






वार्षिक प्रतिवेदन
Annual Report
2020

भा. कृ. अनु. प. – भारतीय सोयाबीन अनुसंधान संस्थान
ICAR-Indian Institute of Soybean Research
ISO 9001 2015 Certified organization

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खण्डवा रोड, इन्दौर – 452 001 (म.प्र.)
Khandwa Road, Indore - 452 001 (M.P.)

प्रकाशन / **Published by**
डॉ. नीता खांडेकर / **Dr. Nita Khandekar**
निदेशक / **Director**
भा.कृ.अनु.प.– भारतीय सोयाबीन अनुसंधान संस्थान / **ICAR-Indian Institute of Soybean Research**
खण्डवा रोड, इन्दौर / **Khandwa Road, Indore**

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डॉ. डी. एन. बारस्कर / Dr. D. N. Baraskar

Citation
Annual Report 2020. ICAR- Indian Institute of Soybean Research, Indore

PREFACE

It is a matter of great honor and pride to present the annual report 2020 of ICAR-Indian Institute of Soybean Research, Indore. The research accomplishments and technological competence of the institute can be judged by the fact that soybean was introduced for commercial cultivation in late 60's, and in a span of 6 decades, it has become the most important oilseed crop of India. At present, the crop is grown in ~ 11.0 million hectare with a production of 13.7 million tones. In a scenario of meeting edible oil demand by importing almost 60% of country's requirement, the contribution of soybean to total oilseeds and edible oil produced in the country is 42 and 22 percent, respectively. Soybean seed contains 40% protein and 20 % oil and it is one of the most economical sources of good quality protein. It also contains many minerals and useful nutraceuticals like iso-flavones having immense health benefits. Therefore, the crop has a potential to provide nutritional security and eradicate rampant protein malnutrition in the country.

Productivity enhancement of the crop is one of the major challenges faced by the soybean researchers. The climatic variability leading to delay in monsoon, drought spells of different durations at various growth stages, water-logging conditions and rise in temperatures particularly at seed fill stage are the main reasons of low productivity of soybean in India. In addition, increased infestation by insects and diseases due to repeated dry spells and increased temperatures further aggravate the situation. Scientists at ICAR-IISR, Indore are making all possible efforts to overcome these problems and continuing to strive for increasing productivity in the face of considerable climatic changes. Major strategies include development of climate resilient varieties and production and protection technologies to overcome the problem of drought, water logging, high temperature and infestation by insects and disease.

The most significant achievements of 2020 includes identification of new soybean genotypes with various agronomically important traits such as high yield; early maturity; tolerance to high temperature, drought and salinity; insect and YMV resistance; vegetable soybean genotypes with fragrance; high oleic acid and lipoxygenase-free genotypes. The Institute Management Committee (IMC) and Research Advisory committee (RAC) meetings were conducted. The linkages with industry and NGOs working in the soybean production and utilization have been strengthened. A three day National Oilseed Brainstorming Meeting was held from 23-25 September 2020, in collaboration with other oilseed research institutes of ICAR for discussing the roadmap for enhancing oilseed production and making India self- sufficient in edible oil. ICAR-IISR trained a number of farmers regarding the recent technologies to enhance the soybean production in the country. Similarly, a number of women farmers were trained regarding preparation of soya based foods and made them aware of their health benefits. It gives me immense pleasure and satisfaction to present the Annual report for the year 2020, which would give a panoramic scenario of research, development and extension activities undertaken by this institute. I take this opportunity to thank the Chairman and members of RAC who guided and directed us for the strategic research planning. I take this opportunity to state my deep sense of gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for his guidance, and consistent support to soybean research and development. I gratefully acknowledge the help and valuable guidance provided by Dr. T.R. Sharma, Deputy Director General (Crop Science) for the progress of the Institute. His keen interest and constant appraisal has resulted in many new initiatives by institute Thanks are also due to the members of editorial committee for making this report crisp, comprehensive and informative. All the scientific, technical, administrative, account and service staff of the institute who have contributed in bringing out this report are worthy of appreciations. I extend my hearty thanks and congratulations to each one of them.

(Nita Khandekar)
Director

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1. कार्यकारी सारांश

- मध्यम कालीन स्टोरेज माड्यूल में 14 जंगली प्रजातियों के 74 परिग्रहणों सहित कुल 5114 जननद्रव्य परिग्रहणों का अनुरक्षण किया जा रहा है।
- AVRDC ताइवान से मंगाये गए एक सौ बारह जर्मप्लाज्म एक्सेसन को 12 गुणात्मक और 11 मात्रात्मक लक्षणों के लिए मूल्यांकित किया गया।
- एक सौ उन्सठ परिग्रहणों का मूल्यांकन 8 केंद्रों (पालमपुर, पंतनगर, इंफाल, रायपुर, इंदौर, जबलपुर, परभानी, पुणे) में किया गया और शीघ्र परिपक्व, उच्च उपज देने वाले और मोटे बीज वाले जननद्रव्य की पहचान की गई।
- रोग प्रतिरोधक क्षमता के लिए 50 प्रवेशों का मूल्यांकन 5 केंद्रों (पालमपुर, धारवाड़, पंतनगर, इंदौर और जबलपुर) में किया गया और विभिन्न रोग प्रतिरोधी जर्मप्लाज्म की पहचान की गई।
- एआईसीआरपी–IVT 2021 के तहत परीक्षण के लिए सर्वोत्तम प्रविष्टियों के चयन के लिए संस्थान स्थानीय परीक्षण के तहत विभिन्न क्रॉस से प्राप्त लगभग 60 आशाजनक प्रविष्टियों का मूल्यांकन किया गया था।
- NRC7 X SL525 के BC3F1 का परीक्षण संकरण की सत्यता के लिए किया गया।
- JS95-60 X (JS95 - 60 - SL525) के BC_3F_{2-3} को विकसित किया गया तथा MYMIV प्रतिरोधी पौधों के चयन के लिए SSR मार्कर GMAC7L का उपयोग किया गया।
- राष्ट्रीय किस्म JS335 से व्युत्पन्न NRCSL 2 में MYMIV के खिलाफ प्रतिरोध क्षमता पाई गई तथा इसे मध्य क्षेत्र में AVT II में परीक्षण हेतु चयनित किया गया।
- उच्च तेल और MYMIV प्रतिरोधी जीनोटाइप NRC149, को चार कृषि जलवायु क्षेत्रों में AVT I में परीक्षण हेतु चयनित किया गया है।
- शीघ्र परिपक्व जीनोटाइप एनआरसी 138 का मूल्यांकन मध्य क्षेत्र में एवीटी II में किया गया है।
- लिपोक्सीजेनेस 2 और कुनिट्ज ट्रिप्सिन इनहिबिटर से मुक्त जीनोटाइप एनआरसी 142 का परीक्षण एवं मूल्यांकन मध्य और दक्षिणी क्षेत्रों में एवीटी– II में किया गया है और यह कम बीन स्वाद के साथ एंटीन्यूट्रिशनल फैक्टर केटीआई से मुक्त पहला सोयाबीन जीनोटाइप है।
- शीघ्र परिपक्वता LOX 2 मुक्त एवं उच्च तेल वाली जीनोटाइप NRC150 का मूल्यांकन, मध्य क्षेत्र में AVT I में किया गया।
- अतिशीघ्र परिपक्वता वाली LOX 2 और KTI से मुक्त NRC152 का मूल्यांकन AVT I में किया गया।
- शीघ्र परिपक्वता के साथ KTI से मुक्त दो जीनोटाइप एनआरसी 179 और एनआरसी 181 का चयन मध्य क्षेत्र के IVT के लिए किया गया है।
- हॉट–स्पॉट परिस्थितियों में एन्थ्रेक्नोज प्रतिरोध के लिए, ईसी 34372 X जेएस 95–60 और ईसी 457254 X जेएस 95–60 क्रॉस से प्राप्त कुल 350 F 2:3 पौधों को के साथ जांचा गया।
- जीनोटाइप, ईसी 34372, ईसी 457254, ईसी 39063, ईसी 34106, ईसी 39150, ईसी 39172, ईसी 916032, आईसी 250350, एनबी 136, आरएससी 10–46, ईसी 915983 और ईसी 39022 एन्थ्रेक्नोज रोग के प्रति अत्यधिक प्रतिरोधी पाए गए।
- संस्थान में लगाए गए कुल 36 जीनोटाइप में से 8

जीनोटाइप (पीके 472, जीडब्ल्यू 253, जीडब्ल्यू 70, जीडब्ल्यू 207, जीडब्ल्यू 108, जीडब्ल्यू 111, जीडब्ल्यू 75, जेएस 20–69) प्राकृतिक रूप से कॉलर सड़न के लिए प्रतिरोधी पाए गए।

- अस्सी अग्रिम प्रजनन लाइनों का शुष्कीकरण तनाव के प्रति मूल्यांकन, बीज भरण अवस्था में KI 2% (w/v) का छिड़काव करके किया गया।
- एक क्रॉस (जेएस 97–52 / एनआरसी 37) से प्राप्त 176 लाइनों की एफ10 RIL की आबादी को विलंबित लीफ सेनेसेंस और स्टेम रिजर्व मोबिलाइजेशन लक्षणों के लिए मूल्यांकित किया गया ।
- आठ–तरफा क्रॉस अर्ली जेनरेशन (F2s), बैकक्रॉस पॉपुलेशन और अन्य मल्टी–पैरेंट पॉपुलेशन को बीज के आकार और अर्लीनेस का चयन करने के लिए रासायनिक डिसिकेशन आधारित विधि के माध्यम से F3 आबादी में उन्नत किया गया था।
- F2 जनसंख्या को जल भराव सहिष्णु प्रजनक JS 20–38 (FDS=2) एवं अतिसंवेदनशील प्रजनक JS 95–60 (FDS=8) के संकरण से विकसित किया गया तथा जलप्रभाव सहिष्णुता की आनुवांशिकता का आंकलन किया गया।
- NRC 7 X EC 538828 के कुल 490 RIL को F6 पीढ़ी के लिए उन्नत किया गया , एवं इनमें से उच्च उपज एवं बेहतर बढ़त वाली लाइनों का चयन किया गया।
- लेजर बायोस्पेकल आधारित सेंसर तकनीकी का विकास सोयाबीन की फसल में चारकोल सड़न रोग को चिह्नित करने के लिए किया गया है।
- GRSP और मिट्टी के पोषक तत्वों जैसे नाइट्रोजन, फॉस्फोरस और मृदा कार्बनिक कार्बन के बीच सकारात्मक सहसंबंध देखा गया।
- ब्रेडी रैजोबियम डाक्वीजीन्स और AMF कवक के साथ पौधों के सह–संक्रमण ने N और P उर्वरकों को 25% कम करने के साथ ही पौधों के पोषण और स्वास्थ्य को बढ़ाया।
- सिंचित और बारानी दोनों परिस्थितियों में संस्थान में 3 साल के प्रयोगात्मक डेटा का उपयोग करके विभिन्न सोयाबीन किस्मों (जेएस 95–60, जेएस 335 और जेएस 97–52) के लिए DS–SAT के तहत क्रॉपग्रो मॉडल का अंशांकन और सत्यापन किया गया था।
- जिलेवार कीट घटना का भू–स्थानिक निर्णय हेतु समर्थन मानचित्र विकसित किया गया है और यह सूचना साप्ताहिक सलाह के रूप में मध्य प्रदेश, महाराष्ट्र, राजस्थान, आंध्र प्रदेश, तेलंगाना और कर्नाटक के सोयाबीन किसानों में प्रसारित की जा रही है।

1. EXECUTIVE SUMMARY

- A total of 5114 germplasm accessions including 74 accessions of 14 wild species are being maintained in MTS.
- One hundred twelve germplasm accessions procured from AVRDC Taiwan were characterized for 12 qualitative and 11 quantitative traits.
- One hundred fifty nine accessions were evaluated at 8 centres (Palampur, Pantnagar, Imphal, Raipur, Indore, Jabalpur, Parbhani, Pune) in augmented trial and early maturing, high yielding and bold seeded germplasm were identified.

- Fifty accessions were evaluated for disease resistance at 5 centres (Palampur, Dharwad, Pantnagar, Indore and Jabalpur) and resistant germplasm to FLS, Pb (ct), BP, YMV, SMV, CR, RAB, BLB and Rust were identified
- Around 60 promising entries derived from different crosses were evaluated under institute station trial for identification of best entries to test under AICRP IVT 2021.
- BC3F1 of NRC7 X SL525 were raised and tested for their trueness to hybridity.
- BC3F2:3 of JS95-60 X (JS95-60 X SL525) were raised and genotyped for SSR marker GMAC7L for selection of MYMIV resistant p000lants.
- NRCSL 2, an EDV (Essentially Derived Variety) of national variety JS335 with resistance against MYMIV has been promoted to AVT II in Central Zone.
- NRC149, a high oil and MYMIV resistant genotype developed in the project has been promoted to AVTI in 4 Agroclimatic zones.
- NRC 138, early maturing genotype has been evaluated in AVTII in Central Zone.
- NRC142, a genotype free from lipoxygenase 2 and Kunitz trypsin inhibitor has been promoted and evaluated in AVTII trial in central and Southern Zones and is the first soybean genotype free from antinutritional factor KTI with reduced beany flavour.
- NRC150, a early lox 2 free and high oil genotype developed in the project has been promoted evaluated in AVT1 in Central Zone .
- NRC152, a extra early and free from lox2 and KTI genotype developed in the project has been promoted and evaluated in AVTI .
- Two genotypes free from KTI with early maturity namely NRC179 and NRC181 have entered in IVT of central zone.
- During Kharif 2020, a total of 350 F2:3 families derived from the crosses EC34372 x JS95-60 and EC457254 x JS95-60, along with parents were screened for anthracnose resistance under hot-spot conditions.
- During Kharif 2020, under high disease pressure, genotypes, EC34372, EC457254, EC39063, EC34106, EC39150, EC39172, EC916032, IC250350, NB136, RSC10-46, EC915983 and EC39022 were found to be highly resistant to anthracnose disease.
- At ICAR-IISR Indore, out of total 36 genotypes planted, 8 genotypes (PK 472, GW 253, GW 70, GW 207, GW 108, GW 111, GW 75, JS 20-69) were found resistant to color rot in natural field condition.
- Eighty advance breeding lines were evaluated under desiccation stress induced by spraying KI 0.2% (w/v) at seed fill stages.
- A F10 RILs population of 176 lines derived from a cross (JS 97-52/NRC 37) were characterized for delayed leaf senescence and stem reserve mobilization traits
- Eight-way cross early generations (F2s), backcross populations and other multi-parent populations were advanced to F3 populations through Chemical desiccation based method for selecting seed size and earliness.
- The F2 population was developed through hybridization of water logging tolerant parent JS 20-38 (FDS=2) with water logging susceptible parent JS 95-60 (FDS=8) & Polygenic inheritance reaveled during evaluation.

- A total of 490 RIL's of NRC 7 X EC 538828 were advanced to F6 generation selecting non-shattering, high yield with better field emergence.
- A laser biospeckle based sensor has been developed to characterize the charcoal rot disease in soybean crop.
- Positive correlation was observed between GRSP and soil nutrients like N, P and soil organic carbon (SOC).
- The co-inoculation of plants with B. daqingense and AM fungi at 25% reduced N and P fertilizers not only enhanced the nutrition and health of plants but also shoed higher response than the 100% fertilizers.
- Calibration and validation of CROPGRO model under DSSAT was done for different soybean cultivars (JS 95-60, JS 335 and JS 97-52) by using 3 years' experimental data at ICAR-IISR, Indore under both irrigated and rainfed conditions.
- Geo-Spatial Decision support map of District-wise insect incidence has been developed and the advisories have been disseminated weekly to soybean farmers of Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Telangana and Karnataka.

2. INTRODUCTION

Indian Council of Agricultural Research (ICAR) was established the ICAR-Indian Institute of Soybean Research (IISR) in the year 1987 at Indore in the State of Madhya Pradesh to take up the centralized research to support soybean production systems with basic information and breeding material. Coordinating unit of All India Coordinated Research Project on Soybean (AICRPS), Soybean Breeder Seed Production (BSPS) and National Active Germplasm Site (NAGS) for soybean germplasm are also situated at ICAR-IISR.

Physiography

ICAR-IISR campus is located in the village Piplyarao of district Indore, which lies in Vidhyanchal range of Malwa Plateau at 22o 4'37"N latitude and 75o 52'7"E longitude. It is positioned at an altitude of 550 meter above the mean sea level. The Institute with an area of 56.7 hectare is situated at a distance of 4 km from the heart of Indore city and 6 km from railway station.

Soil

The soil of ICAR-IISR research farm is deep black cotton soil with pH 7.6 to 8.1 (basic / alkaline), low to medium in organic carbon and available phosphorus and high in potassium. Taxonomically it is classified as fine, montomorillonitic, hyperthermic family of typic chromusterts and fine clay loam, montmorillonitic family of lithic vertic ustochrepts.

Climate

The climate of the Malwa Plateau of Madhya Pradesh is semi arid with a growing period of 150 180 days. As such, the climate of this region is characterized by 3 distinct agricultural seasons. These are: (a) rainy season, also known as monsoon or kharif, usually begins from mid June and extends up to early October. Generally duration of monsoon is approximately 98 days with about 800 mm mean annual rainfall and soybean is grown during this season as rainfed crop. (b) post-rainy season which runs from mid October to March, also known as rabi, is dry and cool and (c) warm and dry season, which begins in February and lasts until April May/June is called zaid or summer/spring and any crop grown during this season requires irrigation.

Past achievements

Major achievements of this Institute includes a vast collection of soybean germplasm comprising exotic, indigenous, breeding lines and wild species. Currently, 4097 germplasm accessions are present with ICAR-IISR and ICAR-NBPGR. Further, for better management of genetic resources and to enhance germplasm utilization, core-collection of germplasm has been developed successfully. A number of genetic resources were identified for various traits like photoperiod insensitivity, drought tolerance, and resistance to diseases such as rust and YMV and insect pests. Genotypes with high oleic acid (NRC 106, IC 210), low linolenic acid (VLS 59), vegetable soybean genotypes (NRC 105), null kunitz trypsin inhibitor genotypes (NRC 101, NRC 102) have been developed at this institute. High yielding varieties having resistance to various biotic and abiotic stresses (NRC 7, NRC 37, NRC 86, JS 97-52) were bred and have been released for cultivation in different agro-ecological regions of the country. First Null KTI genotype in the country, NRC 127, has been identified for release in the Central Zone. Two germplasm accessions EC 390977 and MACS 330 having photoperiodic genes and early maturity traits were registered at ICAR-NBPGR, New Delhi.

In the field of crop production, In situ moisture conservation technology and the associated mechanization for soybean-based cropping system (BBF, FIRBS R&F) have been developed and commercialized. Integrated management for soybean-wheat and soybean-chickpea, and integrated weed management for soybean cropping system were developed. Soil health enhancing microbes including Zn, Fe solubilizing bacteria and rhizobia have been identified. In the field of plant protection, integrated management schedule for major soybean insect pests were worked out. Studies on epidemiology of rust occurrence in soybean revealed that the source of rust inoculum for south India was lying lies in the Krishna valley. The economic benefit of adoption of rust resistant varieties in rust prone districts of Maharashtra and Karnataka states were estimated and widespread adoption of rust resistant soybean varieties significantly contributed to farm income and crop stabilization in the region. Web-based expert systems for varietal and disease identification and data management systems for AICRPS have been developed. Soybean Gyan- a mobile app for soybean farmers has been developed by the institute provides information on different aspect of cultivation viz., agronomic package of practices, insect and disease management etc. It also gives information about selection of suitable varieties; seed treatment seed rate and seed storage. Consequently, the Institute has emerged as a catalyzing force to facilitate rapid increase in acreage and production of soybean since 25 years. It has also been instrumental in providing sustainability to soybean cultivation in different regions of the country. The transfer of research emanated improved production technology has led to increase in national productivity from 700 to 1300 kg/ha during past 25 years.

Mandate

Following are the mandate to support production systems research along with basic information and breeding material:

- Basic, strategic and adaptive research on soybean for improving productivity and quality
- Provide access to information, knowledge and genetic material to develop improved technology and enhanced soybean production.
- Coordination of applied research to develop location specific varieties and technologies;
- Dissemination of technology and capacity building

Organizational set-up

For efficient functioning of institute and to achieve the mandate and objectives, the organizational pattern of the Institute has been evolved and depicted on the next page.

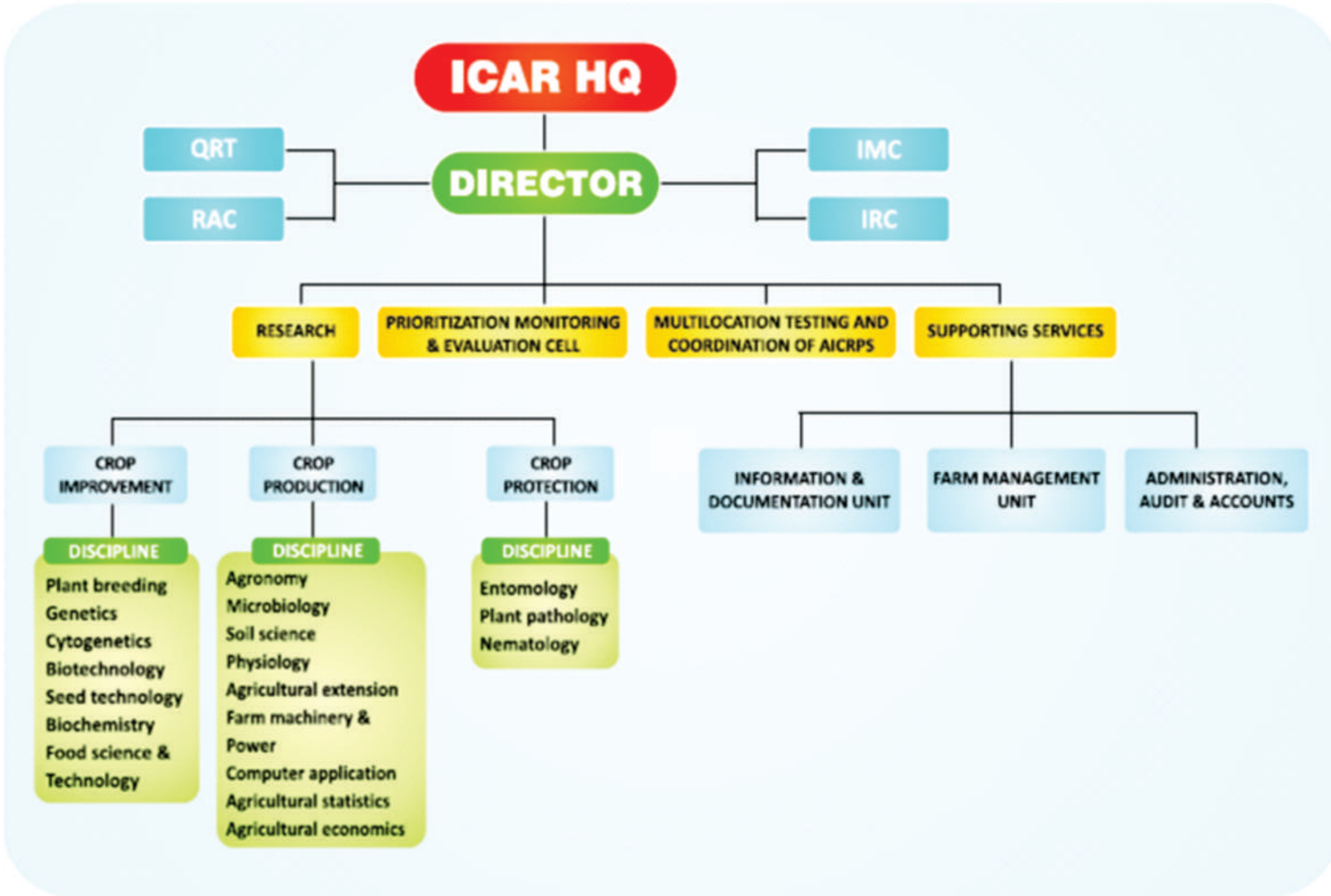


Fig. 2.1 Organogram of ICAR-IISR

Library

Institute has developed a reasonably good library equipped with relevant books, journals, etc. to provide the research support needed to the scientists. At present, the library is equipped with 3269 books and subscribing 01 international and 39 national journals. The library is also a beneficiary of CERA for accessing more than 2000 scientific journals on-line.

Staff and budget

The total sanctioned staff position of ICAR-IISR as on 31 December 2020 is 79 comprising 34 scientific, 22 technical, 23 administrative and supporting positions. Out of which 69 are in positions as on 31 December 2020.

Table 2.1 Budget and expenditure of ICAR-IISR for 2019 - 2020 (₹ in lakhs)

Head	**ICAR-IISR grant**
	Actual Exp.
Pay & Allowances	1179.54
T.A.	15.56
Other Charges Recurring	0.0
(a) Information Technology	3.98
(b) Equipments	9.14
(c) Works	7.88
(d) Library	3.87
(e) Furniture & Fixures	1.34
(f) HRD	2.48
(g) Pension & Retirement Benefits	39.93
(h) Loans & Advances	25.50
Total	**1289.22**

3. CROP IMPROVEMENT

NRCS 1.1/87 Augmentation, Management and Documentation of Soybean Genetic Resources.

- **Germplasm Maintenance and characterization :** A total of 5114 germplasm accessions including 74 accessions of 14 wild species are being maintained in MTS. Three hundred twenty two trait specific germplasm accessions forming a trait specific set for characters like photoinsensitivity, long juvenility, drought tolerance, water logging tolerance, high temperature tolerance, YMV resistance, disease resistance, rust differentials, antibiosis to spodoptera, insect tolerance, vegetable type, early maturity, bold seeded, small seeded, salt tolerance, high seed longevity, high yielding, high oil, low linolenic acid, null KTI, Lox 2 free, high protein, high oleic, low lipoxygenase, less mechanical damage are being maintained. More than 200 germplasm lines of core set along with allele specific panel are also being maintained. During Kharif 2020, 257 germplasm accessions of trait specific panel and 152 germplasm accessions of core set were characterized for 9 qualitative traits.

- **Germplasm Evaluation**

  One hundred twelve germplasm accessions procured from AVRDC Taiwan were characterized for 12 qualitative and 11 quantitative traits at Indore location. Purple coloured flowers, erect growth habit, intermediate leaf shape with 3 leaflets, presence of leaf and stem pubescence and of gray colour were the most frequent characteristics . Range and mean for days to maturity, 100-seed weight, grain yield/plant and row yield (3mt) are given in Table 3.1. Early maturing and higher yielding accessions (EC 915983, EC 915908, EC 915 989) in comparison to checks could be identified

Table 3.1: AVRDC germplasm evaluation

Trait	Range	Mean	Germplasm Accession
Early Maturing (Days)	86-98	90.94	EC 915908 (86), EC 915921 (86), EC 915922 (87), EC 915989 (87), EC 915900 (88) **Checks:** NRC-105: 88; AGS Farm Acc: 86
100 Seed Weight (g)	5.2-18.8	12.36	EC 915908 (18.8), EC 915997 (18), EC 916025 (17.4), EC 915983 (16.6), EC 915964 (14) **Checks:** NRC-105: 12.5; AGS Farm Acc: 12

Trait	Range	Mean	Germplasm Accession
Grain Yield / Plant (g)	0.68-7.4	3.47	EC 916025 (7.4), EC 915964 (7.36), EC 915909 (6.48), EC 915983 (6.42), EC 915989 (5.06) **Checks**: NRC-105: 1.98; AGS Farm Acc: 1.3
Row yield (3 mt) (g)	3.4-79.9	23.63	EC 915983 (79.9), EC 915964 (53.4), EC 915989 (43.4), EC 915908 (41.60), EC 916025 (37) **Checks**: NRC-105: 10; AGS Farm Acc: 6.5

One hundred fifty nine accessions were evaluated at 8 centres (Palampur, Pantnagar, Imphal, Raipur, Indore, Jabalpur, Parbhani, Pune) in augmented trial and early maturing, high yielding and bold seeded germplasm were identified. Top 5 accessions for all of these traits for each centre are given in Table 3.2.

Table 3.2: Multi-Location Germplasm Evaluation

Zone (Centre)	Early Maturity	Grain Yield	Seed Size
NHZ (Palampur)	EC 251506, EC 251531, EC 457285, EC 251383, AGS-32	EC 251506, NRC 2007-1-3, UPSM 662, UPSL 786, NRC	PS 1336, JS 95-52, EC -251531, SAL 12, RVS-2006-4
NHZ (Almorah)	EC 333897, EC 481571, JS 20-38, AGS 163 B, EC 251516	IMP 1, RICUM, EC 280149, EC 251470, EC 313915	UPSL 786, PS 1336, GP 525,EC 171194, EC 172578
NPZ (Pantnagar)	EC 333897, AGS 163 B, AGS-32, TNAU 20-49, AGS 116	EC 393222, JS 95-52, AMS-MB-51-18, AGS 99, EC 251506	AMS 38-24, EC 172578, JS 20-41, EC 251516, PS 1336
NEHZ (Imphal)	AGS 163 B, SAL 12, AGS 116, NRC 59, NRC 41	EC 393222, EC 391162, Ec309512, AMS 60-2-3-4, EC 171194	EC 171194, PS 1336, EC 391012, Ec309512, RVS-2006-4
EZ (Raipur)	EC 309512, EC 1682, AMS 243, EC 383165, EC 313915	AMS 56, AMS 195, EC 457285, NRC-2006M, EC-457185	NRC 23-20, RKS 21, PK 1220, NRC 57, EC 1682,
CZ (Jabalpur)	AMS-MB-51-18, NRC 37, AGS 32, AMS-243, EC 457214	AMS 38-24, AGS 163 B, NRC 80-1, JS 75-30, SEHORE-1	AGS 163 B, AMS 38-24, UPSL 340, EC 391012, RKS 52

Zone (Centre)	Early Maturity	Grain Yield	Seed Size
CZ (Parbhani)	EC 393222, EC 333897, UPSL 162, AGS 56, EC 457285	UPSL 472, EC 383165, EC 457185, EC 333897, ICAL0122	EC 172578, NRC 23-20, EC 171194, JS 20-41, NRC 57
SZ (Pune)	EC 333897, JS 20-38, EC 481571,AGS 163 B, AGS-32	AMS 38-24, EC309512, NRC 2006 M, NRC 41, PS 1336	EC 383165, EC 241780, AMS 38-24, BDS 190, UPSM 57

Fifty accessions were evaluated for disease resistance at 5 centres (Palampur, Dharwad, Pantnagar, Indore and Jabalpur) and resistant germplasm to FLS, Pb (ct), BP, YMV, SMV, CR, RAB, BLB and Rust were identified (Table 3.3).

Promising germplasm for girdle beetle and defoliators were also identified from this multi-location testing at Indore, Sehore, Kota, Ludhiana, Dharwad and Imphal (Table 3.3).

Table 3.3: Multi-lcation germplasm evaluation for disease and insect resistance

Centre	Disease	Resistant Germplasm
Disease Resistance		
Palampur	FLS & Pb (ct)	TGX 293-41E, EC 391181, UGM 77, EC 14117, Harder and EC 241780
	BP & Pb (ct)	MACS 303, EC 381884 and Z-22 (20-146)
Jabalpur	YMV, SMV, CR, RAB	SL 525, PK 122
Indore	YMV, Pb (ct), SMV, RAB	VLS 11
	YMV, Pb (ct), RAB	LDS 256 and SL 525
Pantnagar	RAB, YMV and BLB	RKS-54
	YMV and BLB	JSM 285, JS 20-86, PK-431337 and Z-22
Dharwad	Rust	EC 241780
Insect Tolerance		
Girdle beetle	JSM 195, JSM 232, SL 525, EC 457074, SL(E) 1.	
Defoliators	JS 20-86, SL 738, MACS 171, EC 457074.	

Identification of germplasm with high oil content

One hundred fifteen germplasm accessions were evaluated for oil content and the frequency distribution is shown in Fig 3.1A. Oil content varied from 13.7 – 22.4 % with the average of 18.2 %. CM 60 an Australian accession and VLS 63 had 22.4 and 22.1 % oil. EC 916015, NB 220, SL 955, EC 915983, RVS 2007-6 were found to be with more than 21% oil.

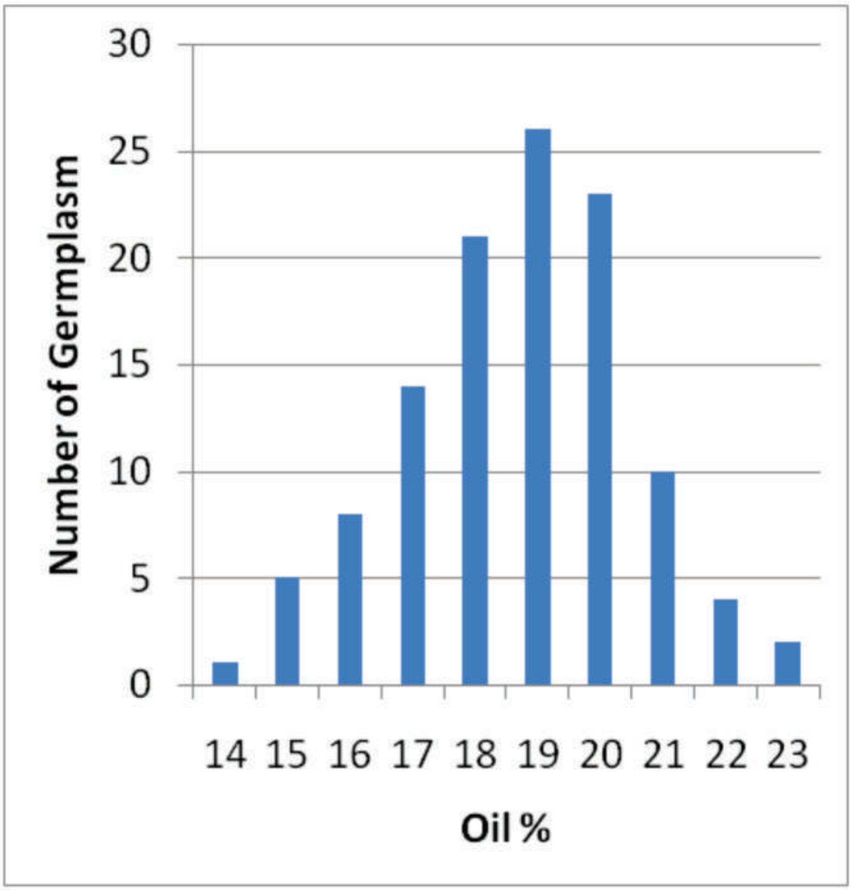


Fig 3.1A : Frequency distribution of oil content in germplasm accession

Genotyping of USDA Core Collection of 000 to IX Maturity Group and Indian soybean varieties

Three to six accessions of each of 000 to IX maturity groups (total 56 accessions) were genotyped for their allelic status at E1, E2, E3 & E4 loci and compared with 117 Indian soybean varieties. Because of more incidences of diseases during *Kharif* 2020 phenotyping for determining the maturity group of Indian soybean varieties could not be accomplished.

Recessive e4 allele was found only in 000 & 00 MG. Recessive e1 allele was most frequently present in early maturity groups (000-II). Recessive e2 was the most frequent allele and could be observed upto MG VII. Presence of dominant alleles for all genes was most frequent in later maturity group accessions.

Recessive alleles were rare in Indian soybean varieties and 6 genotypic classes e1-asE2E3E4, E1e2e3E4, E1e2E3E4, E1e2E3E4, E1E2e3E4 and E1E2E3E4 were identified. Only JS 95-60 was identified to have the recessive allele at E1 and recessive e2 was present in JS 20-34, LSb1 and PRS 1. Among recessive alleles e3 was most frequent and present in 10 varieties. With one hundred six varieties genotypic class E1E2E3E4 was the most frequent (Table 3.4).

Table 3.4: Genotyping of USDA accessions for photoperiodic loci and comparison with Indian varieties

Maturity Group	Genotypic class	Accessions
USDA Accessions		
000	*e1ase2e3e4, E1e2e3e4, e1e2e3E4,*	EC993505, EC993507, EC993526, Ec993472
00	*E1e2e3E4, e1e2E3e4, E1E2e4e4*	EC993485, EC993486, EC993502, Ec993527 Ec993540
0	*E1E2E3E4, e1E2E4E4, E1e2e3e4*	EC993475, EC993436, EC993434, Ec993438 Ec993442
I	*e1E2E3, E1e2e3E4, e1E2E3E4*	EC993496, EC993448, EC993446, EC993439, Ec993510
II	*e1E2E3E4, e1E2E3E4*	EC993447, EC993443, EC993440, EC993487, Ec993474
III	*E1E2E3E4, E1e2E4*	EC993988, EC993457, EC993441, EC993433, Ec993528
V	*E1e2E3E4, E1E2E3E4*	EC993552, EC994004, EC994002, EC993916, Ec993921

Maturity Group	Genotypic class	Accessions
VI	*E1e2E3E4, E1E2E3E4*	EC993560, EC993920, EC994005, EC993919, Ec993914
VII	*E1E2E3E4, E1e2e3E4*	EC994026, EC993918, EC993908, EC993936, Ec994010
VIII	*E1E2E3E4*	EC993911, EC993909, EC993574, Ec994003
IX	*E1E2E3E4, E1E2e3E4*	EC993952, EC993948, Ec993998
Indian Soybean Varieties		
Not Known	*e1-asE2E3E4*	JS 95-60
Not Known	*E1e2e3E4*	PRS 1
Not Known	*E1e2E3E4*	Lsb1
Not Known	*E1e2E3E4*	JS 20-34
Not Known	*E1E2e3E4*	Alankar, Co-1, Durga, Indira Soya, JS 75-46, JS 76-205, Kalitur, MAUS 612, PS 1024, RAUS 5, TAMS 98 (10)
Not Known	*E1E2E3E4*	All other (106)

Germplasm Distribution and Utilization

A total of 1958 germplasm accessions were distributed to Indian researchers (Table 3.5).

Table 3.5: Distribution of soybean germplasm in 2020

Institute	Germplam type & number
PJTSAU, Rudrur	20 (Trait specific)
ICAR-IISS, Bhopal	40 (15 wild)
KAU	11
CAU, Imphal	50 AVRDC Vegetable soybean lines
MPKV, Rauri	6 photoinsensitive and 3 long juvenile

Institute	Germplam type & number
AICRP Centres (Breeding)	159 germplasm
AICRP Centres (Pathology)	50 germplasm
AICRP Centres (Entomology)	30 germplasm

Identification of genotypes combining photoinsensitivity and long juvenility

Combining of photoinsensitivity and long juvenility is required for developing early maturing long juvenile varieties with wider adaptability across the seasons and sowing dates. A recombinant inbred population (46 lines) from the cross of photoinsensitive JS 95-60 (e1-as E9) and long juvenile accession AGS 25 (E1e9) was genotyped and 5 lines 51PB 136 (NRC 252), 51PB 12 (NRC 253), 51PB66/2(8) (NRC 254), 51PB 75 (NRC 255), 51PB 8-64 (NRC 256) were identified to have the combination of recessive alleles of E1 and E9.

NRCS 1.6/92: Hybridization, selection and development of multi-parent population for genetic improvement of yield potential in soybean.

Hybridizations and Selections

To increase the diversity in the breeding populations new crosses were attempted by involving four way hybrids derived from diverse parents. The list of the crosses attempeted are presented in table 3.6. Backcrosses (BC2) were also attempted to reduce the maturity duration and increase the seed weight of JS 97-52 variety.

Table 3.6 List of multiple crosses attempted by involving diverse parents.

Sl no	Crosses (Multiparent)	No. of F1 seeds
1	[(NRC 155 x NRC 128) x (7A-109 x EC 538828)] x [(IC 15089 x 14-36B) x EC 34372 x 6A-34-25]	11
2	[(NRC 155 x NRC 128) x (AGS 155 x JS 95-60)] x [(IC 15089 x 14-36A) [(Ic15089 x 14-36B) x EC 34372 x 6A-34-25]	15
3	x (EC 34372 x 6A-25-34)] x [(NRC 155 x EC 538828) x AGS 155 x JS 20-34)]	14
4	[(AGS 155 x JS 95-60) x (AKSS 67 x NRC 155)] x [(IC 15089 x 14-36 b) x EC 34372 x 6A-34-25)]	17
5	[(NRC 155 x NRC 128) x (AGS 155 x JS 95-60) x [(IC 15089 x 14-36A) x (EC 34372 x 6A-34-25)]	12
6	[(VP 1165 x JS 95-60) x (6A-33-1 x PB 220 YMV)] x [(IC 15089 x 14-36B) x (EC 34372 x 6A-34-25)]	13

Sl no	Crosses (Multiparent)	No. of F1 seeds
7	[(EC 34372 x 6A-34-25) x (AGS 155 x JS 95-60)] x [(EC 538828 x NRC 128) x P501 x DS 3106)]	8
8	[(IC 15089 x 14-36B) x (EC 34372 x 6A-34-25)] x [(AKSS 67 x NRC 155) x AGS 155 x JS 20-34	12
9	[(NRC 155 x NRC 128) x (7A-109 x EC 538828) x [(EC 34372 x 6A-34-25) x (AGS 155 x JS 95-60)]	14
10	[(NRC 155 x NRC 128) x 7A-109 x EC 538828)] x [(IC15089 x 14-36A x AGS 155 x JS 20-34)]	5

Generation advancement:

Several selections were made among the diverse crosses (JS 9560 × NRC 128; NRC 128 × EX 538828; JS 20-69 × NRC 155, NRC 128 × NRC 155; NRC 156 × NRC 128; NRC 155 × EC 538828, EC 457254 × JS 95-60, EC 34372 × JS 95-60 etc) based on more number of pods, yield and maturity (95 days) advanced to F4 generation. Similarly, numbers of selections were made in F3 generations belonging to different crosses.

Evaluation of advanced breeding lines

A total of 83 advanced breeding lines derived from different crosses were evaluated for yield and attributing traits. Breeding lines consisted of early maturity (up to 80 days), medium maturity (95-100) and inter-specific backcrossed derived improved breeding lines were evaluated along with check varieties JS 20-34, JS 95-60, JS 20-29, JS 20-69 and NRC 86 were sown in Randomized complete block design. A line no. 16 derived from cross MACS 330 × NRC 86 matured in 69 days and majority of the lines from this cross matured within 80 days with considerable higher yield than earliest maturing checks JS 20-34 and JS 95-60. Several G. soja derived lines (YMV series) yielded more than best check JS 20-69 (Table 3.7)

Table 3.7 Performance of selected entries for yield (kg/ ha)

Code	Name of entry	Yield (Kg/ha)	Days to maturity	Per day productivity (kg/ha)
2	E-13-5	552	75	7.36
4	E 13-6	723	72	10.04
5	E 21-4	657	75	8.76
10	E-7-2	868	72	12.05
13	E-7-1	475	75	6.33

Code	Name of entry	Yield (Kg/ha)	Days to maturity	Per day productivity (kg/ha)
16	E-13-4	564	69	8.17
17	E-21-2	678	75	9.04
27	E-65-2	1659	97	17.10
30	YMV-12	1888	101	18.69
32	YMV-9	1984	100	19.84
33	YMV 16	2000	101	19.80
35	E 65-1	2128	97	21.9
36	YMV-8	1856	99	18.74
46	YMV-7	1808	101	17.90
47	YMV-17	1777	99	17.94
48	YMV-2	2016	99	20.36
51	E-65-3	1176	94	12.51
53	YMV-1	2240	100	22.4
Checks	JS 95-60	64	88	0.72
	JS 20-34	406	90	4.51
	JS 20-69	1872	102	18.35
	NRC 86	368	100	3.68
	JS 20-29	953	100	9.53

Evaluation of promising entries in station and AICRP trial

The ten promising entries derived from different crosses were evaluated under institute station trial for identification of best entries to test under AICRP IVT 2021. Similarly, Four entries derived from four different crosses, JS 335 × EC 538828, Type 49 × EC 538828, EC 538828 × JS 97-52, MACS330 × NRC 86 with maturity duration of ≈ 90 days maturity under IVT early of Central Zone. Similarly, one genotype NRC 158 has been evaluated in AVT I in Central Zone.

IISR 1.33/16 : Development of YMV resistant soybean varieties using marker assisted selection

- BC_3F_1 of NRC7 X SL525 were raised and tested for their trueness to hybridity .

- $BC_3F_{2:3}$ of JS95-60 X (JS95-60 X SL525) were raised and genotyped for SSR marker GMAC7L for selection of MYMIV resistant plants.
- All the segregating lines were tested with MYMIV resistance linked markers Satt 322 and GMAC7L for selection of MYMIV resistant plants.
- All the homozygous recessive plants for MYMIV resistance gene based on PCR results of linked markers were raised at hot spot Ludhiana for validation of MYMIV resistance. All the homozygous recessive plants showed resistance to MYMIV at Ludhiana.
- NRCSL 2, an EDV (Essentially Derived Variety) of national variety JS 335 with resistance against MYMIV has been promoted to AVT II in Central Zone.
- NRC 149, a high oil and MYMIV resistant genotype developed has been promoted to AVTI in 4 Agroclimatic zones.

DSR.1.28/14: Mapping QTLs for oleic acid and development of high oleic acid soybean

Advanced breeding lines with oleic acid about 60% oleic acid from different parental combinations, namely, IC210 x P4-19, NRC106 x NRC105, IC210 x NRC105; NRC106 x IC210, NRC106 x HO2 (Hardee x NRC7), LSb1 xNRC7 x IC210, NRC105 x LSb1 x IC210, HO31 (Hardee x NRC 7) x IC210, IC210 x H3-9, LSb1 x IC210, IC210 x P4-4 (derived from LSb1 x NRC 7); NRC 106 x LSb1 x NRC7; H3-9 (derived from Hardee x NRC7) x AGS 191 were raised in the field in the cropping season 2020. Field data like morphological traits viz. days-to-flowering, days-to-maturity and yield/plant of each breeding line of the different parental combinations were recorded. Freshly harvested seeds of these advanced breeding lines are being analysed for oleic acid content.

Screening of F_2:$_3$ families for anthracnose resistance under hot-spot conditions

During *Kharif* 2020, a total of 350 F_2:$_3$ families derived from the crosses EC34372 X JS95-60 and EC 457254 X JS 95-60, along with parents were screened for anthracnose resistance under hot-spot conditions. Two parents, EC 34372 and EC 457254 were found to be resistant while JS 95-60 exhibited susceptible reaction. About 150 resistant F2:3 families were selected based on early maturity, plant height, number of pods and yield. These families will be advanced to next generation so as to select early maturing, high yielding and anthracnose resistant genotypes.

Identification of potential resistant sources for anthracnose disease

During *Kharif* 2020, under high disease pressure, genotypes, EC 34372, EC 457254, EC 39063, EC 34106, EC 39150, EC 39172, EC 916032, IC 250350, NB 136, RSC 10-46, EC 915983 and EC 39022 were found to be highly resistant to anthracnose disease. These genotypes can be employed in breeding for anthracnose resistance

Hybridization for resistance against anthracnose and charcoal rot diseases

Table 3.8 : Following crosses have been made targeting different traits

Ec457254 x JS95-60	Anthracnose Resistance
EC34372 x JS95-60	
JS 20-98 x Ec457254	Anthracnose and Charcoal rot Resistance
JS 9752 x Ec457254	
JS 20-98 x PS 1611	Charcoal rot Resistance
PS 1225 x JS20-20	
PS 1225 x PS 1611	Charcoal rot Resistance and higher yield
PS 1611 x JS95-60	Charcoal rot Resistance and early maturity
JS 20-98 x JS95-60	
EC 538828 x PS 1611	
8-94-4 x PS 1611	
JS20-20 x JS95-60	
JS20-34 x JS95-60	
[(JS97-52 x AMS5-18) x (JS20-69 x NRC128) x [(7A-109 x EC 538828) x (CAT47 x JS95-60)]	
[(JS97-52 x AMS5-18) x (JS20-69 x NRC128) x [(P501 x DS3106) x (Young x EC 538828)]	Charcoal rot Resistance, early maturity and higher yield
[(JS20-69 x NRC128) x (DS97-12 x AMS5-18) x [(P501 x DS3106) x (EC 538828 x NRC128)]	
AMS5-18 x NRC128	Higher yield

Screening of selected genotypes for charcoal rot resistance at Jabalpur

Five genotypes were screened at Jabalpur for charcoal rot resistance. Among them, EC 34372 was found to be absolute resistant with 0% disease incidence, followed by EC 457254 (5.4%) and EC 538828 (8.2%). These three genotypes which are resistant also to anthracnose, can be used in breeding for charcoal rot and anthracnose resistance

Table 3.9 : Details of charcoal road resistance at Jabalpur

Genotypes	Charcoal rot	
	% incidence	Reaction
EC 457254	5.4	MR
AKSS 67	88.6	HS
EC 34372	0.0	AR
EC 538828	8.2	MR
Type 49	14.4	MS

Figure 3.1B : Veinal necrosis caused by anthracnose

Figure 3.2: Brown discoloration of pods due to anthracnose

Figure 3.3 : $F_{2\cdot 3}$ families showing resistant and susceptible disease reaction

Soybean improvement against defoliating insect

During Kharif 2020, a set of 60 soybean germplasm (56 Glycine max and 4 Glycine soja) lines were screened in field and lab conditions against defoliating insects in RBD with 4 checks (2 resistant and 2 susceptible). Also screened F1`S of 13 crosses attempted during 2019.

- In field conditions, based on the leaf damage percentage and in lab conditions, based on preference index (C) of antixenosis for Spodoptera litura, soybean accessions were categorized based on the resistance.
- Four genotypes viz., F4P21 (0.24), CAT 2503 (0.32), PI 407170 (0.43), G5P22 (0.44) exhibited strong antixenosis. Seven genotypes moderate antixenosis (0.61-0.74). For the respective genotypes, field screening based on leaf damage percentage was less than 25% defoliation, considered as least susceptible genotypes

Table 3.10 : Antixenosis of soybean genotypes.

S. No.	Genotypes	'C' Values	Interference
	Glycine max		
1	F4P21 (PS 564 x TGX 855-53 D)	0.26	Strong Antixenosis
2	CAT 2503	0.32	Strong Antixenosis
3	G5P22 (MACS 330 x L 129)	0.44	Strong Antixenosis
4	EC309537	0.53	Moderate antixenosis
5	AGS 751	0.58	Moderate antixenosis
6	EC481369	0.58	Moderate antixenosis

S. No.	Genotypes	'C' Values	Interference
	Glycine max		
7	AGS 113	0.6	Moderate antixenosis
8	TGX-849-813	0.6	Moderate antixenosis
9	EC113773	0.64	Moderate antixenosis
10	DCB 137	0.73	Moderate antixenosis
	JS-335	1	Preferred host
	Glycine soja		
1	PI 407170	0.43	Strong antixenosis
2	PI549046	0.76	Slight antixenosis
3	PI407131	0.89	Slight antixenosis
4	PI479752	0.97	Slight antixenosis

Table: Antixenosis of soybean genotypes.

Thirteen F1 crosses were tested for antixenosis and antibiosis against *Spodoptera* litura.

one cross AKSS 67 x JS 20-34 (0.42) exhibited strong antixenosis. Two crosses, JS 9305 x SL1104 (0.60) and AKSS 67 x AGS 155 (0.60) exhibited moderate antixenosis (0.61-0.74).

Table 3.11: Antixenosis of F1 crosses attempted during 2020.

S. No.	Genotypes	'C' Values	Interference
1	AKSS 67 x JS20-34	0.42	Strong antixenosis
2	JS 9305 x SL1104	0.6	Moderate antixenosis
3	AKSS 67 x AGS 155	0.6	Moderate antixenosis
4	AGS 155 x AKSS 67	0.77	Slight antixenosis
5	JS 20-116 x SL1104	0.84	Slight antixenosis
6	JS 335 x AKSS 67	0.84	Slight antixenosis
7	SL1104 x JS9560	0.9	Slight antixenosis
8	JS 2069 x AKSS 67	0.98	Slight antixenosis

S. No.	Genotypes	'C' Values	Interference
9	JS 9305 x AKSS 67	0.99	Slight antixenosis
10	JS 9305 x AGS 155	1.07	Preferred host
11	JS 2069 x SL1104	1.11	Preferred host
12	RKS113 x SL1104	1.28	Preferred host
13	JS 335 x SL1104	1.33	Preferred host
	JS-335	1	Preferred host

Nine F1 crosses showed antibiosis reaction for AD/ECI/ECD and in combination exhibiting presence of antibiosis. For the respective genotypes, field screening based on leaf damage percentage was less than 25% defoliation, considered as least susceptible genotypes. Also recorded yield and yield component characters.

Table 3.12: Antibiosis of F1 crosses attempted during 2020.

S. No.	Genotypes	AD	ECI	ECD
1	JS 20-69 x SL 1104	82.37 (65.17)	71.33 (57.63)	85.58 (67.68)
2	JS 335 x SL 1104	71.98 (58.04)	64.55 (53.46)	89.50 (71.09)
3	JS 20-116 x SL 1104	71.80 (57.93)	48.38 (44.07)	67.72 (55.38)
4	JS 20-69 x AKSS 67	76.31 (60.87)	54.34 (47.49)	72.12 (58.13)
5	RKS 113 x SL 1104	82.21 (65.05)	35.20 (36.39)	43.31 (41.15)
6	JS 9305 x AKSS 67	67.18 (55.05)	52.95 (46.69)	79.09 (62.79)
7	JS 335 x AKSS 67	64.27 (53.29)	46.01 (42.71)	73.01 (58.70)
8	AGS 155 x AKSS 67	77.98 (62.01)	62.68 (52.35)	79.82 (63.30)
9	SL 1104 x JS 9560	67.94 (55.51)	29.30 (32.77)	46.81 (43.17)
10	JS 9305 x AGS 155	82.89 (65.57)	25.60 (30.40)	31.07 (33.88)
11	JS 9305 x SL1104	87.45 (69.25)	20.54 (26.95)	23.52 (29.01)
12	AKSS 67 x AGS 155	81.04 (64.19)	35.04 (36.30)	43.57 (41.31)
13	AKSS 67 x JS 20-34	87.42 (69.22)	45.65 (42.50)	52.71 (46.55)
	JS 335	76.44 (60.96)	59.20 (44.54)	65.53 (54.05)

During second year evaluation, fifty one genotypes which performed well against defoliators in 2019 were evaluated in field condition in RBD with 4 checks (2 resistant and 2 susceptible). Thirteen genotypes performed well field screening based on leaf damage percentage ranging from 5 % to 15% defoliation, considered as least susceptible genotypes.

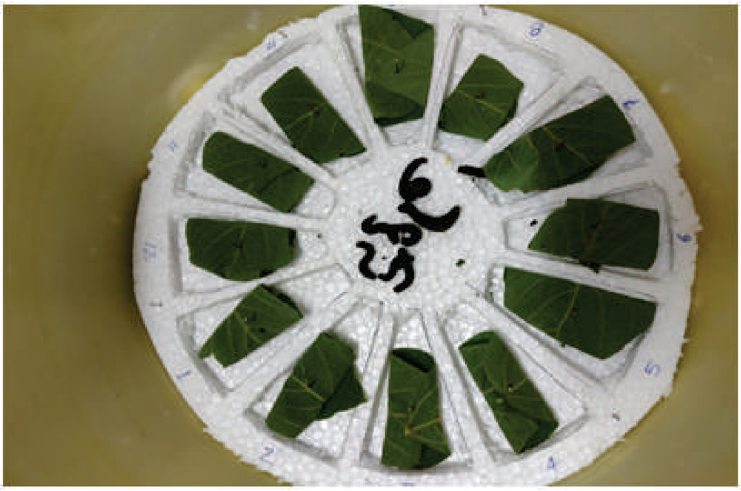


Fig 3.4 : Antixenosis

Fig 3.5 : Antibiosis

Twenty crosses were attempted for defoliating insect resistance as well as stemfly and girdle beetle.

Table 3.13 : Hybridization for defoliating insects resistance

S. No.	Crosses	S. No.	Crosses
1	F3P18 X JS 9560	11	F4P21 X JS 9560
2	F3P18 X JS 9305	12	F4P21 X JS 335
3	F3P18 X Line 220	13	F4P21 X JS 9305
4	F3P18 X Line 202	14	F4P21 X Line 220
5	JS 335 X G5P22	15	JS 20-34 X Harasoya
6	JS 20-34 X G5P22	16	JS 20-34 x Line 220
7	JS 9560 X G5P22	17	JS 20-34 X Line 202
8	AKSS 67 X G5P22	18	JS 9560 X Line 220
9	G5P22 X AKSS 67	19	JS 20-34 x AGS 155
10	JS 335 X F4P21	20	JS 335 X Line 220

A set of 111 soybean germplasm lines (60 first year and 51 second year) were screened in field conditions for stemfly and girdle beetle resistance.

During first year, in case of stemfly, genotypes viz., EC 389149, AKSS 67, V1, GC 17, EC 241696 recorded less than 26% stem tunneling which can be considered as least susceptible after further evaluation. In case of Girdle beetle, 24 genotypes recorded 0 % girdle beetle damage as well as infestation which can be considered as least susceptible after further evaluation.

During Second year, in case of stemfly, genotypes viz., VLS 65, G5P22, LINE 220, JS 20-116, F4 P21 recorded less than 26% stem tunneling which are least susceptible.In case of Girdle beetle, 25 genotypes recorded 0 % girdle beetle damage as well as infestation which are least susceptible.

Prebreeding

Pre breeding attempted using Glycine soja as male parents viz.,PI 549046, PI 407170, PI 593983 and Cultivated varieties (*Glycine max*) used as Female Parents viz., JS 20-34, JS 9560, JS 20-98, JS335, JS 97-52 and EC 538828 for broadening genetic base and also for traits like Early maturity, Insect resistance.

During off-season (*Rabi*- 2020), F1`s of four interspecific crosses viz., JS 20-34 x PI 593983, EC 538828 x PI 549046, JS 20-34 x PI 407170, JS 335 x PI 549046 are multiplied in protected condition and advanced to F2 generation.

Preharvest sprouting Tolerance

Evaluated 27 genotypes for preharvest sprouting tolerance by standardizing through artificial screening method.

Fig 3.6 : Artificial Screening procedure for preharvest sprouting tolerance in soybean.

- Twenty seven genotypes were evaluated for preharvest sprouting tolerance in 3 replications. Observations were recorded for 9 quantitative characters and one qualitative character.
- Quantitative characters include Fresh pod wt, Pod length, Pod diameter, Pod wall thickness, Pod wt after 24 Hrs, Water imbibition by pods, Total seed in pod, Number of seed ruptured in pod, Seeds germinated in pod (Preharvest sprouting) and Qualitative character viz.,Pubescence of the pod.
- Diversity analysis reveals genotypes are grouped into 8 clusters.Diversity contribution by Pod length (26.21 %), Seeds germinated in pod (Preharvest sprouting)

(23.36 %), Fresh pod wt (19.66 %), Total seed in pod (17.38 %).

- Seeds germinated in pod (Preharvest sprouting) recorded positive phenotypic correlation with all quantitative 8 traits except for Water imbibition by pods.
- Path analysis revealed Seeds germinated in pod (Preharvest sprouting) have positive direct effects with Number of seed ruptured in pod, Pod diameter, Pod wall thickness with residual effect of R= 0.0887.
- Genotypes EC 34087 and RSC 10-46 recorded zero (0), JS 97-52 (1.19), JS 20-98 (1.23), Bragg (1.33), JS 20-29 (1.45) Seed germination percentage where as genotypes, NB 136 (43.88), NRC 86 (48.93), RVS 18 (54.76), JS 20-34 (78.16) seed germination percentage. These genotypes will be evaluated again and standardization of procedure will be done.

Fig 3.7 : Artificial Screening of soybean genotypes for preharvest sprouting tolerance.

IISR 3.1./19 : Evaluation of germplasm and breeding for collar rot disease caused by *Sclerotium rolsfsii* Sace in soybean

Collar rot caused by *Sclerotium rolfsii* is the major threat for the successful production of soybean in India. On account of its 30–40% yield loss potential, it is a major obstacle in harnessing full potential of soybean production in most soybean growing areas including India. Till date, none of the soybean cultivars are reported as immune to Sclerotium blight. However, Soybean 'PK 327' 'NRC 37' and AMS 5-18 were reported as slightly tolerant/resistant; therefore, crosses viz. 'JS 20-69 x PK 327', 'AMS 5-18 x Bragg' and 'PK 327x AMS 5-18' were attempted. At ICAR-IISR Indore, out of total 36 genotypes planted, only 8 genotypes (PK 472, GW 253, GW 70, GW 207, GW 108, GW 111, GW 75, JS 20-69) were found resistant in natural field condition.

DSR 5.6/09. Breeding for drought tolerant varieties in soybean.

Entries promoted to IVT(E)-2021 and IVT-2021:

An elite drought tolerant genotype, having JS 95-60 as an early maturing parent, was promoted to Initial Varietal Trial (Early) 2021.

Table 3.14 : Drought tolerant genotypes were promoted to Initial Varietal Trial (early) 2021

S. No.	Genotype	Cross	Seed Yield (kg.plot-1)
1	GKS 20-7	JS 95-60 x Young	0.986
2	JS 20-34 (C)	-	0.462

Two promising drought tolerant genotypes were promoted to Initial Varietal Trial 2021.

Table 3.15 : Drought tolerant lines promoted to IVT (yield) 2021

S.No.	Genotype	Cross	Seed Yield (kg.plot-1)	Days to Maturity
1	GKS 20-4	Davis x Kaeri 651-6	1.226	101
2	GKS 20-5	JS 97-52 x JS 335	0.957	101
3	JS 20-98 ©	-	1.204	102

Entries selected for station trial - 2021:

Based on drought resistance index and better yield attributes following entries were selected for station trail (2021):

Table 3.16 : Drought tolerant lines selected for station (trial) 2021

S.No.	Genotype	Cross	Drought resistance index for seed yield (DRIsy)
1	GKS-21-1	JS 97-52 xKaeri 651-6	1.6
2	GKS-21-2	JS 97-52 x JS 335	1.0
3	GKS-21-3	JS 97-52 x JS 335	2.0
4	GKS-21-4	JS 95-60 x Young	0.9
5	GKS-21-5	JS 97-52 x JS 335	1.1
6	GKS-21-6	JS 97-52 x JS 335	1.5
7	GKS-21-7	JS 93-05xJS 97-52	0.9
8	JS 97-52 (T)		0.9
9	NRC 2 (S)		0.5

*value for NRC 37 (S)

Soybean drought tolerance breeding pipeline: A complete workflow

Soybean drought tolerance breeding pipeline, is a complete workflow starting from multi-parent hybridization through chemical desiccation based early generation advancement, 3-tier traits extraction system to analyzing multiple drought related rainout shelter data and root traits data though multi-trait trait indexing by Principle Component Analysis (PCA) for correlation matrix using SAS (Version 0.3). Lines with more than average index value are considered as elite drought tolerant high yielding lines (Fig. 3.7 B).

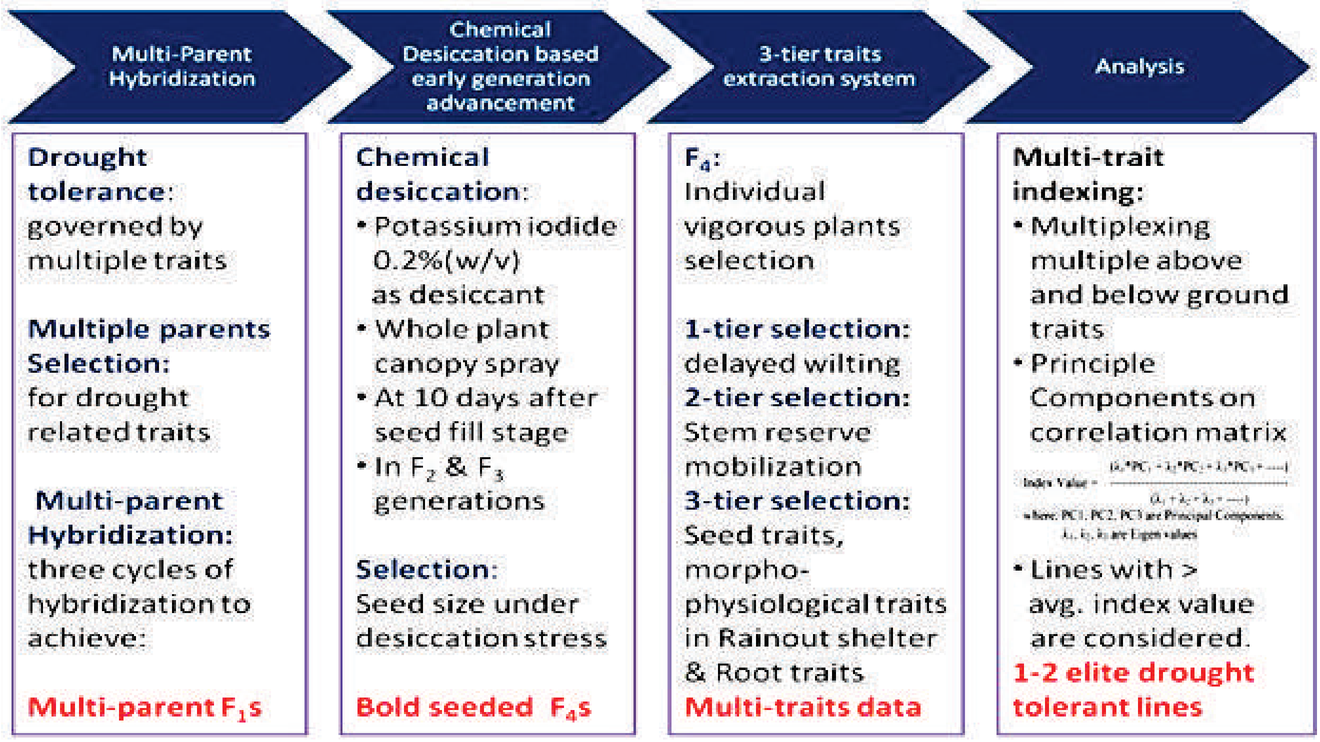


Fig. 3.7B : Soybean drought tolerance breeding pipeline for identifying lines/ accessions for drought related traits

Evaluation of advance breeding lines to desiccation tolerance:

Stem reserve mobilization for seed yield.plant-1 (SRM) %) - a dehydration tolerance trait and tightly linked to grain yield, were high in JS 97-52, JS 71-05 and JS 335 while low in NRC 2. The trait ensured seed filling in a genotype under transient photosynthesis due to desiccation stress. Eighty advance breeding lines were evaluated under desiccation stress induced by spraying KI 0.2% (w/v) at seed fill stage (Fig. 3). Out of these, eleven genotypes revealed high SRM values for seed yield.plant-1 as compared to tolerant check and sixteen genotypes to susceptible check (Table 3.7B).

Table 3.17 : Genotypes with high stem reserve mobilization as compared to tolerant check JS 97-52

S.No.	Adv Lines	SRM for Seed yield.plant-1 (%)
1	BC 3 JS 50	94
2	BC 3 JS 57	92
3	BC 3 JS 52	89

S.No.	Adv Lines	SRM for Seed yield.plant-1 (%)
4	BC 3 JS 52P1	81
5	BC 3 JS 106	67
6	BC 3 JS 102	61
7	S-2-1	61
8	BC 3 JS 60	60
9	S-1-10	60
10	BC 3 JS 59	55
11	S-1-11	52
12	JS 335	66
13	JS 71-05 (T)	49
14	JS 97-52 (T)	49
15	NRC 2 (S)	30

Fig. 3.8 Stem reserve mobilization in advance breeding soybean lines under non stressed control vis-à-vis desiccation stress.

Evaluation of CZ soybean varieties for drought related traits:

Delayed leaf senescence in soybean induces extreme drought tolerance. Twenty five released varieties of Central Zone were evaluated for delayed leaf senescence in summer season and stem reserve mobilization in kharif season trials. Seven varieties viz. JS 97-52, JS 71-05, JS 20-29, NRC 121, Pb1, JS 20-69 and NRC 7 showed high SRM and high score of delayed leaf senescence (Fig. 3.9).

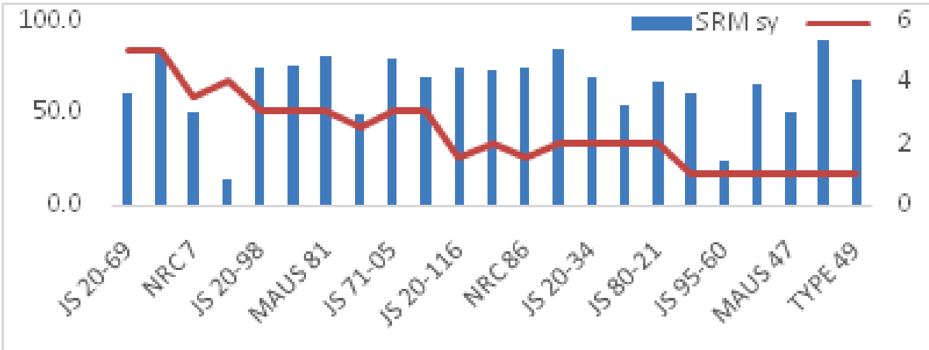


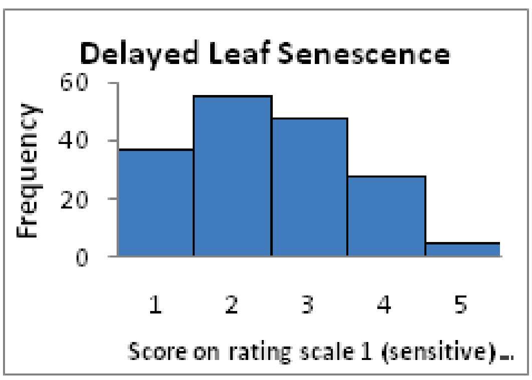
Fig. 3.9 CZ varieties showing variation in drought related traits

Phenotyping of RILs and RHLs:

A F10 RILs population of 176 lines derived from a cross (JS 97-52/NRC 37) were characterized for delayed leaf senescence and stem reserve mobilization traits (Fig. 3.10). Transgrassive segregation was identified in the population for these traits (Table 3.18). Significant variation was captured for eight drought related traits in two RHLs derived from this RILs population (Table 3.19).

Table 3.18 : Transgressive segregants identified in the RILs population

S.No.	RIL	Delayed leaf senescence	SRMsy
1	107-28	5	68
2	107-89	5	53
P1	JS 97-52	5	48
P2	NRC 37	3	28
Mean		2	49
SE±		0.1	1.6



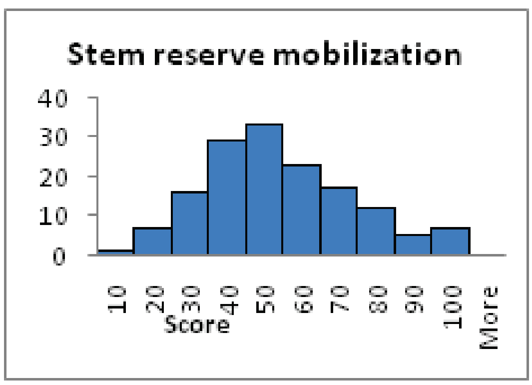


Fig. 3.10 Histogram for frequencies of delayed leaf senescence and stem reserve mobilization traits

Table 3.19 : Variation in drought related traits in two residual heterozygous lines (RHLs) derived from a cross (JS 97-52/NRC 37)

RHLs	Parameter	DS score	SRM	CTD	SLW	SCMR	RWC	DRIsy	DRIsw
(No. of lines)									
107-48 (20 lines)	Range	2 - 4	14 - 66	-4.4 – 2.0	3.6 - 8.0	23.0 – 31.8	35.0 - 95.2	0.6 – 1.8	0.8 - 1.3
	Mean ± SE	3 ± 0.7	32 ± 7.1	-0.7 ± -0.2	5.7 ± 1.3	28.6 ± 6.4	69.8 ± 15.6	1.1 ± 0.2	1.1 ± 0.2
107-51 (30 lines)	Range	1 - 5	14 - 40	-2.1 - 12.7	4.2 - 6.7	41.0 - 45.7	11.6 - 85.2	0.4 - 2.2	0.7 - 1.6
	Mean ± SE		26 ± 4.8	6.1 ± 1.1	5.5 ± 1.0	43.5 ± 7.9	65.6 ± 12.0	1.1 ± 0.2	1.1 ± 0.2
JS 97-52			49	7.9	5.8	40.0	63.6	0.6	0.9
NRC 37			26	1.4	4.3	33.2	33.8	0.2	0.6

DS: Delayed leaf senescence score; SRM: stem reserve mobilization (%);
CTD: canopy temperature depression (°C); SLW: specific leaf weight (mg.cm2);
SCMR: SPAD chlorophyll meter reading; RWC: relative water content (%);
DRIsy: drought resistance index for seed yield; DRIsw: drought resistance index for 100-seed weight

In two RHLs significant variation was captured for 8 drought related traits. Drilling down to senescence genes and carbohydrate metabolism/mobilizing genes and fine mapping of QTLs for drought related traits, genomic DNA of 176RILs / 50RHLs isolated.

In another F10 RILs population, 116 lines derived from a cross (JS 97-52/JS 90-41) were characterized for stem reserve mobilization for seed yield and for 100-seed weight traits (Fig. 3.11) and transgressive segregants were identified (Table 3.20).

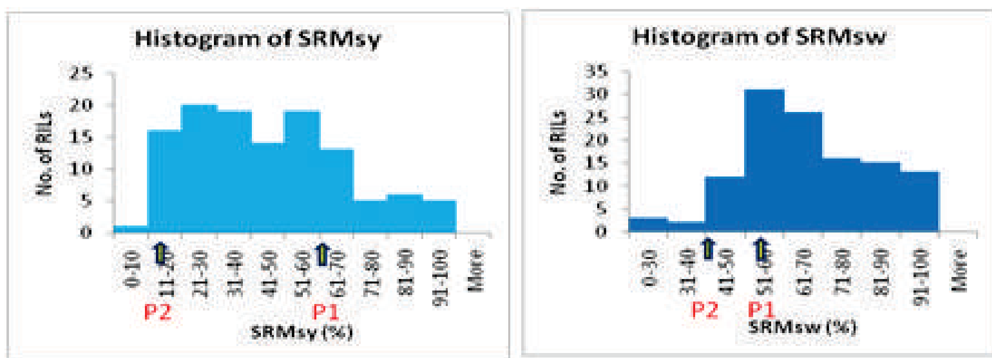


Fig. 3.11 Histogram for frequencies of stem reserve mobilization for seed yield and 100-seed weight

Table 3.20 : Transgressive segregants identified in the RILs population

S.No.	RIL 104	SRM (y)	SRM (100sw)
1	104-51	93	85
2	104-39	93	59
3	104-88	93	59
4	104-7	88	66
5	104-118	87	84
6	104-25	87	92
7	104-47	86	71
8	104-32	84	98
9	104-109	78	64
10	104-3	76	58
11	104-108	74	58
12	104-102	74	84
13	104-76	71	66
14	104-120	67	96
15	104-20	66	78
16	104-15	66	91
17	104-77	66	72
18	104-110	65	95
19	104-86	65	66
20	104-58	64	70
21	104-100	64	67
P1	JS 97-52	62	55
P2	JS 90-41	15	42
Mean		45	66
SE±		2.1	1.6

Hybridization:

Low soil moisture condition during terminal growth stage of soybean favors charcoal-rot disease development. AMS MB 5-18 is a resistant genetic resource source for charcoal rot. Three F1s were realized from crosses between drought related multi-parents F1s and charcoal rot resistant parent AMS MB 5-18. Additionally, four multi-parents F1s were realized incorporating drought related traits, earliness, photo-insensitivity, high temperature and YMV resistance. Biparental crosses were realized to attempt multi-parental inter-crosses populations with drought related traits, constitutive root traits, charcoal rot resistance, earliness (Table 3.21).

Table 3.21 : Hybridization for drought related traits

S. No.	Cross	No. of Seeds
Multi-parent crosses		
1	AMS MB 5-18 x ((((EC 602288 x JS 71-05) x EC 538828) x DS 3106) x JS 95-60)	12
2	AMS MB 5-18 x (((PK 472 x JS 335)x(EC 602288 x EC 390977)) x JS 20-38)	4
3	AMS MB 5-18 x (((JS 335 x PI 416937) x EC 538828) x SL 958)	2
4	(104-2 x JS 335) x AMS MB 5-18	7
5	((((EC 602288 x EC 390977) x JS 20-34) x SL 979) x JS 20-34) x	2
	((((EC 602288 x JS 71-05) x EC 538828) x DS 3106) x JS 95-60)	
6	((((EC 602288 x JS 71-05) x EC 538828) x DS 3106) x JS 95-60) x MACS 345	3
7	((((EC 602288 x JS 71-05) x EC 538828) x DS 3106) x JS 95-60) x 38-11-265	14
8	((((EC 602288 x EC 390977) x JS 20-34) x SL 979) x JS 20-34) x NRC 146	3
Biparental F1s for attempting 4-way cross F1s		
9	JS71-05 x NRC 37	9
10	PI 159923 x JS 95-60	2
11	38-11-265 x TGX 822-10E	2
12	AMS MB 5-18 x JS 95-60	1
13	PI 159923 x JS71-05	2
14	PI 159923 x NRC 37	2
15	38-11-265 x JS 95-60	3

Development of multi parent intercross population and breeding populations:

Eight-way cross early generations (F2s), backcross populations and other multi-parent populations were advanced to F3 populations through Chemical desiccation based method for selecting seed size and earliness. Multiple parents involved were six drought tolerant parents viz. EC 602288, PK 472, Young, JS 97-52, C -2797, JS 71-05, one parental line for photoinsensitivity EC 390977 and two well- adapted cultivars viz. JS 335, JS 90-41 (Table 3.22).

Table 3. 22 : Details of multiple parent intacrosses

Eight-way cross F3s	
[(PK 472×JS 335) × (EC 602288 × EC 390977)] × [(Young × JS 335) × (JS 97-52 × JS 90-41)]	
[(JS 335 × Young) × (EC 602288 × JS 90-41)] × [(C-2797 × JS 71-05) × (PK 472×JS 335)]	
(Young x JS 335) x (EC 602288 x JS 90-41) x (C-2797 x JS 71-05) x (PK 472 x JS 335)	
[(C-2797 × JS 71-05) × (PK 472 × JS 335)] × [(PK 472 × JS 335) × (EC 602288 × EC 390977)]	
[(Young × JS 335) × (EC 602288 × JS 90-41)] × [(Young × JS 335) × (JS 97-52 × JS 90-41)]	
[(PK 472×JS 335) × (EC 602288×EC 390977)] × [(Young × JS 335) × (EC 602288 × JS 90-41)]	
BC_2F_3	
[(JS 335 x Young) x JS 335] x JS 335	drought tolerance, adaptability
[(PK 472 x JS 335) x JS 335] x JS 335	
[JS 335 x (JS 335 x PI 416937)] x Js335	
BC_1F_3	
[RVS 2001-18 x 23-104-32rt] x RVS 2001-18	drought tolerance, root traits, Early
[RVS 2001-18 x 22-104-57rt] x RVS 2001-18	
[RVS 2001-18 x 20-2 Drt] x RVS 2001-18	
F_3 population	Traits
[107-70 x 104-57rt] x RVS 2001-18	Early, root traits, drought tolerance
[70-4 x 20-2 Drt] x RVS 2001-18	
EC 602288 X Young	Drought tolerance
[(PK 472 x JS 335)x(EC 602288 x EC 390977)] x JS 20-38	Drought and Water logging tolerance
Vp1165 X JS 20-38	Water logging tolerant, Insect tolerance

Fifty-two 4-way crosses were advanced to F3 combining drought tolerance, earliness, photo insensitivity, adaptability, YMV resistance, insect tolerance, water logging tolerance and seed size traits. Twenty-one 3-way crosses were advanced to F4 combining drought tolerance, earliness, photo insensitivity, adaptability and seed size traits.

DSR 5.6b/18. Soybean breeding for water logging tolerance.

Hybridization for water logging tolerance with other abiotic stresses tolerance traits

A total of 25 new crosses were attempted to develop populations/elite breeding lines with the objectives of recombining water logging tolerance and high temperature tolerance with other abiotic stress tolerance, earliness and high yielding traits. All crosses were attempted in hybridization structure during kharif season 2020.

Table 3. 23 : Hybridization for drought related traits

Hybridization programme	targeted traits
JS 20-69 × TGX 317-37 E JS 20-69 × EC 456556 JS 20-69 × EC 602288 JS 20-34 × TGX 317-37 E JS 20-34 × EC 456556 JS 20-34 × EC 602288 JS 20-98 × TGX 317-37 E JS 20-98 × EC 456556 EC 602288 × NRC 158 AMS MB 5-18 × EC 456556 CAT 1258 × EC 456556	Water logging tolerance with high yield traits, earliness and other abiotic stresses tolerance
JS 20-69 × NRC 146 Early adv. breeding line [MACS 330 × NRC 86] × NRC 146 EC 602288 × NRC 146 EC 602288 × EC 396065 JS 20-98 × CAT 1258 JS 20-98 × NRC 158	High temperature tolerance with high yield traits, earliness and other abiotic stresses tolerance
JS 20-69 × CAT 1149 JS 20-69 × TGX 328-049 JS 20-69 × CAT 1258 JS 20-34 × TGX 328-049 Early adv. breeding line [MACS 330 × NRC 86] × NRC 158 NRC 158 × TGX 328-049 JS 20-34 × NRC 158 NRC 158 × CAT 1258	Drought tolerance with high yield traits, earliness and other abiotic stresses tolerance

Inheritance of water logging tolerance trait

Foliar damage score (FDS) is the important parameter, used to measure the status of water logging tolerance in soybean genotypes especially in the situations where flooding/water logging stress occurs in vegetative stages. The F2 population was developed through hybridization of water logging tolerant parent JS 20-38 (FDS=2) with water logging susceptible parent JS 95-60 (FDS=8). The water logging conditions were provided in Vegetative 2-Vegetative 3 (V2-V3) stages of plant for 10 days by saturating the soil with water up to 10 cm above the soil in plastic pots under water logging structures. The segregating population (N= 485) along with parents was phenotyped for foliar damage score on the scale of 1-9, where 1 and 9 indicated less than 10 and more than 85% of foliar damage, respectively. During assessment with chi-square ($\chi 2$) test, segregation pattern in F2 could not fit in any ratios of one, two or three gene models. Frequency distribution was about normal in the population for foliar damage score (Figure 3.12), suggesting the involvement of many genes for controlling this trait, so polygenic inheritance was revealed in this cross for water logging tolerance.

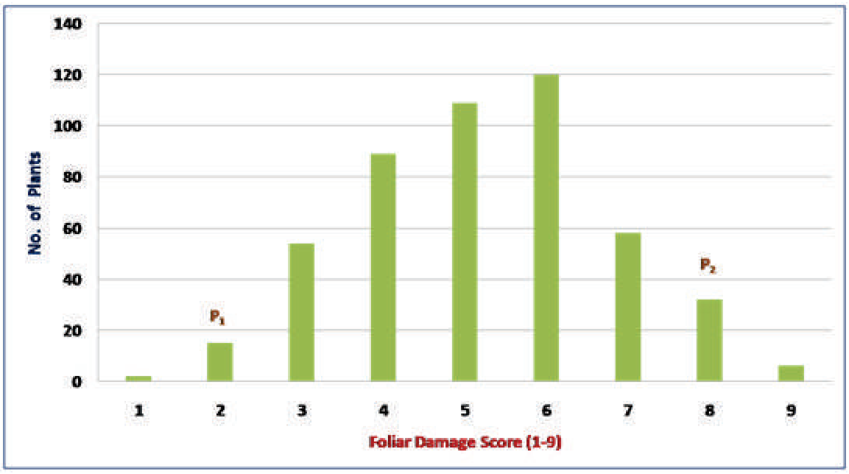


Figure 3.12 : Frequency distributions for foliar damage score in F2 population [JS 20-38 (P1) × JS 95-60 (P2)]

Evaluation of promising entry in station trail

Five entries possessing water logging tolerance and high yield were tested for yield and attributing traits in station trail (2019). Three entries viz., NRC 184 (GKS-19-10), NRC 185 (GKS-19-9) and NRC 186 (Sel 3-73)) were ranked in top five and out yielded best check JS 20-34 with margin of 13% to 38% yield advantages. Two entries NRC 184 (GKS-19-10), NRC 185 (GKS-19-9) were identified for IVT (2020) whereas NRC 186 (GKS-19-8) was identified for IVT (2020) early.

Similarly, seven entries were evaluated for yield traits with adaptive checks during station trail 2020. Two water logging tolerant entries viz., NRC 192 (Sel 1-34) and NRC 193 (Sel 3-60) were ranked in top five with good yield advantages over the checks and selected for IVT 2021.

Generation advancement, Yield evaluation and Selection : Promising thirty eight advance breeding lines derived from numerous diverse crosses involving abiotic stress tolerant parent JS 97-52 and high yielding lines were evaluated for yield per plot in augmented design. In comparison with adaptive checks viz., JS 97-52, JS 20-69, JS 20-34 and NRC 86, twelve prominent breeding lines found to be out yield best check JS 20-69 in this trail (Table 3.24). 50 prominent breeding lines derived from five different crosses involving water logging tolerant genotype JS 20-38 viz., JS 20-38 × JS 95-60, JS 20-34 × JS 20-38, NRC 7 × JS 20-38, VP 1165 × JS 20-38 and JS 20-38 × DS 31-05 were advanced from F3 to F4 generation. A total of 130 breeding lines (F5) derived from different fifteen crosses involving JS 97-52 parent were evaluated for yield per plant, 40 lines were selected on the basis of yield and other traits in comparison to checks.

Table 3.24 : Promising lines for high yielding traits

Promising line	Pedigree	Days to Maturity	Kg/ha
A-20-19	JS 97-52 × 104-31	101	2520.74
Sel 1- 55	JS 97-52 × JS 335	106	2208.15
Sel 1-34	JS 97-52 × JS 335	101	2073.33
A-20-15	JS 335 × JS 97-52	104	2057.78
A-20-9	JS 97-52 × JS 90-41	103	2045.55
A-20-21	JS 97-52 × RVS 2009-9	103	1928.52
A-20-13	JS 97-52 × Ankur	106	1920.37
Sel 3-79	JS 97-52 × JS 88-66	102	1907.78
A-20-24	JS 97-52 × PS 10-29	104	1808.15
A-20-35	JS 97-52 × TAMS 98-21	107	1775.55
A-20-32	JS 97-52 × JS 21-08	91	1751.48
JS 20-69 (Check)		97	1734.52
JS 97-52 (Check)		104	1659.56
JS 20-34 (Check)		89	450.25
NRC 86 (Check)		99	390.27

Evaluation of Soybean genotypes for high temperature tolerance

A set of twenty soybean genotypes along with tolerant and susceptible checks were evaluated in polyhouses under controlled environmental conditions for high temperature tolerance. Several morpho-physiological traits viz., specific leaf weight (SLW), canopy temperature (CTD), SCMR (SPAD readings), seed yield per plant, no. of pods per plant and 100 seed weight were recorded in controlled day/night temperatures [control - (30°C/20°C) and stress - (40°C/28°C)] conditions. High temperature stress was induced onset of reproductive stages from R1 to maturity. In this investigation, genotypes NRC 146, JS 20-98, 6A-58-5 and JS 20-38 found to be better in high temperature conditions in comparison to check JS 97-52 (Table 3.25) while genotypes ICS 84/86-85B-4, JS 95-60, JS 90-41 were highly sensitive to high temperature. Same set of genotypes was also planted in field conditions to screen genotypes for high temperature tolerance at reproductive stages in hot weather conditions during summer season of year 2020. In this trail, genotypes JS 20-98, NRC 146, DS 97-12, JS 20-38 and 6A-58-5 performed better in high temperature conditions based on delayed leaf senescence score and other physiological traits (Table 3.25). In totality, experiments conducted for high temperature tolerance under polyhouse conditions and summer season field conditions with same set of genotypes in year 2019 and 2020 resulted identification of potential high temperature tolerant genotypes viz., variety JS 20-98, elite breeding line NRC 146 (JS 335 × EC 538828), elite breeding line 6A-58-5 (JS 335 × EC 538828) and JS 20-38, which can be further utilized in breeding programs to develop climate resilient soybean cultivars.

One population (F3; N=120) developed from cross between high temperature tolerant genotype (EC 538828) and early high yielding genotype (YP1), was screened to identify high temperature tolerant genotypes under polyhouse conditions with controlled day/night high temperatures (40°C/28°C). Top twenty lines performing better than tolerant check (EC 538828) for yield per plant under high temperature conditions were selected and advanced in *Kharif* 2020 to next (F5) generation.

Table 3.25 : Details of yield and morpho-physiological parameters of prominent tolerant lines along with tolerant and susceptible checks

Particulars of Polyhouse experiment	**Range**	**JS 97-52a**	**JS 95-60b**	**NRC 146**	**JS 20-98**	**JS 20-38**	**6A-58-5**
Percentage reduction in SCMR	5.10% - 17.33%	6.55	14.32	5.10	6.29	9.83	8.15
Percentage reduction in specific leaf weight (SLW)	6.55% - 29.85%	9.43	21.69	7.19	6.55	8.31	6.88
Reduction in CTD (Stress) in relation to CTD (Control)	0.53°C - 5.11°C	0.73	3.27	0.53	0.76	0.88	1.46
Percentage reduction in seed yield per plant	14.25% - 79.53%	19.44	55.82	14.25	18.95	18.29	20.87
Percentage reduction in 100 seed weight	15.23% - 53.94%	18.35	43.46	15.23	17.37	15.41	19.23
Percentage reduction in numbers of pods	4.85% - 49.47%	12.04	36.20	4.85	9.68	13.26	6.59
Particulars of summer screening	Range	JS 97-52a	JS 95-60b	NRC 146	JS 20-98	JS 20-38	6A-58-5
Delayed leaf senescence score/rating	1 to 5	4.33	1.33	5	5	4	4.67
SPAD chlorophyll meter reading (SCMR)	29.20 - 48.23	44.52	40.90	48.23	45.34	44.30	46.60
Canopy temperature	29.33 °C - 35.1 °C	30.60	34.40	29.84	29.33	31.62	30.28
Canopy temperature depression (CTD/ δ°C)	2.37 °C - 4.19 °C	2.88	-1.06	3.56	2.91	0.98	3.11

[a]Tolerant check, [b]Susceptible check

NRCS 1.12/02 Breeding for food grade characters and high oil content.

- 148 advanced and segregating lines developed for high oil content were analysed for oil content.
- NRC 138, early maturing genotype has been evaluated in AVTII in Central Zone.
- NRC142, a genotype free from lipoxygenase 2 and Kunitz trypsin inhibitor has been promoted and evaluated in AVTII trial in central and Southern Zones and is the first soybean genotype free from antinutritional factor KTI with reduced beany flavour.
- NRC150, a early lox 2 free and high oil genotype developed in the project has been promoted evaluated in AVT1 in Central Zone .
- NRC152, a extra early and free from lox2 and KTI genotype developed in the project has been promoted and evaluated in AVTI .
- Two genotypes free from KTI with early maturity namely NRC179 and NRC181 have entered in IVT of central zone.
- Three genotypes free from KTI and Lox2 with early maturity namely NRC180, NRC 182 and NRC 183 have entered in IVT of central zone.

Characterization of abiotic stress tolerance factors in soybean using biochemical and molecular approaches

Method for estimation of chlorophyll, carotenoids, proline, MDA, ascorbate, soluble sugar, soluble protein, free amino acids have been standardized. The comparative study on control and drought stress have been done. The protein soluble protein content in control samples was much higher than in drought treated samples. There was also difference in metabolite composition of control and drought treated samples which will be characterized later.

Distribution of TF family across the 20 chromosome was studied. Most of the high copy number TF genes are distributed among all the chromosomes; however the relative number of TF varied for each chromosome. (Table 3.26) Five out of 20 chromosomes (Chr2, Chr6, Chr8, Chr10 and Chr13) contain more than 200 loci of TF genes. The chromosome 16 has the lowest number of TF genes while Chr13 has the maximum number of TF genes. No specific pattern of chromosomal location for different TF gene family was observed i.e. different TF gene family have different distribution pattern.

Table 3.26 : Distribution pattern of transcription facter genes.

Chr No	No. of TF	Chr No	No. of TF	Chr No	No. of TF	Chr No	No. of TF
1	172	6	210	11	185	16	120
2	219	7	197	12	182	17	183
3	179	8	234	13	275	18	161
4	187	9	162	14	136	19	176
5	176	10	221	15	168	20	174

S. No.	Number of gene products	Transcription factor family
1	1-20	13
2	21-100	23
3	101-200	11
4	<200	10
	Total	57

S. No.	Number of gene locus	Transcription factor family
1	1-20	21
2	21-100	25
3	101-200	7
4	<200	4
	Total	57

Number of TF genes per locus was calculated. The TF genes which produce more products from the same gene have higher values. These include BBR-BCP (2.9; 29/10), E2F/DP (2.71; 38/14), VOZ (4.33; 28/6), Whirly (2.57; 18/7) and YABBY (2.76; 47/17).Five out of 57 families have same number of gene products and gene locus (HR like, LFY, RAV, s1fa like and Sap). These are also low copy number transcription factor genes. The genes having lower values have less gene product variants. These are BES 1 (1.19), Dof (1.23), eil (1.08), ERF (1.12), gebp (1.11), M-type MADS (1.05) WOX (1.24) and ZFHD (1.09). The overall gene product to locus ratio was 1.63.

IISR 1.32/16. Screening soybean germplasm for vegetable type characteristics and optimization of processing parameters.

Screening of soybean lines for sweetness, color physical and sensory characteristics:

Edamame (Vegetable soybean) is a profitable, low input, highly nutritious (39% protein and 16% oil), short crop cycle and soil-enriching crop. There is a great potential for increased production and market for Edamame in India due to its resemblance to pea and other beans. Changing life style and consumer inclination towards healthier vegetarian foods like edamame may help to alleviate protein malnutrition. True vegetable soybean varieties can be distinguished from immature soybean grain due to unique characteristics including the larger seeds, ease of cooking, slightly sweet, mild flavor and nutty texture, with less objectionable beany taste. Total soluble solids (TSS) measured had positive correlation with sensory score and sucrose content and thus TSS may be used as objective method for approximate estimation of sweetness. Out of 160 lines tested for TSS, 55 were found to have TSS more than 6.5%. Color of pods was evaluated using horticultural color chart and it was found pods having d color value of 144A were most desirable and appeared brighter. Storage studies revealed that color of pods degraded with time depending on method of processing. 144A is desirable color of pods at time of picking and thus may be used as one of physical methods to determine time of picking. Some AVRDC lines as well as lines selected organoleptically from IISR germplasm had sucrose content more than 5% (Table 3.27 & 3.28).

Table 3.27 : Details of TSS in germplasm lines

Variety	TSS	Variety	TSS	Variety	TSS	Variety	TSS	Variety	TSS
EC 915922	5	EC 915968	5	EC 915920	7.5	SQL112	4	CAT3386	6.5
EC 915979	6	EC 915906	6	EC 915927	7	PS1483	4	EC456620	7
EC 915897	6	EC 915924	5.5	EC 915902	6	HIMSO1685	5.5	Js2	5
EC 916021	4	EC 915919	6	EC 916002	5.5	AGS farm acc	7.5	CAT3398	6
EC 915972	4	EC 916012	7.5	EC 915964	5.5	HARA SOYA	5	CAT2125B	6.5
EC 915958	5.5	EC 915961	5.5	EC 916030	7	NRC121	7	Ec458351	8.5
EC 915970	3.5	EC 915903	4	EC 915921	7	HARDEE	7	NRC105	9.5
EC 916008	5	EC 915923	5	EC 916017	5	CAT3425	5.5	CAT2201	7
EC 915912	5.5	EC 916040	6	EC 915989	5	JSM242	7	CAT73	6.5
EC 915945	6	EC 915926	6	EC 916029	5.5	CAT3353	7.5	CAT754	5
EC 916005	6	EC 915991	6.5	EC 892821	5.5	DSb15	5.5	EC33915	7.5
EC 9159595	5.5	EC 915915	6.5	EC 892881	4	Karune	6.5	CAT1607	6
EC 915956	6.5	EC 915915	7.5	EC 892867	6.5	CAT354	7	EC457052	6.5
EC 915895	5.5	EC 915914	6	EC 892855	6	CAT362	7.5	CAT1994	6.5
EC 915993	6	EC 916031	5.5	EC892810	6.5	EC456620	7	EC771147	4
EC 915918	5	EC 915970	7	EC892853	6	CAT785	6.5	CAT354	8
EC915978	5	EC892872	6.5	EC892809	5	CAT619	7.5	PK472	8.5
EC892820	4.5	EC892858	5.5	EC892822	5	CAT57	8	CAT3386	5.5
EC892885	7	EC892806	5.5	EC892883	6	MACS1508	6.5	AGS746	6
EC892893	7	EC892814	6.5	EC892880	7	CAT3426	4.5	CAT2201	6
CAT619	7	CAT796	4	CAT3073	5.5	EC456650	4.5	CAT3418	7.5
CAT65	5.5	CAT998	5.5	CAT1529	7.5	CAT1421B	8	CAT189	6
CAT14	4	CAT411	4	MAUS162	4	CAT1691	8.5		

Table 3.28 : TSS and sucrose content of organoleptically selected soybean

Genotype	Sucrose%	Total soluble solids %
CAT3386	3.9159	6.5
EC456620	5.843402	7
CAT362	5.598868	7.5
CAT354	6.00163	8
PS1483	3.978232	4
KARUNE	5.196107	6.5
CAT619	4.654296	7.5
JS2	3.378884	5
CAT189	3.517932	6
EC456620	6.063962	7
NRC121	6.217395	7
AGS FARM ACC	6.097526	7.5
EC915965	6.083142	-
CAT57	6.298907	8
CAT3428	6.874971	-

IISR 1.35/17
Improvement in soybean seed viability and strength of seed coat by genetic amelioration of seed coat traits

- Following crosses were made during Kharif 2020 to improve seed germination and seed coat strength to popular variety. Hardee x EC 538828, JS 2069 x EC 538828, Hardee x NRC 7, JS 20-116 x NRC 7 and Karune x VC 109.
- Promising advanced RIL's of VLS1 x EC 538828 were multiplied and screened for Pod blight (Ct), SMV and YMV disease reaction as well as insect infestation score. Yield performance and yield traits were also observed. DUS characters of these promising lines were documented during *kharif* 2020.
- Vegetable type variety of soybean namely Karune having poor seed germination was crossed with EC 538828 (bold seed with rapid seed development). RIL's of this cross were advanced up to F5 generation during kharif 2020. 441 segregating RILs were

studied for field emergence rate, flower colour, pod pubescence, seed size and disease susceptibility.

- A total of 490 RIL's of NRC 7 X EC 538828 were advanced to F6 generation selecting non-shattering, high yield with better field emergence.

Table 3.29 : Performance of promising lines from the RIL's of VLS 1 X EC 538828

Line name	Seed colour	Yield (q/ha)	Seed Index(g)	No. of pods/plant
VCII GP 81-2	Black	30.11	13.59	66.0
VCIIGP 50-1	Black	30.65	15.03	63.2
VCI SP 214-2	Black	27.0	16.54	58.4
VCIISP 200-1	Yellow	29.7	15.81	66.5
VCIIGP232-1	Yellow	29.11	17.65	68.0
VCI SP 133-1	Yellow	28.15	15.61	65.6
VCIGP 63-2	Yellow	29.0	16.58	72.0
VIIGP 126-3	Yellow	28.50	14.94	77.6
VCI SP148-2-1	Yellow	26.95	14.44	67.5
VCISP207-1	Yellow	28.5	16.85	69.8
VCISP40-2	Yellow	27.0	15.58	53.6

Table 3.30 : Screening of promising RIL's of VLS 1 X EC538828 and NRC 7 X EC 538828 for disease reaction and insect infestation

Line name	Disease reaction			Insect infestation score			
	Pb (Ct)	SMV	YMV	Girdle beetle damage (%)	Girdle beetle infestation (%)	% Stem tunneling due to Stem fly	Defoliator lava/meter of row length
VCII 50-1(bl)	R	MR	R	0.00	0.00	67.86	9
VCII SP 200-1	MR	MR	R	0.00	3.57	75.28	3
VCII SP 232-1	R	R	R	0.00	0.00	79.66	2
VCI SP 133-1	R	R	R	0.00	0.00	81.44	3

Table 3.31 : Screening of elite lines for disease reaction and insect infection

Line name	Disease reaction			Insect infestation score			
	Pb (Ct)	SMV	YMV	Girdle beetle damage (%)	Girdle beetle infestation (%)	% Stem tunneling due to Stem fly	Defoliator lava/meter of row length
VCI GP 63-2	MR	R	MR	3.45	6.90	49.23	1
VCII GP 126-3	R	MR	MR	3.23	9.68	77.68	0
VCI SP 148-2-1	MR	MS	MR	0.00	3.33	73.79	6
VCI SP 214-2 (bl)	MR	R	R	0.00	0.00	1.73	3
VCI SP 207-1	R	MR	R	0.00	4.17	3.81	4
VCI SP 40-2	R	R	R	0.00	0.00	0.49	2
VCI SP 141-2-1	MR	R	R	0.00	0.00	6.03	1
CN 1	R	MR	R	0.00	0.00	2.73	4
CN 17	MR	MS	R	0.00	0.00	41.67	3
CN 32	MS	MR	R	0.00	0.00	68.57	2
CN 37	MR	MR	R	0.00	0.00	50.88	2
CN 41	R	S	R	0.00	2.50	46.55	2
CN 42	R	MS	R	0.00	0.00	51.43	1
CN 44	R	MS	R	0.00	0.00	44.79	1
CN 47	MR	R	R	0.00	2.86	86.26	2
CN 5	MR	MR	R	0.00	0.00	43.85	0
CN 43	R	MR	R	0.00	0.00	60.33	3
VCI GP 4-2	MS	MR	R	0.00	0.00	41.41	3

Name	Yield (q/ha)	Maturity (days)	Seed index (g)	Germination (%)	Vigour	Index II	Shattering
VCI 134-1	MR	R	R	0.00	0.00	38.20	0
VCIISP (y) 214-3	MR	S	R	0.00	13.04	43.27	2
VCI SP 236-1	R	MR	R	0.00	2.17	47.92	0

Table 3.32 Seed quality and yield performance of promising RIL's of EC538828 X NRC 7

CN-4 (SP) 29-1	26.72	102	16.88	73.50	1085.9	Non shattering
CN-7 (GP) 38-2	22.29	100	16.60	81.50	1499.4	Non shattering
CN-7 (GP) 52-3-2	24.58	100	17.65	71.50	1358.5	Non shattering
CN-7 (GP) 20-3	23.32	100	17.25	75.00	1370.0	Non shattering
CN-7 (GP) 123-3	19.0	100	16.40	82.50	1212.5	Non shattering
CN-4 (GP) 44	18.63	101	17.79	74.50	1110.6	Non shattering
CN-7 (GP) 31-2	20.19	100	15.87	80.50	1368.5	Non shattering
CN-7 (GP) 19-2	26.69	99	16.61	85.50	1812.6	Non shattering
CN-6 (SP) 2	25.68	102	15.45	84.00	1554.0	Non shattering
CN-2 -1	19.20	99	16.05	82.00	1618.4	Non shattering
CN-7 (GP) 36-3	20.09	99	16.68	78.00	1825.2	Non shattering

4. CROP PRODUCTION

Evaluation of residue management practices under changes in land configurations/crop establishment methods for sustaining/ improving resources use efficiency, soil health and crop productivity in soybean-based cropping systems

The field experiments were conducted during *kharif*, 2020 to evaluate the effect of cropping systems, crop establishment's method/land configuration and residue management practices on yields of soybean. In this context, the experiment comprised of three cropping systems namely, soybean-wheat, soybean-maize and soybean-chickpea (main plot) and four crop establishments method/land configuration methods namely, permanent broad bed furrow with residue (PBBF + R), permanent broad bed furrow without residue (PBBF + WR), conventional tillage as per farmers practices with residue (CTFP + R) and conventional tillage as per farmers practices without residues (CTFP + WR) (sub plot). Residue retention practices follows, 50 % soybean residue retained during *kharif* season in the respective treatments, and 30 % of each of wheat and maize and 50 % of chickpea residue retained during rabi season in the respective treatment.

Seed yield and economics

Among the cropping systems, significantly the highest yield of soybean was registered under the soybean-chickpea cropping systems as compared to soybean-maize and soybean-wheat. Among the different crop establishment techniques significantly the highest soybean yield was registered under permanent broad bed furrow + residue retention (PBBF + R) treatment followed by permanent broad bed furrow + without residue retention (PBBF + WR). The yield was increased by 17.09% under PBBF + R and 16.36% under PBBF + WR as compared to conventional tillage as per farmers practices + without residue retention (CTFP +WR). The highest cost of cultivation was registered under CTFP + R followed by CTFP +WR and lowest under PBBF + WR. The highest cost: benefit ratio was registered under PBBF + WR (2.05) followed by PBBF + R (1.90) and lowest under CTFP + R (1.45).

Soil microbial properties

The soil enzymatic activities and nutrient uptake were significantly higher under permanent broad bed furrow with or without residue retention as compared to conventional tillage as per farmers practices. The activities of β-Glycosidase (μg p-nitrophenol/g soil/hr) and Dehydrogenase activity (μg triphenyl formazon/g soil/24 hrs) were increased by19.4% and 5.73 % under PBBF + R as compared to CTFP +WR, respectively. Similarly, the activities of Alkaline and acid phosphatase (μg p–nitro phenol/g soil/hr) were increased by19.6% and 22.2 % under PBBF + R as compared to CTFP +WR, respectively.

Table 4.1: Effect of cropping systems, crop establishment's method/land configuration and residue management practices on yields and economics of soybean

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Cost of cultivation (₹/ha)	Net income (₹/ha)	B:C ratio
Cropping Systems (CS)						
Soybean-maize	1768	2899	4668	27556	45862	1.67
Soybean-chickpea	1849	2937	4787	27556	49090	1.79
Soybean-wheat	1773	2853	4626	27556	45946	1.68
SEm±	13.61	19.72	21.46	-	-	-
CD (P=0.05)	53.43	77.42	84.26	-	-	-
Crop establishment methods/land configurations (LC)						
PBBF + R	1918	3121	5039	27078	51511	1.90
PBBF + WR	1906	3004	4911	26234	53724	2.05
CTFP + R	1725	2786	4511	28878	41758	1.45
CTFP + WR	1638	2675	4313	28034	40871	1.46
SEm±	35.8	51.	62.6	-	-	-
CD (P=0.05)	124.1	179.0	216.6	-	-	-

Table 4.2: Effect of cropping systems, crop establishment's method/land configuration and residue management practices on microbial properties during *kharif,* 2020

Treatment	β-Glycosidase (µg p-nitrophenol /g soil/hr)	Dehydrogenase activity (µg triphenyl formazon/g soil/24 hrs)	Acid phosphatase (µg p-nitro phenol/g soil/hr)	Alkaline phosphatase (µg p-nitro phenol/g soil/hr)
Cropping Systems (CS)				
Soybean-maize	269.1	129.9	222.6	484.7
Soybean-chickpea	214.3	115.6	219.6	454.7
Soybean-wheat	187.9	116.9	196.3	378.9
SEm±	7.34	3.67	7.72	21.71
CD (P=0.05)	28.81	14.40	30.29	85.22

Treatment	β-Glycosidase (µg p-nitrophenol /g soil/hr)	Dehydrogenase activity (µg triphenyl formazon/g soil/24 hrs)	Acid phosphatase (µg p-nitro phenol/g soil/hr)	Alkaline phosphatase (µg p-nitro phenol/g soil/hr)
Crop establishment methods/land configurations (LC)				
PBBF + R	241.1	123.0	225.1	491.8
PBBF + WR	226.7	125.9	237.2	455.6
CTFP + R	225.3	117.9	200.8	407.8
CTFP + WR	201.9	116.4	188.2	402.5
SEm±	10.93	4.00	7.59	9.14
CD (P=0.05)	37.82	13.82	26.27	31.63

Fig. 4.1 : Soybean crop under permanent broad bed furrow (zero till) technology during *kharif* season

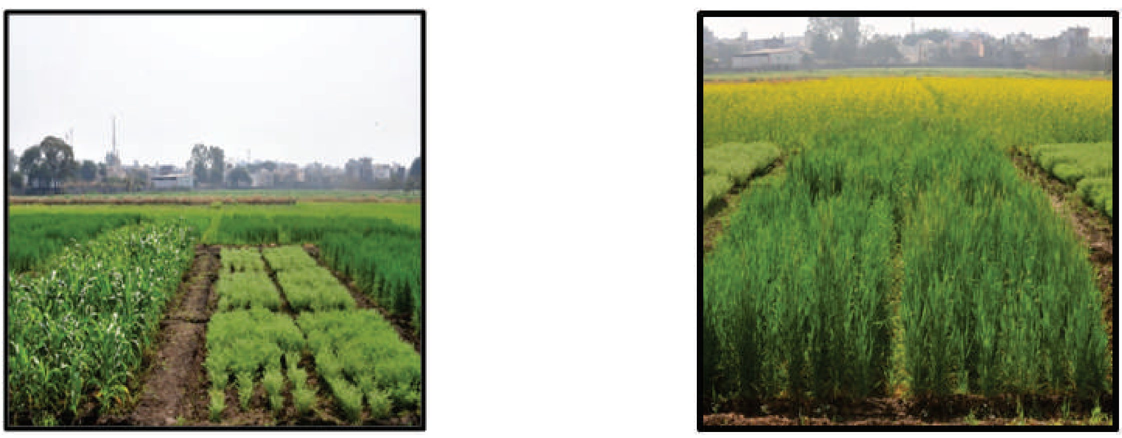


Fig. 4.2 : Wheat, maize and chickpea crops under permanent broad bed furrow (zero till) technology during *rabi* season

Yield and economics as influenced by omission and addition of technologies from recommended soybean production technologies

The field experiment was conducted during rainy (*kharif*), seasons of 2017 and 2018 in the Research farm of ICAR-Indian Institute of Soybean Research, Indore, Madhya Pradesh, to study the effect of deletion and addition of different agronomic practices from recommended package of practices on yield attributes and yield of soybean. The additional use of micronutrients (Zn, B and Mo) and secondary nutrient sulphur (S) along with recommended package of practices (RPP) showed significant positive effect on yields and harvest index. On pooled basis, the addition of micronutrients (Zn, B and Mo) and secondary nutrient sulphur as soil application with RPP increased the yield by 6.0 and 3.21% as compared to RPP, respectively. On the contrary, the deletion of any recommended practice from the RPP reduced the yield by 1.14 to 71.69% as compared to RPP. Similarly, the addition of micronutrients and secondary nutrients with RPP recorded higher harvest index as compared to deletion of individual recommended practice. Economics point of view, all the treatments differ significantly among themselves in respect to the cost of cultivation, significantly the highest cost of cultivation was associated with additional use of micronutrients (Zn, B and Mo) with RPP and lowest with control. Significantly the highest net returns was registered with RPP + Zn, B, Mo application and remained statistical identical with RPP + S application, RPP alone, 50% RDF (recommended dose of fertilizers) as basal + 2% urea spray at pod initiation stage and RPP + narrow row spacing (30 cm). In case of B: C ratio, significantly the highest B: C ratio was recoded with omission of RDF treatment and remained statistical identical with control treatment followed by 50% RDF as basal + 2% urea spray at pod initiation. Furthermore, when comparing yields and economics (except B: C ratio) of all the treatments with RPP in terms of positive and negative effect, the differential yields and economics both were positive with additional use of micro and secondary nutrients. Similarly, the negative trend was observed with the deletion of any practice from RPP except in case of 50% RDF + 2% urea spray where the yield showed negative trend and net income showed positive trend. Moreover, the highest positive partial factor productivity (PFP) registered with omission of RDF followed by control and then 50% RDF as basal + 2% urea spray. Whereas, other treatments exhibited negative trend in term of PFP the lowest negative values were registered with RPP + Zn, B, Mo and RPP + 25 kg S /ha.

Table 4.3 : Effect of recommended soybean production technologies on yields and cost of cultivation

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (₹)	Net income (₹)	B:C ratio	PFP*
RPP*	2739^{bc}	3529^{b}	25543^{c}	76150^{a}	2.95^{c}	-
RPP + Zn, B, Mo	2905^{a}	3508^{b}	28203^{a}	78710^{a}	2.77^{cde}	$-0.18e^{fg}$

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Cost of cultivation (₹)	Net income (₹)	B:C ratio	PFP*
RPP + 25 kg S /ha RPP +50% RDF +	2827^{ab}	3440^{bc}	26943^{b}	77239^{a}	2.84^{cd}	-0.11^{fg}
2% urea spray	2708^{bc}	3365^{cd}	23808^{g}	76464^{a}	3.18^{b}	+0.23^{defg}
RPP + narrow row spacing (30 cm)	2673^{c}	3674^{a}	25543^{c}	74239^{a}	2.88^{c}	-0.07^{fg}
RPP + 50% seed rate (30 kg/ha)	1595^{g}	2836^{g}	23739^{h}	37396^{f}	1.56^{h}	-1.39^{a}
Omission of RDF	2362de	3306de	19851^{k}	68490^{b}	3.42^{a}	+0.47^{bc}
Omission of seed treatment	2451^{d}	3298de	25473^{e}	65875^{bc}	2.56^{ef}	-0.39^{cde}
Omission of bio-fertilizer	2456^{d}	3328^{d}	25498^{d}	65990^{bc}	2.56^{ef}	-0.39^{cde}
Omission of herbicide	2216^{e}	3202^{e}	23739^{i}	59485^{d}	2.48^{fg}	-0.47^{bc}
Omission of insecticide	2273^{e}	3069^{f}	23149^{j}	61695^{cd}	2.64^{def}	-0.31^{cdef}
Intercultural operations (dora)	2222^{e}	3054^{f}	24643^{f}	57605de	2.32^{g}	-0.62^{b}
Control	1798^{f}	2697^{f}	15538^{l}	52834^{e}	3.38^{ab}	+0.43^{bcd}

RPP= Recommended package of practices; PFP*= Partial factor productivity

Standardization of good agronomic management practices for sustainable soybean production

The field experiment entitled "Standardization of good agronomic management practices for soybean" conducted for three consecutive years during *kharif* seasons of 2018, 2019 and 2020 at the ICAR-Indian Institute of Soybean Research, Indore. The experiment consisted of three varieties (JS 95-60, JS 97-52 and JS 20-29), two rows spacing (30 cm and 45 cm) and three seed rate (25, 45 and 65 kg/ha). The data related to various criteria used for treatment evaluation were analyzed statistically using standard statistical methods to test their significance. The results revealed that data pertaining to seed yield and yield attributes were significantly influenced by the different varieties, spacing and level of seed rates (Table 4.4 & 4.5). Among the varieties, variety JS 97-52 produced significantly higher yields followed by JS 20-29 as compared to JS 95-60. Among the two-row spacing, sowing of soybean at 30 cm with increasing level of seed rate produced higher yield as compared to 45 cm. For early and medium duration varieties, 30 cm row spacing was found better and economical. In case of seed rate, 45 kg/ha seed rate is sufficient for small seeded varieties.

Table 4.4 : Effect of varieties, spacing and seed rate on yields of soybean (Average of three year)

Treatments	Plant height (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)
Varieties				
JS 95-60	38^{c}	1181^{c}	2040^{c}	3221^{c}
JS 97-52	70^{a}	1931^{a}	3113^{a}	5045^{a}
JS 20-29	57^{b}	1779^{b}	2735^{b}	4514^{b}
Seed rate (kg/ha)				
25 kg/ha	54^{b}	1469^{c}	2304^{b}	3773^{c}
45 kg/ha	56^{a}	1608^{b}	2816^{a}	4530^{a}
65 kg/ha	56^{a}	1714^{a}	2770^{a}	4478^{b}
Spacing (cm)				
30 cm	56^{a}	1743^{a}	2722^{a}	4465^{a}
45 cm	55^{b}	1518^{b}	2537^{b}	4055^{b}
Years				
1st year	55^{b}	1457^{b}	2692^{a}	4148^{b}
2nd year	56^{a}	2215^{a}	2537^{b}	4752^{a}
3rd year	55^{ab}	1220^{c}	2661^{a}	3881^{c}

Table 4.5 : Effect of varieties, spacing and seed rate on seed yield of soybean

Varieties	Row Spacing	Seed rate (kg/ha)	1st year (Seed yield kg/ha)	2nd year (Seed yield kg/ha)	3rd year (Seed yield kg/ha)
JS 95-60	**30 cm**	25	801±37	1605±46	406±36
		45	989±47	2236±47	696±36
		65	1023±59	2281±69	801±13
	45 cm	25	685±26	1558±108	373±11
		45	970±61	1888±42	605±6
		65	908±37	2216±47	712±14

Varieties	Row Spacing	Seed rate (kg/ha)	1st year (Seed yield kg/ha)	2nd year (Seed yield kg/ha)	3rd year (Seed yield kg/ha)
JS 97-52	**30 cm**	25	1861±108	2433±84	1879±54
		45	1964±138	2592±43	2230±114
		65	1691±76	2173±114	2076±103
	45 cm	25	1229±75	1353±298	1638±127
		45	1804±78	2015±88	1973±148
		65	1404±89	1915±33	1694±7
JS 20-29	**30 cm**	25	1638±40	2324±65	957±8
		45	1909±44	2508±78	1236±68
		65	2110±100	2700±63	1399±82
	45 cm	25	1338±44	2120±39	915±102
		45	1855±56	2314±146	1133±32
		65	1956±117	2330±58	1225±24

Effect of thiourea on growth and productivity of soybean under field conditions

A collaborative research project of DBT-BBSRC project was started at Bhabha Atomic Research Centre, Mumbai and ICAR-IISR, Indore on "exploring chemical 'de-priming' and quantitative genetics to improve growth and yield of soybean under abiotic stress". Under this project the field experiment entitled 'effect of thiourea application on growth and productivity of soybean (JS 20-29 and JS 20-69) under field conditions were carried out at ICAR-IISR, Indore during kharif, 2019. The experiment comprised of five treatments such as Control (No spray), Thiourea @ 250 PPM, Thiourea @ 500 PPM, Thiourea @ 750 PPM and Water Spray. The two sprays of each treatment except control were given after sowing. The results revealed that the higher seed yield and B: C ratio were observed with application of thiourea @ 750 ppm followed by thiourea @ 500 ppm. The lowest seed yield was registered under control followed by water spray. Among the varieties the highest seed yield and B:C ratio were obtained with JS 20-69 as compared to JS 20-29.

Drought Amelioration in terms of morpho-physiological, biochemical characters and seed yield in soybean through foliar application of nutrients.

The third-year drought amelioration study in soybean were carried out with three different nutrients i.e., K, Ca and Zn and their combinations during the kharif season of 2020 in control poly house condition. The drought given for 7 days at two times i.e., flowering (R1) and at grain filling (R5) showed soil moisture 30.5 and 26.5% respectively. The soil moisture decreased up to 15.4 and 14.3% at the time of release of drought. The drought resulted in 44.7% reduction in JS-20-29 and 38.4% in NRC-37. The nutrient spray given two days after withholding irrigation at both the stages ameliorates drought effect and showed increase in yield over the drought. The increase in yield was up to 57% in JS-20-29 and 40.6% in NRC-37 with the treatment of K (1%) m + Zn (0.5%). The ameliorating effect of nutrient was mainly because of significant change in different physiological parameters i.e, gas exchange parameters, RWC, MSI, SPAD and yield attributing characters. Drought stress imposed at R1 and R5 stage reduced photosynthesis by 54 and 52.7% in JS-20-29 and NRC-37 and 57 and 57.2 % in NRC-37 respectively while the best mitigation by the K + Zn resulted up to 59 and 72 % in JS-20-29 and 70 and 72.7 % increase in NRC-37 at stage R1 and R5 respectively. The drought stress also decreased stomatal conductance and decrease in stomatal conductance was significantly mitigated by different nutrients. Stomatal conductance showed positive significant relationship with photosynthesis. Photosynthesis also showed position relationship with seed yield. The nutrient spray also increased SPAD (relative chlorophyll) value and maximum SPAD was measured with (K,1%+Zn, 0.5%) in both the genotypes. The increased canopy temperature was measured in plant grown under drought and get decreased by the spray of different nutrients. The maximum decrease was measured with the treatment K (1%) + Ca (0.025%) and followed by K (1%). Thus, the nutrient plays an important role in ameliorating drought in soybean crop. Present study showed that spray of K (1%) with Zn (0.5%) ameliorate drought and significantly increase seed yield over drought condition. The genotype JS-20-29 showed superiority over NRC-37.

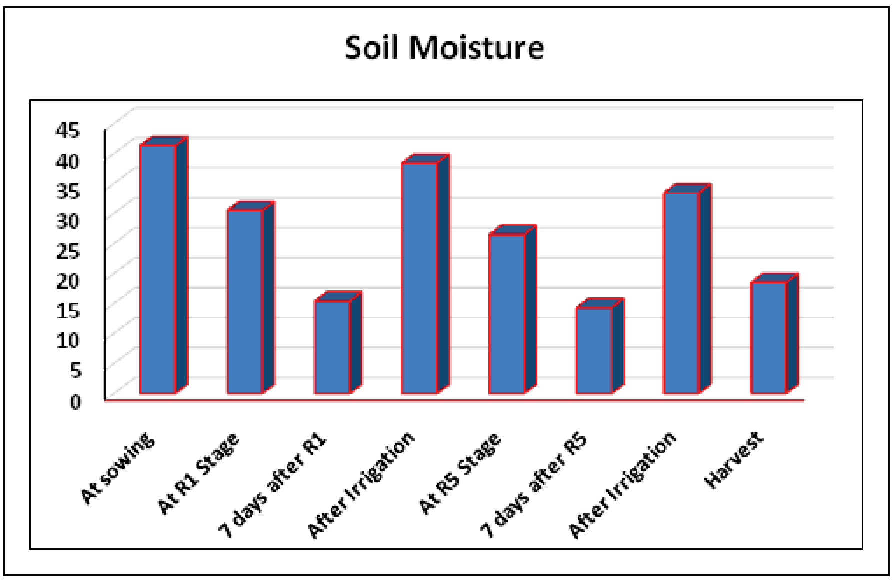


Fig 4.3 : Soil moisture content during the experiment

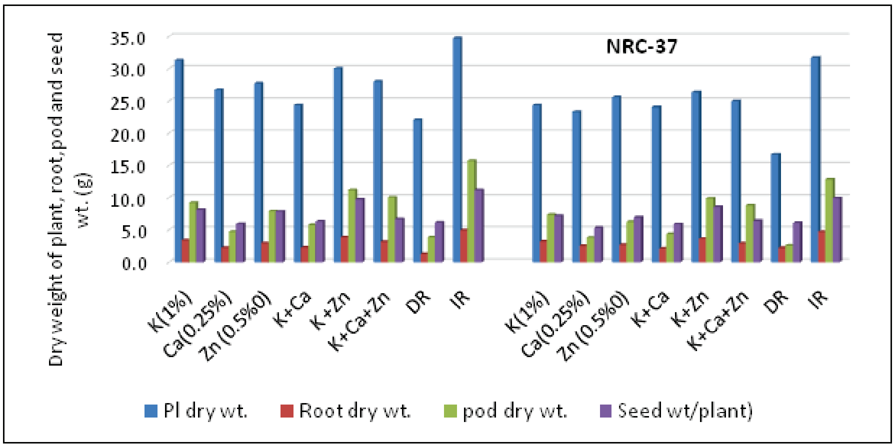
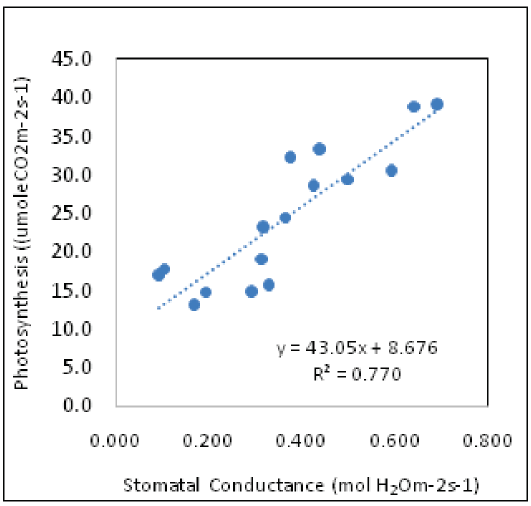
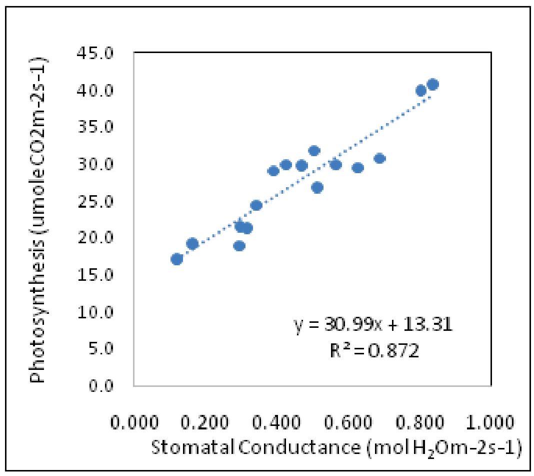


Fig. 4.4 : Effect of different treatments on plant dry weight, root dry weight, pod dry weight and seed yield of soybean genotypes

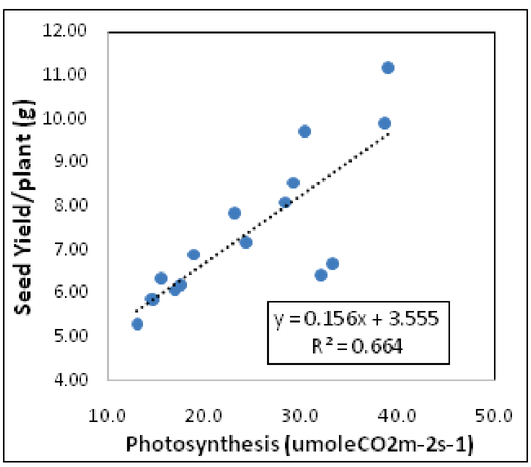
Stage R2



Stage R5



Stage R2



Stage R5

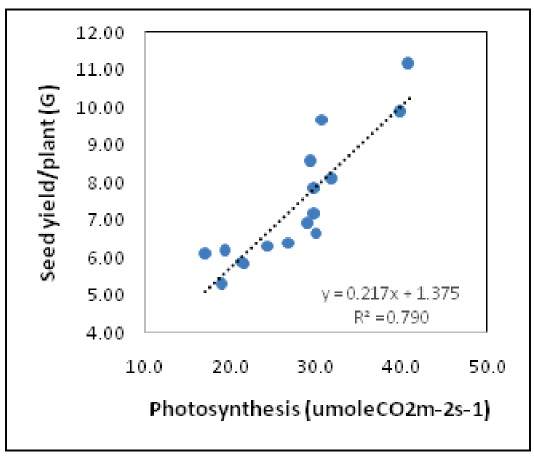


Fig 4.5 : Correlation of Stomatal conductance with photosynthesis and photosynthesis with seed yield.

Agronomic biofortification of micronutrients in conservation agriculture-based soybean-wheat cropping system.

Crop establishment techniques and micronutrients application methods significantly influenced on rhizosphere properties and available soil micronutrients content in conservation agriculture-based soybean-wheat cropping system (Table 4.6 and Fig. 4.6). The improvement in rhizosphere properties (at R2 stage in soybean and maximum flowering in wheat) such as dehydrogenase, β-glucosidase, auxin content, substrate induce respiration (SIR), soil pH and available micronutrients (DTPA-Zn and DTPA-Fe) at harvest of soybean and wheat soil was found in conservation tillage compared conventional tillage practices. Among the micronutrient's application methods seed inoculation of MDSR 14 + MDSR 34 strains brought improvement in all rhizosphere properties as compared to control. Whereas, soil application of Zn + Fe significantly improved DTPA-Zn and DTPA-Fe compared to control.

Table 4.6 : Integrated field response of soybean rhizobia (*Bradyrhizobium daqingense*) and AM fungi application at reduced doses of nitrogen and phosphorus fertilizers on soybean during *kharif* 2020

Treatments	Soil pH		Dehydrogenase activity (μg triphenyl formazon g^{-1}soil $24h^{-1}$)		β-glucosidase activity (μg p-nitrophenol g^{-1}soil h^{-1})		Auxin content (mg IAA equivalent kg^{-1} soil)		SIR (mg CO_2 kg^{1} h^{1})	
	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat	Soybean	Wheat
Crop establishment techniques (CET)										
Conservation tillage	7.60^{A}	7.61^{A}	71.3^{A}	78.2^{A}	345^{A}	378^{A}	78.2^{A}	83.4^{A}	38.1^{A}	40.8^{A}
Conventional tillage	7.61^{A}	7.58^{B}	65.7^{B}	74.0^{B}	339^{B}	370^{B}	76.1^{B}	78.6^{B}	34.7^{B}	36.7^{B}
Agronomic Bio-fortification Methods (ABM)										
Control	7.71^{A}	7.72^{A}	50.1^{E}	65.3^{E}	330^{D}	356^{E}	73.2^{B}	69.9^{G}	21.4^{F}	30.2^{D}
Soil application of Zn	7.70^{AB}	7.76^{AB}	55.3^{DE}	72.9^{D}	336^{CD}	363^{DE}	75.8^{AB}	74.2^{FG}	25.2^{EF}	32.2^{D}
Foliar application of Zn	7.61^{ABC}	7.58^{AB}	68.8^{C}	76.7^{BCD}	342^{BC}	376^{ABC}	77.7^{AB}	83.0^{CD}	39.1^{C}	40.0^{BC}
Soil application of Fe	7.68^{AB}	7.64^{AB}	59.2^{D}	74.6^{CD}	337^{CD}	372^{CD}	76.5^{AB}	77.2^{EF}	30.5^{DE}	34.8^{CD}
Foliar application of Fe	7.55^{ABC}	7.57^{AB}	72.6^{BC}	$79A^{BC}$	345^{ABC}	381^{ABC}	77.8^{AB}	85.3^{BC}	40.7^{BC}	43.6^{AB}
Soil application of Zn and Fe	7.65^{ABC}	7.59^{AB}	67.9^{C}	75.8^{BCD}	340^{BCD}	374^{BC}	77.6^{AB}	80.2^{DE}	37.3^{CD}	36.8^{CD}
Foliar application of Zn and Fe	7.49^{BC}	7.51^{B}	78.8^{B}	80.9^{AB}	350^{AB}	382^{AB}	78.7^{AB}	87.9^{AB}	47.1^{AB}	45.0^{AB}
MDSR 14 + MDSR34	7.47^{C}	7.50^{B}	95.3^{A}	83.4A	355^{A}	384^{A}	80.0^{A}	90.1^{A}	49.8^{A}	47.2^{A}
ANOVA										
CET	0.5929	0.2879	0.0002	<.0001	0.0033	<.0001	0.0336	<.0001	0.0067	0.0004
MAM	0.0022	0.0019	<.0001	<.0001	<.0001	<.0001	0.0431	<.0001	<.0001	<.0001
CET x MAM	1.0000	0.9871	0.8809	0.9317	0.9962	0.9978	0.995	0.986	0.7531	0.9689

Data are mean values of three replicates; Values followed by same capital letters are not significantly different among crop establishment techniques and micronutrients application methods at P=0.05. Tukey's range test was used to separate the treatment means. Values under ANOVA are the probabilities (P values) of the source of variation.

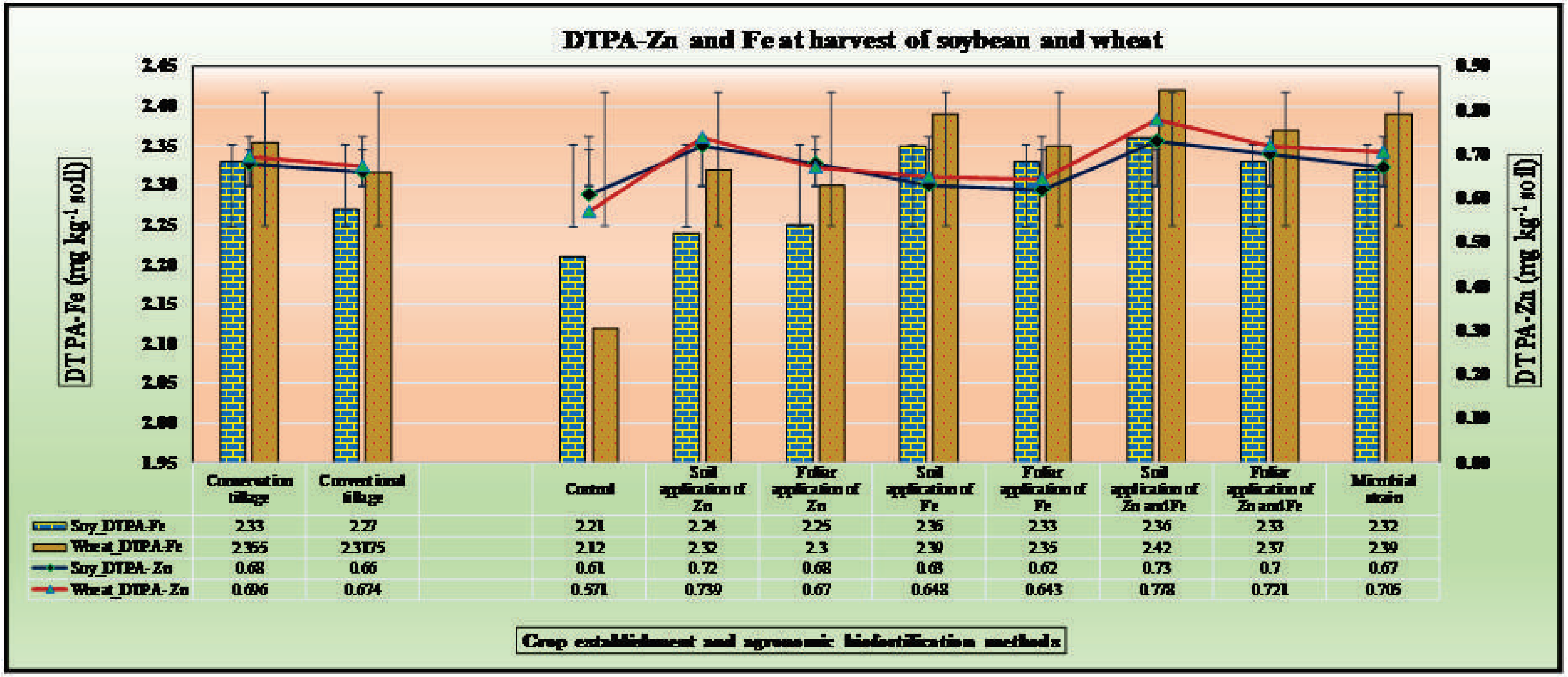


Figure 4.6 : Effect of crop establishment techniques and agronomic bio-fortification methods on DTPA-Zn and DTPA-Fe at harvest of soybean and wheat under conservation agriculture based soybean-wheat cropping system[Microbial strain (MDSR 14+MDSR34); Initial: DTPA-Zn: 0.6 mg kg^{-1}, DTPA-Fe: 2.15 mg kg^{-1}]

Strategies for enhancing yield of soybean (*Glycine Max L*) and pigeon pea (*Cajanus cajan, L*) in India using climate variability information and crop growth simulation models"

1. Collected model input data base (soil profile data: 37 locations, meteorological data: 59 locations) from different sources (Table 4.7).
2. Calibration and validation of CROPGRO model under DSSAT was done for different soybean cultivars (JS 95-60, JS 335 and JS 97-52) by using 3 years' experimental data at ICAR-IISR, Indore under both irrigated and rainfed conditions. The CROPGRO model under DSSAT again validated to 14 AICRP soybean centers by using already conducted experimental data of all three cultivars at the centers located across India (Figure 1).
3. The CROPGRO-Soybean model under DSSAT was simulated for soybean growth and grain yield an average of 35 years across 43 districts of India under irrigated and rainfed conditions to assess the extent of climatic variability (Rainfall, Tmax, Tmin, Tavge, Solar radiation) on potential yield (irrigated) and rainfed yield. Results revealed that there was a significant and positive association between rainfed grain yield and seasonal rainfall (r=0.76***). The positive and non-significant association was observed between minimum, maximum and average temperature with grain yield of soybean under rainfed and irrigated condition. Whereas, positive and significant association existed between solar radiation (r=0.75***) and irrigated grain yield (Figure 2).
4. Analyzed the simulated yield potential under irrigated (3649 kg ha-1) and rainfed (2326 kg ha-1) conditions across 43 districts in India. Estimated yield gap between irrigated and rainfed conditions, was found to be 1323 kg ha-1 and this can be considered as simulated yield gap in India.

Table 4.7 : Soil profile data created in DSSAT model for different selected study areas across the country

S. No.	Location	Soil ID	Series	Type	Sub group
1	Akola	MAAB750001	Jambha	Black, Amaravathi,Betul, Maharastra	Typic Haplustert,V.Fine, Montmorillonitic, Hyperthe
2	Amravati	MAAB750001	Jambha	Black, Amaravathi,Betul, Maharastra	Typic Haplustert, V.Fine, Montmorillonitic, Hyperthe
3	Banglore	KB00050001	Channasandra		Isoperthermic Kandic Paleustalfs
4	Belgaun	KABG750001	Achmatti	Black,Belgaum,Karnataka	Sodic Haplustert,V.Fine Montmorillonitic, Isohyperh
5	Betul	MAAB750001	Jambha	Black, Amaravathi,Betul, Maharastra	Typic Haplustert,V.Fine, Montmorillonitic, Hyperthe
6	Bhopal	MPBR750004	Jamra	Black,Bhopal,Guna, Hoshangabad,Raisen	Chromic Haplustert, Fine, Montmorillonitic
7	Bijapur	KABG750001	Achmatti	Black, Belgaum, Karnataka	Sodic Haplustert, V.Fine Montmorillonitic, Isohyperh
8	Coimbtor	CO00040001	Coimbatore	Coimbattore Clay	Vertic Ustropept
9	Dehli	DE00940001	Daryapur Series		Fine, Silty, Hperthermic Of Typic, Ustochrepts
10	Dhar	MPIN750002	Sarol	Black, Indore, Mp	Typic Haplustert, Fine, Montmorillonitic
11	Dharwad	KABG750001	Achmatti	Black, Belgaum, Karnataka	Sodic Haplustert,V.Fine Montmorillonitic, Isohyperh
12	Durgapur	RJ00050001	Chomu Series		Typic Ustipsamment
13	Faizabad	PN00840001	Haldi	Haldi Series, Distt Nainital, For Pantnagar	Typic Hapludolls
14	Gulbarga	KA00050004	Kagalgomb Series		Ypic Chromustert, Isohyperthermic, Alkaline,Clay
15	Guna	MP00750003	Saunther	Black, Bhopal, Guna, Hoshangabad, Raisen	Typic Haplustert, Very Fine, Montmorillonitic
16	Hisar	HI00040002	Hisar Series		Fine Loamy, Hperthermic Of Typic Ustochrepts
17	Hosangabad	MPBR750004	Jamra	Black, Bhopal,Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic

S. No.	Location	Soil ID	Series	Type	Sub group
18	Hydrabad	ITSH750001	Kasireddipalli Series		Vertisol, Sodic Haplustert
19	Indore	MPIN750002	Sarol	Black, Indore, Mp	Typic Haplustert, Fine, Montmorillonitic
20	Jabalpur	MPJB750005	Marha	Black, Jabalpur, Mp	Chromic Haplustert, Fine, Montmorillonitic
21	Jalgaun	MAAB750001	Jambha	Black, Amaravathi, Betul, Maharastra	Typic Haplustert, V.Fine, Montmorillonitic, Hyperthe
22	Jhabua	MPIN750002	Sarol	Black, Indore,Mp	Typic Haplustert, Fine, Montmorillonitic
23	Kota	RAKT750001	Chambal	Black, Kota, Rajasthan	Chromic Haplustert, F.Montmor, Hyperthermic
24	Ludhiana	LU00040001	Fatehpur Series		Coarse Loamy Hyperthermic Typic Ustochrepts
25	Nagpur	MAWR750003	Linga	Black, Warda, Maharashtra	Udic Haplustert, Very Fine, Montmorillonitic, Hypc
26	Nanded	MAAB750001	Jambha	Black, Amaravathi, Betul, Maharastra	Typic Haplustert,V.Fine, Montmorillonitic, Hyperthe
27	Nimuch	MPBR750004	Jamra	Black, Bhopal, Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic
28	Pantnagar	PN00840001	Haldi	Distt Nainital, For Pantnagar	Typic Hapludolls
29	Parbhani	MPBR750004	Jamra	Black, Bhopal, Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic
30	Raipur	RA00040001	Raipur Info	Lay Loam Soil Infromation Taken From Infocrop	Clay Loam
31	Rajgarh	MPBR750004	Jamra	Black, Bhopal, Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic
32	Ratlam	MPIN750002	Sarol	Black, Indore, Mp	Typic Haplustert, Fine, Montmorillonitic
33	Sagar	MPBR750004	Jamra	Black,Bhopal, Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic
34	Shajapur	MPIN750002	Sarol	Black, Indore, Mp	Typic Haplustert, Fine, Montmorillonitic
35	Ujjain	MPIN750002	Sarol	Black, Indore, Mp	Typic Haplustert, Fine, Montmorillonitic

S. No.	Location	Soil ID	Series	Type	Sub group
36	Vidisha	MPBR750004	Jamra	Black, Bhopal, Guna, Hoshangabad, Raisen	Chromic Haplustert, Fine, Montmorillonitic
37	Warangal	ITDP750002	Kasireddipalli Series		Vertisol, Sodic Haplustert

Table 4.8 : Meteorological file created in DSSAT model for different selected study areas across the country

S. No.	Weather station code	Locations	Latitude	Longitude	S. No.	Weather station code	Locations	Latitude	Longitude
1	ADBD	Adilabad	19.0809	79.5603	31	KOTA	Kota	25.2138	75.8648
2	AKLA	Akola	20.7002	77.0082	32	LUDN	Ludhiana	30.901	75.8573
3	AMLH	Amlaha	23.205	77.0851	33	LUKN	Luknow	26.8467	80.9462
4	AMRV	Amravati	20.9374	77.7796	34	MRNA	Morena	26.4934	77.991
5	ANAD	Anand	22.5645	72.9289	35	NDED	Nanded	19.1383	77.321
6	ANTP	Anantpur	14.6819	77.6006	36	NDLS	New Delhi	29.6139	77.209
7	BANG	Banglore	12.9716	77.5946	37	NDYL	Nandyal	15.4777	78.4873
8	BARP	Barapani	25.7044	91.9773	38	NGPR	Nagpur	21.1458	79.0882
9	BCHA	Biswanathchariali	29.7267	93.1479	39	NMCH	Neemach	24.4764	74.8624
10	BELT	Belatal	25.2661	79.5744	40	PLMP	Palampur	32.1109	76.5363
11	BHPL	Bhopal	23.2599	77.4126	41	PNTN	Pantnagr	28.961	79.5154
12	BIJP	Bijapur	18.8608	80.7214	42	PRBN	Parbhani	19.2644	76.6413
13	BLGM	Belgum	15.8497	74.4977	43	PTNA	Patna	25.5941	85.1376
14	BLRI	Bellary	15.1394	76.9214	44	PUNE	Pune	18.52	73.85
15	BPTN	Bhavanipatna	19.9074	83.1642	45	RICR	Raichur	16.216	77.3566
16	BTUL	Betul	21.9672	77.7452	46	RIPR	Raipur	21.2514	81.6296
17	COIM	Coimbatore	11.0168	76.9558	47	RISN	Raisen	23.3301	77.7843
18	DHAR	Dhar	22.4959	75.1545	48	RJGR	Rajgarh	23.8509	76.7337
19	DWAD	Dharwad	15.4589	75.0078	49	RJKT	Rajkot	22.3039	70.8022

S. No.	Weather station code	Locations	Latitude	Longitude	S. No.	Weather station code	Locations	Latitude	Longitude
20	FZAB	Faizabad	26.773	82.1458	50	RNCH	Ranchi	23.3441	85.3096
21	GUNA	Guna	24.6455	77.2865	51	RTLM	Ratlam	23.3342	75.0376
22	GWLR	Gwaliar	26.2183	78.1828	52	SAGR	Sagar	25.8388	78.7378
23	HISR	Hissar	29.1492	75.7217	53	SJPR	Sajapur	23.4186	76.5951
24	IMPL	Imphal	24.817	93.9368	54	SMST	Samastipur	25.856	85.7868
25	INDO	Indore	22.7196	75.8577	55	SOLP	Solapur	17.6599	75.9064
26	JBLP	Jabalpur	23.1815	79.9864	56	UJJN	Ujjain	23.1793	75.7849
27	JLNA	Jalna	19.6807	75.9928	57	VDSA	Vidhisha	23.5251	77.8081
28	JNGD	Junagarh	21.5222	70.4579	58	VRNS	Varanasi	25.3176	82.9739
29	KNOL	Karnool	15.8281	78.0373	59	WRDA	Wardha	20.7453	78.6022
30	KNPR	Kanpur	26.4499	80.3319					

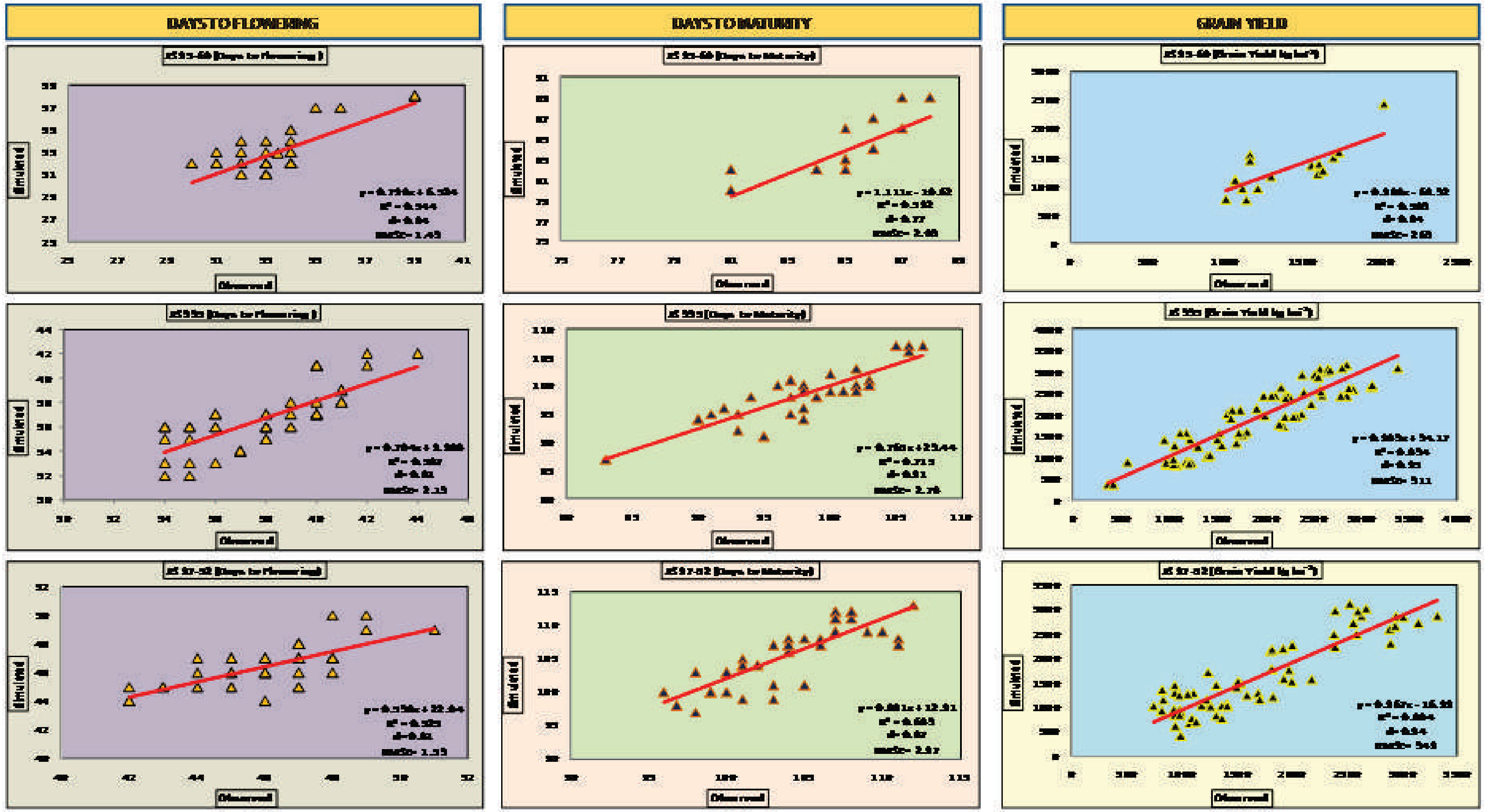


Figure 4.7 : CROPGRO-Soybean model validation for cultivars JS 95-60, JS 335 and JS 97-52 for days to flowering, days to maturity and grain yield at different locations across major soybean growing zones in India

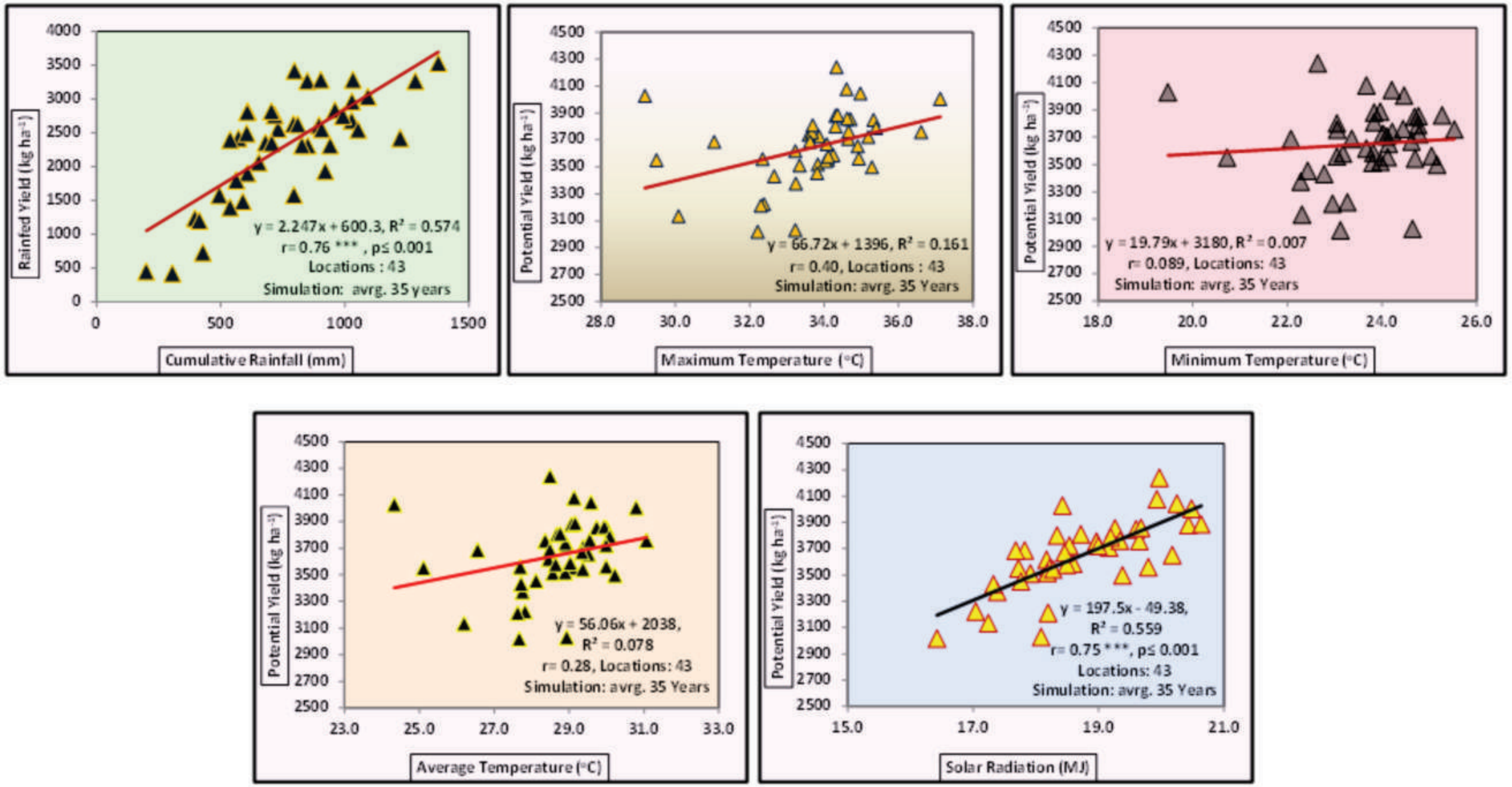


Figure 4.8 : Effect of long-term climatic variabilities (rainfall, maximum, minimum and average temperature) on simulated grain yield of soybean under both irrigated and rainfed conditions for overall 43 districts across major production zones in India

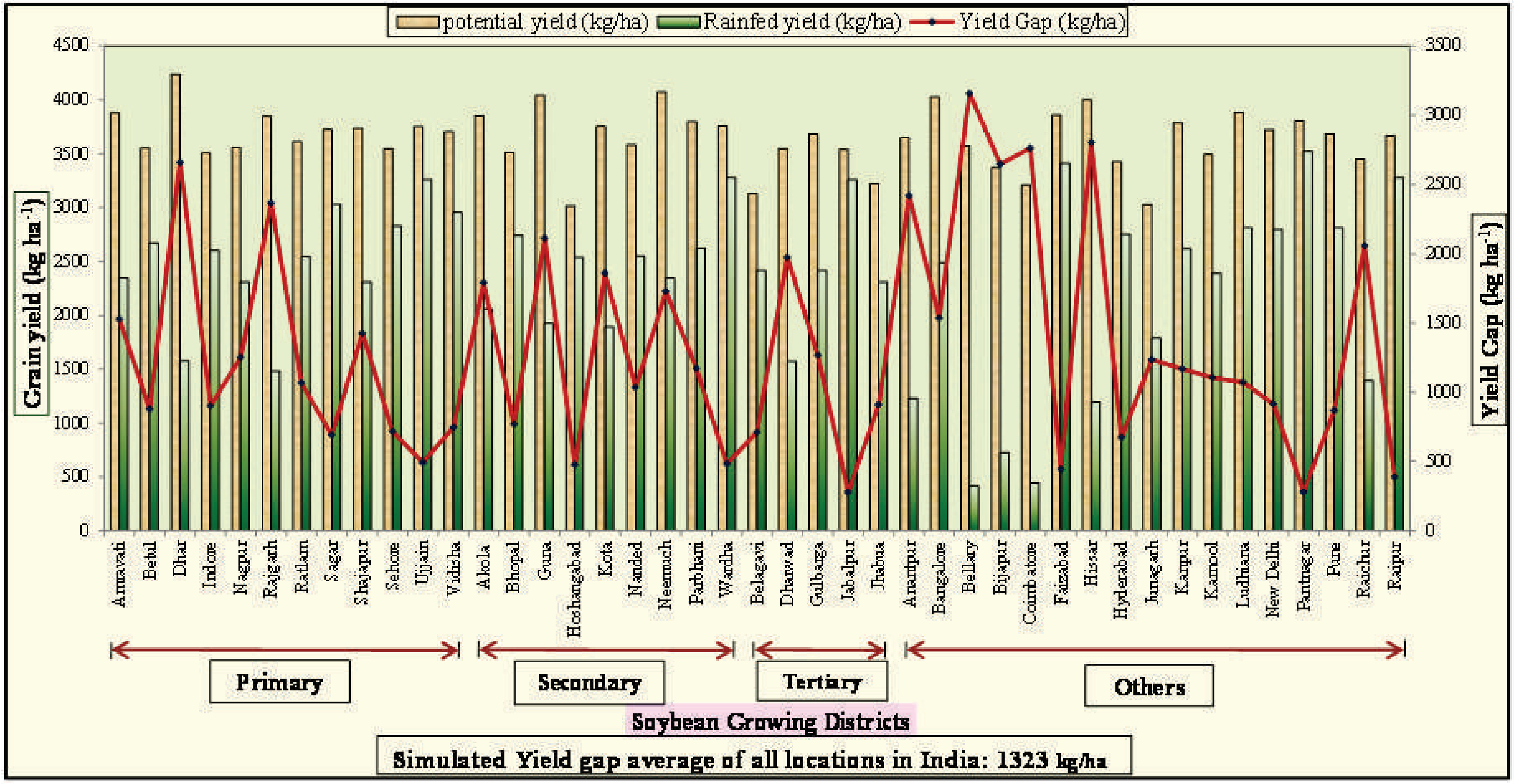


Figure 4.9 : Simulated grain yield under both irrigated and rainfed conditions and their yield gap for 43 soybean cultivation districts in India along with soybean production zones (primary, secondary, tertiary and others)

Design, development and validation of (A) Tractor PTO operated root stock cutting/shaving machine (B) Tractor PTO operated root stock breaking machine to prevent burning of root stock for Vertisols and associated soils.

The project has potential to develop following machinery (1.) Tractor PTO operated root stock cutting/shaving machine (2.) Tractor PTO operated root stock breaking/Picking machine to prevent burning of root stock for Vertisols and associated soils for the Indian farmers to remove the remove the root stock from the fields after harvesting and totally stop the prevailing menace of crop root stock burning among Indian farmers.

The design and revised specifications of the above said machine were prepared and the detailed specifications/Bill of material was and submitted for manufacturing/development of the machines. Project is of a combination of two machines which can slash/shave/uproot and pick the root stock. The operation of both machines will ensure more than seventy percent picking/uplifting of root stock and straw from the fields of wheat crops Therefore, the proposed two machines have a potential to provide the badly needed facility to the soybean farmers to pick the wheat straw and root stock of the wheat crop which is another labour extensive operation. The issues in removal elimination and of straw on the field are uphill tasks in real field conditions before sowing of Soybean crop due to the wheat straw and the root stock of wheat on and in the field. The proposed machines are the only solutions to manage the crop root stock and help easier tillage/sowing of subsequent soybean crop.

Savings in sowing by zero tillage seed drill on permanent BBF system field for wheat crop is to the level of 20% besides saving in time by adopting permanent BBF system. Major issue of higher weed infestation in such zero-tillage sowing method on BBF needs to be managed to have higher yields of wheat crop.

Fig 4.10. Zero tillage sowing operation of wheat on permanent BBF (Broad bed and Furrow)

Fig 4.11 : Field after Zero tillage sowing operation of wheat on permanent BBF

Fig 4.12 : Straw remaining after tractor PTO operated rotary slasher

Fig 4.13 : Field after Zero tillage sowing operation of wheat on permanent BBF

Fig 4.14 Wheat straw after tillage and heavy planking

This machine will also uproot and pick the wheat straw and root stock and will help transport root and wheat straw out of the fields. The specifications have been submitted by me for the manufacturing/purchase of the above said machines.

Permanent BBF: - Under the current project with the sowing machine permanent BBF was formed and sowing was undertaken with the normal seed drill to sow wheat without disturbing the Broad Bed formed earlier for soybean crop, which helped to reduce tillage in the subsequent wheat crop.

Zero tillage with Permanent BBF on wheat: -

Under the current project with the sowing machine permanent BBF was formed and sowing was undertaken with the normal seed drill (modified for zero tillage seed drill. The sowing was relatively easy even with the root stock of previous crop stem standing in the field. Study shows that soybean crop stem does not interfere in sowing operation. Weed infestation is an issue in Zero tillage sowing in vertisols specially where clay content is higher.

Development of Field Monitoring Support System for All India Co-ordinated Research Project trials.

All India Coordinated Research Projects (AICRPs) coordinates multidisciplinary and multi -locational testing of varietal, newly developed improved genotypes, crop management and crop protection technologies across the diverse ecosystems for increasing and stabilizing the production of various crops. AICRPS trial monitoring is an important regular activity for keeping track of field trials conditions during cropping season. Present AICRPS trial monitoring system is completely manual. The monitoring team visit each centre for monitoring the trial and personally record the data for preparation of monitoring report. Moreover, the physical monitoring of all the centres is sometimes not practically feasible. Moreover, it is not possible for monitoring teams to visit the trial location at all the critical stages of crop as the teams can visit only once due to time and budgetary constraints. Finally, the monitoring report prepared personally by the monitoring team is available to stakeholders only after the end of cropping season. There is no scope of gathering additional information in case of doubt.

A Web-based Field Monitoring System (FMS) developed by ICAR-IISR, Indore will strengthen the current manual system of field monitoring using the potential of Information Technology (Fig 4.15).

Fig 4.15. Login Page of the system

It provides a user-friendly tool for continuous monitoring of AICRPS trials at every crop stage. The monitoring is made more effective by getting the field and plant information in the form of pictures, videos, text information on different aspects of field conditions and other related information. The system facilitates the retrieval of crop information based on Trial-wise, Discipline-wise, Location-wise, Date-wise, Variety-wise etc (Fig 4.16).

Fig. 4.16. Information retrieval page

The AICRPS in-charges at different locations can take Geo-tagged photos and videos of their fields and plants of different trials from their smart phones and using the system in their mobiles they can upload it into the FMS along with other related information about their trials (Fig 4.17).

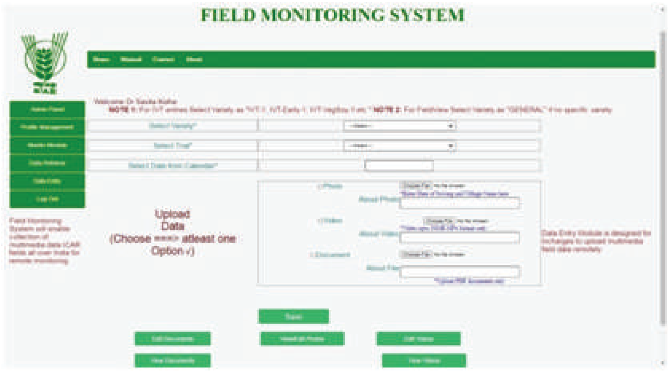


Fig 4.17. Data entry form for uploading photos, videos and text information

Fig 4.18. Screen showing on-line monitoring of field trials

The preliminary version of FMS is available on institute website http://iisrindore.icar.gov.in. The system provides access to only authorized users. The system provides authorization at four levels-i) Admin ii)In-charge, iii) Manager and iv) Scientist. The Admin has full rights, In-charge and Scientist have data-entry and retrieval rights, Managers have data retrieval rights. The authorised user can check the photo and data anytime and ask for additional information from any of the trials in charges, if he has any doubt.

Presently the system is being used for monitoring of soybean trials (Fig 4.18). The system can be used for monitoring of Front-Line Demonstrations and AICRP trials of any crop. The system will also help Varietal Identification Committee (VIC) to see the varietal performance in the fields over the years for taking decision on identification of an entry for release. VIC can check the performance of the entry in Breeding trials, Agronomy trials and Pathology & Entomology trials in single go by simply clicking on the name of entry. The development of the FMS has made the monitoring easy in the pandemic situation due to Covid-19 in the country and lead to a transparent system making the information available to all.

Development, Utilization and evaluation of ICT tools for TOT of Soybean.

In order to study the extent of use of the social media tools developed by ICAR-IISR as well as its application in solving the problems of soybean growers and also for creating the awareness among the farmers, the institute launched its YouTube Channel named IISR Soybean Indore on 9th June 2020 and started preparing short videos of about 3-5 minutes covering wide range of package of practices and approaches, methods and strategies for management of biotic and abiotic problems. The institute also used its other media tools like institute website, whatsapp groups, facebook page etc for sharing these videos and information among the farmers of soybean growing states. Very encouraging results have been received from the users along with positive comments thereby increasing the views and subscribers to more than 1250.

Table 4.9 : Details of videos uploaded on YouTube Channel: IISR Soybean, Indore

S. No.	Title	Category	Date of upload	YouTube Views till Jan 2021
1	Field Preparation	Agronomic package	09.06.20	136
2	Seed treatment with Insecticide	Plant Protection	09.06.20	324
3	Correct sequence of seed treatment	Plant Protection	09.06.20	553
4	Management of white grub & termite	Plant Protection	10.06.20	286
5	Sowing of soybean	Agronomic package	17.06.20	176
6	Use of biofertilizers	Agronomic package	19.06.20	139
7	Sowing with BBF seed driil	Mechanization	19.06.20	428
8	Intercropping	Agronomic package	20.06.20	1358
9	Sowing on Ridge & Furrow	Mechanization	24.06.20	352
10	Management of early-stage insects-blue beetle	Plant Protection	25.06.20	224
11	Use of PPI & PE Herbicides in soybean	Weed Management	26.06.20	159
12	Use of POE herbicides	Weed Management	27.06.20	237
13	Balance Nutrition in Soybean	Agronomic package	29.06.20	181
14	Management of Gram Pod Borer (Heliothis)	Plant Protection	29.06.20	1259
15	IPM in Soybean	Plant Protection	30.06.20	883

S. No.	Title	Category	Date of upload	YouTube Views till Jan 2021
16	Compatibility of herbicide and Insecticides	Plant Protection	01.07.20	192
17	Biological insect control through pesticides of microbial origin	Plant Protection	01.07.20	273
18	Management of Girdle beetle	Plant Protection	03.07.20	6227
19	In-situ moisture conservation	Agronomic package	20.07.20	166
20	Management of charcoal rot disease	Plant Protection	22.07.20	240
21	Management of collar rot disease	Plant Protection	22.07.20	228
22	Management of Tobacco caterpillar (Spodoptera)	Plant Protection	24.07.20	637
23	Management of Yellow Mosaic disease	Plant Protection	27.07.20	2178
24	Management of Anthracnose disease	Plant Protection	28.07.20	469
25	Causes of yellowing in soybean	General	28.07.20	1020
26	Identification of YMV Infection	Plant Protection	05.08.20	1164
27	Identification of Stem Fly infection	Plant Protection	07.08.20	3826
28	Identification of RAB disease infection	Plant Protection	07.08.20	684
29	Farmers Feedback about NRC 127	Soybean Varieties	14.09.20	421
30	Harvesting and Threshing of soybean for seed	Soybean Varieti	21.11.20	96

Predicting the incidence of Stem Fly, Pod Borer and Bihar hairy caterpillar in Soybean – A Geo-spatial approach (Ram Manohar patel)

1. The three insect (Stem Fly, Bihar hairy Caterpillar and Pink Pod Borer) infestation data have been collected from all centers and compiled to analyze. The distributional analysis revealed that Stem Fly infestation starts with the monsoon but peaked at the end of the crop season (SMW 41st), Bihar hairy caterpillar also starts with monsoon but peaked at about 31st SMW and Pink Pod Borer start appearing from 34th week and peaked in the last i.e. 41st week as shown in Fig-1 and other statistics including CV and range upto 2 standard deviation, are in Table-4.10.

Figure 4.19 : Weekly Incidence Graph across the year and location

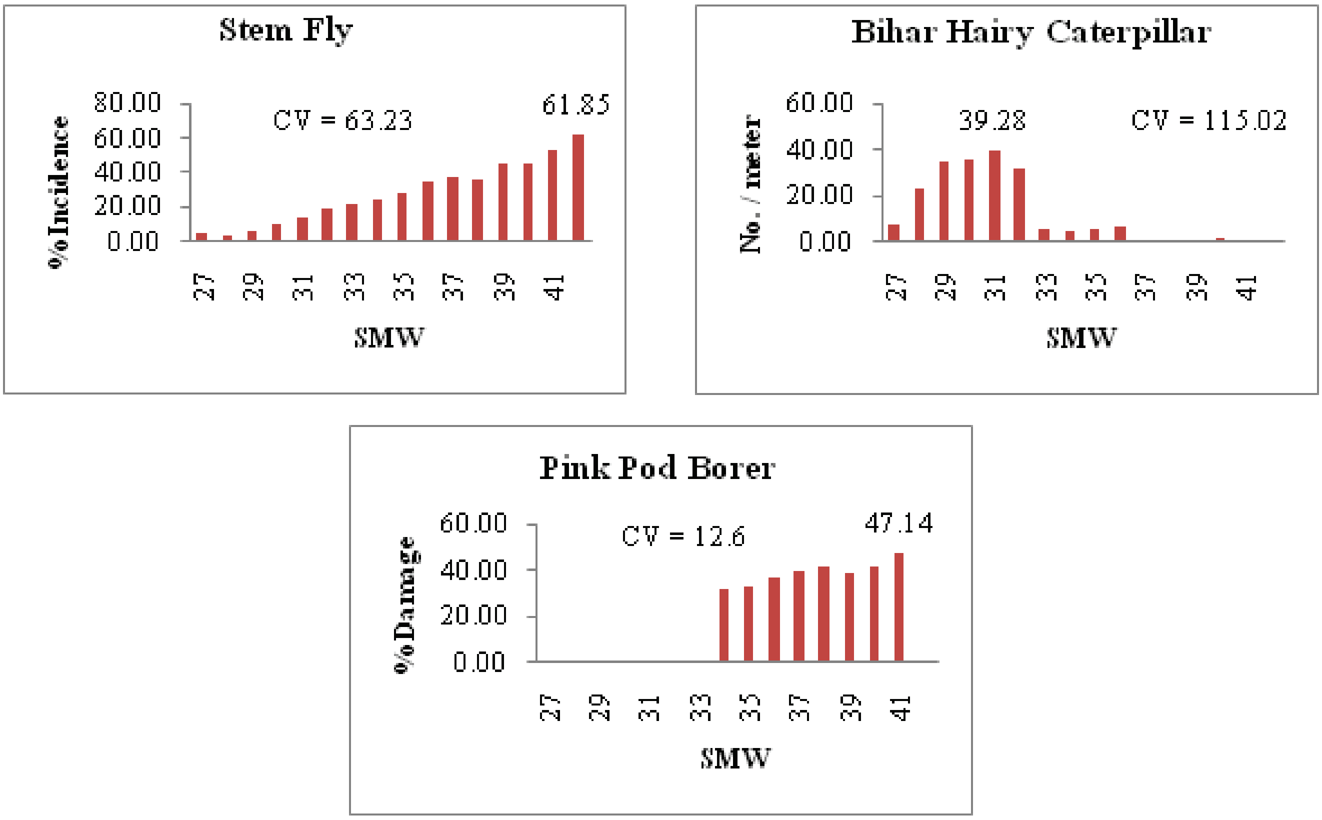


Table 4.10 : Center-wise Distributional Statistics of the insect incidence

Insect	District	Peak Value	CV	Mean+ 2SD	Mean- 2SD	Remarks
Pink Pod Borer %	Dharwad	47.14	12.60	48.68	29.09	
BH Caterpillar no./m	Bangalore	4.16	52.42	5.08	0.00	
	Dharwad	2.65	28.53	3.20	0.88	
	Imphal	116.47	120.64	123.51	0.00	
	Pantnagar	4.30	207.47	3.42	0.00	Irregular/Rare infestation
	Overall	**39.28**	**115.02**	**41.98**	**0.00**	
Stem Fly %	Amaravati	37.24	78.88	43.63	0.00	
	Bangalore	11.13	99.39	11.22	0.00	
	Dharwad	15.90	31.22	17.72	4.10	
	Kota	26.67	28.68	26.06	7.06	Year to Year variation

Insect	District	Peak Value	CV	Mean+ 2SD	Mean- 2SD	Remarks
	Pantnagar	98.61	46.35	138.59	5.25	
	Parbhani	28.90	105.80	25.20	0.00	Irregular/Rare infestation
	Sehore	76.93	64.82	101.91	0.00	
	Overall	**61.85**	**63.23**	**63.60**	**0.00**	

2. The Pink Pod Borer was significantly correlated with RainyDays, TMax, RH-I, RH-II and Mean RH, however, rainydays, TMin, RH-I, RH-II and MeanRH were negatively correlated; Bihar Hairy Caterpillar was significantly and positively correlated with rainfall, rainydays, TMin, RH-II and Mean RH, but have significantly negative correlation with TMax and Sun Shine Hour (SSH); and Stem Fly was correlated significantly negative with rainfall, rainydays, TMin, RH-I, RH-II but significantly positive only with SSH.

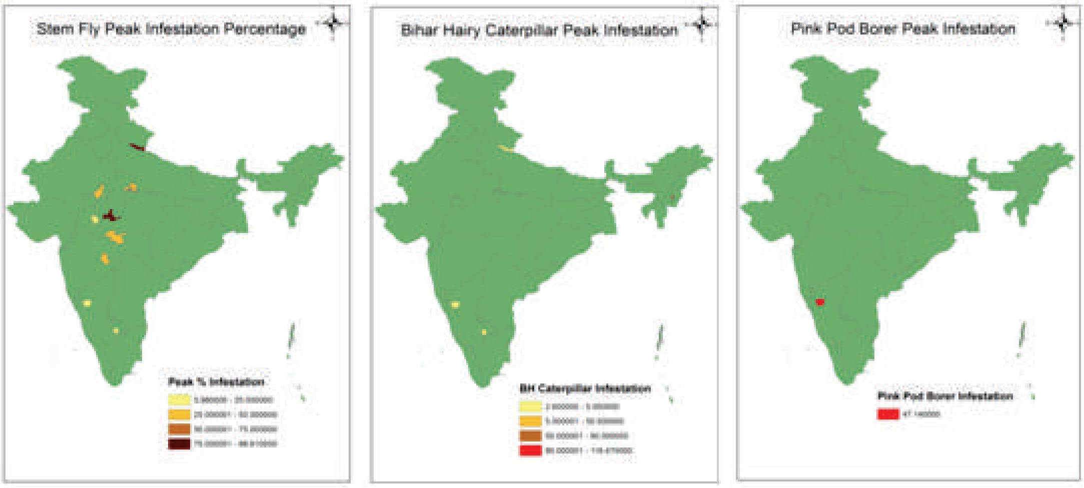
Table 4.11 : Correlation Between Insect incidence and Weather Variables

Variables	Pink Pod Borer	Bihar Hairy Caterpillar	StemFly
Rainfall	0.24	0.43 ***	- 0.76 *
RainyDays	- 0.71 **	0.69 *	- 0.85 *
TMax	0.68 ***	- 0.78 *	0.34
TMin	- 0.53	0.57 **	- 0.88 *
Relative Humidity - I	- 0.76 **	0.17	- 0.54 **
Relative Humidity - II	- 0.73 **	0.67 *	- 0.68 *
SSH	-	- 0.48 ***	0.81 *
MeanRH	- 0.75 **	0.56 **	- 0.06

Note: *,,*** is 1%, 5% and 10% level of significance.**

3. Insect panel database and district-wise shape file of India has been super-imposed on Arc-GIS software and then shape file database has been joined with the insect panel database using primary-foreign key (district). Then Hot-Spot spatial map were developed to show the susceptible areas (Figure 4.20).

Figure 4.20 : Insect Hot-Spot Map



2. Spatial District-wise Insect forewarning Advisory:

- Geo-Spatial Decision support map of District-wise insect incidence has been developed and the advisories have been disseminated weekly to soybean farmers of Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Telangana and Karnataka.
- Geo-Spatial District-wise Soybean Insect Forewarning weekly Advisory for

(i) 20-26 Jul 2020, (ii) 29 Jul- 04 Aug 2020, (iii) 13-19 Aug 2020, (iv) 27 Aug - 02 Sept 2020

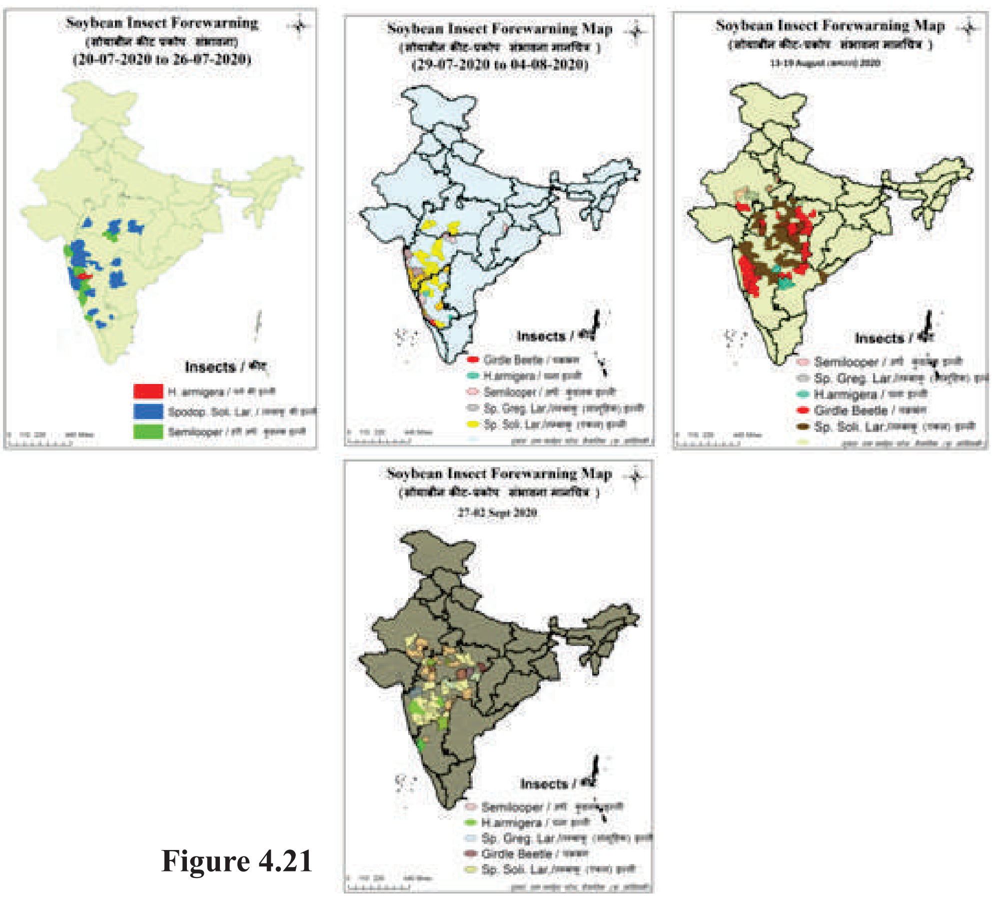


Figure 4.21

5. CROP PROTECTION

Antixenosis and antibiosis based host plant resistance in soybean genotypes against *Spodoptera litura*

Antixenosis and Antibiosis studies were done on different soybean genotypes to identify the resistant genotypes against *Spodoptera litura*. In Antixenosis studies on 11 soybean genotypes against *Spodoptera litura* preference Indices were calculated and varieties were classified based on reference values. Based on the reference values five genotypes namely, Dsb 33, JS 21-71, NRC 138, NRC 142, NRC SL1 and NRC SL2 were found slight antixenosis and rest of the genotypes were found to be preferred hosts. 'C' values of all the genotypes were given Table 5.2.

Table 5.1: Reference values

C value	Antixenosis response
0.10 to 0.25	Extreme antixenosis
0.26 to 0.50	Strong antixenosis
0.51 to 0.75	Moderate antixenosis
0.76 to 0.99	Slight antixenosis
1.00 or > 1.00	Preferred host

Table 5.2: C values of eleven genotypes under study

Sr. No.	Genotypes	'C' Values	Interference
1.	AMS 100-39	1.21	Preferred host
2.	Dsb 33	0.90	Slight antixenosis
3.	JS 21-71	0.91	Slight antixenosis
4.	Karune	1.11	Preferred host
5.	MACS NRC 1667	1.01	Preferred host
6.	NRC 138	0.97	Slight antixenosis
7.	NRC 142	1.01	Slight antixenosis
8.	NRC SL1	0.97	Slight antixenosis
9.	NRC SL2	0.97	Slight antixenosis
10.	RVSM 2011-35	1.06	Preferred host
11.	JS-335	1.00	Preferred host

In antibiosis studies on these selected 11 genotypes, the larvae reared on NRC-142 found to have the highest value of AD (72.45 %) while the lowest AD value (54.66 %) was found in case of AMS-100-39. The highest ECI values were found in NRC-142 (60.01%) and the lowest values of ECI was found in NRCSL 2 (38.18 %). The highest ECD value was found in RVSM 2011-35 (89.87 %) and the lowest in NRCSL 2 (70.02%). The highest and lowest weight of per pupae was found in AMS-100-39 (0.226 mg) and Karune (0.131 mg), respectively.

Table 5.3: Wt of pupae, AD, ECI and ECD values of different varieties under study

Sr. no.	Genotype	Wt of pupae (in mg)	AD	ECI	ECD
1.	AMS-100-39	0.226	54.66 (47.67)	46.29 (42.87)	85.25 (67.41)
2.	Dsb 33	0.172	59.48 (50.47)	46.45 (42.96)	78.41 (62.31)
3.	JS 2171	0.198	61.27 (51.52)	53.61 (47.07)	87.81 (69.57)
4.	Karune	0.131	61.69 (51.76)	44.13 (41.63)	73.78 (59.20)
5.	MACS -NRC1667	0.199	60.94 (51.32)	51.40 (45.80)	84.50 (66.82)
6.	NRC-138	0.153	64.40 (53.37)	55.74 (48.30)	87.25 (69.08)
7.	NRC-142	0.214	72.45 (58.34)	60.01 (50.77)	83.25 (65.84)
8.	NRCSL 1	0.208	60.17 (50.87)	52.39 (46.37)	87.01 (68.87)
9.	NRCSL 2	0.166	57.09 (49.08)	38.18 (38.16)	70.02 (56.80)
10.	RVSM 2011-35	0.192	56.60 (48.79)	50.91 (45.52)	89.87 (71.44)
11.	JS 335	0.170	69.90 (56.73)	53.98 (47.28)	76.38 (60.92)
	CD at 5%	(0.06)	(5.98)	(8.65)	(20.66)
	SEm±	(0.03)	(2.87)	(4.14)	(9.90)
	CV	(18.22)	(6.77)	(11.24)	(18.05)

***All the values are mean of three replications**

Molecular characterization of Macrophomina phaseolina causing charcoal rot in soybean Total 42 isolates were purified and genomic DNA isolation was extracted by using extraction and purification kit as per the manufacturer's protocol (HiPurATM fungal DNA purification kit; HiMedia). The DNA was quantified with Nanodrop spectrophotometer (Thermo Fisher Scientific, Mumbai, India). The 42 isolates were identified by their morphological characteristics and also by sequencing the internal transcribed spacer (ITS) regions of each isolate by using PCR. The PCR products were separated by electrophoresis along with 1 Kb DNA ladder (MBI, Fermentas) and visualised under Gel-Doc system (AlphaImager® Corporation, Santa Clara, CA, USA). The PCR products were directly sequenced by using the same primers. The sequences of the ITS regions were compared with the existing species sequences in GenBank using BLASTN software. The sequences and the nomenclature of each species were submitted to GenBank. Dendrogram was constructed by neighbor joining menthod by Mega 6 sofware. Total 42 isolates were identified as based on cultural, morphological and ITS sequence. The phylogenetic tree was constructed for all isolate by UPGMA method. The tree revealed association and relatedness among the isolates.

Pathogenecity study of diffent isolates of *Macrophomina phaseolina*

The pathogenecity study was carried out using cut stem technique. The top portion of soybean seedlings were cut during V2 stage and inoculated with *M. phaseolina* using pipette tips. It was done for all the isolates collected from soybean as well as other host plant. All the 60 isolates produced disease on infection in plants. Even the *M. phaseolina* isolated from different host plants also caused disease on soybean, thus showing cross infectivity as well as wide host range of *M.phaseolina.* The interaction of 30 soybeans *M. phaseolina* (*R. bataticola*) isolates with 3 genotypes i.e. AMS 5-18, JS 335, JS 95-60 was also carried out.

Table 5.4 : Identification of most virulent isolates of *M. phaseolina*

Isolate No	AMS 5-18	JS 335	JS 95-60
HB 1	2.58	3.98	4.4
HB 2	4.53	4.96	5.01
HB 3	4.61	5.08	5.4
HB 4	4.61	5.89	5.18
HB 5	0.8	1.32	3.02
HB 6	0.35	2.92	0.88
HB 7	4.58	5.37	6.12
HB 8	1.24	1.54	3.35
HB 9	1.82	1.73	1.11
HB 10	0.17	0.66	0.42
HB 11	4.3	3.84	4.16
HB 12	4.39	4.44	2.93

Isolate No	AMS 5-18	JS 335	JS 95-60
HB 13	0.23	1.28	1.73
HB 14	4.6	4.64	4.57
HB 15	3.86	4.82	5.06
HB 16	0.76	0.98	2.42
HB 17	0.58	0.47	0.32
HB 18	0.35	0.17	0.48
HB 19	3.48	1.22	5.77
HB 20	0.37	0.3	2.35
HB 21	0.54	0.48	0.35
HB 22	4.08	2.67	1.42
HB 23	1.89	2.54	0.96
HB 24	2.11	2.62	0.62
HB 25	0.54	0.43	0.43
HB 26	1.44	2.23	2
HB 27	0.23	0.15	0.21
HB 28	3.35	1.75	2.4
HB 29	3.19	3.31	4.2
HB 30	0.42	0.39	0.36

Disease evaluation was based on lesion length on stem. Based on lesion length HB 2, HB 3, HB 4, HB 7, HB 11, HB 14, HB 15, HB 19, HB 29 were found to be highly virulent. The Virulent Isolate x Genotype Interaction was found to be statistically significant.

Biochemical, functional and molecular characterization of potential endophytes

Endophytes have plant growth promoting ability through production of IAA, solublization of phosphorus and production of siderophore. This activity was estimated for selection of potential endophytes

IAA production assay

Each endophytic strain was incubated at 28°C in BOD shaker at 180 rpm for 2 days in 10 mL of LB media with and without 5 mM L-tryptophan. After 48 h the entire media was centrifuged for 20 min at 3000 rpm to collect the supernatant. A 1 mL of supernatant was mixed with 4 ml of Salkowski reagent (0.5 M $FeCl_3$ and 34.3% perchloric acid) and incubated for 1 hr at room temperature. Production of pink colour was positive indication of IAA production. Total 200 µL of mixtures was used to determine the absorbance (O.D.) at a single wavelength of 530 nm in through microplate reader. Standard graph was plotted for absorption value of different concentration of IAA 0, 5, 10, 20, 50 and 100 µg/mL. Sterile LB media was taken as control. To avoid background substraction the absorbance value of LB media was subtracted from concentration of IAA. We determine 100% bacteria endophytes isolated from soybean are capable of producing IAA. Soybean endophytic bacteria EB 5 *Paenibacillus polymyxa* was able to produced maximum IAA (115.21 µg/mL) followed by EB 28 Kurthia gibsonii (107.47 µg/mL), whereas minimum IAA 83.81 was produced by EB 3 (*Bacillus cereus*). Similar experiment was performed with endophytic fungus with slight modification. Each endophytic strain was incubated at 25°C in BOD shaker at 180 rpm for 15 days in 10 mL of LB media with and without 5 mM L-tryptophan. Interestingly 41.66 % endophytic fungus isolated from soybean are capable of producing IAA. Maximum IAA 11.83 µg/mL was produced by EF 42 (*Fusarium spp*).

Siderophore production assay

The bacteria isolates were incubated on Chrome azurol S (CAS) agar medium at 28°C ± 2°C for 4 days. The colony turn yeelow on CAS media treated as side siderophore producing bacteria and non-siderophore producing bacteria no colour change was observed. Two soybean endophytic bacteria EB 28 (*K. gibsonii*) and EB 16 (*Brevundimonas diminuta*) were produces high amount of siderophore, whereas EB 5 (*P. polymyxa*), EB 111 (*P. macerans*), EB 3 (*B. cereus*) and EB 25 (*P. macerans*) were produces moderate amount of siderophore.

Phosphorus (P) solubilization assay

The Pikovskaya agar was used for estimation of P solubilization. The soybean endophytic bacteria and fungus were inoculated on Pikovskaya agar media and incubated at 28°C ± 2°C until growth appears. The presence of halo zone or clearance around the colony after 7 days incubation qualitatively ensures phosphate solubilizing potential for fungus and 4 days for bacteria. None of endophytic bacteria is P solubilizer, whereas only one soybean fungal endophytes EF 51 (*Fusarium spp*) had little P solubilization activity.

Growth assay on nitrogen free media

Burk's nitrogen free media and Norris glucose nitrogen free media were used to assay the growth of the isolates with or without the addition of ammonium chloride, as a unique nitrogen source. The observation was made after 7 days of incubation at 28°C based on the type of growth morphology and appearance as a qualitative study on nitrogen fixation. Most of fungal endophytes were able to fix or assimilate nitrogen, among them EF Se7 (*F. falciforme*), EF N1 (*M. phaseolina*), EF 41 (*A. niger*), EF 3 (*A. flavus*), EF

1 (*Fusarium sp*), EF 29 (*Fusarium sp*) and EF 57 (Unknown) were produced profuse growth in nitrogen free media. Addition of ammonium chloride to media leads to inhibite the growth of most of isolates, whereas EF N1 (*M. phaseolina*), EF 41 (*A. niger*), EF 3 (*A. flavus*) and EF 57 (Unknown) were produced profuse growth in nitrogenous media.

Table 5.5 : Plant growth promoting activity of endophytic bacteria

Isolate No	Isolate name	IAA (µg/mL)	Siderophore production	P solubilization
EB 5	*Paenibacillus polymyxa*	115.21	++	-
EB 111	*Paenibacillus macerans*	92.43	+ +	-
EB 29	*Paenibacillus macerans*	97.50	-	-
EB 14.1	*Bacillus cereus*	99.04	-	-
EB 35	*Paenibacillus macerans*	90.82	-	-
EB 25.1	*Paenibacillus macerans*	90.94	+	-
EB 3	*Bacillus cereus*	83.81	++	-
EB 28	*Kurthia gibsonii*	107.47	+++	-
EB 107	*Methylobacterium rhodesianum*	97.65	+	-
EB 15	*Bacillus circulans*	85.75	-	-
EB 25	*Paenibacillus macerans*	90.94	++	-
EB 16	*Brevundimonas diminuta*	97.61	+++	-
EB 27	*Pseudomonas putida*	104.33	-	-

(- no activity, + tiny activity, ++ moderate activity and +++ high activity)

Table 5.6 : Plant growth promoting activity of endophytic fungi

Isolate No	Isolate name	IAA (µg/mL)	Growth on NGM	Growth on BM	Growth on NGM+NH_4Cl	Growth on BM+NH_4Cl
EF N2	*Fusarium sp*	5.79	+	+++	++	+
EF 42	*Fusarium sp*	11.83	++	+++	++	+
EF Se7	*F. falciforme*	0.00	+++	+++	+++	+
EF N1	*M. phaseolina*	0.00	+++	+++	+++	+++

Isolate No	Isolate name	IAA (µg/mL)	Growth on NGM	Growth on BM	Growth on NGM+NH_4Cl	Growth on BM+NH_4Cl
EF 41	*A. niger*	0.00	+++	+++	+++	+++
EF X4	*Mucor ciecinelloides*	0.00	+	+	+	+
EF 3	*A. flavus*	5.21	+++	+++	+++	+++
EF 1	*Fusarium sp*	0.00	+++	+++	++	+
EF 29	*Fusarium sp*	0.00	+++	+++	++	+
EF 15	*Fusarium sp*	6.83	+++	++	++	+
EF 51	*Fusarium sp*	2.50	+++	++		+
EF 57	*Unknown*	0.00	+++	+++	+++	+++

Evaluation of potential endophytes for managing major diseases of soybean (field trial)

Endophytic microbes along with fungicides were evaluated agents against major pests and diseases of soybean during kharif season of 2020 in RBD design with three replications. Seeds of JS 2029 were treated with endophytic fungi @ 5 g/kg of seed, endophytic bacteria @ 5 g/kg of seed, Carboxin 37.5%+ Thiram 37.5%DS @ 2g/kg of seed and Thiophanate Methyl 450g/l + Pyraclostrobin 50g/l w/v FS @ 3 mL/kg of seed. The 106 spores or bacteria/mL of water concentrations of endophytic fungi and bacteria was maintained through hemocytometer and spectroscopy for seed treatment. Treated seed were dried in plain paper for four hours in shaded area and sown immediately after drying. The field experiment was conducted under rainfed condition under black soil with recommended dose of fertilizers as per recommded by ICAR-IISR, Indore. Soybean variety JS 2029 were sowed in 6 rows of 5 cm with 45 cm spacing in ridge and furrow system in plot area of 13.5 m2. Foliar spray of endophytic fungi and bacteria @ 10 g/L of water with concentration of 106 spores or bacteria/mL of water were sprayed twice 30 and 45 days after sowing in respective endophytic fungi and bactetria, whereas in fungicides treated seed Pyraclostrobin 23.6 EC @ 1 g/l of water were sprayed twice 30 and 45 days after sowing. Disease severity was observed at 7 days after last foliar spray with 0-9 disease rating scale. Percentage Disease Index (PDI) was calculated with formula, PDI = (Sum of indivisula rating of leaves × 100)/ (number of leaves observed × maximum scale), whereas percentage disease control was calculated based on disease observed in untreated control plot. Yield of grain was also calculated on basis of this enhancement in yield of grain yield was also calculated. The data was transformed to arc sine values and analyzed statistically. Similarly the percentage stems tunneling of girdle beetles and percentage infestation of stem fly was calculated. Seed treatment with Thiophanate Methyl 450g/l +

Pyraclostrobin 50g/l w/v FS @ 3 mL/kg of seed and foliar application of Pyraclostrobin 23.6 EC @ 1 g/l of water was given maximum soybean grain yield (1329.21 kg/ha) with minimum PDI for anthracnose disease (33.33%), this treatment leads to enhanced 65.50 % in soybean yield as well as reduce anthracnose disease by 49.16 % as compared to control. Among soybean endophytes seed treatment with EF 57 (unknown) @ 5 g/kg of seed combined with foliar application of EF 57 (unknown) @ 10g/l of water was given maximum soybean grain yield (1307.40 kg/ha) with minimum PDI for anthracnose disease (35.56%), this treatment leads to enhanced 62.78 % in soybean yield as well as reduce anthracnose disease by 45.76 % as compared to control. Interestingly, application of two endophytic fungi EF 3 (*Aspergillus flavus*) @ 5g/kg of seed and EF Se 7 (*F. falciforme*) become pathogenic and reduced yield by 95.61 % and 80.49 % as compared to control. Maximum plant height 80.72 cm was obtained through seed treatment of EB 111 (*Paenibacillus macerans*) @ 5g/kg of seed combined with foliar application of same bacteria. Maximum BC ratio 2.90 was obtained through seed treatment with EF 57 (unknown) @ 5 g/kg of seed combined with foliar application of EF 57 (unknown) @ 10g/l of water.

Table 5.7 : Effect of endophytic fungi, bacteria and fungicides on PDI of soybean anthracnose, percentage disease control (PDC), grain yield of soybean (q/ha) and increase grain yield (IY) (%) and plant height of soybean

Treatment	Seed treatment detail	Foliar spray detail	Yield (Kg/ha)	IY (%)	PDI (%)	PDC (%)	Plant height (cm)
T1	EF3 (*Aspergillus flavus*) @ 5g/kg of seed	EF3 (*A. flavus*) @ 10g/l of water	34.97	-95.61	0.00	0.00	0.0
T2	EF41 (*A. niger*) @ 5g/kg of seed	EF41 (*A. niger*) @ 10g/l of water	1022.63	27.33	47.41	27.68	74.92
T3	EF51 (*Fusarium sp*) @ 5g/kg of seed	EF51 (*Fusarium sp*) @ 10g/l of water	956.37	19.08	51.83	20.94	70.73
T4	EF Se7 (*F. falciforme*) @ 5g/kg of seed	EF Se7 (*F. falciforme*) @ 10g/l of water	156.37	-80.49	0.00	0.00	41.73
T5	EF 57 (unknown) @ 5g/kg of seed	EF 57 (unknown) @ 10g/l of water	1307.40	62.78	35.56	45.76	79.75
T6	EB5 (*Paenibacillus polymyxa*) @ 5g/kg of seed	EB5 (*P. polymyxa*) @ 10g/l of water	1155.96	43.93	36.22	44.75	76.85

Treatment	Seed treatment detail	Foliar spray detail	Yield (Kg/ha)	IY (%)	PDI (%)	PDC (%)	Plant height (cm)
T7	EB 111 (*P. macerans*) @ 5g/kg of seed	EB 111 (*P. macerans*) @ 10g/l of water	1199.58	49.36	36.22	44.75	80.72
T8	EB 15 (*Bacillus circulans*)	EB 15 (*Bacillus circulans*)	1083.95	34.97	38.33	41.53	66.70
T9	@ 5g/kg of seed *Burkholderia arboris* @ 5g/kg of seed	@ 10g/l of water *Burkholderia arboris* @ 10g/l of water	1054.73	31.33	42.77	34.76	72.98
T10	Thiophanate Methyl 450g/l + Pyraclostrobin 50g/l w/v FS @ 3 ml/kg of seed	Pyraclostrobin 23.6 EC @ 1 g/l of water	1329.21	65.50	33.33	49.16	72.98
T11	Carboxin37.5%+ Thiram37.5%DS @ 2g/kg of seed	Pyraclostrobin 23.6 EC @ 1 g/l of water	1311.93	63.35	35.56	45.76	70.08
T12	Control	Control	803.29	0.00	65.56	0.00	76.69

Table 5.8 : Evaluation of economic viability of endophytic fungi, bacteria and fungicides against soybean anthracnose

Treatment*	SC	FSC	SC	TCC	COC	TCOC	Yield (q/ha)	GR	BC ratio
T1	60	2000	450	2510	15000	17510	0.35	1357.20	0.08
T2	60	2000	450	2510	15000	17510	10.23	39678.19	2.27
T3	60	2000	450	2510	15000	17510	9.56	37107.49	2.12
T4	60	2000	450	2510	15000	17510	1.56	6067.49	0.35
T5	60	2000	450	2510	15000	17510	13.07	50727.41	2.90
T6	60	2000	450	2510	15000	17510	11.56	44851.52	2.56
T7	60	2000	450	2510	15000	17510	12.00	46544.03	2.66
T8	60	2000	450	2510	15000	17510	10.84	42057.28	2.40

Treatment*	SC	FSC	SC	TCC	COC	TCOC	Yield (q/ha)	GR	BC ratio
T9	60	2000	450	2510	15000	17510	10.55	40923.62	2.34
T10	465	3700	450	4615	15000	19615	13.29	51573.66	2.63
T11	252	3700	450	4402	15000	19402	13.12	50903.05	2.62
T12	0	0	0	0	15000	15000	8.03	31167.74	2.08

SC: Seed treatment cost; FSC: Foliar spray cost; SC: spraying cost; TCC: total cost of chemical, TCOC: Total cost of cultivation; GR: Gross return; BC ratio: Benefit cost ratio. *Treatment detail given in above table

Evaluation of potential endophytes for managing major pests of soybean (field trial)

The percentage stems tunneling of girdle beetles and percentage infestation of stem fly was calculated after seed treatment and foliar application of endopytic fungi, bacteria and fungicides. There were decreased per cent stem fly tunneling in case of foliar application of EF41 (*A. niger*), EF 57 (unknown), EB 111 (*P. macerans*), Burkholderia arboris and Pyraclostrobin of while rest of the treatments were found increasing trends in stem fly infestation in terms of per cent stem tunneling. Maximum percentage infestation of stem fly was reduced by foliar application of EF 57 (unknown). Application of EF Se7 (*F. falciforme*), EF 57 (unknown), EB 111 (*P. macerans*), EB 15 (*Bacillus circulans*) were stabilized girdle beetle infestation as compared to control.

Molecular characterization of potential endophytes

Six endophytes isolates were sub-cultured on Potato Dextrose Agar (PDA) medium in sterilized Petri plates at 27±1°C temperature and further purified by single spore isolation technique. Further, these purified cultures were stored at 4±1°C for future studies. DNA of six endophytes isolates was extracted by using extraction and purification kit as per the manufacturer's protocol (HiPurATM fungal DNA purification kit; HiMedia). The DNA was quantified with Nanodrop spectrophotometer (Thermo Fisher Scientific, Mumbai, India). The fungal isolates were identified by their morphological characteristics and also by sequencing the internal transcribed spacer (ITS) regions of each isolate. PCR amplification of the fungal genomic ITS region 1 and 2 was performed using the following primers: ITS1- Forward primer (TCCGTAGGTGAACCTGCGG) and ITS4- Reverse primer (TCCTCCGCTTATTGATATGC) using an initial denaturalization at 94 °C for 5 min; followed by five cycles of 1 min at 94 °C (denaturation), 1 min at 54 °C (annealing), and 1 min at 72 °C (extension); 10 min at 72 °C (extension). Each reaction mixture (12.5 µl) using procedure described as 50 ng of genomic DNA, 10 X PCR Buffer, 10mM dNTPs, 10 pM of each primer and 1 U of Taq DNA polymerase. The PCR products were separated by electrophoresis on a 1.2% (w/v) agarose gel in tris borate EDTA buffer, stained with ethidium bromide (at 0.5 µg/mL) along with 1 Kb DNA ladder (MBI, Fermentas). To separate the amplified fragments, the electrophoresis was done for about 2 h at 80 V and visualised under Gel-Doc system (AlphaImager® Corporation, Santa Clara, CA, USA). The PCR products were directly sequenced by using the same primers. The sequences of the ITS regions were compared with the existing species sequences in GenBank using BLASTN software. The sequences and the nomenclature of each species were submitted to GenBank (accession number is shown in Fig 1). Dendrogram was constructed by neighbor joining method by Mega 6 software. Six endophytes were identified as based on cultural, morphological and ITS sequence. Endophytic fungus belonged to three families such as Nectriaceace, Trichocomaceae and Ceratobasidiaceae. The phylogenetic tree was constructed for all isolate by UPGMA method. The tree revealed association and relatedness among the isolates.

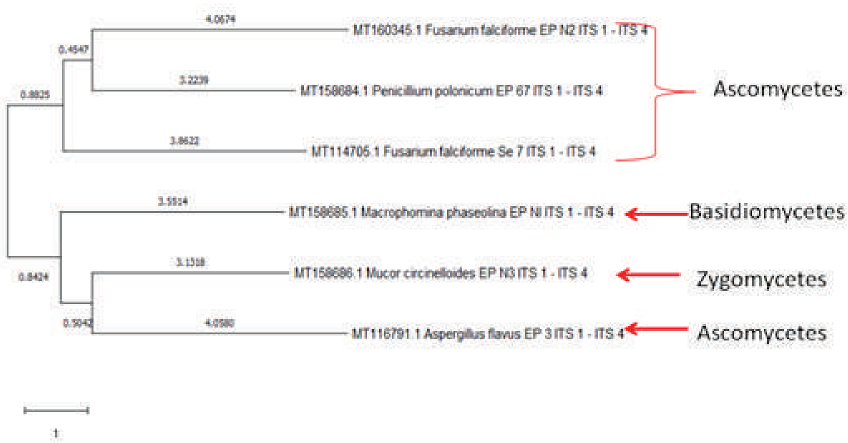


Fig 5.1: UPGMA method phylogenetic tree based on ITS sequence of fungal endophytes

Biospeckle based sensor for characterization of charcoal rot disease in soybean crop

Charcoal rot is the most devastating fungal disease of soybean, caused by the pathogen called *Macrophomina phaseolina*. This disease thrives in warm and dry conditions, affecting the yield of soybean and other agronomical crops worldwide. Conventional methods used to screen the charcoal rot disease suffer from several drawbacks including, manual rating, low accuracy, high operating time, complex operations, and require rigorous analysis. To circumvent these drawbacks, we developed a laser biospeckle based sensor to characterize the charcoal rot disease in soybean crop. For experiment, total plant population was divided into two groups namely; healthy and diseased. To create infection in plants, for the diseased group cut stem inoculation technique was used. The proposed sensor as well as standard rating protocol (i.e. measuring the length of necrosis) was used to analyze the extent of disease in both the groups. To characterize the disease progression and the genetic resistance of different genotypes against *M. phaseolina*, two new metrics, charcoal rot severity index (CSI) and disease susceptibility index (DSI) were introduced. Biospeckle activity (BA) was found to be strongly correlated with the lesion length (for JS 90-41, r=0.96, and for AMS-MB-5-18, r=0.95 ($p<0.01$)) of infected plant stems. Experimental results clearly indicate that the sensor can also be advantageously used as an efficient tool to evaluate charcoal rot disease during seedling stage in soybean. The study provided important data that is beneficial for the development and implementation of disease control measures and increased production. Furthermore, it can also strengthen breeding programs related to development of disease-resistant cultivars.

Laser biospeckle based early identification and classification of seed-borne fungal pathogen (*Colletotrichum truncatum*) in soybean using support vector

In soybean, seed borne plant pathogens affect healthy seedling stand resulting in significant reduction in yield. Sowing of healthy seed is crucial to avoid such losses. As often, infected seeds appear symptomless due to presence of low inoculum of pathogen, thus making it difficult for its detection through conventional methods. Conventional techniques of seed-borne disease detection also suffer from several other drawbacks including high cost and operating time, involving complex operations, requiring mycological skills, and less or non-sensitive to low inoculum concentrations. To address this problem, we demonstrated the use of laser biospeckle technique for early detection and classification of seed-borne fungal pathogen in conjunction with support vector machine (SVM). *Colletotrichum truncatum* is a seed borne fungal pathogen in soybean. Soybean seeds inoculated with *C. truncatum* were monitored using traditional (percentage area covered by disease (%ACD)) as well as biospeckle technique to formulate the possible relationship between biological activity and pathogen interaction, with or without the use of frequency signatures. The results showed that biospeckle signature obtained for both raw and frequency filtered data presented significant increase ($p<0.05$) in biospeckle activity (BA) of diseased seeds. In contrast, the amplitude values of lower frequency spectral components for diseased seeds were higher than those of healthy seeds. Classification between healthy and diseased seed groups was performed by support vector machine with maximum classification accuracy of 97.40%, including minimum spore concentration of *C. truncatum.* Consequently, the results obtained from the study show that biospeckle technique in association with SVM can be used as an effective intelligent diagnosis method for early detection of the seed-borne fungus pathogen at low inoculum concentrations.

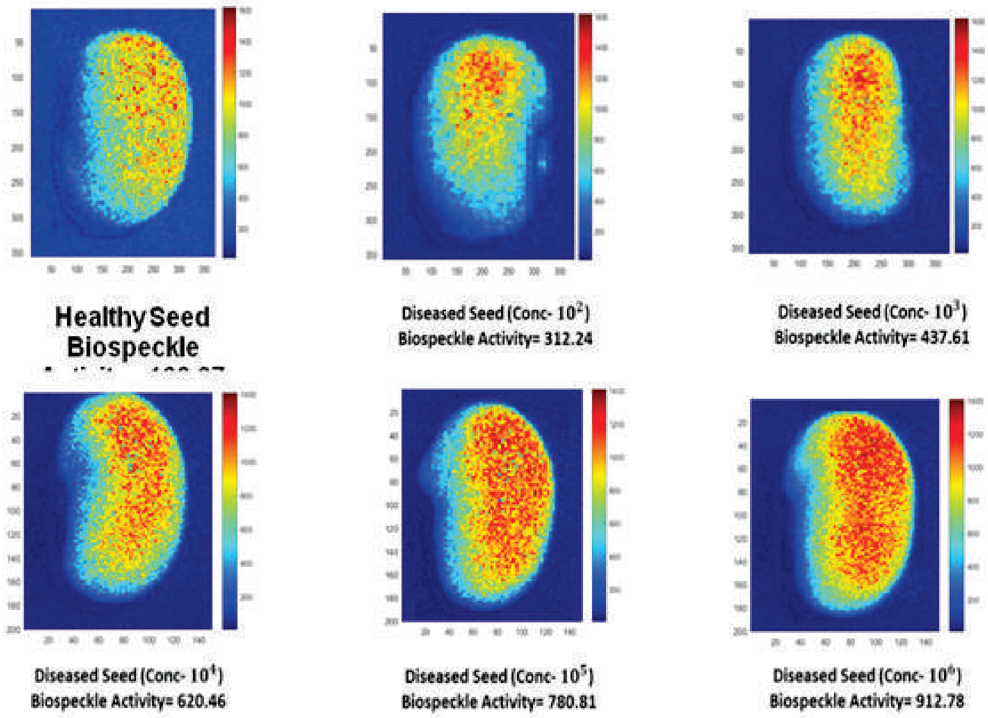


Fig 5.2 : SA map for differently treated with seeds different spores concentration of *C. truncatum* in increasing order

Evaluation of elite genotype against major disease of soybean in *Kharif* 2020 under station trail at ICAR-IISR, Indore

Total 55 elite genotype of soybean was evaluated under field condition against major disease of soybean in *Kharif* 2020 under station trail at ICAR-IISR, Indore (Table 5.9). A randomized complete block design with two replicates was used to evaluate 55 elite genotype of soybean. Visual disease ratings were made in by visually examining of each plot at flowering stage and harvesting stage. Disease severity was calculated based on percent leaf area under disease using 0-9 scale (Table 5.9). Based on severity, the elite genotypes were categorised as 0 for Highly resistant, 1 for resistant, 3 for Moderately resistant, 5 for Moderately susceptible, 7 for Susceptible, 9 for Highly susceptible. Out of 55 elite genotypes 13 genotypes showed resistance reaction to soybean anthracnose disease i.e., WLP 20-1 to WLP 20-7, MP 80, CN 48, ECN 10, AVKS 150, AVKS 160 and GKS 20-6. Out of 55 elite genotypes 16 genotypes showed moderate resistance, 11 genotypes showed moderate susceptible, 9 genotypes showed susceptible and 6 genotypes showed highly susceptible reaction to soybean anthracnose disease. Out of 55 elite genotypes 21 genotypes showed resistance reaction to soybean against *Rhizoctonia aerial* blight disease i.e., WLP 20-1 to WLP 20-6, CN 48, ECN 10,YP11, YP 28, YP 29, AVKS 150, AVKS 148, AVKS 160, AVKS 149, AVKS 154, GKS 20-2 to GKS 20-6. Out of 55 elite genotypes 20 genotypes showed moderate resistance, 7 genotypes found showed moderate susceptible, 1 genotypes found susceptible and 6 genotypes showed highly susceptible reaction to *Rhizoctonia* aerial blight disease of soybean. Out of 49 elite genotypes 27 genotypes showed resistance reaction to yellow mosaic disease of soybean i.e., WLP 20-1, WLP 20-2, WLP 20-4, WLP 20-5, PM 25, PME 68, PM 92, PM 80, CN 41, EN 14, YP 27, YP 15, YP 28, AVKS 140, AVKS 142, AVKS 150, AVKS 147, AVKS 160, AVKS 149, AVKS 157, AVKS 141, AVKS 155, AVKS 154, GKS 20-1, GKS 20-2 GKS 20-4 and GKS 20-5. Out of 49 elite genotypes 9 genotypes showed moderate resistance, 11 genotypes found showed moderate susceptible and 2 genotypes found susceptible reaction to YMV disease of soybean. Out of 49 elite genotypes 8 genotypes showed resistance reaction to SMV disease of soybean i.e., WLP 20-3, WLP 20-7, PM 25, CN 48, CN 30, AVKS 150, AVKS 146 and AVKS 155. Out of 49 elite genotypes 20 genotypes showed moderate resistance, 8 genotypes found showed moderate susceptible, 8 genotypes found susceptible reaction and 5 genotypes found highly susceptible reaction to SMV disease of soybean.

Table 5.9 . Evaluation of elite genotypes against major diseases of soybean

Entry	Pb (Ct)	RAB	YMV	SMV
WLP 20-1	R	R	R	MR
WLP 20-2	R	R	R	MR
WLP 20-3	R	R	MR	R
WLP 20-4	R	R	R	MR
WLP 20-5	R	R	R	MR
WLP 20-6	R	R	MR	MR
WLP 20-7	R	MR	MS	R
BSN-1	MR	MR	MR	S
PM 25	MR	MR	R	R
PM 92	MR	MR	R	S
ECN 10	R	R	MR	MR
PME 68	S	S	R	MR
MP 80	R	MR	R	MR
CN 48	R	R	S	R
CN 41	MR	MR	R	S

Entry	Pb (Ct)	RAB	YMV	SMV
CN 30	MR	MR	MS	R
EN 14	MR	MS	R	MS
YP 21	MS	MR	MS	MS
YP 12	MR	MR	MR	HS
YP 27	MR	MR	R	HS
YP 15	S	MR	R	HS
YP 11	MR	R	MS	HS
YP 9	MS	MR	MS	MS
YP 28	MS	R	R	MR
YP 30	S	MR	MR	MS
YP 10	MS	MR	MS	MR
YP 29	S	R	MS	HS
AVKS 153	HS	HS	-	-
AVKS 151	HS	HS	-	-
AVKS 140	MS	MR	R	MR
AVKS 144	HS	HS	-	-
AVKS 143	S	MS	MS	MS
AVKS 142	MR	MS	R	MR
AVKS 150	R	R	R	R
AVKS 146	S	MR	MS	R
AVKS 148	S	R	S	MR
AVKS 147	S	MR	R	MR
AVKS 158	HS	HS	-	-
AVKS 159	HS	HS	-	-
AVKS 160	R	R	R	MR

Entry	Pb (Ct)	RAB	YMV	SMV
AVKS 149	MR	R	R	MR
AVKS 145	HS	HS	-	-
AVKS 157	MS	MS	R	MR
AVKS 156	HS	HS	MS	MS
AVKS 141	S	MS	R	MR
AVKS 155	MS	MR	R	R
AVKS 154	MR	R	R	MR
AVKS 152	S	MS	MS	MR
GKS 20-1	MR	MR	R	S
GKS 20-2	MR	R	R	MS
GKS 20-3	MS	R	MR	S
GKS 20-4	MR	R	R	S
GKS 20-5	MR	R	R	MS
GKS 20-6	R	R	MR	S
GKS 20-7	MS	MR	MR	S

Evaluation of germplasm line against major disease of soybean in *Kharif* 2020

Total 3397 germplasm lines along with check of soybean was evaluated under field condition against major disease of soybean in 2020 at ICAR-IISR, Indore . Visual disease ratings were made in by visually examining of each line at flowering stage and harvesting stage. Disease severity was calculated based on percent leaf area under disease using 0-9 scale . Based on severity, the genotypes were categorised as 0 for highly resistant, 1 for resistant, 3 for moderately resistant, 5 for moderate susceptible, 7 for susceptible, 9 for highly susceptible. Out of 257 traits specific lines 43 lines were showed resistance reaction, 19 lines showed moderate resistance, 38 lines showed moderate susceptible, 53 lines showed susceptible and 104 showed highly susceptible reaction to soybean anthracnose disease. Out of 152 core germplasm lines, 2 lines showed resistance reaction, 2 lines showed moderate resistance, 16 lines showed moderate susceptible, 31 lines showed susceptible and 101 showed highly susceptible reaction to soybean anthracnose disease. Out of 2088 new germplasm lines 138 lines showed resistance reaction, 113 lines showed moderate resistance, 125 lines showed moderate susceptible, 176 lines showed susceptible and 1269 showed highly susceptible reaction to soybean anthracnose disease.

Soybean diseases and insect pest monitoring and pathogen prolifing

To assess the extent of soybean disease and pest severity, on the request of state agriculture department intensive roving survey was conducted during *Kharif* 2020 in major soybean growing districts i.e., Indore, Ujjain, Dhar and Dewas. At least five villages of each district were randomly selected on both sides of road when the crop was in pod formation stage. Such fields were assessed for anthracnose and RAB severity by recording the disease on 0-9 disease ratings scale. Ujjain, Dewas and Indore district was having maximum severity of soybean anthracnose and RAB (80.65-90.65%). Minimum soybean anthracnose disease severity was observed in Dhar district (50.00-85.65%). The farmers were advised to spray thiophenate methyl @ 1 kg/ha or tebuconazole @ 625 ml/ha or tebuconazole + sulphur 1 lit/ha or hexaconazole @ 500 ml/ha or pyroclostrobin @ 500 g/ha using 500 litre of water for effective magement of the soybean anthracnose and RAB diseases. The farmers were also advised to use seed treatment with @ 3 Thiophanate Methyl 450g/l + Pyraclostrobin 50g/l w/v FS @ 3ml/kg of seed or with Trichoderma viridae @ 8 to 10 g/ kg of seed for management of soil borne diseases and mix zinc sulphate 25 kg and borax 0.5 kg in soil at time of field preparation.

Role of phytohormones in promoting AM symbiosis

During 2020, at IISR, Indore research on mass production of AM fungi using phytohormones was attempted in soil-soil pots using maize as host plant.

Out of all hormones explored, seven phytohormones tried as seed treatment, cytokinin followed by Brassinosteroids (BR), abscisic acid (ABA) promoted spore density (upto 15 spores/g soil) over the control (3 spores/ g soil). The IAA and SA although improved spore density when compared to control but not good as CK, BR and ABA. Nevertheless, a time course study will be carried out both as seed treatment and foliar spray to decipher the role of these hormones (e.g., SA and IAA in promoting the AM symbiosis.

1.2. Deciphering the role of AM mediated glomalin in bioremediation of heavy metal contaminated sites

Under DBT-NER AMF bioremediation project the municipal solid waste (MSW) disposal which poses environmental risks in terms of heavy metal (HMs) accumulation was assessed the dynamics of AM mediated glomalin (Glomalin related protein-GRSP) in relation to heavy metals in 20 different soil samples of MSW dumping sites in Boragaon, Guwahati, Assam, India. Besides studying the physicochemical properties, the distribution pattern of GRSP concentrations in relation to HMs was studied to predict the potential of GRSP IN bio-stabilization of Hms. GRSP exhibited weak positive correlation with essential (Zn, Cu) and toxic HMs (Cd, Ni). The Cr and Mn were possibly sequestered in AMF structures and thus found to be negatively correlated with GRSP. Positive correlation was observed between GRSP and soil nutrients like N, P and soil organic carbon (SOC). It was revealed that AMF residing at contaminated sites produced higher amount of GRSP potentially to bio-stabilize the HMs, and reduce their bioavailability and also facilitate SOC sequestration (Fig 5.3 & 5.4). Examining the glomalin levels in environmentally vulnerable ecosystems such as heavy metal polluted sites can be used as potential indicator to predict the success of restoration programme to mitigate the stresses for utilizing such ecosystems for agriculture food crops. The govt. environment regulatory agencies may amend glomalin in their SOPs appropriately while auditing the sites for environmental clearance and maintaining ecological balance.

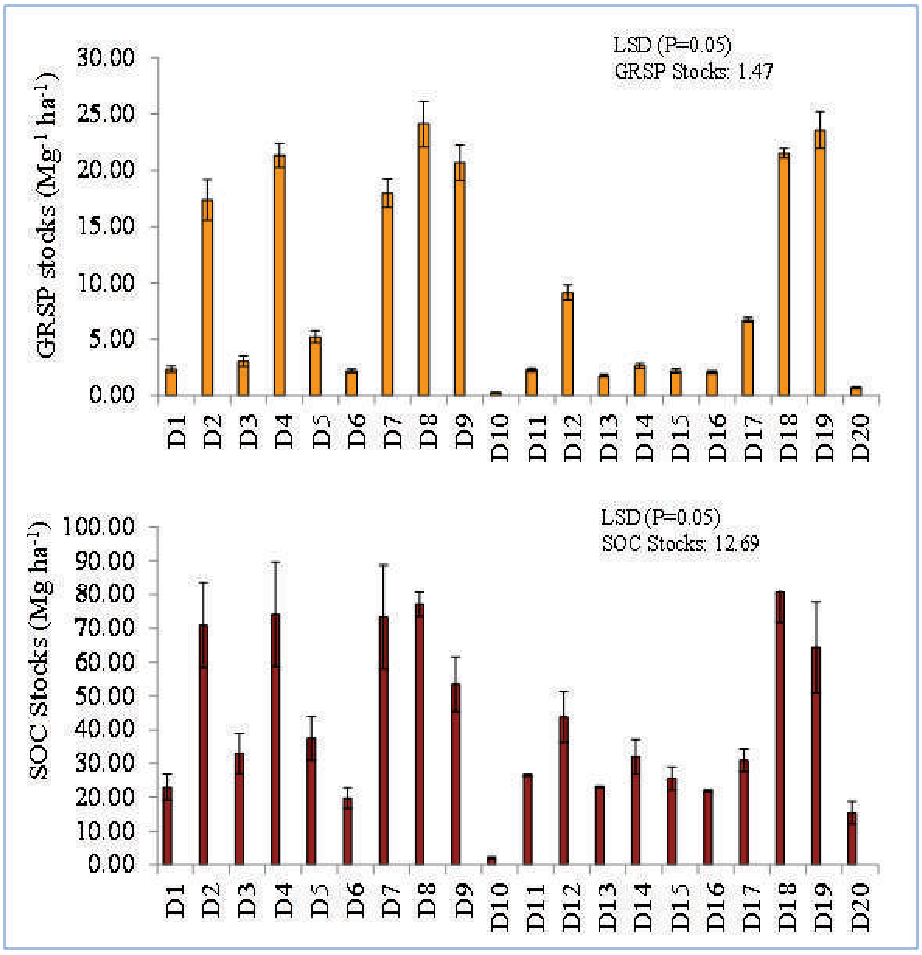


Fig.5.3 GRSP and SOC stocks at different sampling locations of municipal waste dumping site. The bars of treatment followed by the same letter did not differ significantly by Duncan's multiple range test (DMRT; P=0.05); LSD, least significant difference by ANOVA.

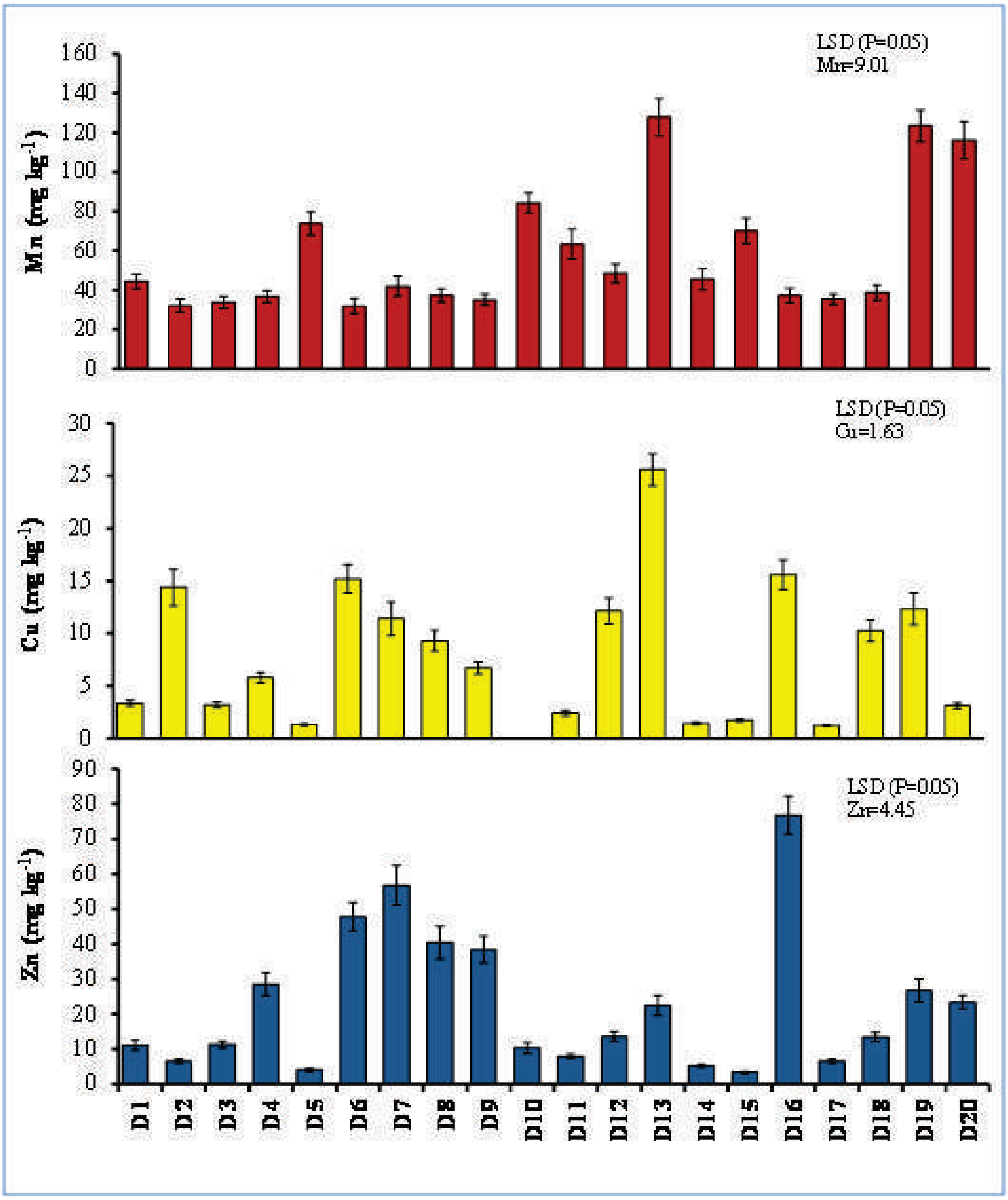


Fig. 5.4 : The concentration of essential heavy metals at different sampling locations of municipal waste dumping site. The bars of treatment followed by the same letter did not differ significantly by Duncan's multiple range test (DMRT; P=0.05); LSD, least significant difference by ANOVA.

1.3. Field evaluation of drought tolerant soybean rhizobia

Potential rhizobial strains were evaluated for conferring drought tolerance in soybean during third consecutive year in the field during kharif 2020. The strains were evaluated and compared their efficacy with commercial culture and AM fungi for improving the productivity of soybean (JS 95-60) during *Kharif* 2020. The cumulative response of treatments in field on soil PLFA microbial community was also assessed.

During field evaluation, irrespective of fertilization, the microbial application has significantly increased the soybean nodulation (nodule dry weight and number) and leghaemoglobin content in nodules when compared to their respective non-inoculated counterparts. However, the magnitude of response was found to vary with the microbial combinations and fertilization. Seed priming with B. daqingense and AM fungi at 25% reduced dose of N and P fertilizers respectively was found to be equally effective than 100% N and P fertilizers. The response of combined inoculation of both B. daqingense and AM fungi at 25% reduced N & P fertiPlizers has further enhanced the nodulation significantly when compared to other combinations and 100% RDF (table 1).

Similarly, the chlorophyll content, proline content, N and P content of soybean shoots were significantly higher in *B. daqingense* and AM fungi plants than non-inoculated plants. The co-inoculation of plants with *B. daqingense* and AM fungi at 25% reduced N and P fertilizers not only enhanced the nutrition and health of plants but also shoed higher response than the 100% fertilizers. Therefore, B.daqingense +AMF have been identified as a potential strains as N and P biofertilizers for increased sustainability and productivity of soybean after validation through multilocation trials (table 1).

While assessing the response of microbial treatments followed in the preceding two years to PLFA soil microbial community required for maintaining the soil health, it was observed that amongst all the combinations, fertilization with 75% RDF with *B. daqingense* either alone or with AM fungi followed by RDF found to be highly responsive or explained up to 82.8% variance (Fig 3 (D). There were three PCs or dimensions which accounted a cumulative of 82.8% variance explained through PC 1 (42.68%), PC 2 (26.13%) and PC 3 (13.5%). The biplots in which PC 1 and 2 which explained 68.82% mainly through lipid biomarkers of AMF, NLFA, gram positive, gram negative bacteria loaded in the plots applied with B. daqingense with 75% RDF plots and found to be positively correlated with grain yield (Fig 3B, C). The plots inoculated with *B. daqingense* either alone or with AM showed maximum lipid biomarkers than the other plots. Therefore these plots were seems to be most favorable to the AMF, gram positive and gram negative bacteria microbial community explaining maximum variance and contributing towards the soil health and productivity.

Table 5.10 : Integrated field response of soybean rhizobia (*Bradyrhizobium daqingense*) and AM fungi application at reduced doses of nitrogen and phosphorus fertilizers on soybean during *kharif* 2020

Treatment	LegH (mg/g fresh nodules)	Nodule dw (mg/Plant)	Nodule (no./Plant)	Chlorophyll (mg/g fresh leaves)	P-content in shoots (%)	N-content in shoots (%)	Proline (ug/ml)	Shoot biomass kg/ha
Control	1.91e	0.14de	33.33e	0.81ef	0.11d	2.08e	1.2c	1309.58f
B.daqingense	4.43d	0.22bc	42e	1.74ab	0.15c	4.48cd	1.22bc	2131.48c
AMF	4.41d	0.18cd	39.66	1.12def	0.17c	3.44d	1.23bc	1940.37d
B.daqingense + AMF	5.15cd	0.24cd	55d	1.17cde	0.17c	4.78c	1.29b	2245.48c
B.daqingense + 75%N+ 100PK	7.03b	0.28ab	83.33b	1.65abc	0.20b	6.94ab	1.22bc	2472.4b
B.daqingense +AMF+ 100%NK+75%P	5.66c	0.25abc	67.66c	1.46bcd	0.17c	6.18b	1.21c	2318.51bc
B.daqingense +AMF+ 75%NP+100%K	9.38a	0.31a	103.33a	1.99a	0.25a	7.51a	1.56a	2670.92a
RDF	2.22e	0.08e	38.33e	0.74f	0.18bc	4.18cd	1.17c	1594.62e
LSD (0.05)	0.809	0.064	11.31	0.434	0.024	1.162	0.068	179.4

Data are mean of three replications. The means followed by same letter did not differ significantly by Duncan's multiple range test (DMRT) of ANOVA (p=0.05); LSD, least significant difference

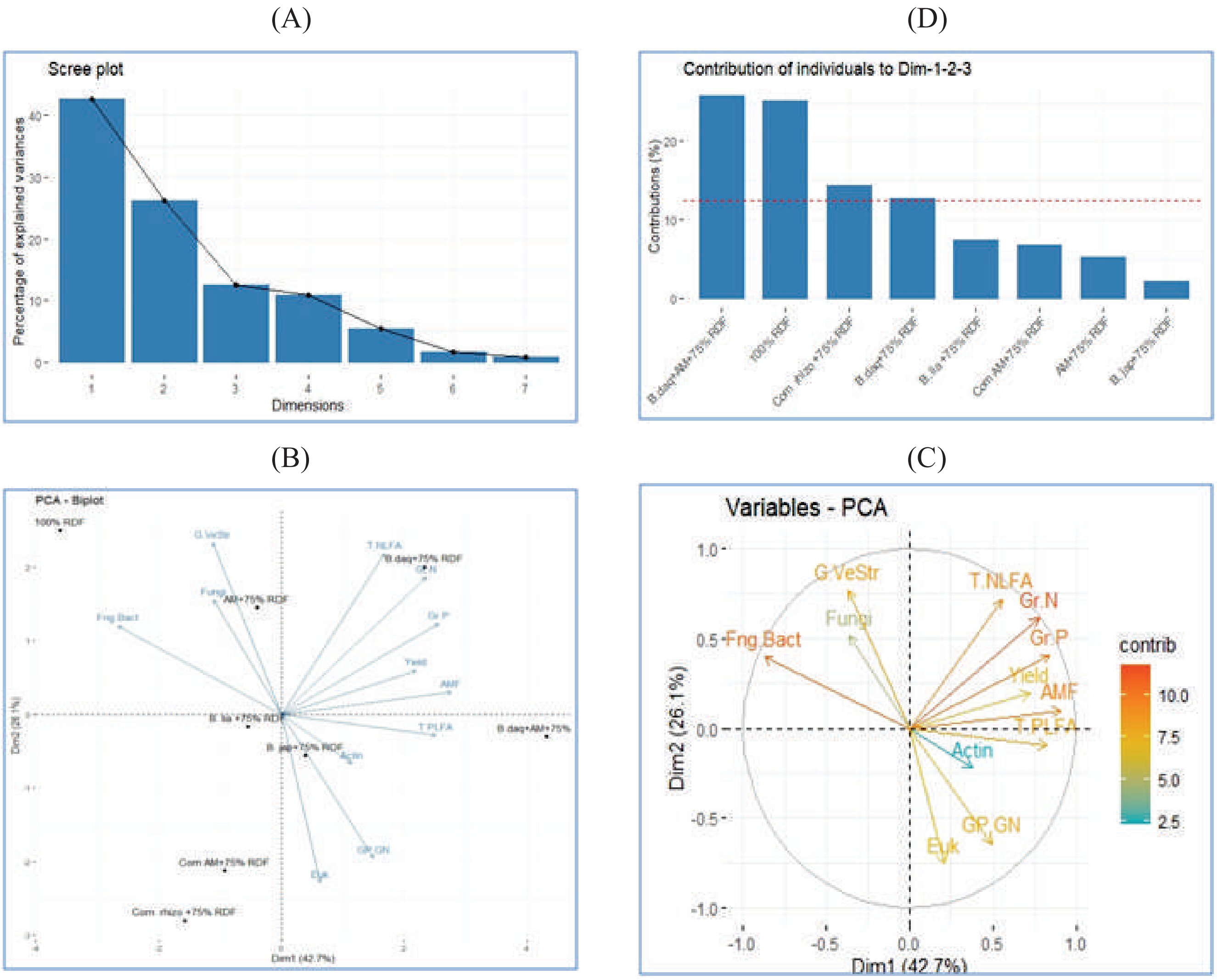


Fig 5.5: Principal component analysis (PCA) plots of microbial inoculations and their response to variables assessed in soybean rhizosphere soil. The magnitude of explained variance of PCs in scree plot (A), biplots (B, C) shows loadings of lipid biomarkers (variables or vectors) in rhizosphere soils across different combinations of microbial inoculation and fertilizer treatments. The PCA biplots (PC1 and 2) in B and C show the magnitude of variance and contribution to variables where ordination axes (based on Eigen values) explaining the variance across the combinations of treatments followed. The individual contribution of the microbial and fertilizer application practices to dimensions 1to 3 (D).

6. SOCIAL SCIENCE AND TECHNOLOGY TRANSFER

Impact of Technological Interventions on Socio- Economic Status of Soybean farmers under changing climate scenario – A comparative analysis

In order to study the impact of technological intervention it is important to study the level of adoption of the technologies and enumerate the independent variables which affect this gap. The impacts of the social-economical and communication variables were studies with reference to technological gaps in different variables.

Technology Gap : Technology gap indicates the extent to which technologies have not been adopted. This feedback information is essential to identify the weakness of technology transfer programme, to remove bottlenecks and accelerate adoption. Total three packages of practices were finalized to find out the technology gap. These practices were relates to seed treatment, agronomical practices and plant protection measures. The data on yield difference was also collected to see the impact of these variables. The general formula for measuring technology gap, which can be applied irrespective of the nature of technology is

$$TG = \frac{R-A}{R} \times 100$$

Where,

TG = Technology gap

R = Recommended package score

A = Adopted package score

The overall mean scores were calculated taking the scores of all respondents.

As evident from the Table 6.1 it is apparent that technological gap did not differ significantly in most of the categories in the different variable. With regard to yield gap to a similar trend is observed in the Table.

Table 6.1 : C values of eleven genotypes under study

Variables	Category	f	Technological Gap			Yield gap
			Agronomy Plant	Protection	Seed treatment	
Age	≤30	1	47.62[a]	85.71[a]	66.67[a]	64.00[a]
	30-50	43	52.49[a]	76.08[a]	63.57[a]	56.99[a]
	>50	28	51.70[a]	78.57[a]	65.48[a]	55.98[a]
Education	Illiterate	11	55.84[a]	74.03[b]	66.67[a]	62.67[a]
	Primary	20	53.57[ab]	73.57[b]	66.67[a]	56.11[ab]
	Secondary	11	51.08[ab]	84.45[a]	63.64[a]	57.12[ab]
	Intermediate	21	49.43[b]	76.19[ab]	60.32[a]	54.74[b]
	≥ Graduation	9	51.85[ab]	82.54[ab]	66.67[a]	54.76[b]
Land Holding	≤ 1 ha	20	54.05[a]	78.57[a]	66.67[a]	60.85[a]
	1- 2 ha	23	52.38[a]	76.40[a]	65.21[a]	54.51[b]

Variables	Category	f	Technological Gap			Yield gap
			Agronomy Plant	Protection	Seed treatment	
	2- 4 ha	18	50.79[a]	74.60[a]	62.96[a]	57.40[ab]
	4-10 ha	9	50.22[a]	80.52[a]	60.60[a]	52.55[b]
Mass Media	Low	4	51.19[a]	71.42[a]	66.67[a]	56.33[a]
	Medium	64	52.38[a]	77.45[a]	64.58[a]	57.43[a]
	High	4	48.80[a]	78.57[a]	58.33[a]	45.23[b]
Extension Contact	Low	3	41.26[b]	85.71[a]	66.67[a]	60.76[a]
	Medium	63	52.83[a]	77.09[a]	65.07[ab]	56.65[a]
	High	6	50.00[a]	73.80[a]	55.56[b]	55.15[a]

Further, the correlation was worked out between the independent and independent variable and a perusal of Table 6.2 shows that negative correlation in most variable which shows that higher the value of the variable lesser the gap. These were found significant in case of education with regard to the gap in agronomical and plant protection practices and of Extension contact with gap in the seed treatment practices. The Table 6.2 also shows that higher the education and land holding lesser was the yield gap.

Table 6.2 Correlation between the independent variable

Variables	Technological Gap			Yield gap
	Agronomy	Plant Protection	Seed treatment	
Age	0.077451	0.002548	0.13294	-0.05398
Education	-0.29568**	0.210171*	-0.17745	-0.25572**
Land Hold	-0.03937	0.112015	-0.15467	-0.26184**
Mass Media	-0.10222	-0.02287	-0.08443	-0.12109
Extension Contact	0.02283	-0.11917	-0.28248**	-0.01404

***10% Level of Probability **5% Level of Probability**

Externally funded Project: Establishment of BIOTECH-KISAN Hub at Manthan Gramin Evam Smaj Seva Samiti, Bhopal

Department of biotech sponsored Biotech-Krishi Innovation Science Application Network was initiated in Sehore district of Madhya Pradesh with ICAR-IISR, Indore as partner of the main hub established at Manthan, Amlaha, Sehore district (MP). Continuing with the demonstration in the second year in the ten villages meetings, farmers' field school, field days were held to intensify the dissemination of the use of Broad Bed and Furrow machine for sowing in soybean cultivation as well as resource conservation technologies. All the beneficiaries were distributed inputs. At each phase of the crop cycle group of farmers registered under the Farmer's filed school were demonstrated all the technologies in the second year too. Information with regard to benefit of BBF machine in adverse climatic condition (drought and heavy rainfall) and seed treatment was also provided.

Fig. 6.1 : Seed distribution and treatment being demonstrated at Farmer's field school

Fig. 6.2 : Sowing by BBF machine

Fig. 6.3 : Demonstration plot plant ladden with pods

Fig. 6.4 : Farmer's practice plot showing sparse pods on plants

Fig. 6.5 : Demonstration plot showing water in furrow

Fig. 6.6 : Water logged farmer's plot with mature cop

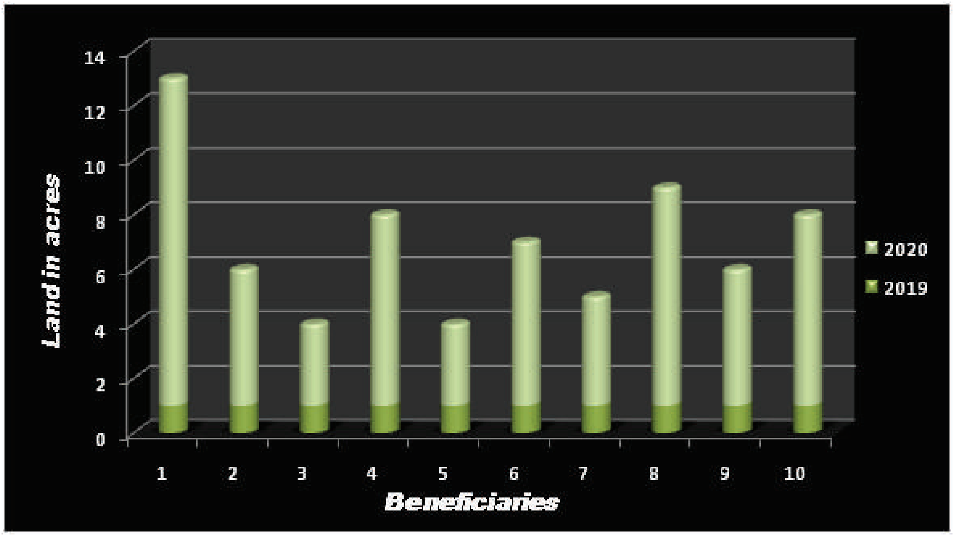
As in the first year of the project the average yield of the beneficiaries' demonstrations (one acre each) was 3.7 q/acre, as compared to 1.17 q/acre in conventional practices. The average cost of cultivation was Rs 12,715 per acre under demonstrations plots and Rs 9,574 per acre under other fields of the same farmers where they followed conventional practices. Gross returns of demonstrations were Rs 19,570 per acre and Rs 4,611 per acre under conventional practices with net return of about Rs 6,865 per acre and Rs -4,963 per acre respectively, as shown in Table 6.3. The B: C ratio realized was 1.53 under demonstrations plots and 0.47 under conventional practices plots.

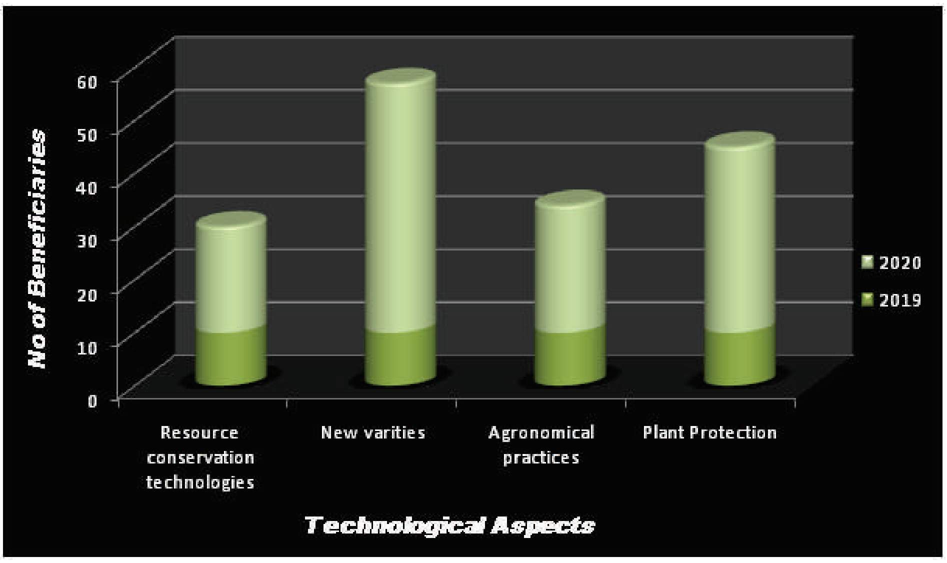
Table 6.3 : Effect of conservation agriculture practices (Permanent Borad Bed Furrow technology: PBBF) on yields and economics of soybean

Particulars	Average yield and economics of farmers field (with conventional practices)	Average yield of demonstrations (BBF/CA)
Yield (kg/acre)	117	370
Cost of cultivation (Avg. Rs)	9574	12715
Gross Income (Rs)	4611	19570
Net Income (Rs)	-4963	6865
B: C ratio	0.47	1.53

The demonstrations had a positive impact with regard to the increase in the area of adoption of the new varieties (JS 20-69 & JS 20-34) a shift from the popular variety i.e 95-60, use of resource conservation technologies including broad bed and furrow, agronomical practices (seed treatment, use of pre-emergent herbicides, seed rate etc) and plant protection recommendations not only among the beneficiary farmers (fig-1) from the year 2019 to 2020 among the beneficiaries. In the second year of the project the different technologies were also adopted by up to 47 farmers additionally (fig-6.7).

Fig . 6.7: Adoption of technologies in additional acreage by beneficiaries





Conservation agriculture is an important component of the overall strategy for enhancing productivity, improve environmental quality and preserve natural resources for food security and poverty alleviation. Soil tillage is one of the fundamental agro technical operations in agriculture because of its influence on soil properties, environment and crop growth. Since continuous soil tillage strongly influence the soil properties, it is important to apply appropriate tillage practices that avoid the degradation of soil structure, maintain crop yield as well as ecosystem stability. The efficiency of input use viz. water, fertilizers, herbicides and others depend on tillage and crop establishment practices. It is therefore, essential that the soil environment be manipulated suitably for ensuring a good crop stand and improve resource-use efficiency.

Table 6.4: Adoption of technologies in additional acreage by beneficiaries

S no.	Inputs					Output			
	Particulars	**Unit**	**Equivalent energy (MJ)**	**Quantity per unit area**	**Total energy equivalent (MJ/ha.)**	**Particulars**	**Equivalent energy (MJ)**	**Quantity per unit area**	**Total energy equivalent (MJ/ha.)**
1	Human labour	Man-hour	1.96	47	92.2	Main product (kg)			
2	Electricity	kWh	11.93	303.67	3622.78	Soybean	14.7	7246.98	106,530.6
3	Machinery (Tractor)	H	62.80	5	314	By product (kg)			
4	Chemical fertilizers			0	0	Straw	18	6175	83980
A	Nitrogen	kg	60.60	161.44	9783.26				
B	Phosphorus	Kg	11.10	158.08	1753.73				
c	Potash	kg	6.70	79.04	529.56				
d	Zink	kg	20.9	45.1	942.86				
5	Herbicide	kg	238.0	2.528	601.66				
6	Seed	kg	14.7	177.84	2614.24				
	Total 20214								**190510.6**
	Energy use efficiency (MJ/ha)					**27.04**			

Table 6.5 Effect of conventional practices on energy input, output and energy use efficiency in soybean

S no.	Inputs					Output			
	Particulars	**Unit**	**Equivalent energy (MJ)**	**Quantity per unit area**	**Total energy equivalent (MJ/ha.)**	**Particulars**	**Equivalent energy (MJ)**	**Quantity per unit area**	**Total energy equivalent (MJ/ha.)**
1	Human labour	Man-hour	1.96	50	98	Main product (kg)			
2	Electricity	kWh	11.93	303.67	3622.78	Soybean	14.7	7246.98	768055
3	Machinery (Tractor)	H	62.80	5	314	By product (kg)			
4	Chemica fertilizers			0	0	Straw	18	6175	662001
A	Nitrogen	kg	60.60	89.25	5408.55				
B	Phosphorus	Kg	11.10	100	1110				
c	Potash	kg	6.70	60	402				
d	Zink	kg	20.9	2.528	601.66				
5	Herbicide	kg	238.0	225	3307.5				
6	Seed	kg	14.7	50	98				
	Total				**14962.49**				**774675**
	Energy use efficiency (MJ/ha)				**51.78**				

Conclusion

The study therefore advocates CA practices in soybean-wheat cropping system to curtail the energy inputs, conserving natural resources, and sustaining the crop productivity. The energy efficiency of conversation practices is 27.04 (MJ/ha) comparatively less than conventional practices 51.78 (MJ/ha).

Field Day-
Field day organization under DBT Biotech project,

Field Day Village	Date	Participants	Crop
Gajikhedi	04/02/2020	125	Wheat
Bhilkhedi	05/02/2020	100	Wheat
Lasudiya Khas	11/02/2020	119	Wheat
Kothri	12/02/2020	125	Wheat
Bafapur	13/02/2020	125	Wheat
Amlaha	10/09/2020	113	Soybean
Bafapur	11/09/2020	86	Soybean
Ankiya	18/09/2020	70	Soybean

Fig. 6.8 : Interaction and Field Visit with Farmers on field Day

1 **Extension Activities**

Trainings organized:

Topic	Date	No of Beneficiaries	District
Soya processing For Women	15/12/2020	112	Sehore

Farmer Training and Input distribution under schedule caste sub-plan

The Institute organized Farmer training and input (Single and Double row Vegetable transplanter) distribution programme on July 1st and 3rd 2020, at Krishi Vigyan Kendra Barwani, Barwani district and Krishi Vigyan Kendra Khandwa , Khandwa district of Madhya Pradesh respectively under the Schedule caste sub plan. The special invitees for the training were Dr Alok Deshwal Head KVK Kasturbagram Indore, Shri S. K. badodiya, Head KVK Barwani, Dr D.K. Vani Head KVK Khandwa and the programme was presided over by Principal Scientist & Director Incharge, Dr Nita Khandekar. All the dignitaries addressed the farmers and urged them to use the Vegetable Transplanter. Emphasis was also laid on improving the livelihood of SC farmers who comes in below poverty line. A total of 200 single and 200 Double row vegetable transplanter distributed in Barwani (total 70 beneficieris), Khandwa (total 100 beneficieries) and Indore (beneficieries 30).

Fig. 6.9 : Director Incharge addressing the SC Farmers at KVK Barwani

Fig. 6.10 : Director Incharge addressing the SC Farmers at KVK Khandwa

Fig. 6.11 : Distribution of Vegetable Planter

Fig. 6.12 : Vegetable planter distribution

Distribution of Hand Weeder (200), Navin Dibbler (200) and Ridge maker (200) number of beneficiaries in different villages of Sehore district

Place/ Village	Date	Number of beneficiaries	Hand weeder	Navin Dibbler	Ridge maker
Bafapur	06/07/2020	53	33	53	33
Amipur	06/07/2020	7	7	7	7
mubarakpur	06/07/2020	2	2	2	2
Nipaniya Sikka	07/07/2020	11	11	11	11
Sevaniya	07/07/2020	39	39	39	39
Kheri	07/07/2020	65	65	65	65
Bhadakhedi	15/07/2020	29	29	29	29
Durgapura	15/07/2020	14	14	14	14

Fig. 6.13 : Distribution of Hand Weeder, Navin Dibbler and Ridge maker in Sehore district

Distribution of Battery Operated Sprayer Pump total number of 130 in Five districts in Madhya Pradesh

Name of District	Date	Number of beneficiaries
Indore	07/11/2020	43
Vidisha	18/11/2020	22
Damoh	20/11/2020	20
Chhatarpur	22/11/2020	25
Rajgarh	25/11/2020	20

Fig. 6.14 : Distribution of Sprayer Pumps in Indore, Vidisha, Damoh, Chhatarpur and Rajgarh District in Madhya Pradesh

7. राजभाषा–कार्यान्वयन

भारतीय संविधान में हिन्दी को संघ की राजभाषा के रूप में स्थापित किया गया है एवं संविधान के भाग सत्रह, अनुच्छेद तीन सौ इक्यावन में वर्णित है कि राजभाषा हिन्दी को इस तरह से विकसित किया जाए ताकि वह भारत की विविध संस्कृति को व्यक्त करने में समर्थवान हो । अतः राजभाषा के रूप में हिन्दी की भूमिका अत्यंत महत्वपूर्ण तथा दायित्व–युक्त भी है । इस उद्देश्य का वहन करते हुए भा. कृ. अनु. परि.–भारतीय सोयाबीन अनुसंधान संस्थान, इंदौर में राजभाषा हिन्दी के प्रसार–प्रचार हेतु अनेकानेक कार्यक्रम किए जा रहे हैं । जिनका स्वरूप भारतीय सोयाबीन अनुसंधान संस्थान में राजभाषा कार्यान्वयन के क्षेत्र में उत्तरोत्तर प्रगति के साथ दृष्टिगोचर होते हैं, जो राजभाषा के प्रगामी प्रयोग में अत्यंत सार्थक सिद्ध हो रहे हैं। इस क्षेत्र में किए जा रहे क्रियाकलापों का संक्षिप्त विवरण निम्नवत् हैं :

क) राजभाषा नियम,1976 के नियम 8 का अनुपालन : संस्थान के अधिकारी एवं कर्मचारी शासकीय कार्यों हेतु राजभाषा नियम,1976 के नियम 8 के उपनियम (1) तथा (4)के अनुसार लिखे जाने वाली टिप्पणियाँ एवं अन्य कार्य हिन्दी में करते है ।

ख) राजभाषा कार्यान्वयन समिति की तिमाही बैठक

- प्रथम बैठक : दिनांक 04 जनवरी 2020
- द्वितीय बैठक : दिनांक 05 जून 2020
- तृतीय बैठक : दिनांक 24 जुलाई 2020
- चतुर्थ बैठक : दिनांक 09 अक्टूबर 2020

ग) प्रशिक्षण : संस्थान में राजभाषा के प्रचार–प्रसार हेतु कृषकों एवं प्रशिक्षणार्थियों को प्रशिक्षण संबंधित सारी सामग्रियाँ हिन्दी में भी प्रदान की जा रही है ।

घ) शब्दकोश में वृद्धि : संस्थान में प्रतिदिन एक शब्द हिन्दी एवं अंग्रेजी को द्विभाषी रूप में "आज का शब्द" के रूप में प्रदर्शित किया जा रहा है, ताकि कर्मचारियों, अधिकारियों एवं वैज्ञानिकों के हिन्दी शब्द ज्ञान में वृद्धि करने के साथ ही साथ हिन्दी के कार्यालयीन उपयोग में भी सहायता प्रदान कर सके ।

ङ) अनुवाद द्विभाषी प्रपत्र : संस्थान में कार्यालयीन कार्य में प्रयुक्त होने वाले विभिन्न पत्रों, प्रपत्रों आदि का अनुवाद कार्य भी प्रगति पर है, जिससे दिनोंदिन प्रायः प्रयुक्त होने वाले सभी प्रकार के पत्रों, प्रपत्रों का द्विभाषी मुद्रित रूप सम्मिलित है। यह कार्य राजभाषा कार्यान्वयन की दिशा में स्थाई एवं आधारभूत उपलब्धि है।

च) राजभाषा तिमाही रिपोर्ट का प्रेषण : संस्थान में राजभाषा हिन्दी से संबंधित समस्त कार्यों का विवरण तिमाही हिन्दी रिपोर्ट के माध्यम से संबंधित विभागों को ऑनलाइन एवं द्रुतगामी डाक सेवा से प्रेषित किया जाता है। इस कार्य को धरातलीय रूप प्रदान करने में संस्थान के समस्त संबंधित अनुभाग का सक्रिय एवं सराहनीय योगदान होता है ।

छ) राजभाषा अधिनियम 1963 की धारा 3 (3): सस्थांन में राजभाषा अधिनियम 1963 की धारा 3 (3) से संबंधित दस्तावेजों जैसे : सामान्य आदेश, अधिसूचनाएं प्रेस विज्ञप्तियाँ संविदा, करार, लाइसेंस परमिट टेंडर के फार्म और नोटिस, संकल्प नियम इत्यादि को (हिन्दी और अंग्रेजी) द्विभाषी रूप में निकाला जाता है, ताकि राजभाषा संबंधित दिशा–निर्देशों का पालन सतत होता रहे ।

(ज) हिन्दी कार्यशालाएं : संस्थान के अधिकारियों एवं कर्मचारियों की हिन्दी में कार्य करने के दौरान होने वाली

समस्याओं के निराकरण हेतु संस्थान में हिन्दी कार्यशालाओं का आयोजन किया जाता है । इसके अतिरिक्त कार्यशालाओं के आयोज का मुख्य ध्येय यह भी होता है कि हिन्दी का प्रयोग किस प्रकार सरल से सरलत्तम् की ओर बढ़ाया जा सकता है । इसलिए प्रत्येक तिमाही में कम से कम एक हिन्दी कार्यशाल का आयोजन किया जा रहा है, ताकि संस्थआन के सभी सवंर्गो में हिन्दी के कार्य संपन्न करने का रूझान में उत्तरोत्तर प्रगति हो सके । इस उद्देश्य हेतु संबंधित विषयानुसार कार्यशालाएं सम्पन्न की जाती है । जनवरी–जून 2020 में अब तक 02 कार्यशालाओं का आयोजन किया गया, जिसकी सूची इस प्रकार से हैं :

Table 7.1 : वर्ष में आयोजित हिन्दी कार्यशालाओं का विवरण

क्र.	दिनांक	विषय	अतिथि वक्ता
1	12 मार्च 2020	चित्र के माध्यम से भाषा का विकास	डॉ. डी.एन. बारस्कर, सहा.मुख्य तक. अधि., भारतीय सोयाबीन अनुसंधान संस्थान, इंदौर
2	25 जून 2020	संसदीय राजभाषा समिति के निरीक्षण संबंधित प्रश्नावली	डा अमरनाथ शर्मा प्रधान वैज्ञानिक विभाग प्रमुख –फसल संरक्षण, भारतीय सोयाबीन अनुसंधान संस्थान, इंदौर
3	08 सितम्बर 2020	सूचना प्रद्योगिकी एवं वाइस टाइपिंग	श्री ए. के. जगदीशन, सहायक निदेशक (राजभाषा) भारतीय बागवानी अनुसंधान संस्थान, बेंगलुरु.
4	13 दिसम्बर 2020	राजभाषा नीति एवं दिशा निर्देश	डा देवेश कुमार त्यागी उप– निदेशक (राजभाषा) प्रधान मुख्या आयकर आयुक्त, भोपाल.

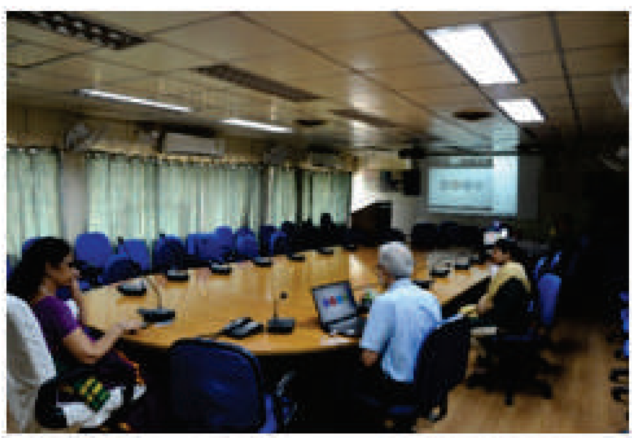



Fig. 7.1: हिंदी कार्यशाला के दौरान प्रशिक्षण प्रदान करते हुए अतिथि वक्ता डा. दी. एन. बारस्कर एवं डॉ. अमरनाथ शर्मा

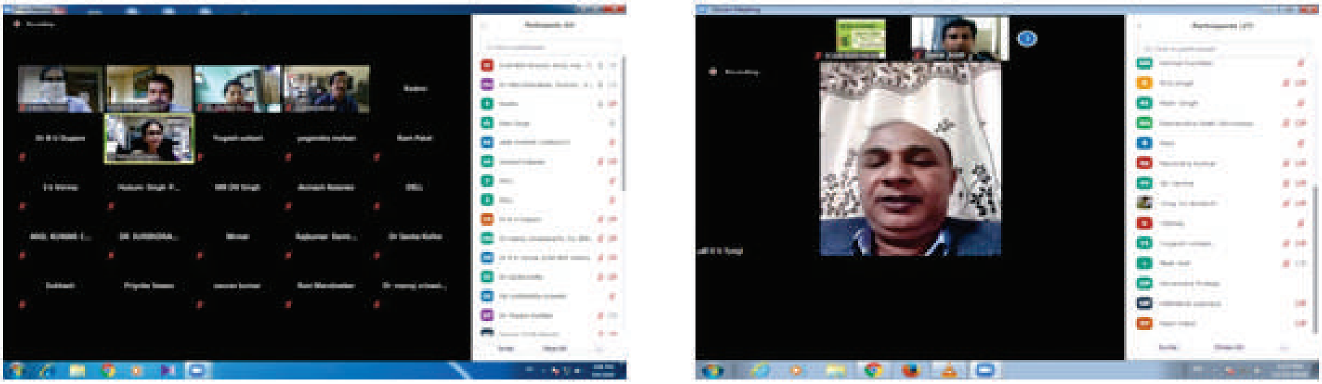


Fig. 7.2 : हिंदी कार्यशाला के दौरान प्रशिक्षण प्रदान करते हुए अतिथि वक्ता

झ) यूनिकोड की सुविधा : संस्थान के अधिकारियों तथा कर्मचारियों की हिन्दी में कार्य करने की रूचि में वृद्धि करने हेतु समस्त कम्प्यूटर में हिन्दी यूनिकोड की व्यवस्था प्रदान की गई है, जिससे एक समान फॉन्ट के माध्यम से पूरा संस्थान एक ही दिशा की ओर अग्रसर हो सके ।

ञ) मौलिक लेखन कार्य का प्रादुर्भाव : संस्थान में राजभाषा संबंधी विभिन्न क्रियाकलापों के साथ मौलिक लेखन कार्य को द्रुतगामी आयाम प्रदान करने में अधिकारियों एवं कर्मचारियों की रूचि अद्वितीय है । विभिन्न प्रतिष्ठित संस्थानों द्वारा इनकी लेखनी को स्थान प्राप्त होते हैं ।

8. ON-GOING PROJECTS, 2020

8.1 On Going Research Projects

8.1.1 Institute Funded Projects

Project No.	Years	Project Title	PI/Co-PI
CROP IMPROVEMENT			
Mega theme- Soybean genetic resource management- Acquisition, conservation, characterization, documentation and utilization			
NRCS 1.1/87	1987-LT	Augmentation, management and documentation of soybean germplasm	Dr. Sanjay Gupta-PI
Mega theme- Genetic improvement of soybean for yield, agronomic traits, resistance to biotic stresses and improvement in quality of soybean seed			
NRCS 1.6/92	1992-LT	Hybridization, selection and development of multi-parent population for genetic improvement of yield potential in soybean	Dr Shivakumar M.-PI
IISR 1.33/16	2016-LT	Development of YMV resistant soybean varieties using marker assisted selection	Dr. Anita Rani -PI
IISR 1.35/17	2017-2022	Improvement in soybean seed viability and strength of seed coat by genetic amelioration of seed coat traits	Dr P. Kuchlan -PI
IISR 3.11b/18	2017-2022	Soybean Improvement against charcoal rot and anthracnose diseases	Dr. Nataraj V.-PI
IISR 1.34/17	2018-2023	Enhancing disease resistance in soybean using genomic approaches	Dr. Milind B. Ratnaparkhe-PI
IISR 3.12/19	2019-2024	Soybean Improvement against defoliating insects	Dr. V. Rajesh-PI
IISR 3.13/19	2019-2024	Evaluation of germplasm and breeding for collar rot disease caused by Sclerotium rolsfsii Sacc in soybean	Dr. R. Ramteke-PI
Mega theme- Managing the impact of current and future climate variability in soybean			
DSR 5.6a/08	2009-2021	Breeding for drought resistance / tolerance varieties in soybean	Dr G. K. Satpute-PI
DSR 5.6b/18	2018-2023	Soybean breeding for waterlogging tolerance	Dr. S. Chandra-PI
IISR 3.14/20	2020-2025	Characterization of abiotic stress tolerance factors in soybean using biochemical and molecular approaches	Dr. Manoj Kumar Srivastava-PI
Mega theme- Development of specialty soybean varieties for secondary agriculture and industrial uses			
NRCS 1.12/02	2002-LT	Breeding for food grade characters and high oil content	Dr. Anita Rani-PI
DSR 1.28/14	2014-2021	Mapping QTLs for oleic acid and development of high oleic acid soybean	Dr. Vineet Kumar-PI

Project No.	Years	Project Title	PI/Co-PI
IISR 1.32/16	2016-2020	Screening soybean germplasm for vegetable type characteristics and optimization of processing parameters	Dr Neha Pandey-PI
IISR 3.15/2020	2020-2024	Development of genome edited soybean lines with improved oil quality	Mr Viraj Kamble-PI
CROP PROTECTION			
Mega theme- Surveillance, forecasting and control strategies for insect pest complex in soybean			
IISR 3.11a/18	2018-2020	Morphological and molecular characterization of Macrophomina phaseolina causing charcoal rot in soybean	Mr. Sanjeev Kumar-PI
IISR 3.11c/18	2018-2021	Selection of potential fungal and bacterial soybean endophytes and their evaluation against major diseases of soybean	Dr. L. S. Rajput-PI
CROP PRODUCTION			
Mega theme- Development of technologies for soybean based cropping system efficiency enhancement through resource conservation technologies, nutrient management. plant growth promoting microbes and farm machineries (S D Billore)			
IISR 5.7/17	2017-2020	Drought amelioration in terms of morpho-physiological, biochemical characters and seed yield in soybean through foliar application of nutrients	Dr. Maharaj Singh-PI
IISR 3.12/2020	2020-2023	Interaction effect of phytohormones and AMF for enhanced nodulation, growth, yield of soybean with improved AMF symbiosis in the rhizosphere.	Dr. M P Sharma-PI
IISR 6.9/17	2017-2020	Bacterial mediated sulphur bioavailability in soybean	Sh. Hemant Maheshwari-PI
IISR 9.9/17	2017-2020	Design, development and validation of (A) Tractor PTO operated root stock cutting/shaving machine (B) Tractor PTO operated root stock picking machine to prevent burning of root stock for Vertisols and associated soils	Dr. DEVVRAT SINGH-PI
IISR 4.13/17	2017-2022	Evaluation of tillage and crop establishment and residue management practices for sustaining/improving resources use efficiency, soil health and crop productivity in soybean based cropping systems	Dr. Rakesh Kumar Verma -PI
IISR 4.14/18	2018-2023	Agronomic biofortification of micronutrients in conservation agriculture based soybean-wheat cropping system	Dr. Raghavendra M.-PI
IISR 9.10/2019	2019-2022	Predicting the incidence of stem fly, pod borer, and Bihar hairy caterpillar in soybean- A Geo-spatial approach	Sh. R. M. Patel -PI
IISR 9.11/20	2020-2023	Field evaluation of potential plant growth promoting rhizobacteria (microbial consortia) on nutrient dynamics and mineral biofortification under soybean- wheat cropping system	Dr. A. Ramesh

Project No.	Years	Project Title	PI/Co-PI
EXTENSION			
Mega theme- Information digitization, technology dissemination, impact analysis and socio-economic research for soybean			
DSR 7.6/19	2019-2022	Development of field monitoring support system for All India Co-ordinated Research project trials.	Dr Savita Kolhe-PI
IISR 8.17/20	2020-2025	Development and evaluation of ICT tools and medias for TOT of Soybean	Dr B. U. Dupare- PI
IISR 8.16/18	2018-2021	Impact of technological interventions on socio-economic status of soybean farmers under changing climate scenario - a comparative analysis	Dr. Nita Khandekar-PI

EXTERNAL FUNDED PROJECTS			
DAC, Government of India	2005-LT	DUS testing of soybean-Central sector scheme for protection of plant varieties and farmers right.	Dr. Mrinal K. Kuchlan-PI (Rs 6.5 Lakhs/Year)
ICAR	2006-LT	ICAR – Seed Project: Seed Production in Agricultural Crops.	Dr. Mrinal K. Kuchlan-PI (Rs 8.5 Lakhs/Year)
DBT , Government of India	2015-2020	Marker assisted elimination of off flavor generating lox II gene from KTI free genotypes	Dr. Vineet Kumar-PI (Rs. 46.59,200 Lakhs)
DBT, Government of India	2017-2020	Assessing the bio-availability of nutrients and reduction of heavy metals in soil amended with inorganic and organic waste in presence of AM fungi and biochar	Dr M.P. Sharma-PI (Rs.19.73,000 Lakhs)
CSIR, Government of India	2017-2020 `	Development of an Efficient Scalable Clustering Algorithms for Big Data and investigation of Integrated system for Protein Sequence Classification	Dr.Milind B. Ratnaparkhe (Rs 30.00 Lakhs)
DAC, Minister of Agriculture	2018-2020	Creation of Seed Hubs for enhancing quality seeds availability of major oil seed crops under NFSM-Oil Seeds	Dr. Mrinal K. Kuchlan-PI (Rs 1.5 Crore)
DBT, Government of India	2018-2021	Development of genetic stocks for maturity and growth habit genes in soyabean (*Glycine max (L.*) Merr.)	Dr Sanjay Gupta-PI (Rs 42.88,400 Lakhs)
ICAR Network Project	2018-2021	Identification of high trehalose -producing soybean rhizobia and their integration with AM fungi for enhanced drought tolerance in soybean	Dr M.P. Sharma-PI (Rs 20.00 Lakhs)

EXTERNAL FUNDED PROJECTS			
National Agriculture Science Funds (NASF), ICAR	2018-2021	Genomics strategies for improvement of yield and seed composition traits under drought stress conditions in soybean	Dr Milind B. Ratnaparkhe -PI (Rs 219.61,093 Lakhs)
IITM, Ministry of Earth Science, Govt. of India	2018-2021	Strategies for enhancing yield of soybean (Glycine max L) and pigeonpea (Cajanus cajan, L) in India using climate variability information and crop growth simulation models	Dr. Raghavendra M.-PI (Rs 80. 94 Lakhs)
DBT, Government of India	2019-2021	Establishment of BIOTECH-KISAN Hub at Manthan Gramin Evam Smaj Seva Samiti,	Dr. Nita Khandekar (Rs 163.20 Lakhs)
DBT, Government of India	2019-2021	Expansions of Activities of Biotech -KISAN Hub in Seven Aspirational districts in Madhya Pradesh under Biotech-KISAN Hub	Dr. Nita Khandekar (Rs 406 Lakhs)
Science & Engineering Research Board (SERB) Govt. Of India	2019-2022	Development of Laser Biospeckle Technique for Applications in Agriculture	Dr. Shashi Prakash, (Rs 30 Lakhs)
DBT, Government of India	2020-2023	Accelerated development of Kunitz trypsin inhibitor free soybean genotypes with charcoal rot resistance	Dr. Vineet Kumar-PI (Rs 39.242 Lakhs)
SERB, DST, New Delhi	2021-2024	Genome- wide association mapping of charcoal rot resistance in soybean *(Glycine max L.)*	Dr. V. Nataraj

* LT: Long Term

9. PUBLICATIONS

Research article

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Popular article

Chandra, S., Vangala R., Nagar, S., Nataraj, V. and Verma, R.K. (2020). Minimizing the impact of water logging and high temperature stress in soybean. In: Agrobios Newsletter 18 (11): 33-34.

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Book Chapter

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Seminar/symposium/conference etc.

International Conference: Satpute, G.K., Ratnaparkhe, M.B., Kamble, V., Chandra, S., Gupta, S., Kumawat, G., Ramgopal, D., Singh, M., Shivakumar, M., Pandey, S.K., Nataraj, V., Rajesh, V. and Bhatia, V.S. (2021). Enhancing productivity of deep rooting soybean genotypes under drought conditions. In: Proc. 43rd COSPAR Scientific Assembly, held in virtual mode at Sydney, Australia.

Presentation in International and National Conferences:

Chandra, S., Satpute, G. K., Singh, M., Nagar, S., Kumawat, G., Shivakumar, M., Rajesh, V., Arya, M., Ratnaparkhe, M.B., Nataraj, V., Pandey, S. and Gupta, S. (2020). Water logging tolerance in soybean at reproductive stage: traits and donors identified. Abstracts of International Web Conference on New Trends in Agriculture, Environment and Biological Sciences for inclusive Development during 21-22 June 2020. pp 188 (Oral Presentation)

Nataraj, V., Kumar, S., Rajput, L.S., Shivakumar, M., Ramteke, R., Rajesh, V., Ratnaparkhe, M.B., Chandra, S., Satpute, G.K. and Gupta, S. (2020) Evaluation of soybean RIL population for charcoal rot resistance. Paper Presented in the National Seminar on "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security" during7th – 8th Fab 2020 at Hyderabad. J oilseed Res. :37 (Special Issue) pp.38 (Oral Presentation)

Raghvendra, M. (2020). Attended International Webinar on Building Climate Resilience in Agriculture through Agro meteorology and other Technological Interventions on dated 15-17 December 2020 held at Centre for Advance Studies on Climate Change Dr. Rajendra Prasad Central Agricultural University, Pusa(Samastipur)-848 125, Bihar through virtual mode.

Raghvendra, M. (2020). Attended National Webinar on "Abiotic Stress in Agriculture: Geospatial Characterization and Management Options" on 27.08.2020. 10.00 hrs. Organized by ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra, India.

Raghvendra, M. (2020). Attended One-day national webinar on problematic soils Nature, extent and management of problematic soils for sustainable agriculture" through virtual mode on 13-08-2020 at 10.30 am organized by Directorate of Research Services, RVSKVV, Gwalior (M.P.) In collaboration with AICRP on Management of Salt Affected Soils & Use of Saline Water in Agriculture, College of Agriculture, Indore, Indore Chapter of Indian Society of Soil Science (ICISSS) Indian Society of Soil Salinity and Water Quality, CSSRI, Karnal.

Raghvendra, M. (2020). Attended one-week Online Training Course on "Crop Weather Modeling: Tools for Climate Smart Agriculture" organized by the Centre for Advanced Science and Technology for Climate Smart Agriculture and Water Management (CAAST-CSAWM), Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra State) under National Agriculture Higher Education Project (NAHEP), Indian Council of Agriculture Research (ICAR), New Delhi during 21-25 December, 2020 through virtual mode.

Raghvendra, M. (2020). Participated in International Webinar on Soil Spectroscopy: An Emerging Technique for Rapid Soil Health Assessment Jointly organized by ICAR Indian Institute of Soil Science, Bhopal & World Agroforestry (ICRAF), Nairobi on 01 October 2020 through virtual mode.

Rajesh, V., Meena, L.K., Gupta, S., Shivakumar, M., Nataraj, V., Kamble, V.G., Ramteke, R., Chandra, S., Singh, R.N. and Sharma, A.N. (2020). Screening of soybean genotypes for antixenosis against Spodoptera litura. Paper Presented in the National Seminar on "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security" during 7th – 8th Fab 2020 at Hyderabad. J oilseed Res. :37 (Special Issue) pp.228(Poster Presentation)

Rajput, L.S., Kumar, S., Sharma, M.P., Maheshwari, H.S., Yadav, S.., Goswami, D., Meena, L.K., Nataraj, V. and Ratnaparke, M.B. (2020), Biocontrol potential of soybean fungal and bacterial endophytes against major soybean fungal diseases. In: International E - Conference on "Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture" held during 6 - 9th October, 2020.

Ramteke, R., Nataraj, V., Shivakumar, M., Kumar, S., Rajput, L.S., Chandra S. and Rajesh V. (2020). Present status of resistance to collar rot disease caused by Sclerotium rolfsiiSacc in soybean. Paper Presented in the National Seminar on "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security" during 7th – 8th Fab 2020 at Hyderabad. J oilseed Res. :37 (Special Issue) pp.226 (Poster Presentation)

Satpute, G.K., Arya, M., Gupta, S., Bhatia, V.S., Ramgopal, D., Ratnaparkhe, M.B., Chandra, S., Singh, M., Nagar, S., Kamble, V.G.,, Pandey, S., Kumawat, G., Shivakumar, M., Nataraj, V. and Rajesh, V. (2020) Identifying drought tolerant germplasm through multiplexing polygenic traits in soybean (Glycine max L. Merrill). Paper Presented in the National Seminar on "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security" during 7th – 8th Feb 2020 at Hyderabad. J oilseed Res.: 37 (Special Issue) pp.56 (Poster Presentation)

III. Research Articles/ Technical Bulletins:

ICAR- IISR published half-yearly bulletin covering the monsoon progress in the country, soybean area sown progress in different states, kharif crops & oilseeds acreage distribution, soybean production scenario in India and World, domestic and international price movements of soybean and products, import and export of soybean products from India.

Soybean Market Monitor can be accessed through institute website:

1. Soybean Market Monitor - Apr-Sept 2020. RM Patel, P Sharma.
https://iisrindore.icar.gov.in/pdfdoc/soybeanmonitorsept2020.pdf

Lectures delivered
(technical Lectures):-

Lectures delivered:
Dr. D.V.Singh

1. Delivered webinar on mechanisation in soybean specifically preparedfor scientists and farmers from ICAR-IISR, Indore .
2. Prepared video program for Doordarshan Bhopal on Covid-19 whichwas part of 35 citizens of Madhya Pradesh to encourage farmers to perform agricultural Operation with safety in Covid-19 situation in the whole country. Telecast was on Bhopal Doordarshan for several days
3. Received ICAR-NASI award on Agricultural Implements from Minister of Agriculture and Farmers welfare on 16-7-2020
4. Delivered lecture for the course on "mechanization for soybean and wheat crop" inheld at FTC Indore at FTC (Farmers training centre), Indore.
5. Prepared 08 YouTube programs and uploaded which contains practical and informative information YouTube programs are specifically prepared for farmers and are related to Agricultural machinery

C. Acted as resource person/eminent speaker/delivered invited talks during national/international conferences/meetings: 07

1. Sharma, M.P. (2020) Exploiting AM fungi in sequestering soil carbon and enhancing the crop productivity assessed under soybean-based cropping system. Invited talk delivered during 7th International IPS conference on Phytopathology in Achieving UN Sustainable Development Goals, organized by IARI, New Delhi, India from Jan 16-19, 2020.
2. Sharma, M.P. (2020) Arbuscular Mycorrhiza Technology: A tool for sustaining the soil biological health, plant productivity and environment an invited talk lead talk delivered during National Conference "Resource Conservation for Soil security and Jalshakti: Farmers Perspective in Bundelkhand" (RCSSJ-2020) held from 3rd - 5th February, 2020 at ICAR-IISWC RC, Datia, Madhya Pradesh, India.
3. Sharma, M.P. (2020) Arbuscular Mycorrhizal Fungi: A new generation fungal biofertilizer and its application in agriculture invited talk delivered during 18th Refresher Programme in Life Sciences (Recent Trends in Life Sciences) organized from 28th Oct 2020 to 10th Nov 2020 through online by UGC-Human Resource Development Centre, DAVV, Indore.
4. Sharma, M.P. (2020) Exploring soybean rhizobia for abiotic stress tolerance invited talk delivered during 18th Refresher Programme in Life Sciences (Recent Trends in Life Sciences) organized from 28th Oct 2020 to 10th Nov 2020 through online by UGC-Human Resource Development Centre, DAVV, Indore.
5. Sharma MP (2020) Prospects of AM fungi sequestering soil carbon under sustainable agriculture delivered invited talk (speaker of eminence) during National Webinar on Soil Health: Role of Microorganisms and Soil Organic Matter organized by IDP-NAHEP-RVSKVV-Gwalior, RAK College of Agriculture, Sehore on July 6, 2020.
6. Sharma, M.P. (2020) am Fungi: A new generation fungal biofertilizer for application in agriculture and environment delivered invited talk (Speaker of the Eminence) in the workshop on development of novel Biofertilizers and Biopesticides on Oct 12th, 2020 during e-Refresher Course on Era of Biotechnology: Innovate by Learning of Advances in Biotechnology organized by the Department of Biotechnology, AKS University, Satna (MP) India from 3rd September-28 October, 2020.
7. Sharma, M.P. (2020) Exploitation of AM fungi in CO2 mitigation under changed agricultural management practices delivered invited talk (speaker of eminence) during International E-conference on Recent Advances in Agriculture & Environment for Improvement of Agricultural Sustainability organizing online by SAGE School of Agriculture, SAGE University Bhopal, in association with Asian PGPR Society for Sustainable Agriculture APSSA-India Chapter on 28 August 2020.

Seminar/Conference/Symposium/Workhop/Training conducted by the Center during 2020

1. Khandekar, N., and Verma, R. K. 2020. Conservation Agriculture: Towards Doubling Farmers' Income. In 9th National Seminar on "Doubling Farmers Income by 2022: Challenges, Opportunities and Way Forward" Jointly Organized by MOBILIZATION (Society for Community Mobilization for Sustainable Development) & Career Point University, Hamirpur February 14-16. (Lead Talk)

Bulletin/ Brochures/folder/spin charts

1. Sharma, A. N., Rajput, L. S., Khandekar, N., Verma, R. K., Yadav, S., Vishvakarma, P., Rathod, B. S., Ghorse, D. K., Garg, P., Chaturvedi, S. (2020) Insect pest management in Soybean. Developed under D.B.T. - Biotech KISAN project, ICAR- Indian Institute of Soybean Research, Indore

2 Rajput L S, Sharma A N, Khandekar N, Verma R K, Yadav S, Vishvakarma P, Rathod B S, Ghorse D K, Garg P, Chaturvedi S (2020) Disease pest management in Soybean. Developed under D.B.T. - Biotech KISAN project, ICAR- Indian Institute of Soybean Research, Indore

3 Verma R K, Sharma A N, Khandekar N, Rajput L S, Yadav S, Vishvakarma P, Rathod B S, Ghorse D K, Garg P, Chaturvedi S (2020) Weed management in Soybean. Developed under D.B.T. - Biotech KISAN project, ICAR- Indian Institute of Soybean Research, Indore

10. AWARDS AND RECOGNITIONS

- Dr. D.V. Singh, Principal Scientist (FMP), Received ICAR-NASI award on Agricultural Implements from Minister of Agriculture and Farmers welfare on 16-7-2020

- Best oral presentation award for research work entitled "Soybean-wheat system productivity and economics as influenced by agronomic biofortification under conservation and conventional tillage practices" at 5th Uttar Pradesh Science Congress on "Enhancing Farmer's Income and Water Conservation: Opportunities and challenges" held on 22-24th February, 2020 at Banaras Hindu University, Varanasi (UP), India.

- Best Oral Presentation Award at the National Seminar on, "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security' jointly organized by Indian Society of Oilseeds Research, Hyderabad and ICAR-IIOR, Hyderabad, held at Hyderabad during February 7-8, 2020 for the poster entitled, "Comparative genomics studies of Rpp1 gene associated with soybean (Glycine max) rust resistance " presented by Ratnaparkhe et al.

- Best Poster Award at the National Seminar on, "Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security' jointly organized by Indian Society of Oilseeds Research, Hyderabad and ICAR-IIOR, Hyderabad, held at Hyderabad during February 7-8, 2020 for the poster entitled, "Identifying Drought Tolerant Germplasm Through Multiplexing Polygenic Traits in Soybean" presented by Satpute et al.

- Dr Vangala Rajesh received Young Scientist award in the field of Genetics & Plant breeding from Society for Scientific Development in Agriculture and Technology (SSDAT) on the occasion of International web conference on Global Research Initiatives for Sustainable

Agriculture & Allied Sciences (GRISAAS-2020) held during 28-30 December, 2020.

- Dr Vangala Rajesh received Best PhD Thesis Award from Samagra Vikas Welfare Society (SVWS) during the "International seminar on modern agriculture approaches in 21st century" held at Auditorium, Department of of Lucknow, Lucknow, Uttar Pradesh, India during 22-23, November, 2019.

Deputation abroad Dr. Giriraj Kumawat

- Dr. Giriraj Kumawat, Scientist (Sr. Scale) (Biotechnology) Japan International Research Centre for Agricultural Science (JIRCAS), Tsukuba, Japan, w.e.f. 01.10.2019 to 31.03.2021

Peer recognitions/member of expert panel/journal editorial board

i. Editor in Frontiers in Agronomy: Soil-plant interactions for a special volume on Managing native AM fungi microbiome through crop and soil management practices in agro-ecosystems (other co-editors are from Spain, China, Switzerland, India)

ii. Reviewer excellence award of reviewing papers of Legume Research awarded during Nov 2020

iii. Member of Scientific and Technical Steering Committee of 6th Asian PGPR Society National Conference being organized by Department of Microbiology, Barkatullah University, Bhopal from 3-4, Sept 2021.

11. LINKAGES & COLLABORATIONS

Effective linkages and collaborations were made with the following International, National and Regional institutions/organizations for soybean research and development and extension activities.

International

Asian Vegetable Research and Development Centre, Taiwan
International Institute of Tropical Agriculture, Ibadan, Nigeria
Brazilian Agricultural Research Enterprise, National Soybean Research Center, EMBRAPA.
University of Illinois, Urbana, Illinois, 61821, USA.
University of Arkansas, USA
Soybean Production Research, USDA, ARS, Stoneville, Mississippi 38776, USA.
IOWA State University, USA.
International Potash Institute, Switzerland.
International Plant Genetic Resources Institute, Rome, Italy

National

SAUs in the States of Madhya Pradesh, Chhatisgarh, Maharashtra, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Rajasthan, Punjab, Haryana, Jharkhand, Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal, North-Eastern States.
ICAR-National Bureau of Plant Genetic Resources, New Delhi
ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
ICAR-Indian Institute of Pulses Research, Kanpur
ICAR-Central Institute of Agricultural Engineering, Bhopal
ICAR-National Research Centre for Plant Biotechnology, New Delhi
ICAR-Indian Institute of Oilseed Research, Hyderabad
ICAR-Indian Agricultural Research Institute, New Delhi
ICAR-National Academy of Agricultural Research Management, Hyderabad
ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra
ICAR-Directorate of Groundnut Research, Junagadh, Gujarat
National Bank for Agriculture and Rural Development
Agharkar Research Institute, Pune
Indian Institute of Technology, Indore
University of Delhi, New Delhi

Regional

Department of Agriculture of Madhya Pradesh, Chhattisgarh, Maharashtra, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Rajasthan, Punjab, Haryana, Jharkhand, Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal, North-Eastern States
NGOs like SOPA, OILFED
State Seed Corporation, Department of Seed Certification

12. IMPORTANT COMMITTEES

There are number of committees which support the R&D programme as well as management and administrative work of the Institute.

12.1 Research Advisory Committee (w. e. f. 07.06.2020 to 06.06.2023)

Chairman	Dr. S.K. Sharma, Former Vice Chancellor, CSK H.P. Krishi Vishwavidyalaya), Shanti Kunj, Ghuggar Tanda, Palampur-176062
Member	Dr. T.K. Adhya, (Former Director, ICAR-NRRI, Cuttack and Professor, School of Biotechnology, KIIT University, Bhubaneswar) Flat # B-423 Rajendra Vihar,Forest Park Bhubaneswar (Odisha) 751 009
Member	Dr. K.R. Koundal, Former Jt. Director (Research), ICAR-IARI & Director, ICAR-NIPB, New Delhi) C-402, Dhauladhar Appartment, Plot 15, Sector 5, Dwarka, New Delhi- 110075
Member	Dr. P.G. Karmakar, Former Director, (ICAR-CRIJAF, Barrackpore, Kolkata) Chittaranjan Colony, Halisahar,Post Office Nabanagar, North 24 Pargana, West Bengal-743136
Member	Dr. Rekha S. Singhal, Professor of Food Technology, Former Head, Food Engineering and Technology Department, Dean (Research, Consultancy and Resource Mobilization), Institute of Chemical Technology, N.P. Marg, Near Khalsa College, Matunga, Mumbai - 400 019 (M.S.)
Member	Dr. Nita Khandekar, Acting Director, ICAR-Indian Institute of Soybean Research, Khandwa Road Indore 452001 (M.P.)
lnL; Member	Dr. S.K. Jha, Acting ADG. (Oil Seeds & Pulses), ICAR, Krishi Bhawan, New Delhi-110001
Member	Shri Bansilal Gurjar, Village Lal Ghati, Post Sabakhada, The. + Distt. Mandsaur (M.P.)
Member	Dr. M.P. Sharma, Principal Scientist (Microbiology) ICAR-Indian Institute of Soybean Research, Khandwa Road, Indore-452001

12.2 Institute Management Committee (2020)

Chairman	Director ICAR- Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)
Member	Deputy Director (Agriculture)Ministry of Agriculture Government of Madhya Pradesh, Indore division, Indore
Member	Shri Sisode Narayan Director, Agriculture (Extension) Maharastra State, Sakhar Sankul Shivajinagar, Pune- 411005
Member	Dr. M.P.Jain Director of Research, Rajmata Vijaya Raje Sciendia Krishi Vishvidyalaya Gwaliar
Member	Dr. A.K.Talukdar, Principal Scientist (Plant Breeding) Division of Genetics, ICAR- IA.R.I. New Delhi
Member	Dr. Nita Khandekar, Principal Scientist (Extension) ICAR-IISR, Indore- 452001
Member	Shri Bansilal Gurjar , Village Lal Ghati. Post- Sabakjada Tehsil and District Mandsore)
Member	Dr. Anita Rani, Principal Scientist ICAR-IISR, Khandwa Road, Indore-452 001 (M.P.)
Member	Dr. Sai Prasad, Head, IARI Regional wheat research Station, Indore- 452001
Member	Assitant Director General (O&P), Indian Council of Agricultural Research, Krishi Bhawan, New Delhi
Member	Finance and Account Officer ICAR-Indian Institute of Soil Science (IISS), Bhopal
Member Secretary	Administrative Officer ICAR- Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)

12.3 Institute Joint Staff Council

Chairman	Dr. Nita Khandekar, Director
	Official side
Member	Dr. Savita Kolhe, Principal Scientist
Member	Dr. G.K.Sarpute, Senior Scientist
Member	Dr. Subhash Chandra, Scientist
Member	Shri R.N. Srivastava, ACTO
Member	Finance & Accounts Officer
Member Secretary	Administrative Officer
	Staff Side
Secretary	Shri Balveer Singh, SSG-II

Member	Shri Devendra Pratap, Technical Officer
Member	Shri Francis Damasus, Sr. Technical Assitt. Smt. Priynka Sawan, Assistant Shri Anil Kumar Carrasco, Sr. Clerk and (CISC Member) Shri Sanjeev Mishra, Duplicating Operator.

12.4. Other Committees of the Centre (2020)

1.	**Official Language Implementation Committee** Director, ICAR-IISR (Chairman) Dr. Poonam Kuchlan, Shri Sanjeev Kumar Dr. D. N. Baaraskar Shri S. K. Pandey Shri S. K. Verma Shri Vikas Kumar Keshari Administrative Officer Finance & Accounts Officer	2.	**Institute Technical Management Committee (ITMC)** Director, ICAR-IISR (Chairman) Dr. M.P.Sharma Dr. Sai Prasad, Head, ICAR-IARI Station, Indore Dr. S. D. Billore Dr. Sanjay Gupta Dr. M.K.Srivastava Dr. M.K.Kuchlan Dr. Millind Ratnaparkhe
3.	**Priority Setting Monitoring and Evaluation (PME) Cell** Dr. S. D. Billore (In charge) Dr. Anita Rani Dr. B. U. Dupare Dr. Milind Ratnaparkhe Dr. Giriraj Kumawat Dr. Rakesh Kumar Verma Dr. Subhash Chandra	4.	**Purchase Advisory Committee** Dr. Maharaj Singh (Chairman) Dr. G. K. Satpute Dr. Giriraj Kumawat Dr. Rakesh Kumar Verma Dr. Rajesh Vangla Indenter Finance & Accounts Officer Administrative Officer
5.	**Human Resource Development Committee** Dr. Sanjay Gupta, (Chairman) Dr. D. V. Singh Dr. Rajkumar Ramteke Shri Rammanohar Patel Shri Nikhilesh Pandya Administrative Officer	6.	**Consultancy Processing Cell (CPC)** Dr. M.P.Sharma (Chairman) Dr. M.K.Kuchlan Dr. Lokesh Meena Dr. Rajesh Kumar Verma Finance & Accounts Officer Administrative Officer

7.	**Student Affairs Committee & Higher Study Committee** Dr. Mikind B.Ratnaparkhe (Chairman) Dr. Giriraj Kumawat Dr. Subhash Chandra Dr. Laxman Singh Rajput	8.	**TSP** Dr. B.U.Dupare (Nodal Officer) Dr. S.D.Billore
9.	**Estate Committee** Dr. Anita Rani (Chairman) Dr. Savita Kolhe Dr. V. Natraj Dr. Rajesh Vangla Dr. Viraj Kamle Shri R.N.Shrivastava Dr. D.N.Baraskar Shri S.K.Verma Shri R. C. Shakya Administrative officer Estate Officer	10.	**Publication Committee (Annual Report/Newsletter)** Dr. M.K.Srivastava (Chairman) Dr. M.Shivakumar (Annual Report) Dr. Rakesh Kumar Verma (Annual Report) Dr. V. Natraj (Annual Report) Dr. Laxman Singh Rajput (Annual Report) Dr. Subhash Chandra (Newsletter) Dr. Vangala Rajesh (Newsletter) Dr. Raghavendra Madar (Newsletter) Dr. Surendra Kumar (Member secretary)
11.	**Library Advisory Committee** Dr. Raghvendra Madar (Chairman) Dr. Rajesh Vangala Dr. Shri Sanjeev Kumar Finance & Accounts Officer Administrative Officer Dr. Surendra Kumar	12.	**Hindi Cell** Dr. Poonam Kuchlan (In charge) Shri S. K. Verma Shri Vikash Keshari Shri Avinash Kalenke
13.	**Works Committee** Dr. M. P. Sharma (Chairman) Dr. Vineet Kumar Dr. Virage Kamle Dr. Raghavendra Madar Estate Officer Administrative Officer Finance & Account Officer Dr. G.K.Satpute	14.	**Foreign Deputation and Higher Study Committee** Dr. A.Ramesh (Chairman) Dr. D.V.Singh Dr. Millnd Ratanaparkhe Shri R.M.Patel Administrative Officer

15.	**Public Information Officer** Administrative Officer/ Head of Office Shri Ajay Kumar, AAO	16.	**Public Relation Officer** Administrative Officer/ Head of Office Shri Ajay Kumar ,Assitt. Admn. Officer
17.	**Women Complaint Committee on Sexual Harassment** Dr. Anita Rani (Chairperson) Dr. Poonam Kuchlan Ms. Neha Pandey Mrs. Priyanka Sawant Third party representative (As when Required) Administrative Officer	18.	**House Allotment Committee** Dr. Rajkumar Ramteke (Chairman) Dr. Raghvendra Madar Dr. Rajesh Vangla Dr. Yogendra Mohan Secretary, IJSC Administrative Officer
19.	**Centralized Public Grievance Cell and Monitoring Systems (CPGCMS)** Dr. Vineet Kumar	20.	**Soybean Market Intelligence Cell** Dr. Ram Manohar Patel
21.	**Nodal Scientist SSCNARS, IASRI-NAIP Statistics Project** Shri Ram Manohar Patel	22.	**Library In Charge** Dr. Surendra Kumar
23.	**Guest House /Management Committee** Dr. Siva Kumar (Chairman) Dr. Anita Rani Shri Sanjeev Kumar Dr. Laxman Singh Rajput Shri R.N.Shrivastava Shri Om Prakash Vishvakarma Km. Seema Chauhan Shri Balvir Singh Administrative officer	24.	**Institute Publication /Printing, Press & Media Committee (General)** Dr. Dr. B.U.Dupare (Chairman) Dr. Lokesh Meena Dr. Rajesh Vangla Dr. Raghvendra Madar Shri Sanjeev Kumar Dr. Viraj Kamle Dr. D.N.Baraskar Shri S.K.Verma
25.	**Vehicle Management Committee** Dr. Maharaj Singh (Chairman) Dr. Lokesh Kumar Meena Dr.Nikhilesh Pandya Shri Sanjay Kr. Pandey (Vehicle Incharge)	26.	**Physical Verification Committee** Dr. G.K.Satpute (Chairman) Mr.Ram Manohar Patel Dr. Lokesh Kumar Meena Dr. V.Nataraj Dr. Raghavendra Madar Store Officer

27.	**Farm Management, Price Fixation, Farm item Disposal Committee** Dr. Maharaj Singh (Chairman) Dr. M.K.Kuchlan Dr. Laxman Singh Rajput Dr. Subhash Chandra Dr. V. P. S. Bundela Store Officer Finance & Accounts Officer Administrative Officer	**28.**	**Condemnation and Auction / Write off Committee** Dr. Vineet Kumar (Chairman) Dr. Shivakumar M. Dr. V. Nataraj Store officer Shri R. N. Shrivastava Shri I. R. Khan Finance & Accounts Officer Administrative Officer
29.	**Laboratory In Charges** Dr. L.S. Rajput - Pathology Dr. Manoj Kumar Srivastava - Central/ Physiology Dr. Sanjay Gupta - Plant Breeding, Seed Technology, Germplasm Dr. M.K.Kuchalan - DUS Testing, Dr. Milind B. Ratnaparkhe - Biotechnology Dr. Dr. Lokesh Kumar Meena - Entomology Dr. Anita Rani - Transgenics Dr. M. P. Sharma - Microbiology Dr. Vineet Kumar – Biochemistry Dr. S. D. Billore - Agronomy Dr. Savita Kolhe - Computer Dr. B. U. Dupare - Extension	**30.** **31.**	**Security Cell** Dr. Rakesh Kumar Verma Dr. Laxman Singh Rajput Shri O. P. Vishwakarma Shri R.C.Sakya **Estate Officer** Shri R.C.Sakya **Record Officer** Shri Ajay Kumar, AAO **Vehicle In charge** Shri Sanjay Kumar Pandey **Store In charge** Dr. Nikhlesh Pandya Shri Vikas Keshri **Tofu Plant In charge** Ms. Neha Pandy Shri S.N.Verma
32.	**MGMG** Dr. B.U. Dupare (Nodal Officer)	**33.**	**Swachh Bharat Abhiyaan Committee** Administrative Officer/ Head of Office (Chairman) Dr. D.N.Baraskar Shri S.K.Verma Shri Devendra Pratap Shri I.R.Khan Shri R.C.Sakya Finance & Account Officer Shri Balveer Singh

34 **Liaison Officer (SC/ST/OBC)**

Dr. Viraj Kamle

35. **Institute Technical Management Unit (ITMU)**

Dr. M.P.Sharma, (Chairman)

36. **Sport and Staff Welfare Committee**

Dr. G.K.Satpute (Chairman)
Dr. Griraj Kumawat
Dr. Laxman Singh Rajput
Dr. Rajesh Vangla
Dr. Raghvendra Madar
Shri R.N.Shrivastava
Shri S.P.Singh Verma
Shri Balveer Singh
Shri Sanjeev Mishra
Administrative Officer
Finance & Account Officer
Shri Balveer Singh

37. **Residential Campus Committee**

Dr. B.U. Dupare (Chairman)
Dr. Rajkumar Ramteke
Dr. V. Nataraj
Shri R.N.Srivastava
Shri S.P.Singh Verma
Shri R.C.Sakya
Administrative Officer
Finance & Accounts' Officer

38. **SCSP Committee**

Dr. Nita Kandekar (Nodal Officer)
Dr. S.D.Billore
Dr. Sanjay Gupta
Dr. M.P.Sharma
Dr. B.U. Dupare
Dr. Rakesh Kumar Verma
Dr. Subhash Chandra
Dr. Laxman Singh Rajput
Administrative Officer
Finance and Accounts Officer

39. **Soybean Market Intelligence Cell**

Dr. Ram Manohar Patel

40. **Agriculture Knowledge Management**
Unit

Dr. Savita Kolhe
Dr. B.U. Dupare
Shei Ram Manohar Patel
Dr. Rajesh Vangla
Dr. Raghvendra Madar
Ms. Priyanka Sawan

13. EVENTS AND MEETINGS

34TH Institute Research Council Meeting

The 34th Annual Institute Research Council Meeting of the institute was held on 16th - 17th June, 2020 using Zoom application. The meeting was chaired by Dr Nita Khandekar, Director (Acting), ICAR-Indian Institute of Soybean Research and was attended by all the scientists. Dr Nita Khandekar, in her opening remarks, welcomed all the scientists and requested them to participate in the discussion and encouraged them to offer constructive suggestions for strengthening the research programmes and work for the larger interest of the ultimate stakeholders. Dr Sai Prasad, Principal Scientist (Plant Breeding) & Head, Dr K.C. Sharma, Principal Scientist (Agronomy), from ICAR-IARI-Regional Station, Dr Venkatta Kumar, Principal Scientist & Head (Agriculture Extension), Dr Chandra Prakash, Senior Scientist (Computer Applications), Division of Social Sciences, IIHR, Bengaluru and Dr G.K. Gupta, Principal Scientist (Plant Pathology) and Ex-Director, ICAR-Indian Institute of Soybean Research, Indore acted as 'Experts' in their respective fields. Project-wise presentations of research work done along with envisaged programmes for year 2020-21 were made by individual scientists. Dr Sai Prasad critically evaluated the progress of all the projects of Crop Improvement Division and gave useful suggestions. He emphasized that biotic stresses are becoming a major problem in the soybean growing areas and breeders should focus on the development of varieties keeping them in mind. Chairman, Dr Khandekar insisted that all the breeding programs should have multidisciplinary approach and should involve pathologist, entomologist, physiologist and other scientists.

In the concluding remark, Dr Khandekar appreciated the research work conducted at the institute and emphasized that the projects should have multidisciplinary approach and scientists from various disciplines should come together for strengthening of soybean research. Dr Khandekar also expressed that research projects should culminate into technologies which are directly useful to the farmers and other stake holders in the agriculture sector.

50th Annual Group Meet of All India Coordinated Research project on Soybean

50th Annual Group Meet of AICRP on Soybean was organized on 20th May 2020 through video conferencing. It was attended by 75 Soybean Scientists across the country. During inaugural session, the Chief Guest Dr. T. Mohapatra, Secretary DARE and DG, ICAR welcomed every one and congratulated the AICRP for developing > 120 high yielding and disease resistant varieties including first KTI free variety. He emphasized that meeting of AICRP for twice a year and informed that low productivity of the crop is major concern and by increasing the production and productivity of major oil seed crop will helps in reducing import of edible oil to greater extent. He also urged that all the Directors of Oil seed crop must be invited for AICRP workshop. Chief guest informed that the current productivity of soybean must be enhanced and some of patches of soybean growing areas recording >1500 Kg /ha and it must reach to 2000 kg/ha by encouraging best production system and engaging with KVK and state Agricultural Department. He urged all scientists to reduce the agronomy gap by using good agricultural practice and other digital languages. Promising germplasm may be imported and utilized in breeding programmes. Speed breeding and value addition should be given much needed thrust. Looking at increased weeds in soybean crop, DG asked the scientist to look for possible ways of using the roundup ready/ herbicide tolerant soybean to reduce the weed problem. DG urged the requirement of strong Human resource development programme (HRD) for AICRP centers and expressed his concerns to reduce the varietal mis-match in breeder seed production. Dr. S.P. Tiwari (Ex-Vice Chancellor, Ex DDG, Edn & CS), in the address mentioned engineering of lots of genes to address climate change issues and expressed the concern on reduction in area due to aberrant climate. He also urged that speed breeding program must be included in the technical program and appreciated the institute in taking up GGE biplots analysis. Dr T.R Sharma, DDG (CS) emphasized that the scientist must use the sequencing information of > 46,000 genes available in the public domain. He stressed upon improving the narrow genetic base of the crop by employing and utilizing wild species. Scientists must take up breeding for tolerance to water logging, early maturity and food grade soybean. DDG also stressed up on haplotypes breeding and strong HRD for all the AICRP centres.

This was followed by technical presentations by PIs Dr Sanjay Gupta (Plant Breeding), Dr. A.N. Sharma (Entomology), Dr. Shamarao Jahagirdar (Plant Pathology), Dr. S.D. Billore (Agronomy & FLD), Dr. M.P. Sharma (Microbiology) and Dr. L. Sophia Devi (Food Technology and Value Addition). Dr. P.K. Chakrvorty, Member ASRB, New Delhi, Dr. D.J. Bagyaraj, Professor Emeritus, Bangaluru, Dr.L.H. Malligawad, Professor emeritus, UAS, Dharwad, Dr. D.K. Yadava, ADG (Seeds), ICAR, Dr. D.K. Agrawal, Director, ICAR-Indian Institute of Seed Research, Mau, Dr. S.K. Jha, ADG(OP), ICAR, New Delhi, Dr. Rajan, ADG(PP), ICAR, New Delhi and Dr. Katiha, TSP I/c ICAR also participated as chairman of various sessions. During the AGM three special lectures were also delivered: Development of specialty varieties in soybean by Dr. Vineet Kumar, PS (Biochemistry), IISR, Indore, Molecular approaches for soybean improvement by Dr. Milind Ratnaparkhe, Sr. Scientist (Biotech), IISR, Indore and Mapping of YMV resistance genes in cultivated and wild soybean and their deployment in development of YMV resistant soybean varieties by Dr. Anita Rani, PS (Plant Breeding), IISR, Indore. Technical Programmes of research for 2020-21 were also presented by respective PIs.

Dr. T.R. Sharma, DDG(CS), ICAR remained with the group throughout the day and gave his valuable comments and guidance for improvement of research programmes and sensitized the scientists to strive for quality research work. During AGM, the varietal Identification committee screened the identification proposals and identified total nine varieties for release in different agroclimatic zones: (i) NRC 128 for NPZ and EZ, (ii) NRCSL-1 for EZ, (iii) RCS 11-07 for EZ and SZ, (iv) AMS 2014-1 for EZ, (v) NRC 136 for EZ, (vi) NRC 132 for EZ and SZ, (vii) NRC 147 for EZ and SZ, (viii) NRC 130 for CZ and (ix) Dsb 34 for SZ.

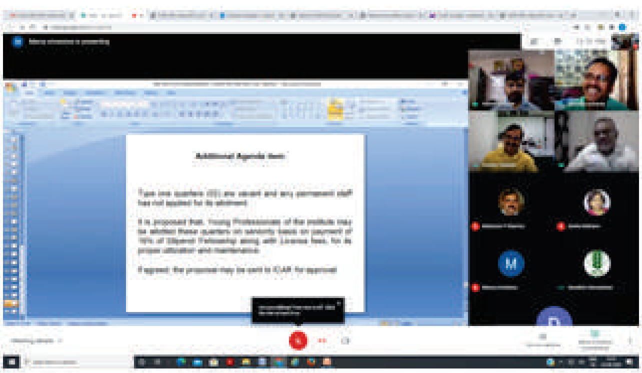
23rd Research Advisory Council Meeting

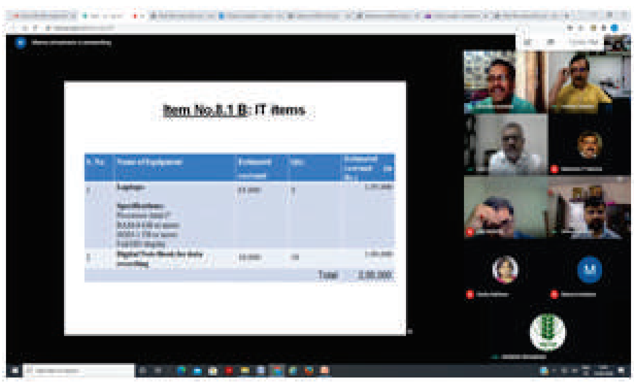
The 23rd Research Advisory Committee meeting of the Institute was organized through online mode on Nov. 26 and 27, 2020. Along with the RAC members, all the Scientists of the institute participated in the meeting. On both days the meeting was held online from at 10:30 am to 2:00 pm. At the outset Director, extended a warm welcome to all the members. The meeting was chaired by Dr S.K. Sharma. In the opening remarks all the esteemed RAC members appreciated the efforts made by the institute in sending video clipping, annual reports and list of research projects and as well as achievements of last year which was helpful in giving an overview. Dr Nita Khandekar Acting Director, presented the recent soybean scenario and status report of the ICAR- IISR. She also provided a road map for area expansion and increasing the productivity of soybeans in the future. The Action Taken Report on recommendations of the last RAC was presented by Dr M.P. Sharma. The salient research achievements made during 2019-20 in various projects of different disciplines were presented by the respective heads i.e., Crop Improvement, Crop Production and Crop Protection Sections. The RAC appreciated the efforts made by the institute in identifying new varieties particularly for central zone and specialty soybean of high oleic acid and KTI free. During and after meeting discussions were held and RAC made specific and general recommendations which should be followed by IISR after seeking approval from the Council.

30th Institute Management Committee Meeting

30th Institute Management Committee meeting was held on 14 August 2020 under the chairmanship of director Dr Nita Khandekar. This was attended by Dr. S. K. Jha, AGD (O&P), Dr. Akshay Talukdar from, IARI, New Delhi, Dr. M. P. Jain, Director (Research), from RVSKVV, Gwalior, Dr. Manoranjan Mohanty from Indian Institute of Soil Science Bhopal, Dr. S. V. Saiprasad, from ICAR-IARI Regional Station, Indore. Mr. R. S. Sengar, ADA, FTC Department of Agriculture, Indore and Dr. Anita Rani, Dr. Sanjay Gupta, S. D. Billore, Dr. Mahaveer Prasad Sharma and Mr. Ravindra Kumar from the institute. The meeting was also attended by the Farmers' representative Mr. Bansilal Gurjar of Mansore (MP).

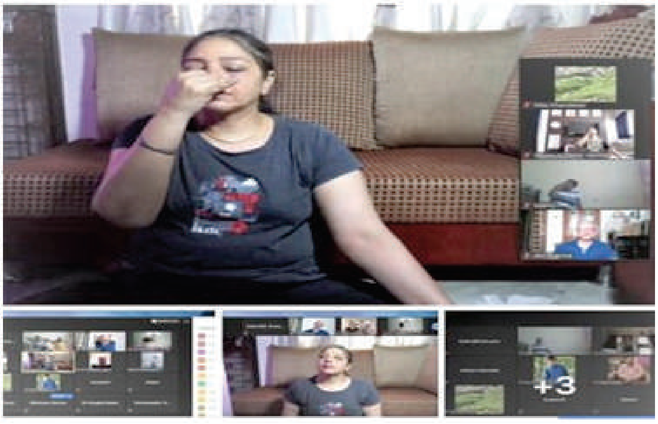
At the beginning, the member secretary, welcomed all the member of the committee and presented a brief about the activities and achievements of last year. The agenda items were presented and discussed in the meeting. All the members appreciated the achievements of the Institute. At the end, chairman thanked all the members for active participation and fruitful suggestions for enhancing productivity of soybean and increasing the visibility and extension activity of the Institute.





International Yoga Day 2020

6th International Day of Yoga (IDY) was celebrated at the Institute on 21st June 2020. On this occasion Ms. Manjeet Kaur, Yoga Trainer, arranged a Yoga, Dhyan and Meditation session for all the staff members on Zoom App. She demonstrated various asana and explained their roles and benefits for enhancing immunity power.



World Environment Day 2020

World Environment was celebrated was celebrated at the Institute on 5th June 2020. On this occasion Dr. Nita Khandekar, Director planted saplings in the office campus. Tree plantation at Horticulture block was done by staff of the Institute.

150th Birthday of the Father of the Nation Mahatma Gandhi

Week-long celebrations were held at Institute from 26.09.2020 to 02.10.2020. The Various programmes like cleanliness drive, plantation programme, training programme on soybean food usages to farmer women's, extempore competition for staff members, painting competition for children, cleanliness competition for room, lab and experimental fields were organized during this weeklong celebration. Special lecture on the "Gandhian philosophy on agriculture, women's empowerment, poverty alleviation and gram swaraj" was delivered on 2 October, 2020 through virtual mode by Dr Aalok Deshwal, coordinator, Kasturba Gram KVK, Indore.

World Food Day-2020

Institute celebrated 75th anniversary of United Nations Food & Agricultural Organization in the form of World Food day on 16th October, 2020. The programme was organized in collaboration with Solidaridad, Bhopal. A special lecture was organized on the occasion of last years' theme "zero hunger" by Dr Suresh Motwani, General Manager, Solidaridad, Bhopal. The programme was attended by all the scientific, technical and administrative staff connected through virtual mode as well as farmers. On this occasion, specially designed one-day training program on soybean food uses was also organized for 14 farm women. Dr Neha Pandey, Scientist, and chairperson, organizing committee, briefed about the importance of celebrating world food day and also about the program schedule and competitions held previously like slogan and poster making. Dr Suresh Motwani elaborated FPO World Food Day theme "Grow, nourish, sustain together. Our actions are our future." He emphasized the importance of food with nutrition. He also explained need for sustained approach and extended his collaboration whenever required. Shri Devendra Pratap Yadav, member secretary, organizing committee announced the prize winners of slogan and poster making competitions. The winners were presented with a certificate and a prize.

Dr Nita Khandekar, Director, ICAR-IISR, Indore briefed about FAO's 75th anniversary and its theme for the year 2020. She mentioned that India has achieved self sufficiency in food grains and that nutrition is an important aspect to be addressed to combat malnutrition. She also said soybean can play an important role in nutrition but needs to be consumed following proper protocol for which the institute organizes trainings for various stake holders particularly for rural farm women. She also informed that soybean is comparatively cheaper and the most economically source of protein and other vital nutrients when compared to pulses, meat or eggs. She informed the farmers who had joined through virtual mode that to combat the challenges of climate change, ICAR-IISR had developed varieties and what under the COVID scenario the distance between the research institution and farmers had reduced and it was much easier now to connect to farmers for addressing their problems. She emphasized that the theme of FAO to be adopted by scientists for the coming year and the need to work in that direction.

A technical lecture on 'soybean ke swasthya laabh' was delivered by Mrs. Neha Pandey, Scientist, Food Technology, ICAR-IISR, Indore. Hands on training on 'soybean domestic food uses'was also organized on the occasion which included preparation of soy milk, tofu, okara fortified products and soy nuts.

International day of rural women/ Mahila kisan divas-2020

Institute celebrated "International day for Rural Women/Mahila kisan diwas" by organizing a lecture and one-day training on program was in collaboration with Solidaridad, Bhopal and Krishivigyan Kendra, Kasturba gram, Indore on 15.10.2020. Thirty-two women participants from the adjoining villages of the district participated in the programme. The staff of the Institute also joined the programme through virtual mode. Special lecture on the "ghar pariwar ko COVID 19 mein surakshit kaise rakhe' was delivered by Dr. Archna Raj Singh (Former Dean, College of home science, SKRAU, Bikaner) through virtual mode. She explained various methods of hygiene and cleanliness to keep their family safe and sound. She emphasized on role of women in keeping COVID 19 under check. She demonstrated right method of hand washing and advised to wash grocery and other food items with soap water and rinse before use. She also suggested adoption of healthy eating habits, role of balance diet and correct way of making immunity booster decoction (kaada). Subject of training was 'soybean se poshan'. Dr Anita Rani, Principal scientist, Plant breeding, ICAR-IISR, Indore coordinated inauguration program.

Three days training program on "Skill development training for regularized labors"

Institute organized three days training program "Skill development training for regularized labors" from 4-6th November 2020 to enhance working skills of regularized labors. Dr. V. Nataraj, program director briefed and urged the participants to utilize the training program.
Dr. Nita Khandekar, Director, ICAR-IISR briefed about the inception of the institute, its mandates, hierarchical stature and the importance of labor in development of the institute. She urged the participants to utilize the program at most and learn the things related to research. Dr. Sanjay

Gupta, HRD chairman and In charge, crop improvement division has given an insight into different research activities being undertaken in the division. Also, explained about different varieties and germplasm lines and their importance in soybean improvement. Dr. S.D Billore, In-charge, crop production division has given an insight into different agronomical practices and technologies being employed in soybean production. Also, he taught about the importance of land preparation, different fertilizers and herbicides. Dr. M.P Sharma, In charge, crop protection division has talked about different diseases and pests of soybean and their control measures. Also, taught about different safeguard measures to be followed while spraying different chemicals in the field. Mr. R.C Shakya, technical officer has facilitated a visit to farm section, where he demonstrated about functionalities of different farm machineries being used from ploughing to harvesting.

Mr. Ravinder, FAO has explained about different rules underling in finance section. Mr. Ajay Kumar Srivastava has explained about different administrative rules such as leave rules, LTC encashment rules, medical reimbursement rules etc. Also, explained about importance of compliance of office rules. Dr. Vangala Rajesh, program coordinator facilitated a visit to laboratories, germplasm lab.

Dr. Subhash Chandra facilitated a visit to different research facilities where, he explained about working principles and handling principles of different facilities such as polyhouse, crossing block, rain out shelter etc.

Extension Activities organized by ICAR-IISR during 2020.

1. Mera Gaon Mera Gaurav: The programme is being implemented in 25 villages of Indore districts in which five multidisciplinary team of scientists are maintaining close contact with farmers. Beside soybean, the scientists are facilitating information flow of other agricultural commodities and the agricultural/developmental schemes launched by Government of India for the overall development of rural masses.
2. One day training programme: During Jan-June 2020, the institute organized 17 one day farmers' training programmes on Improved Soybean Production Technology involving 613 farmers and farm women. Similarly, 4 one day training programmes were organized on "Processing and Utilization of Soybean for Food Uses" with total participation of 149 women belonging to Madhya Pradesh.
3. Training programmes under TSP: The institute organized 3 training programmes in the tribal dominated Barwani district of Madhya Pradesh in association with Krishi Vigyan Kendra, Barwani on 10th, 11th and 12th March 2020. A total of 471 farmers and farm women from the tribal community were trained on "Improved Soybean Production Technology, Seed Production and Processing of Soybean for Food Uses" under these programmes.

4. Participation in Agricultural Exhibitions

Sr. No	Event/Place	Organized by	Venue	Dates
1	Global Potato Conclave-2020	ICAR-CPRI, Shimla	Mahatma Mandir, Gandhinagar	2-30 January 2020

5. Launch of YouTube Channel of the Institute: The institute launched its YouTube Channel "IISRSoybean Indore" during June 2020. Short film/videos containing relevant information on package of practices, management of biotic/abiotic stresses, and technical aspects of soybean production technologies are being updated on this channel on regular basis. Videos on specific advisories for soybean growers are also uploaded on this channel which has received a tremendous response from the viewers across the contry.
6. Weekly advisories on soybean considering COVID 19 transmission: The institute also released specific weekly advisories especially for soybean growers containing relevant information on how to prevent the transmission of CORONA virus among the farming community by adopting specific measures like regular hand washing, Use of facemask, social distancing etc. Further, advisiories were also issued on specific agronomic practices for ensuing kharif season-2020 involving land preparation, preparatory tillage, application of farm yard manure, carrying out germination test for the available seed, purchase of input etc to be used during the crop season.
7. Quiz on Indian Constitution: The event was organized at the institute on 29th February 2020 with the participation of institutional staff. The quiz involved a total of eight round covering the issues like Genesis of the constitution, know your constitution, fundamental rights, preamble of the constitution, Constitution: people and amendments and current affairs.

List of extension publications of ICAR-IISR

A. Bilingual Extension Bulletin: Soybean Production: Package of Practices and Technical Recommendations (Eds. B.U. Dupare, S.D. Billore and A.N. Sharma). Extension Bulletin No. 15. ICAR-IISR Publication.Pp: 100.

द्विभाषी विस्तार बुलेटिनः सोयाबीन उत्पादनः सस्य क्रियाए एवं तकनिकी अनुशंषाए (संपादनः बी.यु. दुपारे, एस. डी. बिल्लोरे एवं ए. एन. शर्मा) विस्तार बुलेटिन क्रमांक 15. भारतीय सोयाबीन अनुसन्धान संस्थान प्रकाशन. पृष्ठय 100

B. विस्तार फोल्डर्स

1. सोयाबीनः उन्नत प्रजातियाँ, गुणधर्म, उत्पादन क्षमता एवं परिपक्वता अवधि. (विस्तार फोल्डर 18.)
2. सोयाबीनः खरपतवार प्रबंधन. (विस्तार फोल्डर 19)
3. सोयाबीनः समेकित कीट प्रबंधन. (विस्तार फोल्डर 20)
4. सोयाबीनः समेकित रोग प्रबंधन. (विस्तार फोल्डर 21)
5. सोयाबीनः प्रसंस्करण तकनिकी एवं खाद्य उपयोग. (विस्तार फोल्डर 22)


भारतीय सोयाबीन अनुसन्धान संस्थान में सतर्कता जागरूकता सप्ताह का आयोजन


भारतीय सोयाबीन अनुसन्धान संस्थान में त्रैमासिक राजभाषा कार्यशाला का आयोजन

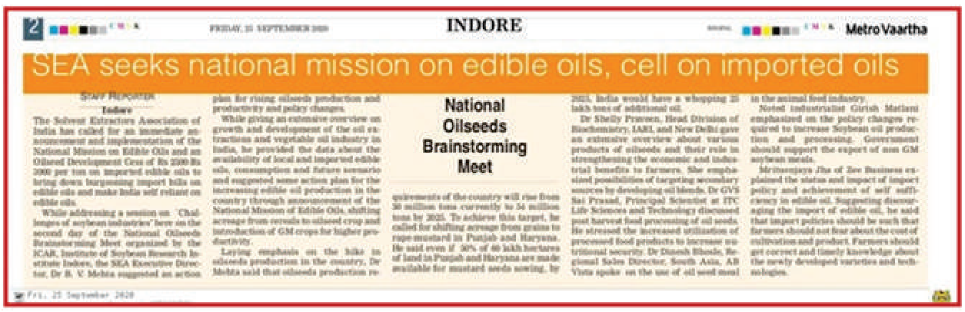

अहिंसा, सत्य और विश्व शांति को अपने जीवन में उतारें सभी


कृषक जगत
10
भारतीय सोयाबीन अनुसंधान संस्थान का स्थापना दिवस समारोह सम्पन्न


FREE PRESS
2/14
Need to adopt Gandhian philosophy
OUR STAFF REPORTER


Centre clears 15 new varieties of short duration soybean


तिलहनी फसलों के उत्पादन में वृद्धि होकर खाद्य तेल में आत्मनिर्भरता आएगी


INDORE
MetroVaartha
SEA seeks national mission on edible oils, cell on imported oils
National Oilseeds Brainstorming Meet

14. PERSONNEL

(As on 31 December 2020)

A.	**Research Management**		
1.	Dr. V.S.Bhatia Dr. Nita Khandekar	Director upto 31th May 2020 Director (Acting) w. e. f. 01st June 2020	
B.	**Scientific**		
2.	Dr. A. N. Sharma	Principal Scientist	Entomology, upto 30th June 2020
3.	Dr. Nita Khandekar	Principal Scientist	Agricultural Extension
4.	Dr. S. D. Billore	Principal Scientist	Agronomy
5.	Dr. Sanjay Gupta	Principal Scientist	Genetics & Plant Breeding
6.	Dr. (Smt.) Anita Rani	Principal Scientist,	Genetics & Plant Breeding
7.	Dr. Mahaveer P. Sharma	Principal Scientist	Microbiology
8.	Dr. Vineet Kumar	Principal Scientist	Biochemistry
9.	Dr. A. Ramesh	Principal Scientist	Soil Science
10.	Dr. B. U. Dupare	Principal Scientist	Agricultural Extension
11.	Dr. Savita Kolhe	Principal Scientist	Computer Application
12.	Dr. Maharaj Singh	Principal Scientist	Plant Physiology
13.	Er. (Dr.) DevVrat Singh	Principal Scientist	Farm Machinery and Power
14.	Dr. Manoj Kumar Srivastava	Principal Scientist	Plant Biochemistry
15.	Dr. Rajkumar Ramtake	Principal Scientist	Genetics & Plant Breeding
16.	Dr. Milind B. Ratnaparkhe	Senior Scientist	Biotechnology
17.	Dr. Gyanesh Kumar Satpute	Senior Scientist	Genetics & Plant Breeding
18.	Dr. Poonam Kuchlan	Senior Scientist	Seed Technology
19.	Dr. Mrinal Kumar Kuchlan	Senior Scientist	Seed Technology
20.	Dr. Giriraj Kumawat	Scientist (Senior Scale)	Biotechnology
21.	Dr. M. Shivakumar	Scientist (Senior Scale)	Genetics & Plant Breeding
22.	Shri Ram Manohar Patel	Scientist	Agril. Statistics
23.	Ms. Neha Pandey	Scientist	Food Technology
24.	Dr. Lokesh Kumar Meena	Scientist	Entomology

25.	Shri Hemant Singh Maheshewari	Scientist	Microbiology
26.	Dr. Rakesh Kumar Verma	Scientist	Agronomy
27.	Dr. V. Nataraj	Scientist	Genetics & Plant Breeding
28.	Shri Sanjeev Kumar	Scientist	Plant Pathology
29.	Dr. Subhash Chandra	Scientist	Genetics & Plant Breeding
30.	Dr. Laxman Singh Rajput	Scientist	Plant Pathology
31.	Dr. V. Rajesh	Scientist	Genetics & Plant Breeding
32.	Dr. Raghvendra Madar	Scientist	Agronomy
33.	Shri Viraj Damodar Kamle	Scientist	Agricultural Biotechnology
C.	**Technical**		
34.	Dr. Surendra Kumar	Chief Documentation	Officer Library & Documentation
35.	Shri R. N. Singh	Chief Technical Officer	Field & Farm
36.	Dr. Nikhlesh Pandya	Chief Technical Officer	Field & Farm
37.	Dr. V. P. S. Bundela	Chief Technical Officer (Farm Manager)	Field & Farm
38.	Dr. Yogendra Mohan	Chief Technical Officer	Field & Farm
39.	Shri S. K. Pandey	Chief Technical Officer	Field & Farm
40.	Shri S. S. Vasunia	Chief Technical Officer	Field & Farm. (Upto 30th June 2020)
41.	Dr. D. N. Baraskar	Chief Technical Officer	Field & Farm
42.	Shri R. N. Shrivastava	Assistant Chief Technical Officer	Artist & Photography
43.	Shri S. K. Verma	Assistant Chief Technical Officer	Field & Farm
44.	Shri O. P. Vishwakarma	Technical Officer	Tractor Driver
45.	Shri I. R. Khan	Technical Officer	Field & Farm
46.	Shri Gorelal Chouhan	Technical Officer	Field & Farm
47.	Shri R. C. Shakya	Technical Officer	Field & Farm
48.	Shri Devendra Singh Yadav	Technical Officer	Field & Farm
49.	Shri Francis Yunis	Senior Technical Assistant	Staff Car Driver

50.	Shri Vikas Kumar Keshari	Senior Hindi Translator	Official Language Cell
51.	Ms. Joyti Meena	Technical Assistant	Laboratory
52.	Shri Bilbar Singh	Senior Technician	Staff Car Driver
53.	Shri Shambhu Nath Verma	Senior Technician	Field & Farm
54.	Ms. Seema Chouhan	Technician	Field & Farm
D.	**Administration and Accounts**		
55.	Shri Rakesh Dubey	Administrative Officer	Administration, upto 28.07.2020
56.	Shri Ravindra Kumar	Finance and Account Officer	Audit & Account
57.	Shri Ajay Kumar	Assistant Administrative Officer	Administration
58.	Shri S.P.Singh	PS to Director	Administration
59.	Ku. Priyanka Sawan	Assistant	Administration
60.	Shri. Ravishankar Kumar	Assistant	Administration
61.	Shri Avinash Kalanke	Assistant	Administration
62.	Shri Anil Kumar Carrasco	Senior Clerk	Administration
63.	Shri Sanjeev Kumar	Duplicating Operator	Administration
	Skilled Supporting Staff		
64.	Shri Gulab Singh	SSG III	
65.	Shri Dhan Singh	SSG III	
66.	Shri Nirbhay Singh	SSG II	
67.	Shri Janglia	SSG II	
68.	Shri Surla	SSG I	
69.	Shri Sur Singh	SSG I	
70.	Shri Balveer Singh	SSG I	
71.	Shri Prahlad Singh	SSG I	Upto 05.04.2020

15. APPOINTMENTS, PROMOTIONS, TRANSFER, ETC.

15.1. Appointments

Nil

15.2. Promotions

S. No.	Name	Promoted to the Post of	w. e. f.
1.	Dr. Rajkumar Ramteke,	Principal Scientist (Plant Genetics)	17.01.2016
2.	Dr. Prushottam Sharma	Principal Scientist Agricultural Economics)	25.07.2018
3.	Dr. M.K. Kuchalan,	Senior Scientist (Seed Technology)	07.01. 2019
4.	Dr. Surendra Kumar	Chief Technical Officer (Library) (Advance Increment)	06.07.2016 20.04.2018
5.	Shri R. N. Singh	Chief Technical Officer (Advance Increment)	20.04.2018
6.	Dr. Nikhilesh Pandya	Chief Technical Officer (Advance Increment)	09.12.2018
7.	Shri S. K. Pandey	Chief Technical Officer	16.08.2017
8.	Shri Devendra Pratap Singh	Technical Officer	09.06.2019
9.	Shri R.C.Shakya	Technical Officer	26.09.2020
10.	Shri Gore Lal Chauhan	Technical Officer	13.03.2020
11.	Shri A. K. Jagadeeshan	Senior Technical Assistant	08.10.2008
12.	Shri Vikash Kesri	Senior Technical Assistant	26.03.2020
13.	Shri Avinash Kalanke	Assistant	24.10.2020

List of staff promoted as TSL:

Sl. No.	Name of Staff	Designation
1.	Smt. Chunki Bai	T.S.
2.	Smt. Sagari Bai	T.S.
3.	Smt. Rumli Bai	T.S.
4.	Smt. Meera Bai	T.S.
5.	Smt. Romu Bai	T.S.
6.	Smt. Teju Bai	T.S.

Sl. No.	Name of Staff	Designation
7.	Smt. Sarita Bai	T.S.
8.	Smt. Parvati Bai	T.S.
9.	Smt. Sangeeta Bai	T.S.
10.	Smt. Surju Bai	T.S.
11.	Smt. Sagar Bai	T.S.
12.	Smt. Rekha Bai	T.S.

15.3. Deputations/ Selection

Name	Deputation/ Fellowship	w.e.f.
Dr. Giriraj Kumawat Scientist (Sr. Scale) (Biotechnology)	Japan International Research Centre for Agricultural Science (JIRCAS), Tsukuba, Japan	Tsukuba, 01.10.2019 to 31.03.2021

15.4. Transfers

Name	From	To	w. e. f.
1. Ms Jyoti Meena Technical Assistant (T-3)	ICAR-CISH, Lucknow	ICAR-IISR, Indore	31.10.2020
2. Shri Rakesh Dubey Administrative Officer	ICAR-IISR, Indore	ICAR- IIOPR, Pedavagi (A.P.)	28.07.2020

15.5. Retirement

1. Dr. V. S. Bhatia, Director, on 31.05.2020
2. Dr. A. N. Sharma, Principal Scientist (Entomology), on 30.06.2020
3. Shri Sukhram Singh Vasunia, Chief Technical Officer, on 30.06.2020

15.6. Higher education

Sl. No.	Name	Name of Degree	University/ Institution
1.	Ms. Rachana Tripathi	Genetics analysis of photoperiodic and growth habit genes in soybean (Glycine max (L) Merrill. Supervisor Dr. Sanjay Gupta	Devi Ahilya Vishva Vidhyalaya, Indore

15.6. Obituary

Shri Prahlad Singh, SSG-II, 05.04.2020

भा. कृ. अनु. प. – भारतीय सोयाबीन अनुसंधान संस्थान

ICAR-Indian Institute of Soybean Research

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