाधव, राहुल पोतदार, भास्कर गायकवाड, के. न. अग्रवाल **(2020)** कोविड-१९ पासून बचावासाठी कृषी कामगार मार्गदर्शक सूचना, अग्रोटच, अंक ११ पृष्ट ३६-३९.
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Mobile Application Developed

1. QR-NIASM: An android mobile app guide to explore facilities and activities at ICAR-NIASM campus. (Taware PB, More PB, Gaikwad BB and Team).
2. FarmTree: An android mobile app for Agroforestry at ICAR-CAFRI, Jhansi. (Chavan SB and Team).

10. MAJOR EVENTS

Sr	Event details	Date
1.	Model training course on 'Climate change and abiotic stress manage-ment strategies for enhancing crop productivity and farmers income'	04-11 January
2.	Agreement for research collaboration with ICAR-IGFRI, Jhansi, UP	10 January
3.	Consultation Workshop 'Establishment of think tank to readdress drought and farmers' distress alleviation'	16 January
4.	MoU for research and academic activities with Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, MS	17 January
5.	Celebration of 71st Republic Day	26 January
6.	MoU with University of Horticulture Sciences, Bagalkot, KN	28 January
7.	Joining of Dr Himanshu Pathak as Director, ICAR-NIASM	07 February
8.	Celebration of 12th Foundation Day	21-22 February
9.	Renewal of ISO 9001:2015 certification and Surveillance audit cum training	06 March
10.	Celebrations of International Women's Day	08 March
11.	10th Pre- IRC meeting	08-10 April
12.	Celebration of Constitution day	14 April
13.	Distribution of daily essentials to migrant labours during lockdown	15 April
14.	Research programme review meeting by DDG (NRM)	22 May
15.	8th RAC meeting	12 June
16.	10th IRC meeting	18 June
17.	Training on e-office implementation	25 June
18.	Workshop on e-office	02 July
19.	Training on e-office implementation	04 July
20.	National E-conference 'COVID-19 and national lockdown: impacts and future strategies in agriculture and environment'	20 July
21.	National Webinar 'Underutilized crops for augmenting farmers income in abiotic stress regions'	10 August
22.	Celebration of 74th Independence Day	15 August
23.	National Webinar 'Abiotic stress in agriculture: geospatial characterization and management options'	27 August
24.	Webinar 'Farmers' constraints in dragon fruit cultivation'	01 September
25.	National Webinar 'Climate-smart integrated farming system'	18 September
26.	National Webinar 'Halophytes for alleviating salinity stress	30 September

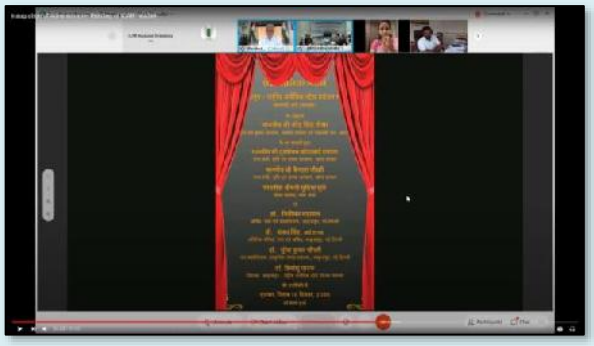
Sr	Event details	Date
	in agriculture: potentials and problems’	
27.	National Webinar 'Translating physiology into techniques for abiotic stress tolerance in crop'	09 October
28.	National Webinar ‘Climate resilient livestock production: opportunities and threats’	03 November
29.	Webinar on ‘Genomics strategies for improvement of abiotic stress tolerance in crop plants'	27 November
30.	Inauguration of ICAR-NIASM Administrative Building by Hon’ble Minister of State, Ministry of Agriculture & Farmers Welfare, GOI.	16 December
31.	Celebration of ‘Swachhata Pakhwada’ and ‘COVID-19 Appropriate Behavior Campaign’	16-31 December

Agreement with ICAR-IGFRI, Jhansi

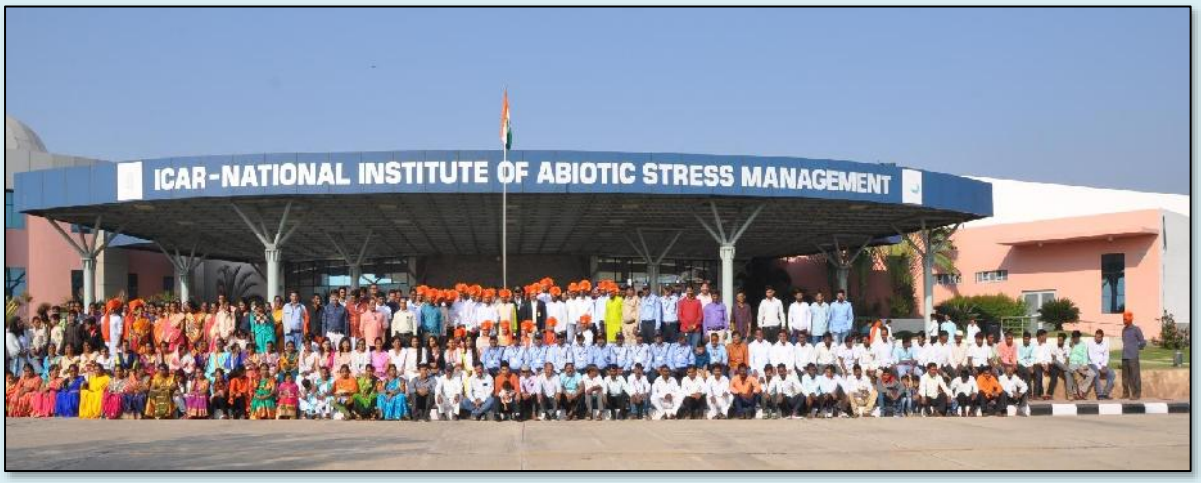
MoU with VNMKV, Parbhani

Celebration of 12th Foundation Day

MoU with UHS, Bagalkot



Inauguration of Administrative Building



Celebration of 71st Republic Day

Distribution of daily essentials to migrant labours during lockdown

Celebrations of International Women's Day

Celebration of 'Swachhata Pakhwada' and 'COVID-19 Appropriate Behavior Campaign

Measures taken by the institute to fight COVID-19

1. **Constitution of COVID Management Committee:** The committee was formulated to look after day-to-day implementation of the COVID-19 prevention measures. The COVID advisory for the institute was developed and widely circulated. The committee conducts periodical meetings and takes necessary steps regarding COVID management.
2. **Awareness creation amongst staff:** The multiple sessions were organized for creating awareness amongst farm labourers, security and other staff regarding precautions to be taken by them by involving authorised Medical Doctor. Security persons were informed about preventing unknown persons or persons with likely symptoms of disease by Medical Doctor employed on contract. Number of security persons has also been brought down to comply with Government orders.
3. **Campus Sanitization Measures:** The system was set in to place to monitor the entry of personnel entering the campus. Following measure are taken,
   - All personnel entering the Institute campus underwent thermal screening at main gate. Face mask was made compulsory.
   - All personnel entering the campus were encourages to sanitize their hands using hand sanitizers kept at entry gate before entering institute campus.
   - The provision of 1% Sodium Hypochlorite is made at entry gate to sanitize vehicles entering campus.
   - Provision of foot operated Hand-Sanitizer dispensers was made at multiple key locations in the campus e.g., School buildings, Farm office, Livestock Farm, etc. and staff is encouraged to frequently sanitize their hands.
   - Necessary arrangements were made to provide farm labourers, security and other staff with protection items like faces mask and sanitizers.
   - Institute campus including sitting places and laboratories were regularly sanitized.
4. **Lecture on COVID19 Awareness and Government Guidelines for COVID19 Vaccination Drive:** On the occasion of "Swachhata Pakhwada & COVID-19 Appropriate Behaviour campaign" ICAR-NIASM organized invited talk of Dr. Anjali Khade (Institute's Authorised Medical Attendant). Virtual lecture has been delivered on very pertinent topic "COVID-19 awareness on zoom meeting. All the staff of NIASM including scientists, technical, administrative, contractual staffs, research fellows and young professionals of institute took part along with their family members.
5. **Providing advisories to the farmers telephonically:** Scientists interacted with farmers and other stakeholders telephonically on regular basis.
6. **Using video conferencing facility on daily basis:** Director, Heads of the Schools, Head of the Administration and Finance were in constant touch with scientists and other staff through online means including video conferencing and cell phone to accomplish the time bound and essential works of the Institute.
7. **Sharing of guest house:** The institute has offered its guest house facilities if needed for accomplishing the task of checking community spread of COVID.
8. **Contributed 1 day salary by all staff:** Nearly Rs 1.5 lakh has been contributed by NIASM staff to support Hon'ble Prime Ministers initiative to fight COVID.
9. **Social Responsibility during COVID:** Institute came forward to help the migrant labourers stuck amid COVID lockdown. Monetary contribution was made by all the staff of ICAR-NIASM to buy and distribute the grocery items to the poor migrant labourers.

86 kits were handed over to the village accountant of Malegaon (Bk), Baramati for its distribution to the needy migrant labour families. Director, ICAR-NIASM, Dr. Himanshu Pathak interacted with the village accountant to understand the situation and promised in extending the help under emergency in future.

11. NEW STAFF/PROMOTION/SELECTION-TRANSFER/SUPERANNUATION

Joioning of New Staffs at ICAR-NIASM

Sr. No.	Name of Staff	Specialization	Date of joining at NIASM	Previous Institute
1	Dr Sangram Chavan	Forestry	10.08.2020	ICAR-CARI, Jhansi
2	Dr. Pratapsingh Khapte	Vegetable Science	14.08.2020	ICAR-CAZRI, Jodhpur
3	Dr. Gurumurthy S	Plant Physiology	17.08.2020	ICAR-IIPR, Kanpur
4	Dr. Vijaysinha Kakade	Fruit Science	03.08.2020	ICAR-IIWC Vased
5	Dr. Basavaraj PS	Genetics & Plant Breeding	04.04.2020	ICAR-NAARM, Hyderabad
6	Mr. Ravi Kumar	Agricultural Extension	23.11.2020	ICAR-IIPR, Kanpur

Transfer of Staffs from ICAR-NIASM

Sr. No.	Name of Staff	Date of Transfer from NIASM	Transfer Institute Name
1	Dr. K.K.Meena	28.11.2020(A.N)	ICAR-CAZRI,Jodhpur Rajasthan
2	Dr. Priya George	26.08.2020(A.N)	ICAR-IISR,Kozikode,Kerala
3	Dr. MP Brahmane	26.09.2020 (AN)	ICAR-CIFE, Mumbai
4	Mr. Madhukar Gubbala	29.10.2020(A.N)	ICAR-DOPR, Rajendranagar, Hyderabad
5	Mr. Rupesh Kumar Amarghade	07.10.2020(A.N)	ICAR-NBSS&LUP,Nagpur

Promotion of Staff at ICAR-NIASM

Sr. No	Name of Staff	Date from which recommended for Placement	Promoted to the Post
1	Dr. D.D.Nangare	09.10.2018	Principal Scientist (Soil & Water Conservation Engineering)
2	Dr. A.K.Singh	06.10.2018	Principal Scientist (Agricultural Biotechnology)
3	Dr.Yogeshwar Singh	29.10.2018	Principal Scientist (Agronomy)
4	Dr.S.S.Pawar	31.08.2017	Senior Scientist (Animal Biotechnology)
5	Mr. Satish Kumar	15.09.2016	Scientist SS (Plant Biochemistry)
6	Mr.Harisha C.B	01.01.2019	Scientist SS (Spices, Plantation, Medicinal & Aromatic Plants)
7	Dr Sangram Chavan	01.01.2018	Scientist SS (Agroforestry)
8	Dr Vijaysinha Kakade	01.01.2019	Scientist SS (Fruit Science)
9	Sh B.K. Sinha	06.03.2020	Chief Administrative Officer

12. BUDGET UTILIZATION

Figures in Lakhs

Head/Sub-head	Allocation	Expenditure
Grants in aid-Capital		
Works		233.53
Equipment		57.72
Information Technology		1.21
Library		1.11
Furniture and Fixtures	300.00	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 and other retirement Benefits	76.60	76.29
Travelling allowance		15.82
Research and Operational Expenses		115.59
Administrative Expenses	449.85	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**

13. RESEARCH PROJECTS

Sr. No.	Project Name	PI	Co-PI
Umbrella Projects			
UP 1.	Abiotic Stress Information System (ASIS): Geo-spatial digital maps of multiple abiotic stresses, management options and future scenarios	BB Gaikwad	Amresh Choudhary, RN Singh, DD Nangare, NP Kurade, SS Pawar, MP Bhendarkar, SV Potekar, Pravin More
UP 2.	Germplasm Conservation and Management (GCM): Genetic garden and gene bank for abiotic stress tolerant plants, animals and fisherie s for food security and sustainability	KM Boraiah	AK Singh, Basavaraj PS, Mahesh Kumar, Satish Kumar, Rajkumar, Karthikeyan N, Paritosh Kumar, SA Kochewad, MP Bhendarkar, Harisha CB, PS Khapte, J Rane, Neeraj K, PB Taware, Aniket More, Rushikesh Gophane, Lalitkumar Aher
UP 3.	Model Green Farm (MGF): Environment-friendly, economically viable, state-of-the-art model farm for abiotic stressed regions	DD Nangare	Himanshu Pathak , GC Wakchaure, BB Gaikwad, Vanita Salunkhe, Rajkumar, Paritosh Kumar, Aliza Pradhan, Amresh Chaudhary, MP Bhendarkar, SB Chavan, VD Kakade, PS Khapte, PB Taware, Rushikesh Gophane, Noshin Shaikh, Santosh Pawar, AV Nirmale
UP 4.	Climate-smart IFS (CIFS): Climate resilient integrated farming system in semi-arid region	SA Kochewad	KK Meena, GC Wakchaure, Vanita Salunkhe, Rajkumar, MP Bhendarkar, Aliza Pradhan, Amresh Chaudhary, N Subash, Laxman Meena, PB Taware, P Chahande
Flagship Projects			
FP 1.	Atmospheric Stress Management Adaptation and mitigation of atmospheric stress in crops, livestock, poultry and fishes for sustainable productivity and profitability	NP Kurade	SS Pawar, SA Kochewad, BB Gaikwad, Rajkumar, MP Bhendarkar, RN Singh, DD Nangre, AV Nirmale, SV Potekar
FP 2.	New Crops: Exploiting under-utilised crops (ex. quinoa) for augmenting income in water scarce regions	J Rane	AK Singh, DD Nangare, GC Wackchaure, Mahesh Kumar, Satish Kumar, Karthikeyan N, Boraiah KM, SA Kochewad, Aliza Pradhan, Amresh Chaudhary, RN Singh, Basavaraj P, Harisha CB
FP 3.	Bio-saline Agriculture: Exploitation of halophytic plant and associated microbiome for amelioration	Satish Kumar	AK Singh, Vanita Salunkhe, SA Kochewad, Mahesh Kumar, Paritosh Kumar, Neeraj Kumar, Aliza Pradhan, Amresh

Sr. No.	Project Name	PI	Co-PI
	of saline agricultural land of arid & semiarid regions		Chaudhary, Himanshu Pathak
FP 4.	Technology Targeting and Policy Targeting prospective technologies for abiotic stress resilience in rainfed and dryland region	DD Nangare	SS Pawar, SA Kochewad, BB Gaikwad, Boraiha K M, Kartikeyan N, Rajkumar, MP Bhendarkar, Himanshu Pathak
Externally Funded Projects			
EAP 1.	Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean (Funded by: ICAR-NASF)	AK Singh	Mahesh Kumar, Jagadish Rane
EAP 2.	Phenotyping of pulses for enhanced tolerance to drought and heat (Funded by ICAR-NICRA)	J Rane	Mahesh Kumar
EAP 3.	Climate smart management practices (Funded by: IRRI)	Mahesh Kumar	J Rane, Amresh Chaudhary, Himanshu Pathak
EAP 4.	Conservation agriculture for enhancing resource-use efficiency, environmental quality and productivity of sugarcane cropping system (Funded by: CA Platform ICAR)	GC Wakchaure	Aliza Pradhan, Amresh Chaudhary, Paritosh Kumar, Himanshu Pathak
EAP5	Characterizing sugarcane and citrus stress responses to abiotic and biotic stresses through hyperspectral remote sensing (Funded by DST project)	BB Gaikwad	
EAP6	Establishment of model herbal garden for medicinal and aromatic plants (Funded by NMPB, New Delhi)	DD Nangare	
In-house Projects			
1.	Study of immune response and HSP genes polymorphism in relation to heat stress in poultry	SS Pawar	NP Kurade
2.	Mitigating water stress effects in vegetable and orchard crops	GC Wakchaure	DD Nangare, Satish Kumar, Aliza Pradhan, K M Boraiah, PS Khapte, J Rane
3.	Exploring cropping system approaches for enhanced water productivity and	Aliza Pradhan	J Rane, Amresh Chaudhary

Sr. No.	Project Name	PI	Co-PI
	income: Evaluating performance of soybean based cropping systems in response to deficit irrigation		
4.	Assessment and detoxification of heavy metals in aquatic water bodies using nutritional approaches	Neeraj Kumar	Paritosh Kumar
5.	Nutrient and gene interaction approaches through nutrigenomics in response to multiple stressors	Neeraj Kumar	KK Meena, AK Singh, Satish Kumar

14. PERSONNEL

Scientific Staff	
Dr Himanshu Pathak	Director (Joined on 7.2.2020)
School of Atmospheric Stress Management	
Dr Nitin P Kurade	I/c Head and Principal Scientist (Veterinary Pathology)
Dr S S Pawar	Senior Scientist (Animal Biotechnology)
Dr Bhaskar B Gaikwad	Scientist (Farm Machinery)
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 Water Stress Management	
Dr Jagadish Rane	I/c Head and Principal Scientist (Plant Physiology)
Dr Ajay Kumar Singh	Principal Scientist (Agricultural Biotechnology)
Dr Dhananjay D Nangare	Principal Scientist (Soil & Water Conservation Engineering)
Dr Goraksha C Wakchaure	Senior Scientist (Agricultural Structure & Process Engg.)
Dr Mahesh Kumar	Scientist (Plant Physiology)
Dr Boraiah KM	Scientist (Genetics and Plant Breeding)
Dr Aliza Pradhan	Scientist (Agronomy)
Dr. Pratapsingh Suresh Khapte	Scientist (Vegetable Science)
Dr. Basavaraj PS	Scientist (Genetic & Plant Breeding)
Dr. Gurumurthy S.	Scientist (Plant Physiology)
School of Soil Stress Management	
Dr Sanjivkumar A Kochewad	I/c Head and Scientist (LPM)
Dr Vanita N Salunkhe	Scientist (Plant Pathology)
Mr Rajagopal V	Scientist (Soil Chemistry/Fertility/Microbiology) (on Study leave)
Dr. Vijaysinha D Kakade	Scientist (Fruit Science)
Dr. Sangram Bhanudas Chavan	Scientist (Agroforestry)
Mr Satish Kumar	Scientist (Plant Biochemistry)
Mr Karthikeyan N	Scientist (Agricultural Microbiology)
Dr Neeraj Kumar	Scientist (Fish Nutrition)
Dr Paritosh Kumar	Scientist (Environmental Science)
Mr Harisha C B	Scientist (Spices, plantation, medicinal & aromatic plants)
Mr Amresh Chaudhary	Scientist (Soil Science)

School of Social Science and Policy Support	
Dr Dhananjay D Nangare	I/c Head and Principal Scientist (Soil & Water Conservation Engineering)
Dr S S Pawar	Senior Scientist (Animal Biotechnology)
Dr Bhaskar B Gaikwad	Scientist (Farm Machinery)
Dr Sanjivkumar A Kochewad	Scientist (LPM)
Dr Boraiah KM	Scientist (Genetics and Plant Breeding)
Mr Karthikeyan N	Scientist (Agricultural Microbiology)
Mr Ravi Kumar	Scientist (Agricultural Extension)
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 Rushikesh Gophane	Senior Technical Assistant (Horticulture)
Mr Lalitkumar Aher	Senior Technical Assistant (Biotechnology)
Mr Sunil Potekar	Senior Technical Assistant (Agro-Meteorology)
Mr Patwaru Chahande	Senior Technical Assistant (Agriculture)
Mr Aniket More	Senior Technician (Farm)
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

As on December 31, 2020

APPENDIX

Institute Management Committee

1. Dr Himanshu Pathak, Director, ICAR-NIASM, Malegaon, Baramati, Maharashtra.
2. Dr Shrikant Kakde, Director (Education), Maharashtra Council of Agricultural Education and Research, Pune, Maharashtra.
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-410505, Maharashtra.
5. Dr Ajay Kumar Upadhyaya, Principal Scientist, ICAR-National Research Centre on Grapes, Pune, Maharashtra.
6. Dr Eaknath B Chakurkar, Director, ICAR-Central Coastal Agricultural Research Institute, Ela, Goa.
7. Dr Pawan L Kulwal, Associate Professor (Genetics and Plant Breeding) State Level Biotechnology Centre, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra.
8. Shri G.Sathish, IFS, Commissioner for Agriculture, Department of Agriculture, Bangalore, Karnataka.
9. Shri Ramchandra V Nimbalkar At/Po- Bhawani Nagar, Maharashtra.
10. Shri Shyam Appa Chakor At/Po- Mandhawagan Farta, Maharashtra.
11. Shri OP Nagar, Deputy Director (Account) II, ICAR, Krishi Bhavan, New Delhi.
12. Senior Administrative Officer, NIASM, Malegaon, Baramati, Maharashtra.

Research Advisory Committee

1. Dr AK Sikka, Chairman, RAC and Ex DDG (NRM), ICAR & IWMI Representative- India & Principal Researcher, International Water Management Institute, New Delhi.
2. Dr DP Waskar, Director of Research, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra.
3. Dr Vidya Gupta, Fellow National Academy of Science, Biochemical Science Division, CSIR-National Chemical Laboratory, Pune, Maharashtra.
4. Dr JS Parihar, Ex-Deputy Director, Satish Dhawan Professor ISRO-Space Application Centre, Ahmedabad, Gujarat.
5. Dr Arun Varma, Former ADG (AN and P), ICAR, Uttar Pradesh.
6. Dr AG Ponaiah, Former Director, ICAR-CIBA, Chennai, Tamil Nadu.
7. Dr Himanshu Pathak, Director, ICAR-NIASM, Malegaon, Baramati, Maharashtra.
8. Dr J Rane, Head SDSM, NIASM, Baramati, Maharashtra (Member Secretary).

भाकृअनुप
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