वार्षिक प्रतिवेदन 2016-17

Annual Report 2016-17

भाकृ अनुप
ICAR

भा.कृ.अनु.प.- भारतीय सोयाबीन अनुसंधान संस्थान
ICAR-Indian Institute of Soybean Research

खण्डवा रोड़, इन्दौर 452001 (म.प्र.)
Khandwa Road, Indore-452001 (M.P.)

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संपादक / **Editors**
डॉ. विनित कुमार / Dr. Vineet Kumar
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P R E F A C E

India is the fifth largest vegetable oil economy in the world. After cereals, oilseeds are the second largest agricultural commodity, accounting for the 14% of the gross cropped area in the country. Soybean accounts for to 45% of the total oilseeds and about 25% of the total edible oil produced in the country. Soybean seed contains 40% protein and 20% oil and it is one of the most economical source of good quality protein. It also contains minerals and useful nutraceuticals like isoflavones, tocopherols, which provide immense health benefits. Therefore, the crop has a potential to provide nutritional security and eradicate rampant protein malnutrition in the country. Despite phenomenal growth in area and production of soybean during the past 40 years, the current productivity levels are much below the world average and the climatic potential of the crop. The bigger challenge for soybean scientists is to meet the manifold increase in demand of soybean for edible oil, animal feed and direct consumption as a food in the face of changing climatic scenario.

During 2016-17, soybean production estimate 14.01 million tones from an area of 11.2 million tones. Good monsoon and uniform rainfall distribution helped in higher production of soybean compared to previous years in the recent past. Overall productivity of soybean was also higher during 2016-17. Scientists at ICAR-IISR are making all-out efforts to increase productivity in the face of considerable climatic fluctuation. Efforts are also on to enhance input use efficiency, minimize risks and improve the quality of end use commodity through conventional as well as new scientific tools.

I am glad to present the Annual Report of ICAR-Indian Institute of Soybean Research, Indore for the year 2016-17. A glance at this report will give the panoramic scenario of research & development activities undertaken last year. I take this opportunity to state my deep sense of gratitude to Dr. T. Mohapatra, Secretary, DARE, Govt. of India and Director General, ICAR for guidance, and consistent support to soybean research and development. I gratefully acknowledge the help and valuable guidance provided by Dr. J.S. Sandhu, Deputy Director General (Crop Science), for the progress of the Institute. I sincerely thank Dr. B. B. Singh, Ex Assistant Director General, (O&P) and Dr. S.K. Chaturvedi, officiating Assistant Director General (O&P) for his support and guidance for the growth and development of the Institute. 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 of them.

(V.S. Bhatia)
Director

CONTENTS

EXECUTIVE SUMMARY

- Nine hundred ninety germplasm accessions received from ICAR-NBPGR's long term storage (LTS) for periodic rejuvenation and evaluation were multiplied and screened for 32 morphological characters
- One hundred thirty germplasm lines were evaluated at Pantnagar, Indore, Imphal, Jabalpur, Parbhani and Pune. Extra early maturing lines and lines with high number of pods, pod cluster, nodes, high 100-seed weight, seed yield and high resistance to charcoal rot were identified
- Two hundred one lines of core collection were multiplied and evaluated for 32 morphological traits. A wide range of variability was observed in various agro morphological traits
- Evaluation of Nested Association Mapping population (NAM) consisting of 20 cross combination (F_3 generation) exhibited significant phenotypic variability for yield and maturity traits
- Twenty six advanced drought tolerant breeding lines were evaluated for physiological and yield traits under drought and irrigated conditions. Two lines showing drought tolerance and high yield have been included in the IVT for testing during *kharif* 2017
- Delayed wilting trait identified 6 germplasm lines for drought tolerance (PI 159923, TGX 709-50E, EC 291448, EC 107407, MACS 345 and J 732)
- Genotypes EC 538828, PK 472, NRC 37, Jackson, Bragg, JS 97-52, NRC 2, JS 90-41 & NRC 7 were found to accumulate higher levels of trehalose in the root nodules. Higher levels of trehalose has been associated with drought tolerance
- Survey of 90 soybean germplasm accessions using dCAPS marker for recessive allele of E2, which confers earliness, resulted in identification of IC 15089
- MYMIV resistance gene has been mapped on chromosome 6 in PI 171443 of *Glycine max* while duplicate dominant genes for this trait from *Glycine soja* have been mapped on chromosome no. 8 and 14
- MYMIV resistance gene from PI 171443 of *Glycine max* has been introgressed in JS 335 using marker assisted backcrossing (MABC) and one of these MYMIV resistant lines has entered in IVT for testing during *kharif* 2017
- Genome wide identification of SNPs from rust resistant accession EC 241780 was performed by comparative analysis with Williams 82 reference genome sequence. Genomic annotation of single nucleotide polymorphisms (SNPs) in EC 241780 revealed that majority of the SNPs and InDels falls in the intergenic region
- Seggregants exhibiting oleic acid content more than 60% have been identified in F_4 population of 4 parental combinations
- Kunitz trypsin inhibitor free line NRC 127 developed in the background of JS 97-52

through Marker Assisted Backcrossing (MABC) entered in IVT 2016 and has been advanced to AVT I for testing during *kharif* 2017

- Lipoxygenase-2 free soybean 'NRC 109' developed at the institute has been commercialized.
- Four hundred advanced and segregating lines developed for high oil content was analysed for oil and protein content which led to the identification of lines with best combination of protein (>40%) and oil content (>21%)
- Foliar spray of 100 ppm salicylic acid at vegetative and pod filling stage showed better plant stand and yield in adverse climatic condition
- One novel rhizobial strain, namely, *Bradyrhizobium daqingense* (isolated from drought-tolerant line PK 472) has been reported from Indian rhizosphere for the first time. The novel strain has been found to have high ACC deaminase activity
- Tractor drawn disc harrow and tractor PTO operated rotary weeding machine (three point assembly system on tractor) for vertisols were developed
- Single channel Broad Bed and Furrow (BBF) sowing machine a variant of Broad Bed and Furrow machine was developed which is useful for sowing of soybean and wheat crop
- Breeder seed production programme undertaken for 5 soybean varieties, namely, NRC 86, NRC 37, NRC 7, JS 20-29 and JS 20-34 at the institute, a total of 304 q was produced during 2016-17 with highest productivity of NRC 86
- The institute organized MANAGE-IISR Collaborative Training Programme on "Agricultural Knowledge Management" during 19-23 September 2016, involving 19 field level officers of Madhya Pradesh and Chhattisgarh
- Under *Mera Gaon Mera Gaurav* Scheme, 6 teams have been constituted. Each team has selected five villages thus establishing contact with 30 villages on regular basis for disseminating technological information among the farmers
- The institute organized 'Soybean Diwas' on 28th September 2016 involving progressive farmers associated with *'Mera Gaon Mera Gaurav'* and Mega Seed Project through which they were exposed to novel technologies related to seed production as well as improved packages for management of weed, insect-pest and diseases under demonstrations at IISR farm
- Twenty frontline demonstrations were conducted on improved soybean production technology
- Twelve training programmes on "processing and utilization of soybean for food uses at household level" were organized with the participation of 399 women belonging Madhya Pradesh and Rajasthan respectively.
- A two day review workshop was organized for the scientists belonging to Krishi Vigyan Kendras located in Madhya Pradesh, Chhattisgarh & Orissa in association with ATARI, Zone VII, Jabalpur during 26-28

April 2016. In this workshop, review was undertaken about different OFTs and VTs on soybean conducted during the year and necessary modifications were suggested for formulation of annual plan for the coming season.

- Under *'Swach Bharath Abhiyan'* sanitation measures were held once in every month. As per the directives under National Sanitation Campaign, a focused sanitation drive was held in the institute

INTRODUCTION

1. INTRODUCTION

The ICAR-Indian Institute of Soybean Research (IISR) was established by Indian Council of Agricultural Research 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 IISR.

1.1. Physiography

IISR campus is situated in the village Piplyarao of district Indore, which lies in Vidhyanchal range of Malwa Plateau at 22° 4'37"N latitude and 75° 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.

1.2. 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.

1.3. 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. Usually pre-monsoon showers are experienced in last week of May or early June. Soybean is generally 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. Any crop grown during this season requires irrigation.

1.4. Past Achievements

Major achievements of this Institute include a vast collection of soybean germplasm holding which stands at 4148 including exotic, indigenous, breeding lines and wild species.

Further for better management of genetic resources and to enhance germplasm utilization core-collection of germplasm has been developed. A number of genetic sources have been identified/developed for various traits like photoperiod insensitivity, drought tolerance, diseases such as rust and YMV & insect resistance. (Rust: EC 241778, YMV: PLSO 84 etc Rhizoctonia root rot: AGS 48, Girdle beetle (TGX 863-26E), Defoliators (333902 etc), high oil content (AGS 191, NRC 7 etc), high oleic acid content (NRC 106, IC 210), low linolenic acid (VLS 59), vegetable soybean genotypes (NRC 105), null kunitz trypsin inhibitor (NRC 101, NRC 102). A number of high yielding varieties possessing resistance to various biotic and abiotic stresses (NRC 2, NRC 12, NRC 7, NRC 37, NRC 77, NRC 86 and JS 97-52) were bred and have been released for cultivation in different agro-ecological regions of the country.

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. INM for soybean-wheat and soybean-chickpea has been developed along with that integrated weed management schedule has also been developed. Microbes that enhance soil health including Zn, Fe solubilizing bacteria, and rhizobia have been identified. In the field of plant protection, integrated management schedule for major soybean insects and pests worked out. Studies on epidemiology of rust occurrence in soybean revealed that the source of rust inoculum for south India is lying in the Krishna valley. Web-based expert systems for varietal and disease identification and data management systems for AICRPS have been developed. Consequently the Institute has emerged as a catalyzing force to facilitate rapid increase in acreage and production of soybean from last 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.

1.5. 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

1.6. Organizational Set-up

For efficient functioning of the Centre and to achieve the mandate and objectives, the organizational pattern of the Institute has been evolved and depicted in Fig.1.

1.7. Library

The Institute has developed a reasonably good library equipped with relevant books, journals, etc. to provide the research needed support to the scientists. At present the library is equipped with 3269 books and subscribing 05 international and 39 national journals. IISR library is also a beneficiary of CERA for accessing more than 2000 scientific journals on-line.

1.8. Staff and Budget

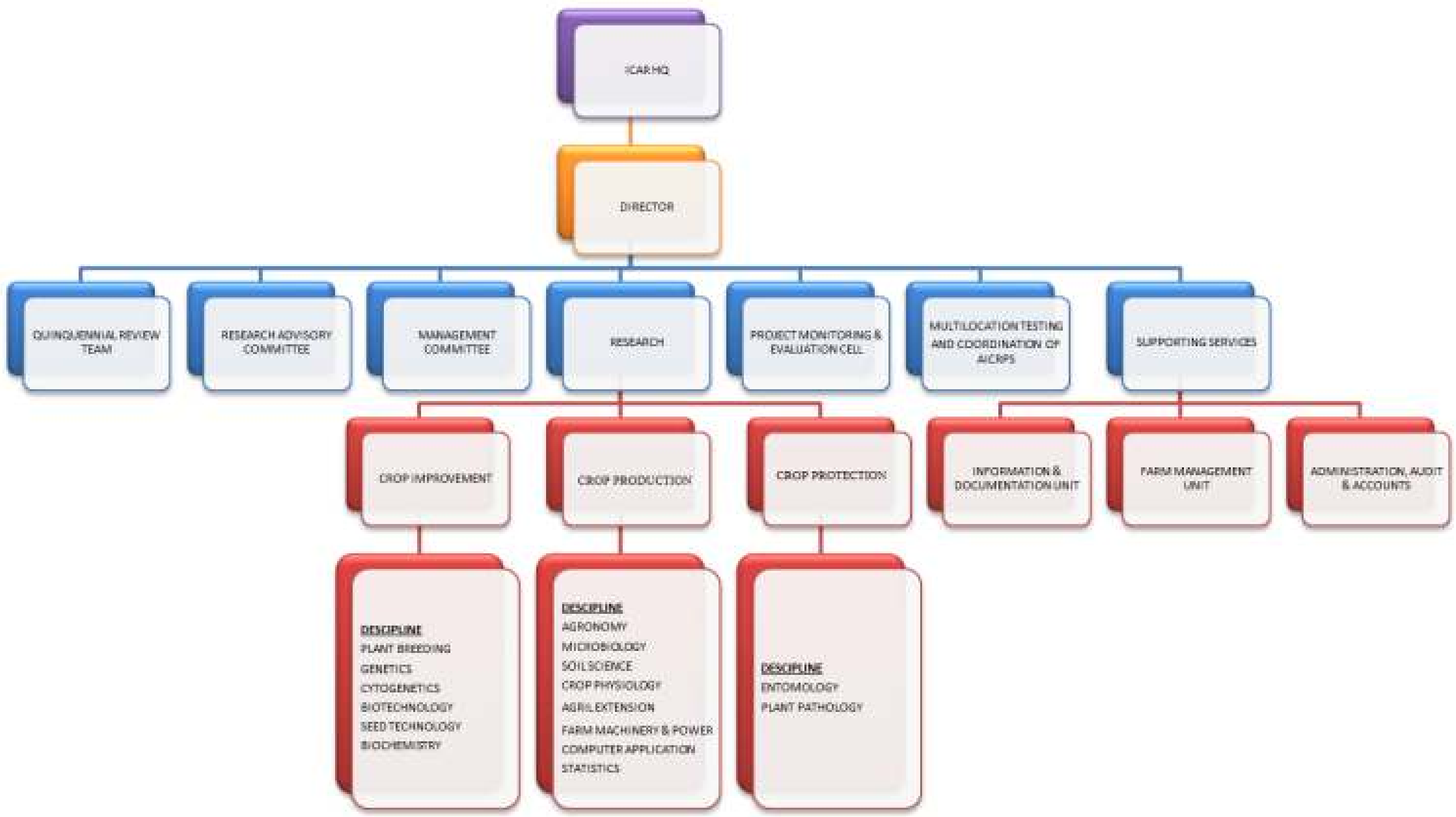
The total sanctioned staff position of ICAR-IISR as on 31 March 2017 is 93 comprising 31 scientific, 20 technical, 09 administrative and 11 supporting positions. Out of which a total of 67 persons were in position as on 31 March 2017 (Details given in Chapter 13).

The budget allocation and expenditure of the ICAR-IISR for 2064-17 is shown below (Table 1).

Table 1: Budget and expenditure of ICAR-IISR for the year 2016-17 **(Rs. in lakhs)**

Head	Plan		Non Plan	
	R. E.	Actual Exp.	R. E.	Actual Exp.
Pay & Allowances	-	-	733.00	732.99
Wages	-	-	11.23	11.23
T.A.	6.36	6.36	6.00	6.00
O.T.A.	-	-	.	.
Other Charges Recurring	156.74	156.74	109.15	106.10
(a) Information Technology	5.20	5.20	-	-
(b) Equipments	3.73	3.71	3.00	2.34
(c) Works	50.18	50.17	22.00	22.00
(d) Library	5.12	5.12	-	-
(e) Livestock	-	-	-	-
(f) Furniture & Fixtures	0.77	0.77	2.00	1.66
(g) others Items	-	-	-	-
(h) HRD	6.90	6.77	-	-
(i) TSP	38.65	38.02	-	-
(j) Pension & Retirement Benefits	-	-	51.12	51.12
(k) Loans & Advances	-	-	0.77	0.77
Total	**273.65**	**272.86**	**938.30**	**934.15**

Fig. 1: Organogram of ICAR-IISR



2.0 Genetic Resources

- **Maintainace, evaluation characterization of genetic resources**
- **Multilocation evaluation of breeding lines**
- **Consortium Research Project on Agrobiodiversity**
- **Evaluation of core collection**
- **Introduction and distribution of germplasm**

2.1. Maintenance, evaluation and characterization of genetic resources

Soybean germplasm accessions including wild species viz. *Glycine soja, G. tomentella, G. tabacine, G. latifolia, G. cenescens, G. clandestine, G. cyrtoloba, G. falcate, G. argyrea, G. microphylla, G. arenaria,* land races, cultivars and breeding lines are being maintained in the medium term storage module at ICAR-IISR, Indore.

2.1.1. Multilocation evaluation of soybean germplasm

Nearly 2500 germplasm lines including 102 wild accessions of 11 wild species were grown for evaluation, rejuvenation and multiplication. In order to broaden the genetic base of future soybean varieties, a set of 130 germplasm lines, in which 105 were exotic, was evaluated at Pantnagar, Indore, Imphal, Jabalpur, Parbahani and Pune. Lines with early maturity, high yield, more pods / plant and bold seeds were identified at different centres. Many line showed desirable characters across centres. For example EC 109563 exhibited early maturity at Pantnagar, Indore, Jabalpur and Pune. Similarly, AGS 751 and EC 615160 exhibited bold seed at all the centres (Table 2). Very early maturing line and lines with high number of pods, pod cluster, nodes, high 100-seed weight, seed yield and high resistance to charcoal rot were identified (Table 3)

Table 2: Identification of promising accessions from multi location trial

Centre	Promising Accessions*			
	High Yield	Early Maturity	High Pods / Plant	High 100-seed wt
Pantnagar	EC 100027, **EC 242002***,EC107416	**EC 109563,** AGS 112, AGS 38, EC 114527, EC 274755, EC 14458	B 1667, **B 1664,** DB 1587, EC 280149, EC 107416	**AGS 751,** EC 114527, EC **615160, AGS 38**
Indore	EC 383165, SQL 37, **EC 251501,** EC 291448, Nanking, AGS 80	**EC 109563,** AGS 158, **AGS 166,** EC 251358	EC 103336, **B 1664,** EC 103332, EC 309509, EC 291448	**EC 615160,** JS 20-34, **AGS 38, AGS 751**, EC 287466
Imphal	EC 241696, EC 309537, Nanking, J 122, **AGS 751**	EC 313976, EC 100027, EC 241309, EC 242038 SQL 37	Nanking, ICAL 127	**AGS 751**, EC 241995, EC 15971, CAT 57 A, AGS 166 AGS 174
Jabalpur	EC 457387, EC 251358, EC 467282, **EC 242002**	AGS 2, **AGS 166**, PI 17443A, **EC 109563**	EC 467282, EC 325103, EC 280148, EC 241309	EC 241309, **AGS 751, EC 615160**, AGS 166, **AGS 38**
Parbhani	EC251431, EC 274755, **ES 251501, AGS-751, EC 103332**	AGS-751, BR4, AGS-2, ES14458	EC 251470, IMP 1, J 122, EC 251383	AGS 751, EC 615160, AGS **38,** EC 333903, P 239
Pune	EC615160, BR3, EC 251396, EC 33940, EC 103332	JS 20-34, EC 325103, ICAL 122, EC 383165, **EC 109563**	EC 33940, EC 251396, EC 109563, B1667, **EC 28466**	**AGS 751, EC 615160, AGS 38,** EC 172663, EC 15971

*Accessions in bold were identified at more than one centre

Table 3: Identification of desirable accessions from multi location trials

Trait	Mean	Range	Desirable Accessions
Days–to- maturity	100	74–112	74-95 days: AGS 2, AGS 205, EC 109563, JS 20-34, EC 14426, EC 313976, AGS 166, AGS 158, EC 251525, EC 615160, EC 241309, EC 30968
Nodes/plant	13	11-15	14–15 Nodes: JS 75-30, B 1664, J 122, AGS 129, Nanking, EC 109563, EC 291398, EC 309537, J 76 – 205, DS 74-20-2, EC 241780, DB 1587, MACS 58, ICAL 127, M 204
Pod clusters/plant	13	5–21	17–21 clusters: EC 251396, Nanking, B 1664, JS 75-30, B 1667, EC 309537, EC 109563, MACS 58, AGS 205, EC 457387, EC 291448, EC309509, J 122
Pods/plant	42	20–75	59 –75 pods: B 1667, DB 1587, EC 251470, B 1664, EC 251431, AGS 80, EC 333879, EC 291448
100-seed weight (g)	11	7–18	13–18 g: AGS 751, EC 615160, AGS 38, EC 241309, EC 251516, EC 14426, EC 242086
Yield / plant (g)	8	4–17	11–17 g: EC 251431, EC 251470, EC 242002, EC 467282 (A), EC 383165, EC 457387, 383165, EC 457387
High Resistance to charcoal rot*	-	-	AGS 116, B 1667, BR 15, BR 3, DCB 199, EC 241695, EC 241750, EC 280148, EC 287466, EC 291451, IMP 1, IPB 142-18, J 76-205, EC 274747

*At Jabalpur

2.1.2. Multiplication and evaluation of germplasm under Consortium Research Project on Agrobiodiversity (CRP-Agrobiodiversity)

Nine hundred ninety germplasm received from ICAR-NBPGR's Long Term Storage (LTS) for periodic rejuvenation and evaluation were multiplied and screened for 32 morphological characters. Salient features for important agro-morphological traits are summarized in Table 4.

Table 4: Important agro-morphological traits in germplasm from CRP on Agrobiodiversity

Trait	Mean	Range	Desirable Accessions
Days-to -flower	44	19-80	19-25 days: EC 771209, EC 771182, EC 771170, IC 0501489, EC 771192, EC 771185, EC 76757, EC 771223, EC 61396, EC 771202
Days-to- maturity	105	70-130	70-80 days: EC 771209, EC 771192, EC 771182, EC 771185, EC 771170, EC 76757, IC 0501489, EC 34087, EC 771186, EC 771202, EC 50103, EC 771226, EC 771214, EC 127504, EC 771218, EC 0033781, EC 771205, EC 771234, EC 771172, EC 77147, EC 771240, EC 37103, EC 85602
Nodes/plant	11.4	5.5–21.8	18-21 nodes: IC 0042148, EC 114526, EC 77205, IC 0501430, EC 118307, EC 771232, EC 24069, IC 0501603, IC 501158, IC 0501325, IC 0501360, EC 771200, IC 0501371, IC 0501439, EC 39777
Pods/plant	38.1	5-172	95-172 : IC 501253, EC 77205, IC 0501239, EC 771173, IC 0501309, IC 0501280, IC 0501200, EC 104871, IC 0501483, IC 18384
100-seed weight (g)	9.3	2.1-22.8	17-22.8 g: EC 771205, EC 771202, EC 77148, IC 0501607, EC 771213, EC 77147, EC 771203, EC 771170, EC 771219, EC 771209, IC 0501603, EC 771185, IC 0501581
Yield/plant (g)	4.2	0.22-15.2	13-15 g: IC 16818, IC 501206, IC 0501317, EC 127504, IC 0501636, EC 771234, EC 39777

2.1.3. Evaluation of core collection

Two hundred one lines of core collection were multiplied and evaluated for 32 morphological traits. A wide range of variability was observed in various agro morphological traits (Table 5).

Table 5: Important agro-morphological traits in core collection

Trait	Mean	Range	Desirable Accessions
Days-to-flower	45	18-66	18-22 days: EC 39042, EC 39066, EC 39172, EC 39063, EC 34092
Days-to maturity	103	72-116	72-84 days: EC 39063, EC 32573, EC 55878, EC 34092, EC 39022, EC 34372, EC 39172, EC 34087, EC 39173, EC 39205, EC 39230, EC 34395, EC 34398, EC 37092, EC 39042, EC 39066, EC 39039, EC 39150, EC 39177-A, EC 55871, EC 39107, EC 93322, EC 55854, WT 182, EC 39739, EC 37021, EC 30209
Nodes/plant	12.3	5-18.8	16.8-18.8 nodes: V 56, EC 116055, GC 17, UPSM 719, EC 39508, EC 241 778, EC 39796, B 1664, DS 203, EC 109540
Plant height (cm)	50.5	15-89.2	80.2-89.2 cm: AGS 31, EC 18646, EC 16729, UPSM 719, IC 16572, B 166
Pods/plant	48.2	12-175	99.4-175 pods: EC 287454, EC 325101, TGX 824-34C, MACS 263, TGX 1073-55E
100-seed weight (g)	9.7	4.4-23.6	17.0-23.6 g: AGS FARM ACC, EC 30209, EC 39173, EC 55878
Yield/plant (g)	6.46	0.1-17.6	16-17.6 g: IC 501244, TGX 899-285D, ICS84/86-85B-41, AGS76, TK 5, EC 325101, IC 501254

2.1.4. Introduction of germplasm from USDA and AVRDC

Efforts have been initiated in collaboration with ICAR-NBPGR, ICAR New Delhi and Biodiversity International to procure soybean germplasm from USDA, USA by overcoming the limitations of phytosanitary certificate. A list of 12,142 accessions belonging to core collection, resequenced core collection and having different traits like high yield, different origins, photoinsensitivity, biotic and abiotic stress tolerance, improved quality traits has been submitted to ICAR-NBPGR New Delhi for their procurement. One hundred forty vegetable soybean accessions are in the process of procurement from Asian Vegetable Research and Development Centre (AVRDC), Taiwan.

2.1.5. Distribution of soybean germplasm

Three hundred seventy nine germplasm accessions were shared with soybean researchers from 16 research institutes / universities.

2.1.6. Evaluation of advanced breeding population from Jabalpur

Fifty advanced breeding lines developed at JNKVV, Jabalpur were received for their use in soybean breeding programme. These lines were evaluated for 32 morphological traits and summarized for important agro-morphological traits in Table 6.

Table 6: Important agro-morphological traits in advance breeding lines of Jabalpur

Trait	Mean	Range	Desirable Accessions
Days-to-flower	42.9	30.0-51.0	30-36 days: JS 20-84, JS 20-18, JS 20-97, JS 20-40, JS 20-39, JS 20-78
Days-to- maturity	96.0	83-104	83-88 days: JS 20-40, JS 20-27, JS 20-84, JS 20-19, JS 20-23, JS 20-18, JS 20-39, JS 20-78
Nodes/plant	11.6	8.6-21.0	14.2-21.0 nodes: JS 20-60, JS 20-53, JS 20-71, JS 20-37, JS 21-06
Plant Height (Cm)	54.6	35.6-73.0	65.8-73.0 cm: JS 21-09, JS 20-71, JS 21-01, JS 20-116, JS 20-94, JS 20-93
Pods/plant	42.5	16.4-94.4	67.0-94.4 pods: JS 20-109, JS 20-37, JS 20-79, JS 20-98, JS 20-96
100-seed weight (g)	11.0	8.5-14.1	13.0-14.1 g: JS 21-08, JS 20-19, JS 20-84, JS 21-09
Yield/plant (g)	9.4	3.3-20.9	14.5-20.9 g: JS 20-37, JS 20-96, JS 20-98, JS 20-64, JS 20-109, JS 21-01, JS 20-71, JS 21-09

3.0 BREEDING

3.1 YIELD ENHANCEMENT

- Evaluation of advanced and mid-generation breeding lines
- Evaluation of Nested association mapping population
- Evaluation of 4 way inter-cross F_3 population

3.2 WIDER ADAPTIBILITY

- Breeding for wider adaptability using photoperiod response and growth habits

3.3 FOOD-GRADE CHARACTERS

- Breeding for quality traits, Genetic elimination of Kunitz trypsin inhibitor and Lipoxygenase, high oleic acid and oil content
- Screening of germplasm for vegetable type soybean

3.1. Yield enhancement

3.1.1. Evaluation of advanced and mid generation breeding lines

A total of 67 advanced breeding lines were evaluated in two separate trials along with checks JS 93-05, NRC 86 and NRC 37. Ten lines were identified with yield superiority over the best check (Table 7). The entry JS 97-52 × PBM-1-1-9-2-6-1 recorded highest seed yield (3234 kg/ha) and found to be yielded higher than better check entered in AICRP trial (Table 7).

Table 7. Agronomic performance of selected advanced breeding lines

Entry	Yield Kg/ha	Days-to-maturity
JS 97-52 × PBM-1-1-9-2-6-1*	3234	112
JS 97-52 × PBM-1-1-9-2-10-1	3160	112
JS 97-52 × PBM-1-1-9-1-3-3	3160	114
JS 97-52 × PBM-1-2-4-4-2-2	3135	115
PS 1225 × JS 95-60-1-3-3-1	3111	106
7A-109-SP	3703	102
6A-22	3703	111
7A-109	3259	103
3A-60	2074	86
7A-85	3555	102
NRC 86 (Check)	2666	108
NRC 37 (Check)	1901	107
JS 93-05 (Check)	2888	103

*PBM (Pantnagar breeding material) : EC389148 × PS1042

3.1.2. Evaluation of nested association mapping (NAM) population

A nested association mapping (NAM) population was developed by hybridizing JS 335, a popular variety of central India with 20 diverse soybean genotypes for mapping and improving towards drought and water logging tolerance, YMV and rust resistance, early maturity and higher yield. NAM populations are used to map loci in a multi-cross mating design where one common parent is shared among all other founder parents. Briefly, the strategy involves crossing several founder lines to a single common parent to generate segregating progenies in multiple populations. The genetic background is normalized by the virtue of having a common parent, which allows mapping of segregating alleles in different populations with reference to common-parent specific alleles. The NAM design has also been used to detect QTL with various effect sizes, including rare alleles, because of its higher statistical power. Nested association mapping population (NAM) consisting of 20 cross combination (F_3 generation) were evaluated for yield and attributing traits. The crosses viz., G-11 × JS 335 (27.78 g) and JS 97-52 × JS 335 (22.50 g) have highest population mean for seed yield. The highest seed yield per plant was recorded in cross JS 97-52 × JS 335 (82.7 g). The cross EC 481347 × JS 335 has lowest population mean yield (4.80 g). The observation on days-to-maturity indicated JS 335 × EC 656641 matured earlier (92 days) as compared to rest of the crosses (Table 8).

3.1.3. Evaluation of 4 way inter-cross F_3 population

A total of 1641 F_3 individual plants derived from 4 way intercross hybrids were evaluated for yield and attributing traits. The cross [EC 546882 × NRC 37] × [EC 572136 × JS 335] exhibited the highest population mean (19.79 g) with mean maturity duration of 105 days, while the cross [EC 572109 × JS 95-60] × [EC 572136 × JS 335] showed low population seed yield per plant, with 95 days mean maturity (Table 9). The highest seed yield per plant (54.10 g) was recorded in [EC 546882 × NRC 37] × [EC 333901 × NRC 86]. The NAM and MAGIC population developed at this institute constitute useful genetic material for genetic improvement of soybean in India.

Table 8: Evaluation of Nested association mapping (NAM) F_3 population for yield and maturity.

Crosses	Population size	Yield/plant* (g)	Days-to-maturity*	Range	
				Yield/ plant (g)	Days-to-maturity
Bragg × JS 335	527	14.98	109	0.2-63.5	101-113
JS 97-52 × JS 335	303	22.50	109	1.2-82.7	109-112
JS 20-38 × JS 335	300	9.11	96	0.1-39.2	89-100
PK 472 × JS 335	99	12.50	103	0.9-44	99-109
DOKO × JS 335	99	12.90	110	1-40	100-113
JS 335 × AGS191	65	7.20	112	0.6-21.6	109-113
JS 335 × IC 501198	76	11.82	107	1-51.2	95-113
EC 546882 × JS 335	315	11.34	108	0.8-51.2	95-115
JS 335 × KDS 889	169	11.86	108	1.3-35.2	95-113
EC 481347 × JS 335	87	4.80	95	0.8-18.3	88-100
JS 335 × Gaurav 2	61	11.46	107	4.50-23.6	91-113
JS 335 × EC 656641	38	5.70	92	0.1-21.3	89-95
Jackson × JS 335	19	15.38	113	3.9-27.1	99-113
JS 335 × IC 15759A	26	7.40	106	0.8-18.10	95-113
Santamaria × JS 335	76	6.74	97	1.1-12.4	91-109
Hardy × JS 335	19	7.7	110	1-20.80	91-113
Kalitur × JS 335	26	6.88	109	2.1-17	109
G-11 × JS 335	13	27.78	103	4-53.3	91-109
NRC 37 × JS 335	10	17.10	106	6.3-27	95-109
Valder × JS 335	3	9.20	95	5.2-14.5	95

* Population mean

Table 9: Evaluation of 4 parents based Multi-parent Advanced Generation Intercross (MAGIC) F_3 populations for yield and maturity

Crosses	Population size	Yield/plant* (g)	Days-to-maturity*	Range	
				Yield/ plant (g)	Days-to-maturity
[EC 546882 × NRC 37] × [EC 572136 × JS 335]	57	19.79	105	5.3-49.4	95-109
[EC 546882 × NRC 37] × [EC 333901 × NRC 86]	255	15.87	104	0.2-54.10	95-109
[EC 546882 × NRC 37] × [EC 572109 × JS 95-60]	124	13.18	99	0.9-46.2	85-109
[EC 333901× NRC 86] × [EC 572136 × JS 335]	382	8.95	98	0.1-32.6	89-101
[EC 572109×JS 95-60] × [EC 572136 × JS 335]	122	8.45	96	0.6-27.4	89-100
[EC 572109 × JS 95-60] × [EC 333901 × NRC 86]	701	10.55	95	0.6-47.6	84-101

* Population mean

Besides, fifteen crosses belong to F_3 generations and three BC_1F_3 populations derived from *G.soja* were evaluated for yield and attributing traits.

3.1.4. Phenotyping of bi-parental mapping populations for yield component traits

Three bi-parental mapping populations previously developed for mapping of yield and attributing triats were phenotyped for three yield component traits viz. 100 seed weight, number of seeds per plant and seed yield per plant in augmented design. A total of 10 plants from each line were sampled for collecting data. The statistical description of phenotypic observations has been presented in Table 10.

Table 10: Phenotypic observations for three bi-parental mapping populations

Character	Variable	Type 49 × EC 538828	JS 335 × EC 538828	EC 538828 × JS 97-52
		Population size		
		220	114	143
100 seed weight (g)	Range	8.3-20.6	9.5-21.2	6.6-20.5
	Mean	13.43	16.12	12.97
	Standard deviation	1.99	2.99	3.57
Seeds/plant	Range	35-162.5	31.9-155.4	31.5-299.4
	Mean	76.51	77.66	105.11
	Standard deviation	24.62	24.49	63.51
Yield/plant (g)	Range	2.34-21.18	4.94-24.41	3.85-25.79
	Mean	10.23	12.47	11.84
	Standard deviation	3.01	3.90	4.44

3.1.5. Phenotyping of advanced backcross populations for yield component traits

A BC_2F_4 and a BC_3F_2 advanced backcross mapping population (*Glycine soja* x JS 335) were phenotyped for three yield component traits viz. 100 seed weight, number of seeds per plant and seed yield per plant in augmented design. A total of 10 plants from each line were sampled for collecting data. The statistical description of phenotypic observations has been presented in Table 11.

Table 11: Phenotypic observations for two advance backcross mapping populations

Character	Variable	BC_2F_4	BC_3F_2
		Population size	
		165	109
100 seed weight (g)	Range	5.5 - 13.7	6.7 - 12.5
	Mean	8.96	10.22
	Standard deviation	1.58	1.27
Seeds per plant	Range	33.5 -182.1	15.2 - 219.3
	Mean	115.63	103.6
	Standard deviation	31.65	37.85
Seed yield/ plant (g)	Range	2.48 - 18.1	3.03 - 20.86
	Mean	10.18	10.36
	Standard deviation	3.12	3.87

3.2. Breeding for wider adaptability using photoperiod response

3.2.1. Evaluation of advanced generation lines for photo insensitivity

Recessive alleles at *e3* and *e4* loci confer photoinsensitivity and early maturity. EC 390977 has recessive photoinsensitive alleles at both of these loci and EC 538828 has recessive allele at *e3* locus. Seven advanced generation lines arising from the cross of these lines were evaluated for the second year and were found to be very early (85-91 days) as compared to JS 95-60 the early maturing check (92 days) (Table 12).

Eleven advance generation genotypes arising from the cross of long juvenile accession AGS 25 and conventional juvenile parents were evaluated for the second year for yield and maturity. Maturity duration of genotypes arising from the cross involving JS 95-60 parent had was less than that of JS 95-60 and one line was superior in yield also. Advance generation lines arising from the cross involving JS 93-05 had longer maturity duration and two lines had higher mean yield than the best check JS 335.

Table 12: Evaluation of advance generation lines from photoperiodic and long juvenile trials.

Entry	Yield 2016 (Kg/ha)	Average yield 2015-2016 (Kg/ha)	Days – to - maturity
Photoperiodic trials EC 538828 × EC 390977			
Pp6 × NRC 121- l.n.-18	2660	2136	90
-do- l.n.-27	2740	2490	89
-do- l.n.- 29	2537	2185	90
-do- l.n.- 31	2540	2124	85
-do- l.n.- 33	2544	2062	90
-do- l.n.-40	2657	2150	88
-do- l.n.-43	2728	2129	91
Long Juvenile trials JS 93-05 × AGS 25			
49 GH 100/2	3122	2045	106
49 GH 102	2722	1490	105
49 GH 130/1	2856	1823	103
49 GH 130/2	2848	1728	105
Long Juvenile trials JS 95-60 × AGS 25			
51 PB 39/2	2825	1657	90
51 PB 65/1	2492	1450	87
51 PB 65/2	2187	1220	90
51 PB 66/1	2506	1848	89
51 PB 86 A	2092	1303	87
51 PB 86 B	2459	1466	87
JS 95-60 × AGS 25 (111/2)	2738	2175	88
Parents and checks			
EC 538828	1818	1452	81
JS 95-60	2492	1386	92
JS 335	3158	1691	98
JS 93-05	2536	1413	96

Besides, one hundred ninety three early generation lines along with checks were evaluated in augmented design and early maturing and high yielding lines were identified. 155 mid generation lines from 24 crosses of photoperiodic and long juvenility experiments were evaluated in augmented design. Two lines were significantly superior to earliest maturing check (JS 95-60) in yield and were at par with it in maturity. One line (C 51-PB GH 39/3) was at par with the best check (JS 335) and had shorter maturity durations. Eight lines were superior to the best check and had maturity duration equivalent to or more than JS 335 (Table 13).

Table 13: Evaluation of early and mid generation lines

Entry	Yield (Kg/ha)	Days – to - maturity
C 51 PB 113	2030	87
C 51 PB 111/1	2059	87
C 51-PB GH 39/3	2869	96
C 51-3 GH 22G	2884	102
C 49 GH 100/1	2923	100
C 26/39-40/5	2926	102
C 53/36-3	3200	100
C 72 / 29g	3274	108
C 72 / 23g	3331	108
C1 / 38.4g	3523	105
C7 / 36g	3074	108
Checks		
JS 95-60	1651	86
JS 335	2822	102
JS 97-52	2488	109
NRC 37	2667	107
JS 93-05	2459	94
PK 416	2370	109

3.2.2. Marker assisted backcross selection for photoinsensitivity

Heterozygous BC_3 plants for *e3* (14), *e4* (34) and *e3e4* (15) alleles were selfed and 8 *e3e3e4e4,* 21 e*3e3E4E4* and 18 *E3E3e4e4* BC_3F_2 plants were identified through foreground selection and multiplied.

3.2.3. Hybridization

A total of forty seven cross combinations were effected and 777 putative F_1s are being confirmed from 23 crosses and true F_1s being advanced to F_2 at University of Agricultural Sciences, Bangalore.

3.2.4. Identification of new germplasm source for recessive alleles of E1 and E2 flowering gene

The dCAPS are simple PCR based markers can be used for molecular breeding program. The gene sequence was PCR amplified and digested with restriction enzyme Dra I. A total of 90 soybean germplasm accessions were analysed for dCAPS marker based detection of a recessive allele of E2 flowering gene. Out of 90 accessions analyzed, only one accession IC 15089, was found with recessive allele of E2 gene (Fig 2). The same accession was also found to contain recessive e1-as allele in the earlier investigation done in the institute.

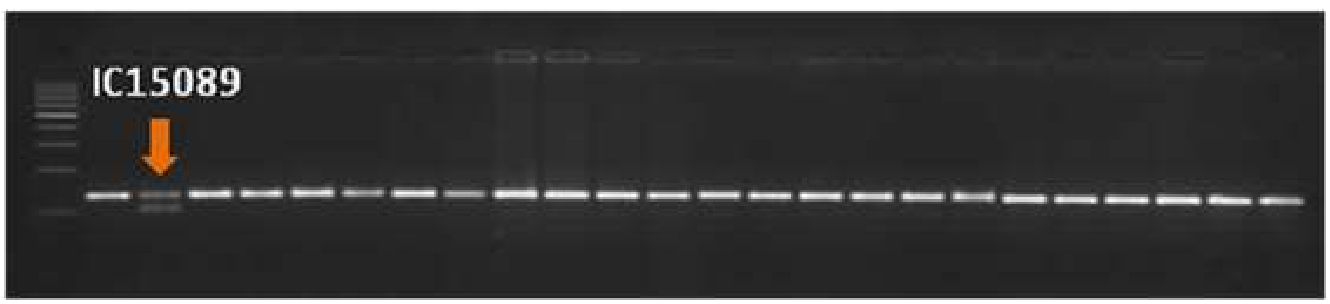


Fig. 2: dCAPS marker based detection of a recessive allele of E2 flowering gene in germplasm accession IC 15089.

3.2.5. Validation of functional marker for pod shattering gene Pdh1

Pdh1 gene reported for pod shattering characteristic and the CAPS marker available for the trait was analysed in a shattering susceptible (but drought resistant, bold seeded and early maturing soybean accession) EC 538828 along with 3 high yielding but shattering resistant genotypes Type 49, JS 97-52 and JS 335. SNP primers were PCR amplified and digested with restriction enzyme Nhe I. The CAPS marker has clearly distinguished shattering resistance and susceptible genotypes.

3.3. Food grade characters

3.3.1. Mapping QTLs for oleic acid and development of high oleic acid soybean

Fatty acid composition of Recombinant inbred lines (RILs) developed from LSb1 × NRC 7 was determined. Seven lines exhibited oleic acid about 50%. Association of genomic regions with oleic acid content for the crop raised in 2016 using Jump Genomic was determined and some of the genomic regions were found to be common with the previous year analysis. F_3 plants of the crosses IC 210 x P 4-4 (Recombinant Inbred Line from LSb 1 × NRC 7); NRC 106 × LSb1 × NRC 7; NRC 108 × AGS 191 IC 210 × NRC 105; IC 210 × P 4-19 (Recombinant Inbred Line LSb 1 × NRC 7); NRC 106 × NRC 105 were raised and $F_{3:4}$ seeds were analysed for oleic acid content through Gas Chromatography. Seggregants with oleic acid more than 60% were identified. PCR of various high oleic acid sources using *FAD2-1A* specific primer generated amplicons which varied in size (Fig 3).

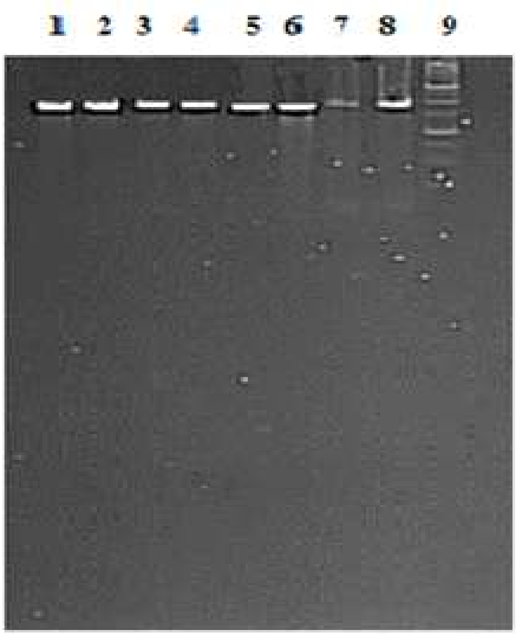


Fig. 3: PCR generated products using *FAD 2-1A* specific primer in high oleic acid sources. Lanes 1 & 2 correspond to IC 210, 3 & 4 to LSb 1, 5 & 6 NRC 7, 7 & 8 to NRC 106 as resolved on 1.0 % agarose.

3.3.2. Post harvest manipulation of anti-nutritional and nutraceutical factors in soybean using electron beam

The effect of 4.8, 9.2, 15.3 and 21.2 kGy of electron beam (EB)-irradiation on major storage proteins viz. glycinin (11S) and β-conglycinin (7S) were studied in 3 soybean genotypes (Fig. 4). Densitometry of SDS-PAGE protein profile revealed significant ($P<0.05$) reduction in α', α, and β subunit of 7S fraction at all the doses. This reduction was higher ($P<0.05$) than the decline observed in acidic and basic subunit of 11S fraction. Basic subunit registered significant ($P<0.5$) increase at specific doses in two genotypes. The study showed higher ($P<0.05$) decline in the concentration of 7S fraction compared to 11S fraction due to exposure to EB-irradiation, which may influence the functional and nutritional value of soy products processed from them.

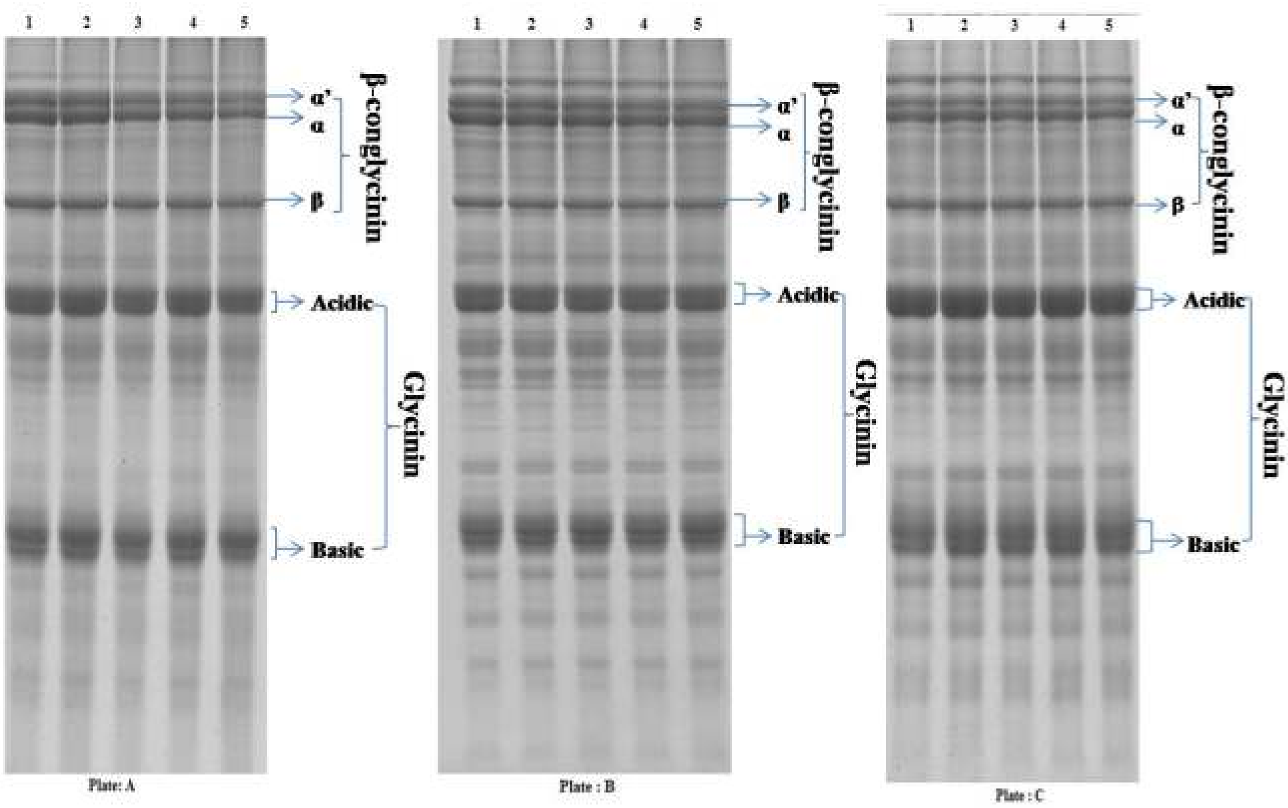


Fig. 4 : Plate A, B, and C corresponds to storage protein profiling of IC 210, NRC 107, and JS 95-60, respectively. In all the three plates A, B, and C: Lane 1,2,3,4, & 5 corresponds to irradiation doses of 0 (control), 4.8, 9.2, 15.3, and 21.2 kGy respectively.

The same 3 genotypes exposed to 4 doses viz. 4.8, 9.2, 15.3 and 21.2 kGy of EB-irradiation were assessed for the changes in the contents of lipoxygenase isozymes and tocopherol isomers. Densitometry of protein profile revealed decreasing intensity of lipoxygenase with increasing EB dose (Fig. 5). All the 3 lipoxygenase isozymes viz. lipoxygenase-1, -2 and -3 registered significant ($P<0.05$) increasing reduction with increasing dose; though genotypic variation was noted for the magnitude of reduction at the same dose. Concomitantly, all the 3 genotypes exhibited significant ($P<0.05$) decline in α, γ and δ isomer of tocopherol. δ Tocopherol was the most sensitive to EB-irradiation. Decline in vitamin E activity corresponding to the dose, which induced maximum reduction for total lipoxygenase also varied in 3 genotypes.

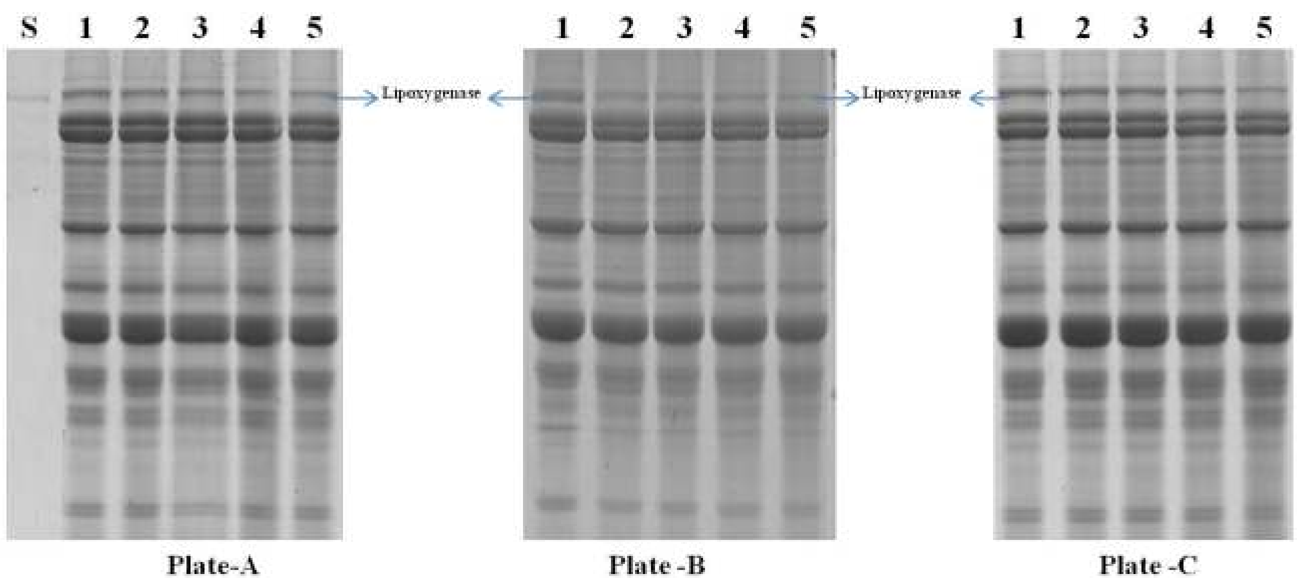


Fig. 5 : Lipoxygenase profiling of irradiated and non-irradiated seeds of soybean genotypes through SDS-PAGE analysis. Plate A, B, C corresponds to JS 95-60, IC 210 and NRC 107, respectively. In all the 3 plates Lane 1, 2, 3, 4, & 5 corresponds to irradiation doses of 0 (control), 4.8, 9.2, 15.3, and 21.2kGy, respectively. S is the lipoxygenase standard protein (108 kDa).

3.3.3. Marker assisted elimination of off-flavour generating lipoxygenase-2 from kunitz trypsin inhibitor (KTI) free soybean genotypes

Parental polymorphism survey was conducted using 390 SSR markers for the kunitz trypsin inhibitor free recipient genotypes in the background of NRC 7, JS 97-52, JS 93-05 and MACS 450, and NRC 109, the null lipoxygenase-2 gene donor for 4 parental combinations viz. NRC 7 × NRC 109 and JS 97-52 × NRC 109 and JS 93-05 × NRC 109, MACS 450 × NRC 109. Crossing was affected between the recipient KTI free genotypes and null lipoxygenase-2 donor and total of 189 and 61 F_1 (putative) seeds were obtained for the crossing of KTI free lines in the background of JS 97-52 and NRC 7 respectively. Fig. 6 is the representative figure using selected SSR markers. However, more SSR markers are being screened on each linkage group. Kunitz trypsin inhibitor free line (NRC 127) was developed in the background of JS 97-52 and entered in IVT.

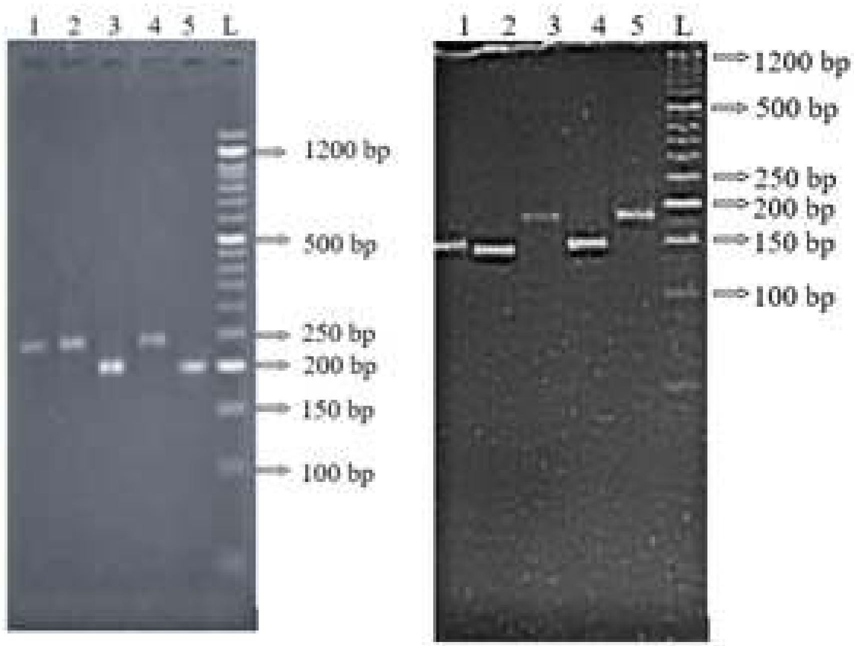


Fig. 6 : Parental polymorphism survey of 4 parental combinations using Satt 198 (left) and Satt 611 (right) marker (LGp D1a). Lanes: 1: NRC 7, 2: JS 97-52, 3: NRC 109, 4: JS 93-05, 5: MACS 450, L corresponds to the Ladder (50 base pair).

3.3.4 Breeding for food grade characters and high oil content

Following crosses were attempted to incorprate null alleles of lipoxygenases, kunitz trypsin inhibitor into high yielding background and vegetable type soybean, to pyramid null alleles of both the character in same genetic background and to develop high oil genotypes.

- F_1(JS 97-52 × NRC 101) × (JS 97-52× PI 542044) × F_1 PI 205085 ×(LSB1 × PI 408251)
- JS 95-60 × BC_1F_1(JS 95-60 × NRC 101)
- JS 335 × BC_1F_1(JS 335 × NRC 101)
- SL 525 × BC_2F_1(JS 335 × NRC 101)
- F_1(JS 97-52 × NRC 101) × (JS 97-52× PI 542044) × F_1 (JS 335×PI 205085) × (LSB1 × PI 408251)
- EC 456546 × (JS 97-52× PI 542044)
- P7-31 × NRC 109
- PI 408251, source of null allele of Lox1 × VG1
- F_1(JS 97-52 × NRC 101) × (JS 97-52× PI 542044) × F1 (JS 335 × PI 205085) × (JS 335 × PI 408251)
- NRC 121 × NRC 101
- NRC 121 × NRC 105

Four hundred advanced and segregating lines developed for high oil content were analysed for oil and protein content. Some of the lines with best combination of protein and oil content are given in Table 14.

Table 14: Advanced and segregating lines with best combination of protein and oil content

Entry	Pedigree	Oil content (%)	Protein Content (%)
NAG 22	NRC 7 × AGS 191	23.96	35.80
HG 11	Hardee × G 76	24.28	39.37
HG 25	Hardee × G 76	24.80	38.37
HN 48	Hardee × NRC 7	25.12	38.81
HN 92	Hardee× NRC 7	24.72	38.81
NG 101	NRC 7 × G 76	25.6	40.65
HNAG 390	(Hardee × NRC 7) × AGS 191	24.23	37.06

3.3.5. Screening of germplasm for vegetable-type characteristics and optimization of processing parameters

The germplasm accessions grown during *kharif* 2016 were evaluated for vegetable type characteristics at R_6 stage by sensory analysis. A total of 2200 germplasm lines were organoleptically tested for vegetable like characteristics. The basic criteria for screening was sweetness, tenderness and boldness of seed and lack of off flavors e.g. beany, astringent, itchy, bitter, soapy. The lines were further categorized on the basis of size and degree of sweetness. Out of 2200 lines tested 122 small seeded lines, 110 medium seeded lines and 28 large seed line were found to have varied degree of sweetness (Table 15). 109 large seeded lines with no perceived sweetness were also considered for further evaluation. Selected lines will be grown in *kharif* season 2017 for further validation.

Table 15: Germplasm lines identified for large seed and sweetness

P 239	EC 457198	IC 501166	IC 0049859
EC 24083	EC 341462	EC 77148	EC 771205
IC 501209	EC 242007	G 688	EC 615139
IC 501553	EC 95287	EC 30209	AGS 190
IC 0073707	PS 1483	NRC 2349	JSM 258
GC 17	EC 333896	EC 572149	EC 615160
IC 0037206	EC 528620	IC 18743	EC 538829

3.3.6. Processing of vegetable soybean through osmodrying

Freshly shelled green seeds of vegetable type soybean NRC 105 were blanched and osmodried in sugar solutions pf varying concentration to increase the shelf life while retaining the quality of product. Vegetable soybean osmodried in 40% sugar solution exhibited better color retention and taste and shorter rehydration time (Fig 7).

Fig. 7: Osmodrying treatment of NRC 105 at 0, 20, 30, 40, 50, 60, 70 degree brix

4.0 ABIOTIC STRESS

- **Evaluation of breeding and germplasm lines for physiological, biochemical and root system architecture**
- **Evaluation for root traits, delayed senescence and yield**
- **Hybridization and generation advancement**
- **Identification of drought tolerant soybean rhizobia**

4.1. Evaluation of elite breeding lines

The elite breeding lines from 3 crosses involving JS 97-52, JS 90-41 and NRC 37, along with 3 drought tolerant (Young, JS 97-52, NRC 7) and 2 sensitive (NRC 2, JS 335) checks were evaluated. Physiological and biochemical traits were assessed in water stress (WS) scenario in rainout shelter, root traits in well watered (WW) scenario in lysimeters of PVC pipes and productivity traits in both rainout shelter and field trial. The traits in rainout shelter were recorded for the target environment of late season water deficit condition induced at R5 stage.

4.1.1. Physiological and biochemical screening for drought adaptive characters

Physiological effect of drought stress was evaluated among 26 lines along with two checks NRC 7 (tolerant) and NRC 2 (susceptible) on the basis of metabolic activities. Relative water content (RWC) has shown higher value in the tolerant check (89.5%) than the sensitive one (83.4%) (Fig. 8). Drought condition resulted in enhanced proline accumulation of 324.7 $\mu M.gm^{-1}$ fresh weight (FW) in tolerant variety than that of sensitive check (82 $\mu M.gm^{-1}$ fresh wt). A significant decrease in H_2O_2 level has been observed in tolerant genotype as compared to elevated levels of H_2O_2 in the susceptible one. Stomatal frequency (No. of stomata/cm^2) in WS condition was more in tolerant check as compared to the sensitive check.

4.1.2. Root system architecture (RSA) and yield improvement

In the same set of 26 lines with 3 drought tolerant (Young, JS 97-52, NRC 7) and 2 drought sensitive (NRC 2, JS 335) checks, RSA was determined for root traits viz. average root diameter, root length density (RLD), root surface area, rooting depth, root dry weight and root volume. Genetic variation over root traits has been found associated with maintaining plant productivity under drought. Percentage decrease in seed yield in WS over WW showed favorably strong negative correlation ($r = -0.890$, $p<0.01$) with seed yield in WS, and significant negative correlation ($r = -0.376$, $p<0.05$) with average root diameter (mm). Average root diameter expressed strong negative correlation ($r = -0.475$, $P<0.01$) with root length density (RLD). RLD had significant positive correlation ($r =0.373$, $p<0.05$) with rooting depth. RLD was also found associated positively at high level of significance with root surface area ($r =0.975$, $p<0.01$), root volume ($r = 0.868$, $p<0.01$) and root dry weight ($r =0.595$, $p<0.01$).

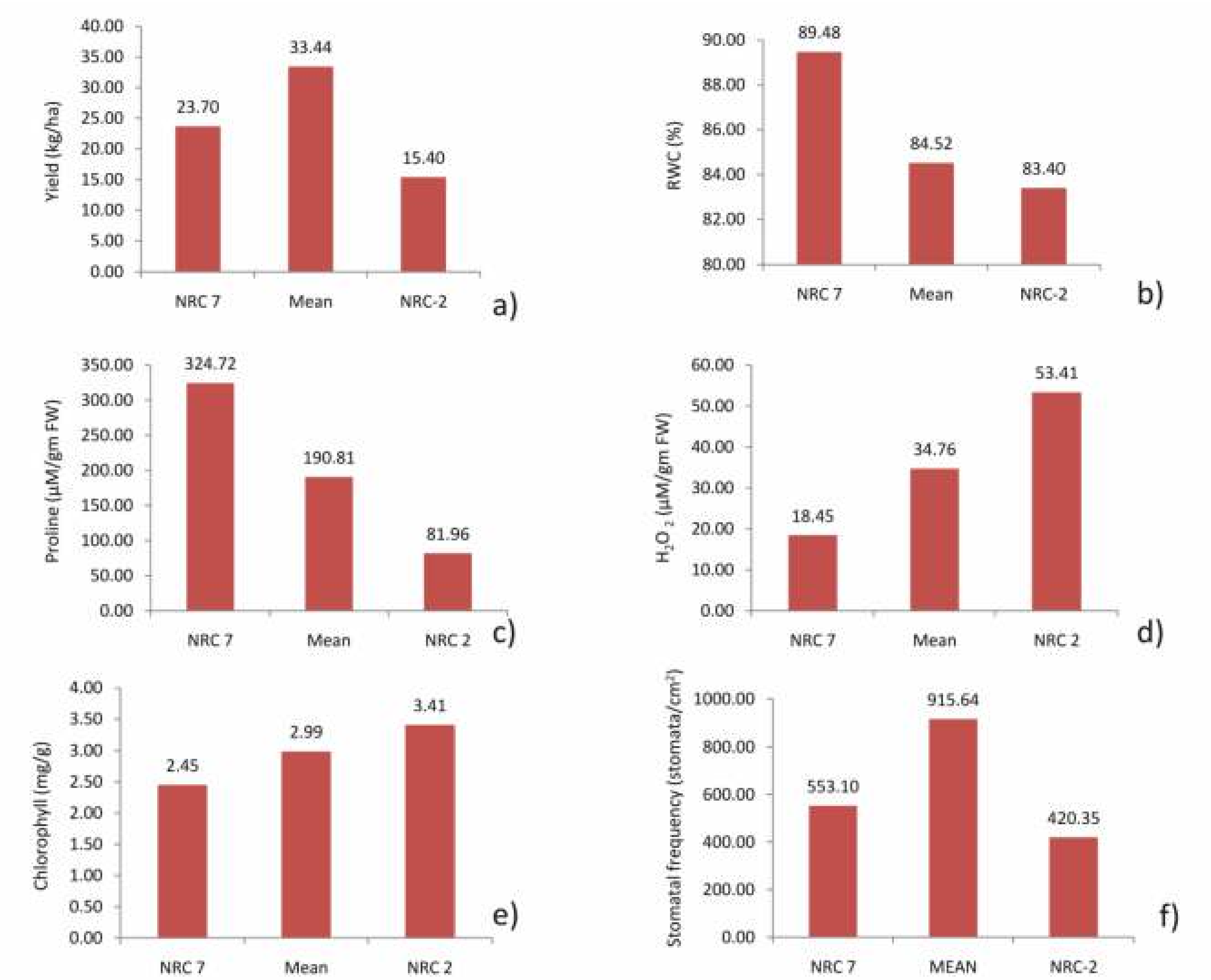


Fig. 8: Response of advance breeding population mean in comparision to drought tolerant (NRC 7) and sensitive (NRC 2) varieties under rain out shelter for (a) Yield and adaptive traits viz. (b) Relative water content – RWC, (c) Proline, (d) H_2O_2, (e) Chlorophyll, and (f) Stomatal frequency

Promising lines were identified for relative water content (RWC), chlorophyll, H_2O_2, proline, stomatal frequency, percentage decrease in canopy temperature depression (CTD) in WS and SPAD chlorophyll meter reading (SCMR) in WW (Well Watered) conditions (Table 16). Among advance lines evaluated, 21 lines have been found with less percentage decrease in seed yield (28.7 – 61.1%) as compared to the tolerant check JS 97-52 (62.5%) in WS condition. In terms of more than 5% seed yield enhancement, five lines exhibited higher yields in WS condition as compared to check (Table 17).

Table 16: Promising lines for physiological traits under water stress (WS) scenario

Physiological Traits	Mean	Range	Promising lines
RWC (%)	84.5	62.4 - 106.4	104-41, 104-27, 104-23, 104-25 (>95)
Chph (mg/g)	3.0	1.8 - 4.4	104-57 (4.4)
H_2O_2 (µM/gm FW)	34.8	18.4 - 75.1	104-1 (18.4)
Proline (µM gm^{-1} FW)	190.8	42.3 - 525.1	107-70, 104-32 (> 470)
Stomatal frequency	921.0	376 - 2279	104-31, 107-70, 104-2 (>1240)
($No./cm^2$)			
% Decrease in CTD	8.8	-12.6 - 32.9	104-51, 104-73, 107-4, 107-83 (>16)
SCMR WW	44.9	36.8 - 50.1	107-70, 107-83, 104-42, 104-3 (>48)

Table 17: Promising lines with higher productivity in well watered (WW) and water stress (WS) conditions

Entry	Yield (WW) Kg/ha	Yield (WS) Kg/ha	% Reduction in yield
107-70	2594	1849	28.7
107-83	2932	1541	47.4
108-86	2600	1483	42.9
104-57	2516	1320	47.5
107-4	2861	1260	56.0
JS 97-52 (T)	3163	1186	62.5
NRC 2 (S)	2160	164	92.4

Line 107-70 was the best amongst high yielding lines under WS condition, having more than 5% improvement over the check NRC 7 in WW condition along with the least percentage decrease in seed yield (28.7%) as compared to tolerant check JS 97-52. This line had significantly higher proline content in WS condition (525.1 µM/gm FW). Percentage increase in stomatal frequency (78.1%) of this line in WS condition was at par with the check tolerant NRC 7 (66.7%). Similarly line 107-83 showed > 5% yield improvement over the best tolerant check JS 97-52 and was the highest seed yielder in WW condition amongst the lines. Line 104-57 had significantly lesser reduction in seed yield (47.5%) than the tolerant check JS 97-52 (62.5%), with more than 5% increase in seed yields over the respective checks in WS and WW conditions. This line had characteristic RSA with average root diameter (0.36 mm), rooting depth (194 cm), root length density (0.95 cm/cm^3), root volume (40.2 cm^3), surface area (4413.1 cm^2), and root dry weight (8.7gm), which were at par with the best check JS 97-52 (Fig. 9).

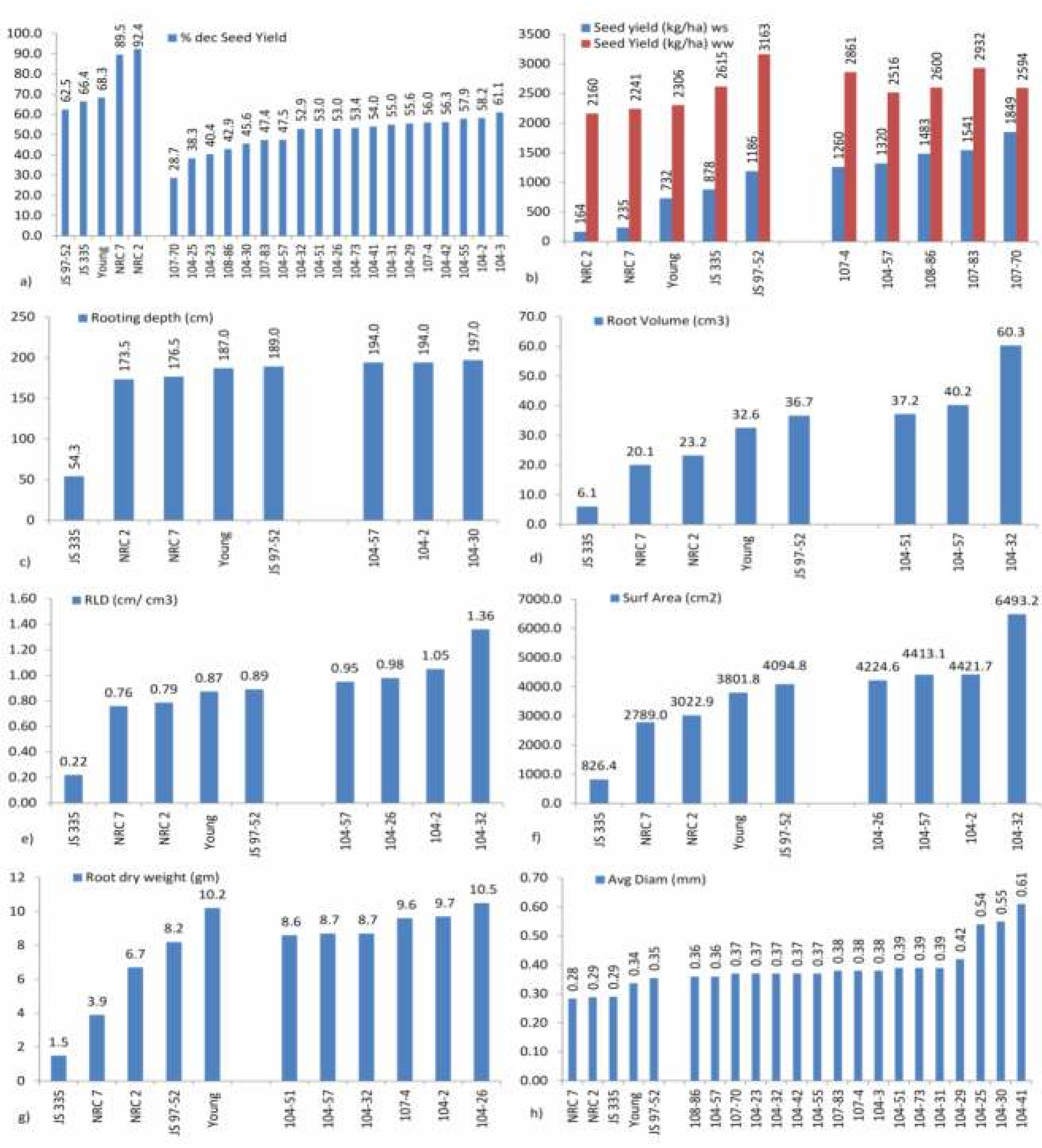


Fig. 9: Performance of elite lines with tolerant JS 97-52, Young, NRC 7 and susceptible NRC 2, JS 335 checks for yield attributes and root traits.

4.2. Evaluation for delayed leaf senescence

During summer 2016, 586 breeding lines (F_4 - F_8) along with tolerant (EC 602288, JS 97-52) and susceptible (NRC 37, JS 90-41) checks were evaluated for delayed leaf senescence trait under field conditions. Out of 185 identified promising lines, 57 advance lines (F_7 - F_8) were further subjected to simulated stress (KI 0.2%). Coefficient of variation for percentage decrease in 100 seed weight was sufficiently high (69.5%). Six lines viz. 108 Drt Sel 7, 105 Drt Sel 70, 105 Drt Sel 68, 105 Drt Sel 1, 108 Spd Sel -15, 1012(1)-3 were found tolerant as compared to the check Young (Table 18). Besides, 6 germplasm accessions viz. PI 159923, TGX 709-50E, EC 291448, EC 107407, MACS 345 and J 732 were identified for delayed senescence trait in 993 accessions evaluated at two stages in summer season followed by KI (0.2%) screening.

Table 18: Performance of breeding lines for delayed senescence trait

Entry	Gen.	Cross	% Decrease in 100 seed weight (KI)	Days - to - flowering	100 seed weight (g)	Yield/ plant (g)
108 Drt Sel 7	F_8	NRC 37×JS 97-52	3.1**	40	9.6	19.7
105 Drt Sel 70	F_8	JS 93-05×JS 97-52	6.0*	34	8.3	24.9
105 Drt Sel 68	F_8	JS 93-05×JS 97-52	7.9	35	8.9	24.6
105 Drt Sel 1	F_8	JS 93-05×JS 97-52	8.6	36	9.3	33.7
108 Spd Sel -15	F_7	NRC 37×JS 97-52	9.7	50	11.3	44.5**
1012(1)-3	F_7	JS 335 × Young	11.4	53	7.0	31.4
Young (T)			12.8	51	12.7	39.6
NRC 2 (S)			29.1	44	10.3	37.5
JS 335			29.8	42	10.0	23.0
NRC 37			31.0	46	9.9	23.6
Mean			22.7	44.1	9.9	30.0
SEm			2.1	0.9	0.2	1.1
CV(%)			69.5	15.8	16.4	29.1

4.3. Hybridization, generation advancement and yield evaluation of advanced lines

Pollinations were realized in eleven cross combinations of tolerant and susceptible parents along with two backcrosses in BC_2F_1 [(Hardee × JS 90-41) × JS 90-41] × JS 90-41, PK 472× [(PK 472 × AGS 25) × PK 472] and BC_1F_1 (Advance line 70-4 × JS 71-05) × JS 71-05 to recover recombination of drought and water logging traits and yield attributes. In F_3 generation, 52 lines from four crosses involving JS 71-05, JS 97-52, PI 416937, JS 335, and 1 M3 mutant line were advanced for drought tolerant traits and 617 lines from nine crosses involving JS 97-52, JS 335, JS 88-66, PK 472 for water logging tolerant trait. RIL population of 128 lines (JS 97-52 × JS 90-41) in F_7 was advanced for water logging tolerance and selections were made on the basis of good plant type and yield. Generation advancement of F_5 of 27 crosses and F_7 of 18 crosses was made through 1302 and 1138 individual plant selections, respectively for high number of pods/plant. In 180 RILs (JS 97-52 × NRC 37), residual heterozygosity for delayed senescence trait was captured in 4 lines through simulated drought stress (KI 0.2%). Evaluation of 46 lines in F_7 and F_8 generations with high number of pods per plant (>50) led to identification of 12 promising lines.

4.4. Identification of drought tolerant soybean rhizobia

Ten lines viz. EC 538828, PK 472, NRC 37, Jackson, Bragg, JS 97-52, Cat 2797, NRC 2, JS 90-41 and NRC 7 were shortlisted based on higher trehalose accumulation in the root nodules and used for isolation of rhizobial strains. Based on FAME profiling only Bradyrhizobial strains were processed further for molecular characterization. Three Bradyrhizobial species (two of B. liaoningense one each from EC 538828, PK 472 and one *B. daqingense* from PK 472) were identified from the root nodules of drought tolerant with high trehalose accumulating genotypes.

One novel rhizobial strain Bradyrhizobium daqingense (isolated from drought-tolerant line PK 472) has been reported from Indian rhizosphere for the first time. The novel strain has been found to have comparatively high ACC deaminase activity. However, with regard to moisture stress tolerance characteristics evaluated under invitro with a gradient of PEG ranged up to 30%, two Bradyrhizobial strains i.e., IND-1 *(B. japonicum)* and *B.liaoningense* performed better than this strain.

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5.0 BIOTIC STRESS

- Genetics of MYMIV resistance and mapping in *Glycine max* and *G. soja*
- Marker assisted introgressing of MYMIV resistance gene
- Pre-breeding for exploiting MYMIV resistance
- Screening soybean genotypes through infectious clones
- Yield loss assessment caused by MYMIV and screening germplasm for various diseases
- Genome wide identification of SNPs from rust resistant accession EC 241780
- Development of forewarning model for insect incidence in based on weather parameters
- Management of pod blight
- Identification insect resistant/ non preferred genotypes & screening for nematode resistance

5.1. Development of yellow mosaic virus and rust resistant genotypes employing breeding, genomics and molecular biology approaches

5.1.1. Mapping MYMIV resistance gene (s) in *Glycine max* and *Glycine soja* and their introgression in JS 335 through Marker Assisted Selection (MAS)

For mapping Mungbean Yellow Mosaic India Virus (MYMIV) resistance gene in PI 171443 of *Glycine max* RILs derived from MYMIV susceptible variety JS 335 and PI 171443, donor of MYMIV resistance gene and F_2 population derived from SL 525 and NRC 101, a susceptible genotype were used to study the inheritance of MYMIV resistance and map the gene responsible for MYMIV resistance. F_1 plants were found to be completely susceptible. F2:3 and RILs population segregated to fit a ratio of 1:2:1 and 1:1 indicating that a single recessive gene controlled resistance to MYMIV (Table 19). BSA was performed using 144 polymorphic SSR markers. MYMIV resistance gene was mapped on chromosome 6 (LG C2) within a 3.5 cM genome region between two SSR markers GMAC7L and Satt322 whose size was estimated to be 77.115 kb (position of 12, 259, 594-12, 336, 709 bp) (Fig 10 and Fig. 11).

For mapping MYMIV resistance gene in *Glycine soja* three F_2 populations between YMV susceptible varieties and *Glycine soja* were developed. All the three F_2 populations showed 15 resistant: 1 susceptible indicating MYMIV resistance is governed by duplicate dominant genes (Table 20). A large F_2 population consisting of 1498 plants was reconstructed from JS 335 × *Glycine soja* and phenotyped for MYMIV infection. Bulk Segregant Analysis (BSA) was performed using susceptible bulk of 30 highly susceptible plants and resistant bulk of 30 resistant plants identified two regions on chromosome 8 and chromosome 14. Seventy eight plants with 100% MYMIV infection expected to be homozygous for recessive genes were genotyped using polymorphic SSR markers adjoining the linked markers on chromosome 8 and 14. Genetic map constructed from recombination frequency mapped MYMIV resistance genes on chromosome no. 14 closely linked to two SSR markers Satt BARCSOY SSR14-1416 and Satt BARCSOY SSR-14-1417 (Fig 12 and Fig 13) and on chromosome no.8 closely linked to two SSR markers. MYMIV resistance gene from PI 171443 and *Glycine soja* has been introgressed in JS 335 using marker assisted selection. Evaluation of MABC lines (BC_4) carrying MYMIV resistance gene from *Glycine soja* for recurrent parent genome (RPG) content led to the identification of 2 genotypes namely NRC 151 and NRC 152, with > 90% recovery of JS 335 genome.

Table 19: χ2 test for segregation of MYMIV resistance gene in *Glycine max* PI 171443

Type of mapping population	Cross combination	No. of plants	MYMIV reaction[a]			Expected ratio	χ2	P value
			S	Seg	R			
RIL	JS 335×PI 171443	89	43	1	45	1:1	.101	0.75
F_2	SL 525×NRC 101	98	23	50	25	1:2:1	.186	0.90

[a]S denotes susceptible progeny rows, Seg denotes progenies segregating for susceptible and resistant plants and R denotes resistant progeny rows

Table 20: χ2 test for segregation of MYMIV resistance gene in ***Glycine soja***

Type of population	Cross Combination	No. of plants	MYMIV Reaction		Expected ratio	χ2	P value
			R	S			
F_2	JS 335 × *Glycine soja*	370	352	28	15:1	1.103	0.20
F_2	Ankur × *Glycine soja*	406	376	30	15:1	.899	0.30
F_2	*Glycine soja* × Sawarn Vasundhra JS 335 ×	310	287	23	15:1	.724	0.30
F_2	*Glycine soja* (reconstructed) JS 335 ×	1498	1408	90	15:1	.148	0.70
BC_3F_2	*Glycine soja*	98	73	25	3:1	.014	0.90

[a]S denotes susceptible progeny rows and R denotes resistant plants

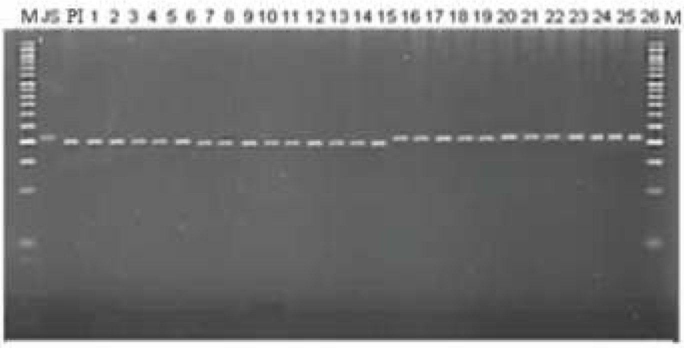

Fig. 10 : PCR amplification of RIL derived from JS 335 × PI 171443 with Satt 322. Lane marked JS represent JS 335, lane marked PI represent PI 171443 and lanes 1 to 26 represent progeny rows and lane marked M represent molecular weight markers of 50 bp ladder

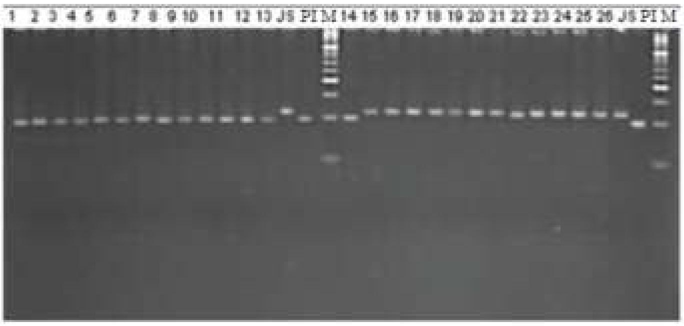

Fig. 11 : PCR amplification of RIL derived from JS 335 × PI 171443 with Satt 322. Lane marked JS represent JS 335, lane marked PI represent PI 171443 and lanes 1 to 26 represent progeny rows and lane marked M represent molecular weight markers of 50 bp ladder

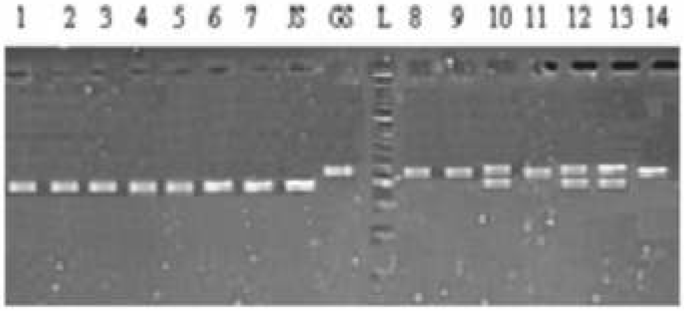

Fig. 12 : PCR amplification of homozygous recessive plants from F_2 derived from JS 335 × *G soja* with Satt BARCSOY SSR-14-1416. Lane marked JS represent JS 335, lane marked GS represent G soja and lanes 1 to 14 represent progeny rows and lane marked M represent molecular weight markers of 50 bp ladder

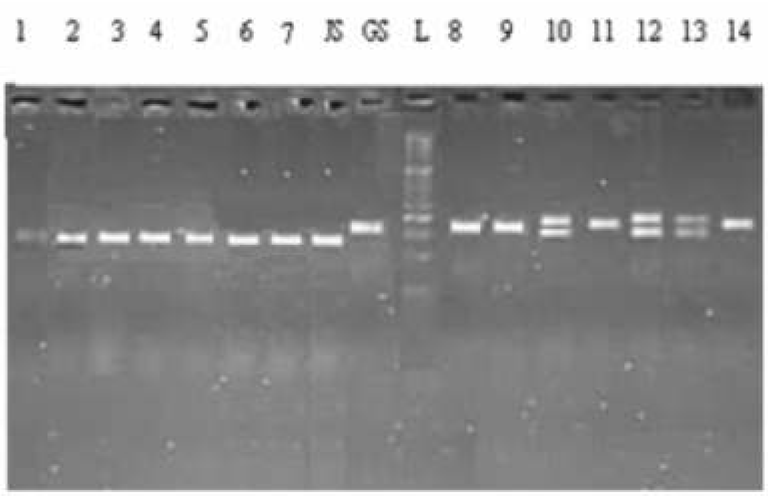

Fig. 13 : PCR amplification of homozygous recessive plants from F_2 derived from JS 335 × *G soja* with Satt BARCSOY SSR-14-1417. Lane marked JS represent JS 335, lane marked GS represent *G soja* and lanes 1 to 14 represent progeny rows and lane marked M represent molecular weight markers of 50 bp ladder

5.1.2. Exploiting wild gene pool through pre-breeding for introgression of yellow mosaic disease resistance in soybean

Screening of 193 (Ludhiana) and 219 (Indore) F_5/F_6 lines derived from JS 335 × *G. soja* indicated YMV resistance is controlled by single gene. Four varieties viz., JS 335, JS 95-60, NRC 37 and NRC 86 were selected to incorporate YMV resistance gene from wild ancestor *Glycine soja*. A total of 95 BC_2F_1 plants derived from JS 95-60 × G. soja, 19 BC_3F_1 plants from JS 335 × *G. soja* and 40 BC_4F_1 plants from JS 335 × *G. soja* were grown under polyhouse conditions. DNA extraction was done from 25 day old seedling to perform PCR with YMV resistance linked SSR marker for selecting plants containing YMV resistant gene. The linked marker was found to be heterozygous for some of the plants. In detail, total of 45 plants of JS 95-60 × *G. soja* (BC_2F_1), 19 plants of JS 335 × *G. soja* (BC_3F_1) and 5 plants of JS 335 × *G. soja* (BC_4F_1) showed heterozygosity to linked marker (Fig. 14). Therefore these plants were selected and used for next backcrossing with recurrent parents viz., JS 335 (BC_4 and BC_5 generation) and JS 95-60 (BC_3 generation) to recover maximum recurrent parent genome. In addition, 29 and 53 plants backcross derived plants from NRC 37 × *G. soja* and NRC 86 × *G. soja* populations were grown and BC_3 generation was developed by crossing of randomly selected BC_2F_1 plants (NRC 37 × *G. soja* and NRC 86 × *G. soja*) with two respective recurrent parents NRC 37 and NRC 86.

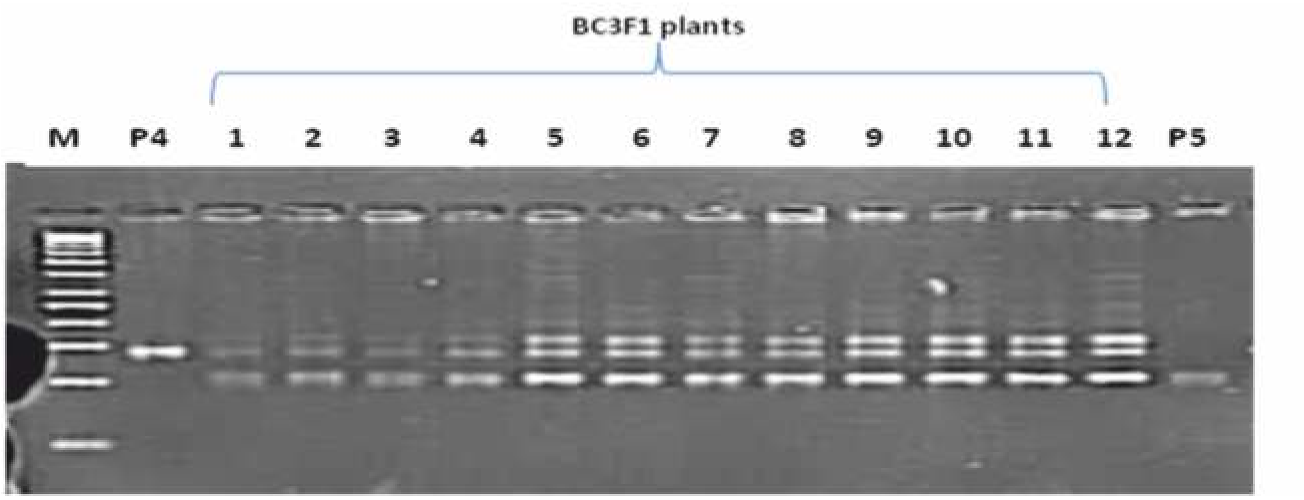

Fig. 14 : Identification of YMV resistant plants by linked SSR marker satt 063. (M – 50 bp DNA ladder; P4- *Glycine soja*; P5-JS 335)

5.1.3. Agro-inoculation of selected soybean genotypes and absolute quantitation of MYMIV

Few soybean genotypes encompassing germplasm material, cultivated varieties, promising lines and breeding materials were selected and MYMIV infection was incited following agro-inoculation procedure. All the inoculated soybean genotypes belonging to susceptible category developed characteristic symptoms associated with yellow mosaic disease (YMD). Soybean genotypes that were categorized as resistant did not develop visible symptoms 9 days post inoculation or mild symptoms were observed in few genotypes.

Following YMD scoring of genotypes based agro-inoculation based screening, absolute MYMIV quantitation was carried out using total DNA extracted from agro-infected plants. The equation of standard curve developed by plotting Ct values against log viral DNA A quantity is Y=-3.13X+36.86; R^2=0.998 (Fig. 15a) with a calculated efficiency of 108%. Similarly the standard curve developed for quantification of MYMIV-sb derived DNA-B is Y=-3.267X+34.83; R^2=0.999 with the efficiency of 98.15% (Fig. 15b).

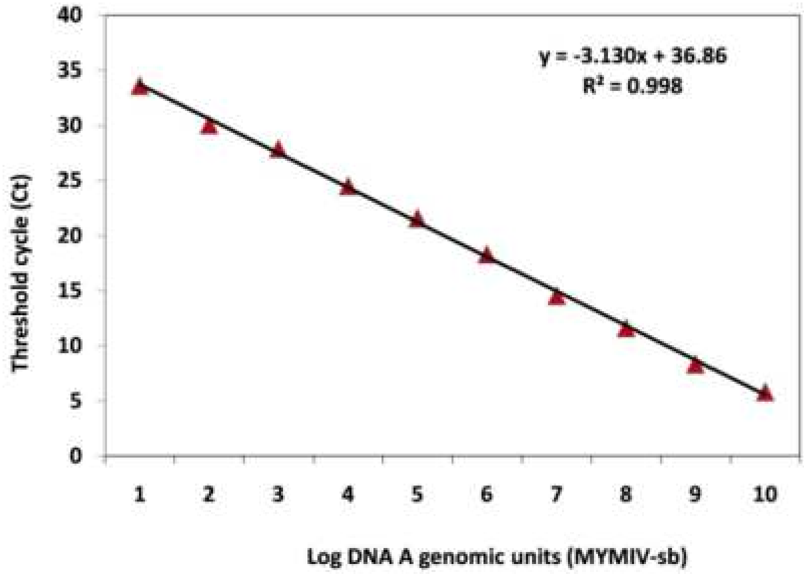

Fig.15a : The equation of standard curve developed by plotting Ct values against log viral DNA A

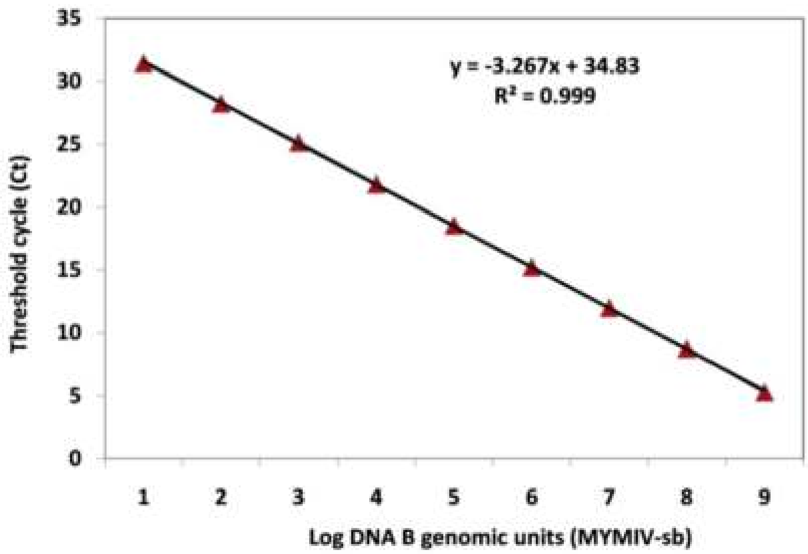

Fig.15b : The equation of standard curve developed by plotting Ct values against log viral DNA B

Absolute quantification of MYMIV, reveal that three different categories of soybean genotypes are emerged (Table 21). Highly resistant or resistant soybean genotypes such as UPSM 534, PS 1042, PK 471, SL 295, PS 1029, SL 525, DS 228, DS 1024 and PK 416 showed very low copy numbers of both DNA A (<10x 105 genomic units) (0.18 x 105 genomic units to 5 x 105 genomic units) and DNA B (0.31 x 105 genomic units to 9.19 x 105 genomic units) genomic components in the agro-infected plants (Fig 16a). Similarly moderately resistant genotypes exhibited medium levels of MYMIV DNA A (10-100x 105 genomic units) (15.57 x 105 genomic units to 51.85 x 105 genomic units) and DNA B copy numbers (15.39 x 105 genomic units to 42.77 x 105 genomic units) (Fig 16b). On the other hand those genotypes that were characterized as susceptible to YMD showed relatively high values of viral titre (>100x105 genomic units) of DNA A (148.21x 105 genomic units to 816.8 x 105 genomic units) and DNA B (102.11 x 105 genomic units to 508.40 x 105 genomic units) (Fig 16c).

Table 21: Selected soybean genotypes for qRT-PCR based viral titre quantitation post agro-inoculation

Resistance status	Genotypes	MYMIV absolute copy number			
		DNA A (x 105 genomic units)	CV (%)	DNA B (x 105 genomic units)	CV (%)
Resistant	UPSM 534	5.03±0.44	1.36	2.78±0.23	1.77
	SL 979	2.05±1.24	0.83	9.19±1.01	1.70
	PS 1042	0.34±0.01	2.70	0.82±0.07	0.17
	PK 471	1.48±0.12	2.52	3.50±0.17	0.40
	SL 295	0.52±0.02	1.31	1.30±0.08	1.62
	PS 1029	0.57±0.05	1.98	0.81±0.01	2.14
	SL 525	0.18±0.01	2.43	0.55±0.03	1.47
	DS 228	0.91±0.05	0.56	1.77±0.08	2.56
	PS 1024	0.45±0.07	1.34	1.28±0.02	1.78
	PK 416	0.29±0.01	1.22	0.31±0.06	1.93
Moderately resistant	NRC 125	26.47±1.78	0.92	15.39±1.01	2.80
	JS 9752	15.57±0.98	0.23	16.23±0.09	1.79
	JS 20-69	41.60±1.99	1.55	35.90±0.06	2.65
	NRC 124	28.77±0.07	0.63	18.55±1.13	0.86
	JS 20-29	36.16±0.76	1.75	27.75±1.08	1.62
	SL 958	51.85±0.03	0.89	42.77±0.93	0.59
Susceptible and highly susceptible	NRC 117	178.39±0.23	1.57	102.11±2.97	1.44
	JS 95-60	167.61±0.56	1.94	110.53±1.57	2.48
	JS 335	325.53±2.12	1.82	508.40±2.39	0.99
	JS 93-05	183.31±0.08	3.50	147.00±1.87	1.05
	VLS 59	148.21±1.08	0.47	131.67±0.04	0.45
	MAUS 2	816.80±2.23	0.43	312.47±1.67	2.41
	Co 3	270.70±0.65	5.30	398.75±1.65	1.32
	NRC 86	161.26±0.78	1.90	161.75±0.96	3.21

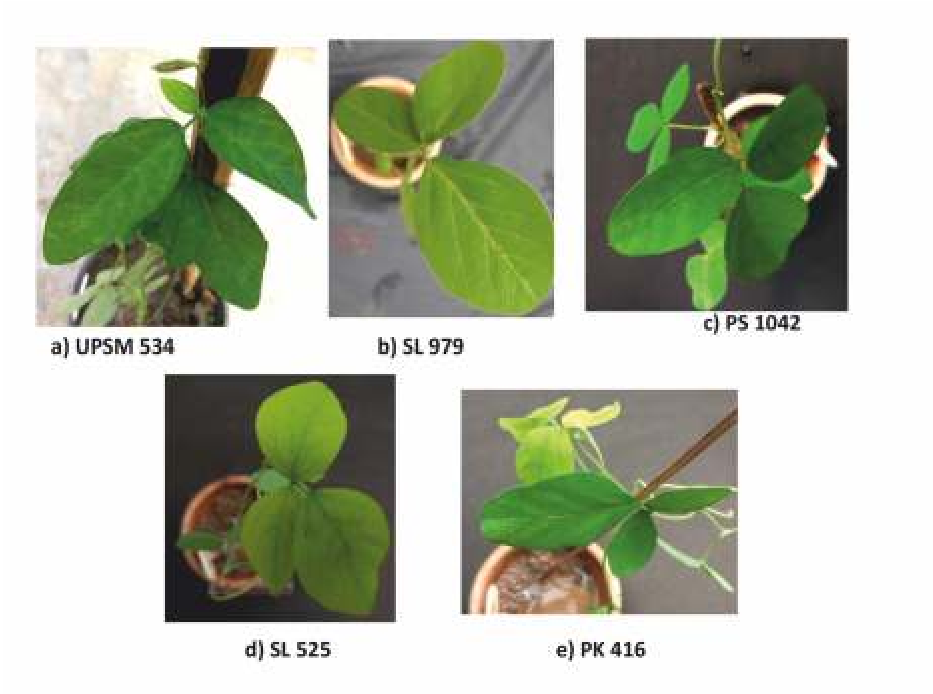

Fig.16a : Genotypes resistant to MYMIV : a to e

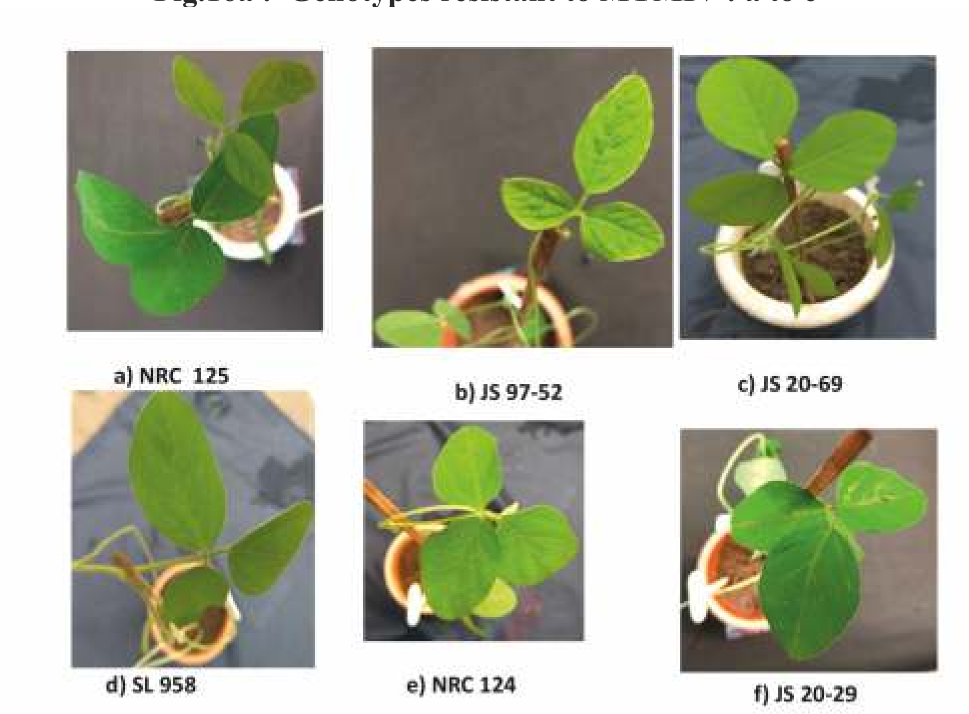

Fig.16b: Genotypes moderately resistant to MYMIV : a to f

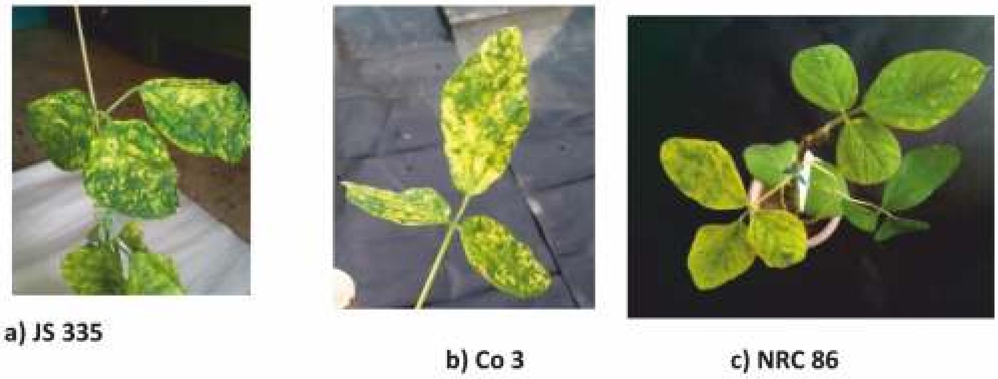

Fig.16c : Genotypes susceptible to MYMIV : a to c

5.1.4. Field screening for YMV and rust resistance

Under field screening at Ludhiana for the hot spot for yellow mosaic virus, the soybean cultivars found resistant were viz., DS 228, DS 97-12, KHSb 2, PK 416, PK 471, PK 472, PS 564, PS 1024, PS 1029, PS 1042, PS 1092, PS 1347, Pusa 20, SL 295, SL 525, and SL 958. Promising YMV tolerant line 'NRC 94' was ranked top third yield per se in AVT-II during *kharif* 2014 of AICRP trial was found with multiple disease resistance. EC 241780 was resistant against rust at Ugarkhurd, the hot spot for rust. The crossing material was developed viz., F_4 [UPSM 534 × Komata] and F_4 [NRC 94 × EC 241780].

5.1.5. Yield loss due to YMV disease in naturally infected soybean varieties

Soybean plants naturally infected with YMV in different varieties were tagged. After maturity the plants were harvested individually and yield contributing characters were recorded. The yield reduction due to YMV ranged from 33% to 90% in different varieties. Infection before flowering reduced more yield than infection takes place after flowering. Maximum yield reduction occurred in NRC 121 and minimum in NRC 86 in the same infection conditions. The yield reduction happened due to reduction in no. of branches, no. of pods per plant, 100-seed wt and yield per plant (Table 22)

Table 22: Yield loss due to YMV in naturally infected soybean varieties

Variety	Plant height (cm)	Branches /Plant	Pods/Plant	100 seed wt (g)	Yield/Plant (g)	% Yield reduction over control
JS 95-60						
Healthy (C)	41.0	3.0	27.8	15.5	9.90	-
Infection (BF)	42.0	1.2	2.60	5.80	1.55	84.0
Infection (AF)	46.0	2.0	20.0	10.15.	7.00	33.0
NRC 86						
Healthy (C)	55.0	3.8	55.0	9.85	7.93	-
Infection (BF)	42.0	5.0	43.8	5.55	4.25	46.0
JS 20-34						
Healthy (C)	48.0	3.0	31.6	14.0	8.2	-
Infection (BF)	44.0	1.6	13.0	8.5	2.96	64.0
NRC 121						
Healthy (C)	37.0	2.8	37.0	21.25	30.66	-
Infection (BF)	39.0	1.0	10.8	11.86	1.5	90.0
Infection (AF)	41.0	2.6	25.0	13.75	7.33	76.0
NRC 37						
Healthy (C)	78.0	2.8	67.5	8.75	12.55	-
Infection (BF)	79.0	1.8	10.0	3.55	1.81	85.0

5.1.6. Seed transmission of YMV

To find out the possibility of seed transmission of YMV disease, the naturally infected plants of variety JS 95-60, JS 20-34, NRC 86, NRC 121, and NRC 37 were tagged individually. The harvested seeds on these varieties were sown in *rabi* season along with healthy seeds of the corresponding variety. Total emergence and the number of YMV infected plants were counted at flowering and pod formation. The seeds from JS 95-60 healthy plants produced 1.61% YMV infected plants, while seeds collected from YMV infected plants wherein YMV appeared before flowering (YMV-BF) produced 1.91% YMV infected plants and seeds from YMV infected plants wherein YMV was observed after flowering (YMV-AF) produced 5.17 % YMV infected plants. In JS 20-34, healthy seeds did not produce any YMV infected plants while, YMV-BF seeds produced 2.08% YMV infected plants. In NRC 86, both healthy seeds and

YMV-BF produced 5.45 and 15.15 YMV infected plants, respectively. In NRC 121, YMV-BF and YMV-AF did not produce any YMV infected plants whereas healthy seeds produced 1.85% YMV plants, while in NRC 37, healthy seeds and YMV-AF both produced YMV infected plants but YMV plants were 0.47 and 1.72% respectively. The results showed that the healthy and diseased seeds both have produced YMV infected plants, thereby confirming that YMV is not seed trasmissible (Table 23).

Table 23: Seed transmission of YMV in infected soybean seeds of different varieties

Variety	No of plants	YMV infection Before Flowering	YMV infection After flowering	Total	% YMV infection
JS 95-60					
Healthy	124	0	2	2	1.61
YMV-BF	51	0	1	1	1.96
YMV-AF	58	2	1	3	5.17
JS 20-34					
Healthy	54	0	0	0	0.0
YMV-BF	48	0	1	1	2.08
NRC 86					
Healthy	55	3	2	5	5.45
YMV -BF	33	1	4	5	15.15
NRC 121					
Healthy	54	0	1	1	1.85
YMV-BF	38	0	0	0	0.0
YMV-AF	74	0	0	0	0.0
NRC 37					
Healthy	248	0	1	1	0.40
YMV -AF	58	0	1	1	1.72

5.2. Genome wide identification of SNPs from rust resistant accession EC 241780

To identify genome wide single nucleotide polymorphisms (SNPs) and InDels, whole genome re-sequencing of rust resistant soybean accession EC 241780 was performed using Illumina HiSeq 2500 platform. High quality reads were mapped to reference soybean genome-Williams 82. The sequences were analysed to discover a large number of DNA polymorphisms including single nucleotide polymorphisms (SNPs) and InDels. In addition, genome wide distribution, intergenic regions, coding and non-coding regions were validated. Genomic annotation of single nucleotide polymorphisms (SNPs) and indels in EC 241780 revealed that majority of the SNPs and InDels falls in the intergenic region and only 2.9 % of SNPs and 1.03 % of the Indels falls within the coding region of the genome. Table 24 gives functional annotation of single nucleotide variation (SNVs) identified in the genome of EC 241780 and JS 335. Several SNPs were further identified in the putative NBS-LRR disease resistance genes in soybean. Our study offers high-density coverage of SNPs across the entire soybean genome, which could be utilized for SNP selection for high-resolution genotyping and genomewide linkage disequilibrium studies for soybean rust resistance. The data can be used in future studies on high-throughput genotyping and molecular breeding.

Table 24: Functional Annotation of SNVs identified in the genome of EC 241780 and JS 335

Variant Class	EC 241780	JS 335
Nonsense	1,035	866
StartLoss	155	161
Missense	56,854	51,293
Silent	42,128	38,623
Frameshift	2,899	2,703
InFrame	2,512	2,198
Total	105,583	95,844

5.2.1. Multiplication of rust resistant differentials:

Fourteen rust resistant differentials viz., EC 391160, PI 459024, 459025(B), PI 200492, PI 23970, TK 5, PI 230971 (B), EC 241778, PI 459025 F, EC 241780, EC 462412 collected from different sources were multiplied to supply different coordinating centre as and when the request comes.

5.3. Germplasm evaluation for resistance to biotic stresses

Fifty of 130 accessions were also evaluated for diseases and insect pests at hot spots (Table 25). EC 34057 exhibited absolute resistance to Frog eye leaf spot at Palampur, EC 457286 had the score of 1 for YMV at Ludhiana, PI 210178 showed multiple resistance to Charcoal rot, RAB (Rhizoctonia aerial blight) and YMV. Many accessions were identified for tolerance to Girdle beetle and Stem fly (Table 25).

Table 25: Promising accessions with resistance / tolerance to insect-pest and diseases

Disease / Insect pest	Centre	Accessions
Frog Eye Leaf Spot	Palampur	EC 34057
YMV	Ludhiana	EC 457286
Charcoal Rot, RAB, YMV	Jabalpur	PI 210178
Girdle Beetle	Sehore and Indore	AGS 95, B 254, EC 325111, EC 333879, EC 467282 (A), PI 21078
Stem Fly	Sehore and Indore	Stem tunnelling < ETL EC 100027, EC 241309, EC 242072, EC 309509, EC 309538

5.4. Management of stem/pod blight

To manage stem /pod blight, a field experiment was conducted in randomized design with three replicates using soybean variety NRC 7. A conidial spray of *C. truncatum* was done at R^2 stage to create a disease pressure. There were 8 different treatments, which includes seed treatment with fungicides and bioagents alone and with spraying of fungicides at 25 and 45 days after sowing (DAS). Untreated and unsprayed control was maintained for comparison. Observations on germination, total number of plant, filled and unfilled pods/plant, anthracnose / stem blight incidence and yield were recorded and percent infection and yield increase /decrease over untreated control were calculated.

The disease causes reduction in filled pods and increase in unfilled pods. The number of filled pods directly proportional to the plant yield. Seed treatment (St) with either fungicide or bioagents + spraying of benlate at 25 and 45 DAS produced minimum disease incidence (T4 and T7) followed by St + spraying of thiophanate methyl (T3 and T8). The minimum disease incidence i.e. 19.0 % was recorded in case of T4 (St with carbendazim + thiram + spraying of benlate @ 0.2%), which is at par with T7 (19.6 %), St with Tv and spraying of benlate followed by T3 and T8 (24.6%) (St with fungicide/bioagent + spraying of thiophanate methyl @ 0.2%) and the maximum in untreated control (45.0 %). St with fungicide/biogent + spraying of benlate or thiophanate methyl has increased the yield by reducing disease intensity and unfilled pods and increasing no. of pods/plant (Table 26). The yield increase ranged from 14.0 to 79.0 % by the treatments over control.

5.5. Screening for stem blight /anthracnose

50 germplasm lines were screened by spraying the pathogen under field conditions. 11 lines viz. EC 333879, EC 309538, EC 467282(A), EC 107407, EC 309509, EC 333879, EC 30957, EC 14458, PI 259539, EC 103332 and EC 251431 showed moderate resistance (MR) to stem blight while remaining showed susceptible reaction.

5.6. Effect of seed dressing on emergence and yield

To find out effect of seed dressers on emergence, plant population and yield, a field experiment was conducted. In bioagent, Trichoderma viride and in fungicide mixture (thiram and carbendazim (2:1) were used as seed dressers and seeds were sown as per the recommendation. Total number of plant population, seedling mortality and other yield contributing characters were recorded. The results revealed that as compared to untreated control the seed treated with either bioagent or fungicide increased emergence 19.4 and 24.5 % and reduced seedling mortality 55.3 and 62.1% and because of the more population of plant, the yield was also increased by 37.5 and 59.0% respectively (Table 27 & Fig 17 a,b,c)

Table 26: Management of stem/ pod blight caused by *C. truncatum*

Treatment	Plant height (cm)	Branches/ plant	Filled pods/ plant	Unfilled pods/ plant	Seed Index	Yield /plant (g)	Yield (kg/ha)	Yield increase over control (%)	Disease incidence (%)	Disease reduction over control (%)
T1- Untreated control	30.26	1.6	28.9	7.2	10.30	5.4	14.41	-	45.0	-
T2- St with thiram 0.3% +carbendazim(2:1)+ spray of kasugamycin +COC @	34.80	3.2	43.7	4.2	12.06	9.2	22.70	57.52	27.34	39.17
T3- St with thiram +carbendazim(2:1)+spray of thiophanate methyl @ 0.2%	34.86	3.5	49.7	5.0	12.20	9.9	20.25	40.52	24.67	45.17
T4- St with thiram + carbendazim(2:1)+spray of benlate@0.2%	34.60	4.1	53.7	3.6	12.33	9.8	25.81	79.11	19.00	57.7
T5- ST with Tv @10g/kg seed + spray of Tv @ 0.6%	33.73	2.5	41.4	6.2	10.50	8.2	16.47	14.29	36.34	19.2
T6- ST with Tv @10g/kg +spray of thiophanate methyl @ 0.2%	33.86	3.7	43.7	5.2	10.13	8.8	16.76	16.30	25.67	43.1
T7- ST with Tv @10g/kg +spray of benlate @0.2%	34.10	4.2	52.9	3.1	11.30	9.5	24.35	68.97	19.67	56.17
T8- T5- ST with Tv @10g/kg + spray of kasugamycin + COC @0.3%	32.3	3.4	51.9	8.1	12.7	11.7	21.73	50.79	24.73	45.17
CD at 5%	**2.6**	**0.69**	**3.73**	**3.12**	**1.76**	**2.11**	**2.21**	-	**3.04**	-

Table 27: Effect of seed dresser on emergence, seedling mortality and yield of NRC 7 over the control

Treatment	Pods/plant	Yield q/ha	% Yield increase	% Emergence	% Emergence increase	% Seedling mortality	% Decrease seedling mortality
T1- Untreated control	29.0	14.41	-	56.10	-	25.64	-
T2- St with thiram +carbendazim(2:1) @3g/kg	49.0	22.92	59.0	70.17	24.5	9.72	62.1
T3-ST with Tv @10g/kg seed	47.5	19.82	37.5	66.98	19.4	11.45	55.4

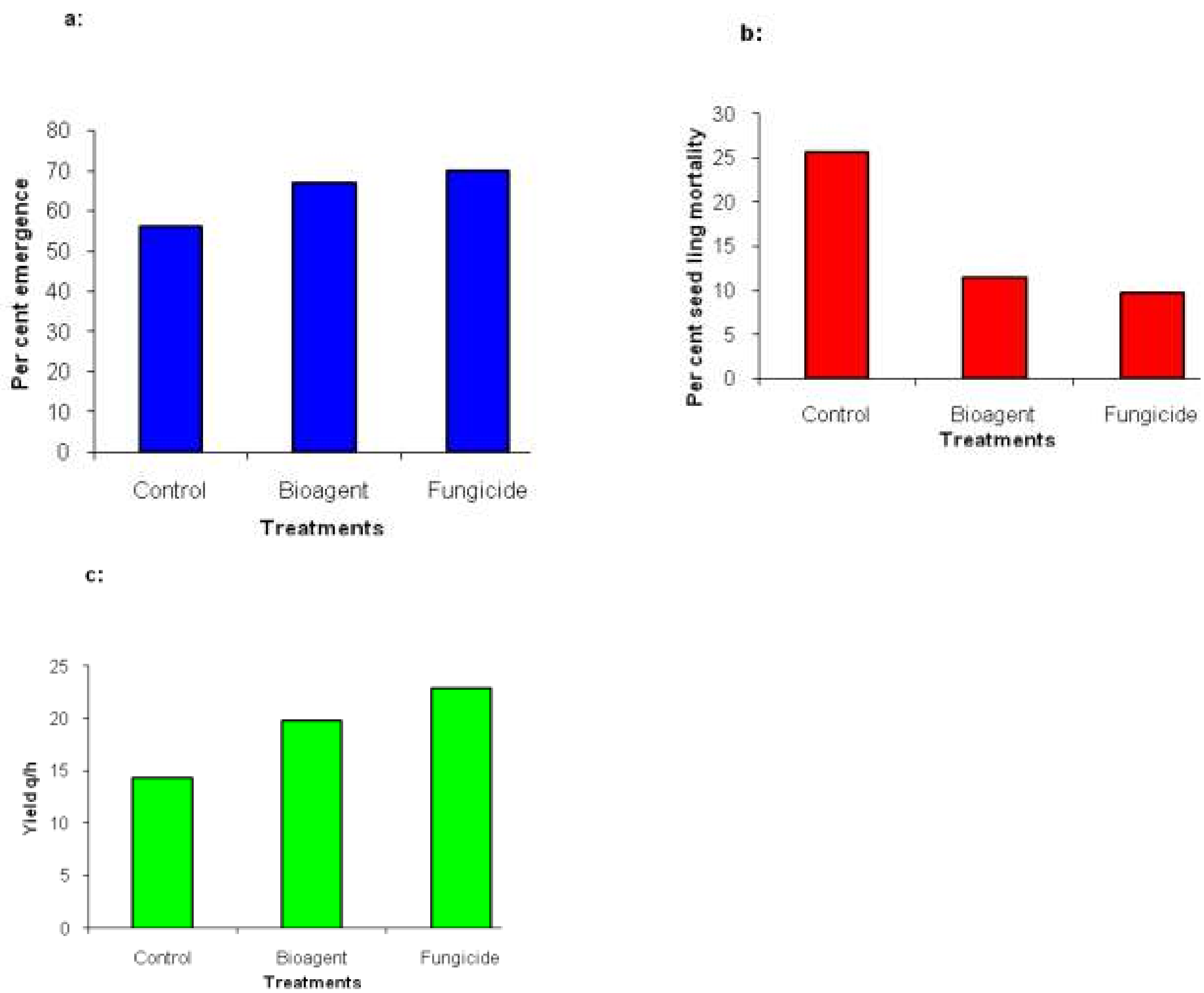

Fig. 17 a,b,c: Effect of seed dressing on plant emergence, seedling mortality and yield.

5.7. Identification of insect resistant/non-preferred genotypes

In order to identify insect resistance/ tolerant soybean genotypes, antibiosis and antixenosis studies were conducted with selected genotypes with *Spodoptera litura* as the representative defoliator.

5.7.1. Antixenosis (non-preference)

Antixenotic study was conducted with 41 soybean genotypes against *Spodoptera litura*. Preference Index was calculated to classify the genotypes based on reference values (Table 28).

Table 28: 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

Germplasm line, EC 333879 found strong antixenosis, while 3 genotypes viz., EC 309538, EC 325111 and PI 259539 showed moderate antixenosis and 8 genotypes viz., AGS 166, B 254, EC 107407, EC 313976, EC 34057, EC 383165, EC 457487 and EC 251358 exhibited slight antixenosis. Rest of 29 genotypes were found to be the preferred hosts. 'C' values of all the varieties were given.

5.7.2. Antibiosis

For antibiosis, study was conducted with 7 genotypes and Approximate Digestibility (AD), Efficiency of Conversion of Ingested Food (ECI) and Efficiency of Conversion of Digested Food (ECD) were calculated using food consumption and utilization indices. The larvae reared on JS 335 found the highest value of AD (76.37%) and ECD (84.21%) and the lowest value of AD (67.94%) and ECD (44.59%) was found in AK 888. The highest ECI values were found in AK 888 (44.59%) and the lowest values of ECI was found in JS 335. The highest weight of pupae was found in VP 1165 (1.03) and lowest in AGS 155 (0.76) genotype, respectively (Table 29).

Table 29: Weight of pupae, Approximate Digestibility (AD), Efficiency of Conversion of Ingested Food (ECI) and Efficiency of Conversion of Digested Food (ECD) values of different varieties

Genotype	Weight of pupae (mg)	AD	ECI	ECD
AGS 155	0.76	75.99	24.01	55.31
AK 888	0.85	67.94	32.06	44.59
C 146	0.96	69.06	30.94	65.17
EC 333902	1.01	74.56	25.44	75.77
VP 1165	1.03	69.02	30.98	76.85
G5P22	0.78	68.77	31.23	59.89
JS 335	0.95	76.37	23.63	84.21

5.8 Screening for resistance to Cyst nematode (*Heterodera cajani*)

A total of 115 soybean varieties were screened for resistance/susceptibility to *H. cajani* under field conditions. Among these varieties, Co Soya 2, Gujrat Soya 1, Gujrat Soya 2, JS 2, LSb 1, JS 95-60, MAUS 2, NRC 7, SL 688 and VL Soya 59 was found to be highly resistant with lowest value of cyst index (Final cyst population ÷ Initial cyst population).

5.8.1 Effect of organic and inorganic management practices on cyst nematode population

Soil samples were collected from the agronomy experimental field on 'effect of organic and inorganic management on productivity of soybean based cropping system' after the harvest of soybean crop during *kharif* 2016, to observe the final cyst nematode population in different treatments. The lower levels of nematode population were observed in the fields treated with only organic amendments as compared to fields received inorganic fertilizers alone or organic + inorganic combinations in both Soybean-Chickpea and Soybean-Wheat cropping sequences. The organic treated fields of Soybean-Chickpea cropping system recorded the least cyst population of 20 cysts/Kg soil. The highest nematode population of 50 cysts/Kg soil was recorded in the fields of Soybean-Wheat cropping system with inorganic fertilizer application. Soil analysis from the same fields were also carried out during *kharif* 2015 and the results were also indicated the lower cyst population from the fields receiving only organic amendments. However, significantly lower cyst population was observed from all the fields as compared to the population encountered during *kharif* 2015.

5.9. Development of forewarning model for insect incidence in soybean based on weather parameters

District-wise weekly data of 20 Maharashtra districts collected on insect incidence and weather parameters from 2010 to 2015. The data analysis revealed *Spodoptera* egg-mass is having maximum incidence during 30-31st Standard Meteorological Week (SMW). Spodoptera egg-mass (no. per meter) with weather variables indicated that maximum temperature greater than 33°C, relative humidity greater than 85% and 44-80 mm rainfall results in higher egg mass population during the season (Fig 18).

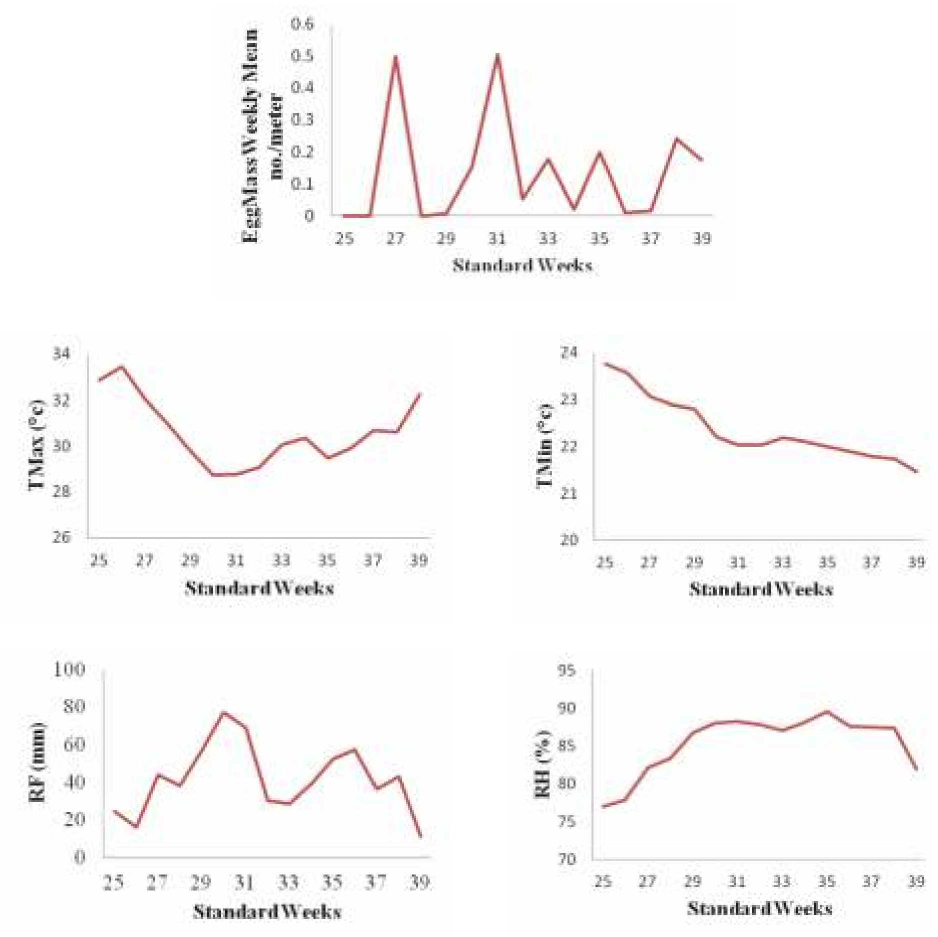

Fig. 18: Spodoptera egg-mass with weather variables viz max. temperature (T max), min. temperature (T min) , relative humidity (RH), rainfall (RF).

5.9.1. Decision Support System for identification of soybean insects and their management

Web-based Data Management System for soybean insect is developed. The data on different aspects viz. scientific name, morphology, distribution, damage detail, economic impact, management, photos and videos were entered for 20 soybean insects. Preliminary design of the user interface of the Decision Support System for identification of soybean insects and their Management is developed (Fig 19 and Fig 20).

Fig. 19: The main web-page of the 'Decision Support System for identification of soybean insects and their management

Fig. 20: Web-page showing the data entry form of Soybean Insect Data Management System

6.0 SEED QUALITY AND BREEDER SEED

- Impact of field weathering on soybean seed quality and management
- Yield performance of soybean varieties in 2016
- Soybean breeder seed production

6.1. Impact of field weathering on soybean seed quality and its management

Salicylic acid (SA) in combination with boron (B) and molybdenum (Mo) was applied to seed through thin layer polymer coating in different doses to study its effect on soybean plant growth, yield, seed quality and tolerance to field weathering. All the treatments were very effective to improve plant growth and seed yield over control. Highest seed yield was obtained with 75 ppm SA, 1g Mo and 200 mg B application to seed. Comparative improvement was also obtained with 75 ppm SA application to seed. Salicylic acid is reported to induce abiotic as well as biotic stress resistance. Boron is key element for embryo development. SA, Mo and B were effective to improve seed quality. Maximum seed germination (90%) was obtained in 75 ppm SA, 1 g Mo and 200 mg B application to seed as compared to control (76%) in seed harvested at physiological maturity. All the doses of SA was found to be effective to control disease incidence. The healthy and quality seeds thus developed were having better capacity to tolerate field weathering when harvested was delayed. The germination of seeds obtained from this treatment retained 76% germination after delayed harvest as compared to control (56.5%) (Table 30).

Foliar spray of salicylic acid (50, 100 and 200 ppm) at vegetative and pod filling stage was done in JS 20-29 to find out the quantum increase in seed yield. It was found that foliar spray of salicylic acid improved seed yield significantly and it was very effective to apply at vegetative and pod filling stage in seed production programme to improve quantity and quality of soybean seeds (Table 31).

The incidence of diseases is increasing in soybean due to adverse climatic conditions. Most of the soybean diseases are seed borne. Pyraclostrobin is a newer molecule and thiophenate methyl is recommended to control *Colletotrichum sp.* in soybean. These two were tested as seed treatment to improve seed germination and reduce seed mortality by controlling seed borne pathogens. The combination of pyraclostrobin (0.1g a.i./kg seed), thiophenate methyl (0.9 g a.i./kg seed) and carbendazim (0.75g a.i./kg seed) was most effective to improve field emergence and to control seedling mortality followed by pyraclostrobin and thiophenate methyl combination (Table 32).

Table 30: Effect of Salicylic acid (SA) & their interaction with Molybdenum (Mo) and Boron (B) on seed germination and yield

Treatment (per kg seed)	Yield (q/ha)	Germination (%)		
		PM	HM	DH
SA 25 ppm + Mo 1g	29.6	79	70.5	60.0
SA 25 ppm + B 200 mg	27.5	80	72.5	67.0
SA 25 ppm + Mo 1g + B 200 mg	30.9	82	71.5	66.0
SA 25 mg	27.2	81	70.5	59.0
SA 50 ppm + Mo 1g	28.5	75	64.0	61.5
SA 50 ppm + B 200 mg	27.5	76	69.5	66.0
SA 50 ppm + Mo1g + B 200 mg	30.3	77	72.0	69.0
SA 50 ppm	29.2	80	65.5	64.0
SA 75 ppm + Mo 1g	28.7	86	81.5	74.5
SA 75 ppm + B 200 mg	28.4	83	79.5	71.5
SA 75ppm + Mo1g + B 200 mg	31.6	90	85.5	76.0
SA 75 ppm	31.1	86	80.5	71.0
Control	22.6	76	65.5	56.5
CD0.05	1.946			

(SA-Salicylic acid; Mo-Molybdenum; B-Boron; PM-Physiological maturity; HM-Harvest maturity and DH-Delayed harvest)

Table 31: Effect of foliar spray of salicylic acid (SA) on seed quality and yield

Treatment	Stage of application	Seed yield (q/ha)
SA 50 ppm	Vegetative & pod filling	32.31
SA 100 ppm	Vegetative & pod filling	34.35
SA 200 ppm	Vegetative & pod filling	35.89
Control	_	23.52
CD 0.05		2.887

Table 32: Effect of pyraclostrobin and thiophenate methyl seed treatment on field emergence and seedling mortality rate*

Treatment	Field emergence (%)	Seedling mortality (%)
Pyraclostrobin & Thiophenate	80.5	0.71
Methyl	(64.48)	(4.747)
Pyraclostrobin & Thiophenate	84	0.59
Methyl + Carbendazim	(66.77)	(4.290)
Carbendazim	76 (59.57)	3.75 (10.88)
Control	67 (55.15)	9.8 (17.84)
CD 0.05	4.972	3.546

*Values given in parenthesis are arc sign converted

6.2. Performance of released and notified soybean varieties during *kharif* - 2016

Soybean production during last few years had suffered due to adverse climatic conditions of drought as well as excess rainfall. Soybean production reached up to 14.7 mt from 10.7 mha areas in 2012, and reduced to 8.5 mt from 11.6 mha in 2015. The productivity reduced from 13.53 q/ha in 2012 to 7.31q/ha in 2015. The major cause for lowest production was erratic rain and increase in temperature. The yield performance of Indian released and notified varieties during this period revealed that out of 102 varieties only few varieties viz., JS 20-29, JS 97-52, Hara Soya, Pant Soya 1029 and Hardee sustained such adverse climatic condition (yield >20q/ha). During *kharif* 2016, released and notified varieties were grown at ICAR-IISR, Indore farm and revealed that all the varieties notified for central zone performed very well and gave productivity more than 3 ton/ha. The most popular varieties released during last 16 years which are mostly contributing to national production e.g. JS 20-29, NRC 86, RVS 2001-4, JS 97-52, RAUS 5, RKS 18 and NRC 37 yielded more than 3.5 ton/ha at IISR farm (Fig. 21). The seed quality of these varieties was significantly higher than certification standard of 70% germination. All the above mentioned varieties had seed germination above 80% except JS 93-05 (Fig. 22).

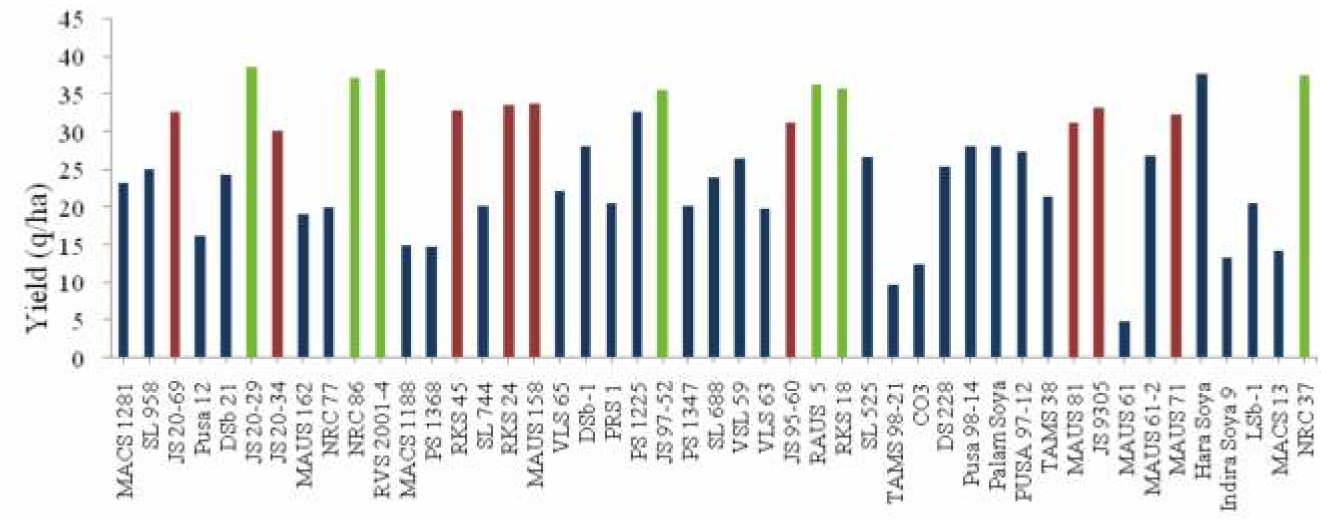

Fig. 21 : The yield of released and notified soybean varieties of 2001 to 2016 during *kharif* 2016 at Indore

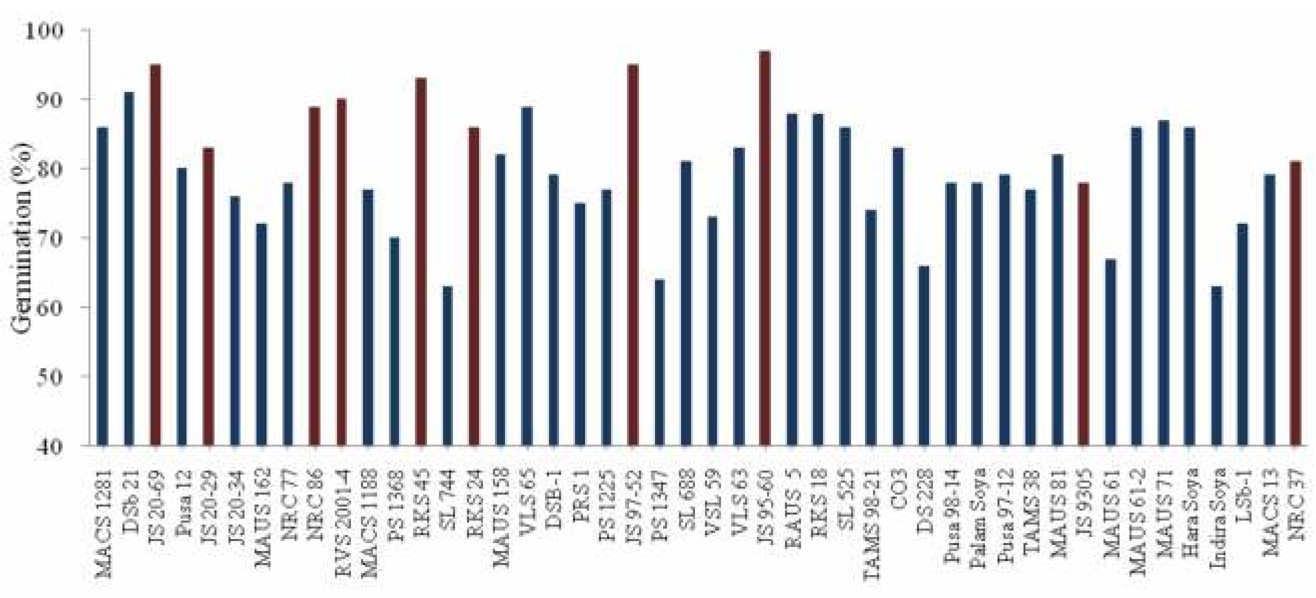

Fig. 22 : The variation in seed germination of soybean varieties (released and notified during 2001-2016) harvested during *kharif* 2016

6.3. Soybean breeder seed production

In breeder seed production programme of soybean varieties, namely, NRC 86, NRC 37, NRC 7, JS 20-29 and JS 20-34, a total of 304 q breeder seed was produced during 2016-17. Of the total 304 q breeder seed produced 105, 115,45, 35 and 4 q was obtained from NRC 86, NRC 37, NRC 7, JS 20-29 , JS 20-34, respectively. Highest productivity was for NRC 86 followed by NRC 37. Higher seed multiplication ratio (SMR) of 28 and 27, compared to national average of 16 was achieved in NRC 86 and NRC 37 respectively (Table 33).

Table 33: Soybean breeder seed production

Variety	Area (ha)	Breeder seed Production (q)	Breeder seed Yield (q/ha)	Seed multiplication ratio
NRC 86	4.9	105.00	21.42	28
NRC 7	2.8	45.00	16.07	22
NRC 37	6.0	115.00	19.2	27
JS 20-29	2.2	35.00	15.9	17.5
JS 20-34	0.4	4.0	10.0	13.3
Total	16.3	304	-	-

7.0 SOIL AND WATER CONSERVATION

- **System efficiency enhancement through conservation technologies**
- **Nitrogen and sulphur use efficiency in soybean**
- **Mass production of AMF in substrates amended with soybean hulls and vermicompost**
- **Assessment of C-sequestration in AM-mediated soil and crop management practices**
- **Design, development and validation of tractor operated disc harrow**
- **Research prototypes for tractor operated rotary weeder**
- **Improved designs of BBF**

7.1. System efficiency enhancement through conservation technologies

A long term field trial (initiated during 2009) was undertaken during 2016-17 involving 7 rotational tillage systems i.e. Conventional-Reduced (CR-CR-CR-CR, CR-RR-CR-RR, CR-RR-RR-CR, CR-RR-RR-RR, RR-RR-RR-RR), SRR (single reduced tillage) and sub soiling and 3 soybean based cropping systems [Soybean-wheat (S-W), Soybean-Chickpea (S-C) and Soybean - Mustard (S-M)]. The eighth year results revealed that all the growth and yield attributes were maximum under conventional tillage carried out every after two year. The highest yield and harvest index was recorded with conventional tillage carried out every after two year and closely followed by sub soiling and conventional tillage carried out alternate year. However, the highest straw yield was with single cultivation followed by conventional tillage carried out once in a four year.

7.2. Nitrogen and sulphur use efficiency in soybean

A field experiment was conducted during *kharif* 2016 to evaluate different levels and methods of nitrogen and sulphur application on mobilization , uptake use efficiency and productivity of soybean. In this context, the experiment comprised of 14 treatments such as Basal application of N (25 and 50 kg ha^{-1}), sulphur (20 and 50 $kgha^{-1}$) and split application of N (12.5, basal+ 12.5 at R_2 stage, 25+25 $kgha^{-1}$) and S (12.5, basal+ 12.5 at R_2 stage, 25+25 $kgha^{-1}$) in combination with N and S. The results revealed that highest plant height was observed with split application of N25+25 and did not significantly vary with basal application of N50 and split application of N and S (N 25+S 50).. The data on pods/plant revealed that highest pod yield was obtained with application of split application of N and S (N 25+S 50) and did not significantly vary with treatments comprising of basal application of N (N 50), split application of N (N 25+25), Split application of N and S (N 25+25, S 12.5+12.5 and N 25+25, S 25+25). Highest seed yield was obtained with the split application of N and S (N 25+25, S 25+25) and did not significantly vary with split application at the rate of N 25+25, S 12.5+12.5 (Table 34).

Table 34: Effect of different levels and methods of application on soybean yield and its attributes

Treatment	Plant height (cm)	Pods/plant	Seed yield ($kg ha^{-1}$)
Control	38±2[e]	77±2[g]	2565±100[i]
N 25	43±2[bc]	100±5[bcde]	2930±42[def]
N 50	45±1[ab]	110±5[ab]	3117±127[bc]
N 25+25	46±1[a]	102±10[abcd]	3072±92[c]
N 12.5+12.5	43±2[bc]	92±6[def]	2852±67[fg]
S 25	41±1[cd]	85±5[fg]	2693±71[hi]
S 50	43±2[bc]	87±[fg]	2782±43[gh]
S 12.5+12.5	40±2[d]	90±4[ef]	2677±83[hi]
S 25+25	41±2[cd]	93±7[def]	2691±126[hi]
N 25+25, S 12.5+12.5	42±1[cd]	104±10[abc]	3207±53[ab]
N 12.5+12.5, S 12.5+12.5	39±2[de]	99±5[cde]	3019±99[cde]
N 12.5+12.5, S 25+25	43±2[bc]	88±5[f]	2908±30[efg]
N 25+25, S 25+25	43±2[bc]	110±7[ab]	3251±24[a]
N 25+ S 50	45±2[ab]	111±7[a]	3048±62[cd]
LSD (p=0.05)	2	11	133

Highest N uptake was recorded with the split application of N and S (N 25+25, S 25+25) and did not significantly vary with split application of N 25+25, S 12.5+12.5. Similarly highest sulphur uptake was observed with application of N 25+25, S 25+25. Highest agronomic use efficiency was recorded with application of N 25+ S 50 and sulphur use efficiency with the split application of N and S of N 25+25, S12.5+12.5 (Table 35). Available N was significantly influenced with split application of N and S N 25+25, S 25+25 and did not significantly vary with basal application of N and split application of N and S. In the case of available S content, split application of N 25+25, S 25+25 recorded higher soil available S and did not significantly vary with basal application of N and S (N 25 + S 50), basal application of S (S 50) and split application of S at the rate of S 25+25 (Table 36).

Table 35 Effect of different levels and methods of application on nitrogen and sulphur uptake and agronomic use efficiency

Treatment	N uptake (kg ha^{-1})	S uptake (kg ha^{-1})	Agronomic N efficiency	Agronomic S efficiency
Control	150±7^{i}	3.14±0.36^{g}	-	-
N 25	176±2de	4.21±0.18^{ef}	14.60	-
N 50	190±7^{bc}	4.86±0.24^{cd}	11.06	-
N 25+25	187±6^{c}	4.46±0.11^{de}	10	-
N 12.5+12.5	171±3^{ef}	3.91±0.16^{f}	11.52	-
S 25	160±5^{gh}	4.44±0.42^{e}	-	5.12
S 50	166±3^{fg}	4.86±0.14^{cd}	-	4.34
S 12.5+12.5	158±4^{h}	4.21±0.26^{ef}	-	4.48
S 25+25	160±7^{gh}	4.48±0.34^{de}	-	2.54
N 25+25, S 12.5+12.5	196±2^{ab}	5.22±0.25^{bc}	12.86	25.72
N 12.5+12.5, S 12.5+12 5	183.±5^{cd}	4.85±0.12^{cd}	18.20	18.20
N 12.5+12.5, S 25+25	175±3^{e}	5.10±0.17^{bc}	13.76	6.88
N 25+25, S 25+25	200±3^{a}	5.98±0.14^{a}	13.74	13.74
N 25 + S 50	185±3^{c}	5.28±0.26^{b}	19.36	9.68
LSD(P=0.05)	8	0.40		

Table 36. Effect of different levels and methods of application on soil available nitrogen and sulphur status

Treatment	Available N content (ppm)	Available S content (ppm)
Control	193±11[e]	2.61±0.26[f]
N 25	228±29[abc]	2.84±0.11[e]
N 50	247±16[ab]	2.99±0.06[cde]
N 25+25	233±29[ab]	2.89±0.08[e]
N 12.5+12.5	210±16[cde]	2.67±0.07[f]
S 25	172±40[de]	3.06±0.09[bcd]
S 50	191±40[de]	3.14±0.07[abc]
S 12.5+12.5	196±28[bcde]	2.99±0.07[cde]
S 25+25	210±24[bcde]	3.08±0.06[abcd]
N 25+25, S 12.5+12.5	224±28[abcd]	3.06±0.04[bcd]
N 12.5+12.5, S 12.5+12.5	214±32[abcde]	2.94±0.04[de]
N 12.5+12.5, S 25+25	224±37[abcd]	3.07±0.05[de]
N 25+25, S 25+25	266±64[a]	3.22±0.08[a]
N 25 + S50	242±16[ab]	3.16±0.05[ab]
LSD (p=0.05)	53.9	0.16

7.3. Development of AM fungi mass production technology and its utilization in carbon sequestration and mitigating CO_2 emission

7.3.1. Mass production of AMF in substrates amended with soybean hulls and vermicompost

AMF biomass as assessed in roots and rhizosphere soil through both the methods i.e., Ester linked fatty acids (ELFA) and conventional microscopic methods and AMF soil protein glomalin was found to be higher in sorghum as compared to amaranthus.

Highest 16:1w5 ELFA in rhizosphere soil (16.28 nmoles g^{-1} soil) and roots (24.04 nmoles g^{-1} roots) was observed in pots grown with sorghum amended with soil-sand mix amended with hulls and vermicompost (Fig. 23) which make the host more suitable for enhanced AM mass production. Besides harbouring higher phospholipid fatty acid (PLFA) live biomass in sorghum, the AM spore density was also found to be the highest in soil-sand mix amended with hulls and vermicompost. The study concludes that among the two hosts and four substrates combinations used, the sorghum grown in substrates amended with soybean hulls with vermicompost were found to be the best and hence can be used as optimal substrate for mass production of native AM fungi.

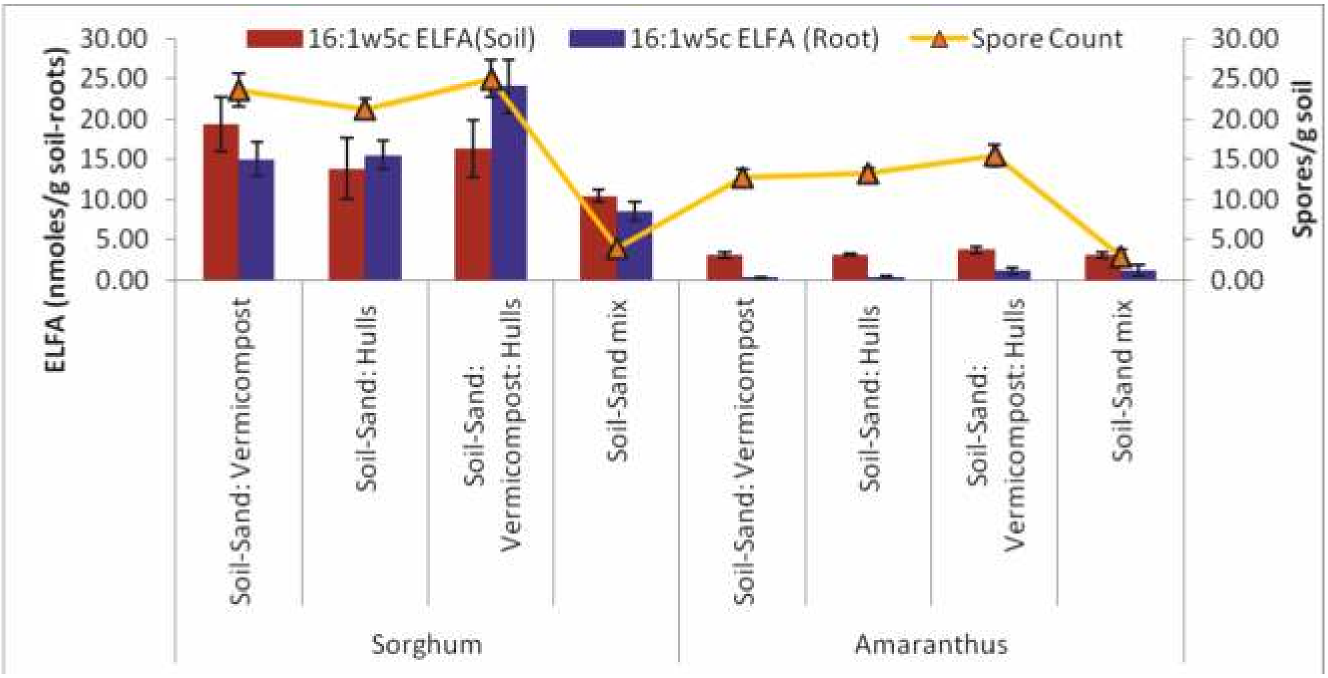

Fig. 23: 16:1w5 Ester Linked Fatty Acid content (ELFA) in soil/root and AMF spore count in soil and root of sorghum and amaranthus grown in different combinations of substrates

7.3.2. Assessment of C-sequestration in AM-mediated soil and crop management practices

Over a period of three years AM inoculated plots of soybean + maize intercropping under organic farming showed highest glomalin and carbon stocks however the values were found to be at par with the organic AM inoculated organic sole maize and sole soybean (Fig. 24). Overall, CO_2 emissions were found to be significantly lower in AM inoculated plots over their uninoculated counterparts. This trend was particularly sharper in case of AM inoculated plots under organic practice. The order of lower CO_2 emissions had the following trend: AM inoculated organic sole soybean< AM inoculated organic sole maize < AM inoculated organic soybean+ maize intercropping (Fig. 24).

In case of AMF biomass assessed through signature fatty acids (16:1w5 PLFA/NLFA) where irrespective of farming practice, the AM-fatty acid biomarker was found to be the highest in plots of sole maize followed by plots of soybean + maize intercropping wherein irrespective of farming practice PLFA 16:1w5 was found to be the highest in AM inoculated plots (Fig. 25). 16:1w5 NLFA, like PLFA, no significant effect of AM inoculation was observed during the first year but later years, irrespective of AM inoculation or farming practice, the plots of sole maize where the native AM recorded highest 16:1w5 NLFA. This was followed by AM inoculated plots of soybean + maize intercropping irrespective of the farming practice followed. Overall, highest 16:1w5 PLFA/NLFA followed a trend as Sole maize> Intercropping> Sole Soybean (Fig. 25).

In general, irrespective of crop sequence, higher grain yield was recorded in AM inoculated plots; however, comparatively higher returns were recorded in intercropping system followed by sole maize.

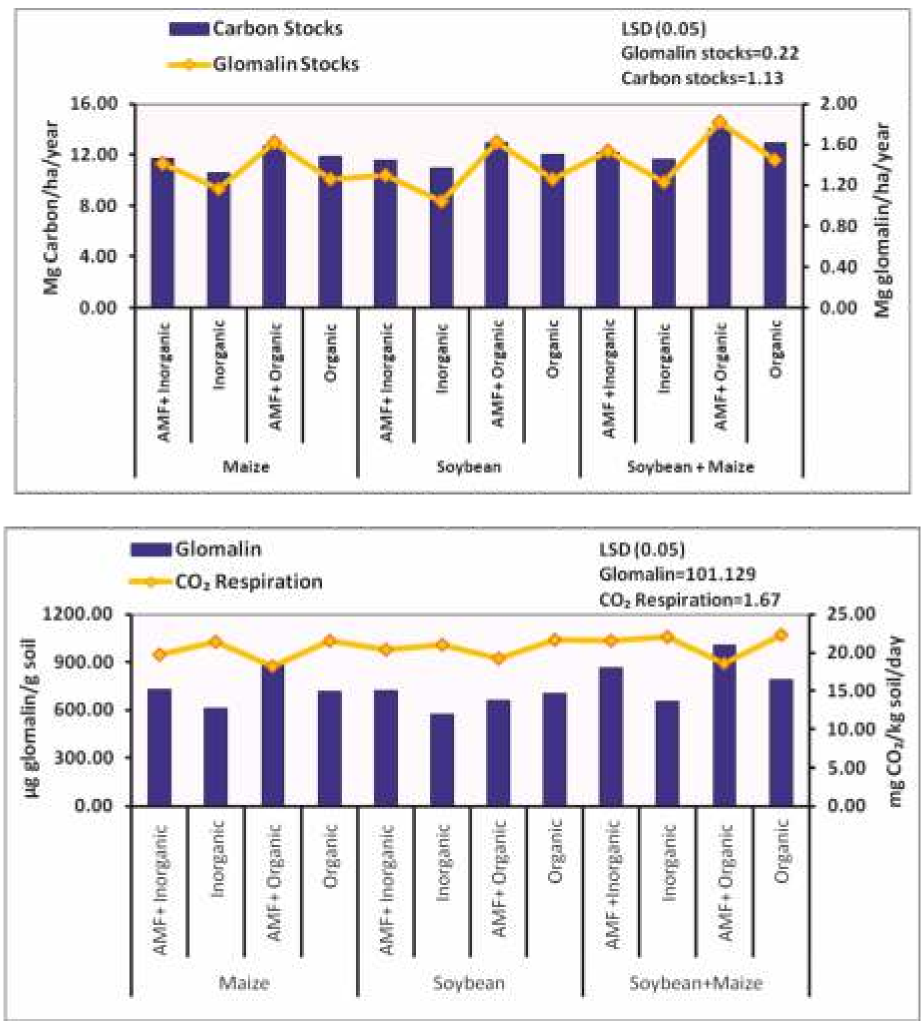

Fig. 24: Cumulative effect of different soil and crop management practices on carbon sequestration under field conditions

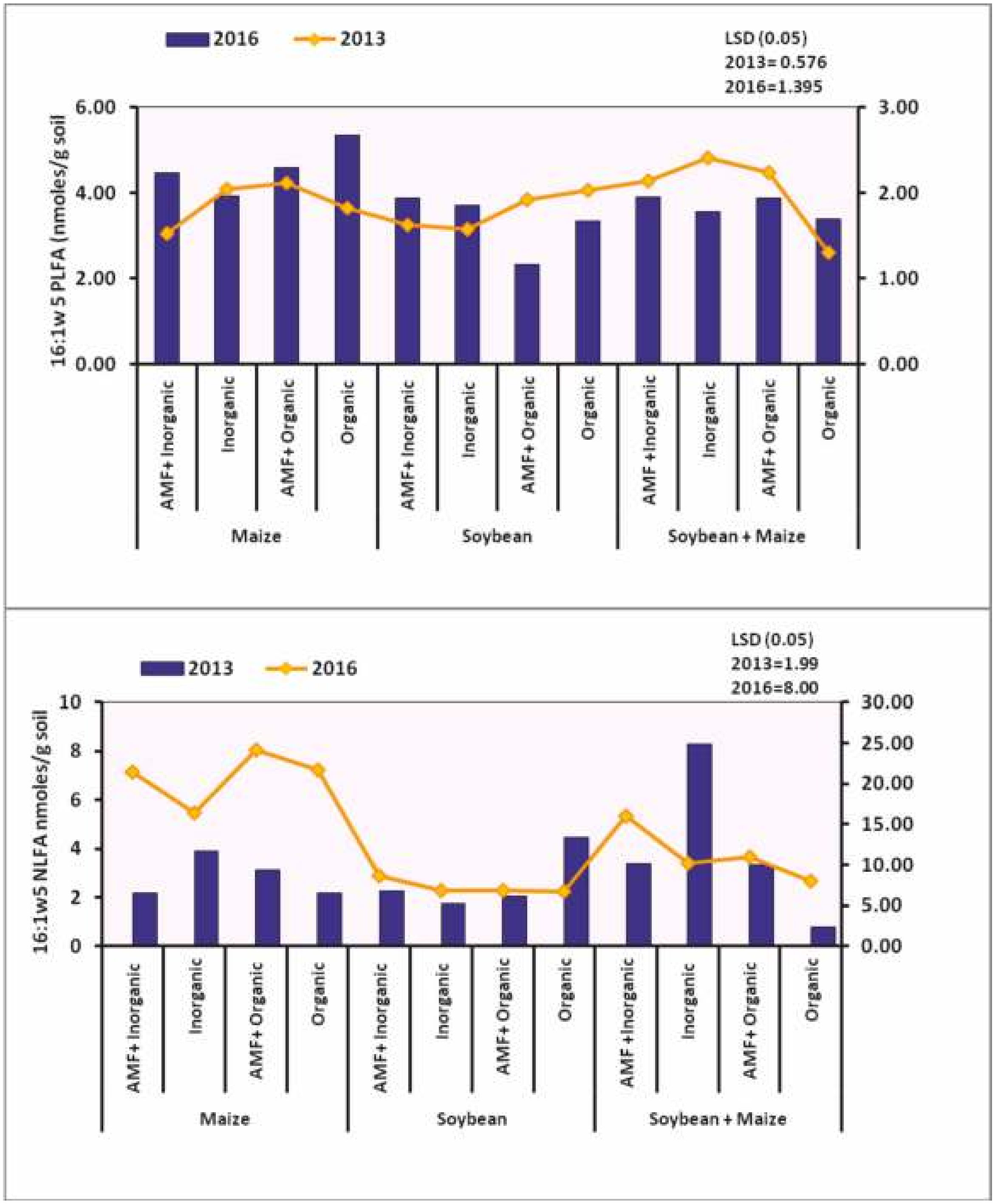

Fig. 25: Effect of different soil and crop management practices on 16:1w5 Phospholipid fatty acid (PLFA) content in soil (top) and 16:1w5 Neutral lipid fatty acid content (NLFA) in soil (bottom) under field conditions during the initial and final year of the trial

7.4. Design, development and validation of tractor operated disc harrow

The research prototype of this machine with discs of 8 mm specification and total weight of the machine along with gang angle was prepared. Subsequently, tractor drawn disc harrow for vertisols was developed and has been found successful in vertisols where moisture is available in soil. The machine effectively performs in vertisols and associated soils and is attachable to the tractor for facilitating uprooting of crop straw and pulverizing the soil. It also helps to facilitate break the root stock of wheat straw. This machine also helps to prepare field better and allows sowing of subsequent crop without obstruction due to crop residue in the fields. This new concept machine can be easily operated with 40 PTOHP range tractors. This machine has potential to crush break and split the crop root stock entrenched in the soil .

7.5. Tractor operated rotary weeder for soybean

Initial study of tractor operated rotary weeder for soybean has indicated that horizontal or vertical blades can be considered. Prototype of this machine was prepared with the provision of change in blade length for increasing or decreasing the width (as per the row-to-row distance of the crop) of cut. Subsequently, a tractor PTO operated Rotary weeding machine three point assembly systems on tractor was conceived, manufactured and farm validated for facilitating elimination of unwanted plants between with soybean crop. Planting of soybean crop in rows and also in straight lines was essential for successful use of the PTO operated machine. The machine has guards to prevent damage to soybean plants. The machine is capable of uprooting and slashing almost 80-90 % of the weeds between the soybean crop rows.

7.6 Improved designs of the BBF (Broad bed and Furrow) machines developed

The variant of Broad Bed and Furrow (BBF) machine can be operated with the help of 30 PTO-HP tractors also whereas other 2 channel (BBF machine) needs at least 40 PTO HP tractors to operate for sowing in vertisols. This machine is also effective for sowing wheat crop and helps in saving time, water and labour. It is also a good alternative to flood irrigation of wheat and soybean crop (Fig. 26).

Fig. 26: Single channel Broad Bed and Furrow (BBF) sowing machine for soybean and wheat crop

8.0 SOCIAL SCIENCES & TECHNOLOGY TRANSFER

- **Determinants of soybean yield variablility**
- **Training programme**
- **Workshops**
- **Frontline demonstrations**
- **Agricultural Exhibitions**
- ***Mera Gaon Mera Gaurav* (MGMG)**
- **Advisory for farmers**
- **Technology commercialised**

8.1. Determinants of farm level soybean yield variability and technical efficiency in Madhya Pradesh

The study analysed the determining factors of farm level soybean yield variability and worked out index of soybean production technology adoption and index of technical efficiency. Preliminary analysis indicated that the yield variability of soybean across farms was mainly due to type, quality and fertility of land; level of adoption of improved soybean production technologies; and socio-economic characteristics of farmers. Soybean yield was found to be low in case of farmers having fields with low depth, undulated land, with larger slope and poor soil fertility status as perceived by farmers. Also, the farmers who have low technology adoption index reaped low soybean yield.

8.2. Training programmes

8.2.1. Model Training Course (MTC)

Model Training Course on "Integrated Approaches for Sustainable Soybean Production" organized during August 22-29, 2016. The participants included 18 officers from state department of agriculture belonging to six states viz. Madhya Pradesh, Chhattisgarh, Maharashtra, Telangana, Haryana, and Nagaland.

8.2.2. Trainers' Training Programmes

The institute organized MANAGE-IISR Collaborative Training Programme on "Agricultural Knowledge Management" during 19-23 September 2016, involving 19 field level officers of Madhya Pradesh and Chhatisgarh.

8.3. Farmers' Training Programmes

8.3.1. Farmers' training programmes on improved soybean production technology

During this year, 53 Farmers' Training Programmes of day long duration were organized with the cumulative participation of 1689 farmers belonging to the states of Madhya Pradesh, Rajasthan, and Maharashtra. All the recommended package of practices including agronomic, moisture conservation techniques during the stress period, integrated approach of managing weeds, insect pests and diseases etc as well as processing aspects of value added soy products were covered in these training programmes which were facilitated in participatory mode.

8.3.2. Women's training programme on processing and utilization of soybean

Twelve training programmes on

"Processing and Utilization of Soybean for Food Uses at household level" were organized with the participation of 399 women belonging Madhya Pradesh and Rajasthan respectively.

8.3.3. Workshops

A two day Review workshop was organized at ICAR-IISR for the scientists belonging to Krishi Vigyan Kendras located in Madhya Pradesh, Chhatisgarh & Orissa in association with ATARI, Zone VII, Jabalpur during 26-28 April 2016. In this workshop, review was undertaken about different OFTs and VTs on soybean conducted during the year and necessary modifications were suggested for formulation of annual plan for the coming season.

MANAGE-IISR Training Programme on Knowledge management during 19-23 September 2016

8.4. Frontline demonstrations

Twenty frontline demonstrations were conducted on improved soybean production technology in villages Arjun Baroda and Silotia of Indore district. Further, under the Tribal Sub-Plan (TSP) scheme of ICAR-IISR, a total of 300 frontline demonstrations were laid out during Kharif 2016 at Dhar, Barwani and Khandwa districts in association with Krishi Vigyan Kendras of respective districts under the jurisdiction of RVSKVV, Gwalior. A total 50 frontline demonstrations were conducted in 14 villages (Arjun Baroda, Silotia, Borkhedi, Navda, Harsola, Sater, Gujarkheda, Memdi, Ambachandan, Bhagora, Chordia, Fulkaradia, Jambudihapsi and Budania). The newly released variety namely JS 20-29 and JS 20-34 were demonstrated with improved soybean production technologies. The adaptation of improved soybean production technologies enhanced the soybean yield by 22.18% with the extra expenditure of Rs. 1995/ha. The improved technology increased the net returns to the tune of 26.65% as compared to farmers practice. The yield gap II was 429 kg/ha.

8.5. Agricultural Exhibitions

The Institute has actively participated in following agricultural exhibitions during the year.

Dates	Event	Organized by	Venue
22-26 November 2016	4th International Agronomy Congress	ICAR-IARI, New Delhi	ICAR-Indian Agricultural Research Institute, New Delhi
28-30 November 2016	Krishi Kumbh	ICAR-IIFSR, Modipuram	Muzaffarnagar, U.P.
5th December 2016	World Soil Health Day	KVK, Indore	Krishi Vigyan Kendra, Kasturbagram, Indore
10-12 December 2016	Krishi Vigyan Mela	Office of DDA, Dist-Indore	Laxmibai Mandi Ground, Indore
04.03.2017	Wheat Day	IARI Regional Station, Indore	IARI Regional Station, Indore

8.6. Organization of *Soybean Diwas*

The institute has successfully organized *Soybean Diwas* on 28th September 2016 involving progressive farmers associated with *Mera Gaon Mera Gaurav* and Mega Seed Project through which they were exposed to novel technologies related to seed production as well as improved packages for management of weed, insect-pest and diseases under demonstrations at IISR farm.

Organization of "Soybean Diwas" at ICAR-IISR

8.7. *Mera Gaon Mera Gaurav* (MGMG)

Five team of scientists constituted under this programme have been maintaining close contact with farmers of selected MGMG villages. Each team has selected five villages thus establishing contact with 25 villages on regular basis for inroads of technological information among the farmers for improving economic status. During *kharif 2016*, 20 frontline demonstrations on soybean have also been laid out in this villages introducing newly released soybean varieties ie. JS 20-34 and JS 20-29. Further, 203 frontline demonstrations on improved soybean production technology were also laid out in one of the MGMG village Puwarda Dai, Puwarda Happa, Makodiya and Machhukhedi in colloboration with Mahindra and Mahindra Firm, Mumbai.

Mera Gaon Mera Gaurav Farmer-Scientist Interaction

8.8. Advisory for farmers

During *kharif* 2016, the institute has issued weekly advisories containing specific information regarding agronomic practices to be followed by soybean growers as well as measures for control of insect-pest and diseases using email, websites, mobile phones, television, radio and also through officers of Department of Agriculture and SAUs of major soybean growing states of Madhya Pradesh, Rajasthan, Maharashtra, Karnataka and Telangana. Further, the advisories on specific topic were sent via mKisan Portal to more than 3 lakh soybean farmers.

8.9. Technology commercialised

A non-exclusive license of Lipoxygenase-2 free soybean genotype (NRC 109) developed at the institute was transferred to Sonic Biochem Extraction Limited, Indore (M.P.) following inking of MoU between ICAR-IISR and Sonic Biochem Extraction Limited, Indore (M.P) on 06/12/2016. The soy products processed from lipoxgenase-2 free soybean have reduced beany/off flavor.

A glimpse of MOU signed with M/s Sonic Biochem Extraction Limited; Indore for Lipoxygenase-2 free soybean line (NRC 109) of IISR during 2016-17

9.0 XLVII ANNUAL GROUP MEETING OF AICRP ON SOYBEAN

9.1. XLVII Annual Group Meeting of AICRP on Soybean

47th AGM of AICRP on Soybean was organized by ICAR-Indian Institute of Soybean Research, Indore and G.B. Pant University of Agriculture & Technology, Pantnagar (Uttrakhand) from May 2-4, 2017, which was attended by 101 soybean scientists and development workers from various states of the country. The meet was inaugurated by Dr. J. Kumar, H'ble Vice Chancellor, GBPUA&T, Pantnagar with Dr. S.K. Chaturvedi, Asst. Director General (O&P), ICAR as the Chief Guest.

The Varietal Identification Committee under the Chairmanship of Dr. S.K. Chaturvedi, Assistant Director General (O&P), ICAR scrutinized thirteen proposals of eight soybean varieties and identified six varieties for different zones. A brief account of identified varieties is as follows:-

PS 1556: The variety was identified for release in Himachal Pradesh and Uttrakhand. It has yield potential of more than 22 q/ha and moderately resistant against frog eye leaf spot and pod blight prevalent in the region.

JS 20-98: The variety besides having good yield potential is resistant to some threatening diseases like Charcoal rot and YMV. It has been identified for release to cultivate in the states of Madhya Pradesh, Bundelkhand region of UP, Rajasthan, Gujarat and Marathwada and Vidarbh region of Maharashtra.

RSC 10-46: Owing to its wider adaptability (NEHZ, CZ and SZ), the variety was identified for release in West Bengal, Jharkhand, Chhattisgarh and Orissa.

MACS 1460: The variety has shown consistent early maturity and wider adaptability in three zones and hence was identified for release in West Bengal, Jharkhand, Chhattisgarh, Orissa, Assam and North Eastern States, Southern Maharashtra, Karnataka, Telengana, Andhra Pradesh and Tamil Nadu.

KDS 753: In view of 16-20% yield superiority over best check and wider adaptability, this variety has been identified for release in West Bengal, Jharkhand, Chhattisgarh, Orissa, Assam and North Eastern States, Southern Maharashtra, Karnataka, Telengana, Andhra Pradesh and Tamil Nadu..

DSb 28-3: Based on yield superiority over best check, high resistance against soybean rust and moderate resistance against pod blight this variety has been identified for release to cultivate in Southern Maharashtra, Karnataka, Telengana, Andhra Pradesh and Tamil Nadu.

Against the DAC indent of 21748.71 quintals of breeder seed of 33 soybean varieties, target of 21657 quintals of breeder seed production has been fixed for 2017. The DAC indent for five varieties only viz. JS 335, JS 93-05, JS 95-60, JS 20-29 and JS 20-34 dominated the entire indent.

During the year, 28 centers conducted 1137 FLDs on farmer's fields against the target of 1100 FLDs in plot of 0.4 ha each. The FLDs were conducted by farmers belonging to SC (11.17%), ST (14.90%), OBC (45.72%) and general category (28.21%). The average yield of 1848 kg/ha was realized through improved production technology against 1470 kg/ha in farmers practice. The increase in yield and net returns to the tune of 28.43 and 38.19% respectively over farmers practice was achieved by the additional expenditure of only ₹.3412/ha. Among the varieties, soybean variety MACS 1281 gave highest yield (3167 kg/ha) followed by MACS 1188 (2933 kg/ha), KDS 344 (2743 kg/ha), JS 20 34 (2377 kg/ha) and MAUS 158 (2376 kg/ha) under improved soybean production practice.

To speed up the process of varietal development, a national hybridization programme has been formulated with emphasis on enhanced crossing programme during *kharif* season and to take up generation advancement during off season. Suitable centres have been identified and activities have been earmarked for this purpose.

In view of no or limited cooperating centres in some potential regions, voluntary centres have been identified to take up soybean research work under different disciplines. The coordinating unit shall provide need based contingency to such voluntary centres.

This year, following technical recommendations of practical utility were made from the deliberations held during the Annual Group Meet:-

1. The new herbicide molecule Fluthiacet-methyl 10.3% EC (F7121) @ 12.5g ai/ha (121.30 g/ha) + NIS @ 2.5%as PoE is recommended for management of broad leaf weeds in Eastern and Central zone subjected to the label claim.
2. Hydrogel @ 2.5 kg/ha is recommended under the moisture deficit condition across the zones.
3. On the basis of two year field trials at Imphal and Medziphema of NEH Region, following insecticides were found effective and are therefore recommended for insect management in the region:

Insect	Insecticide
Bihar hairy caterpillar	Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha, Quinalphos 25 EC @ 1500 ml/ha, Triazophos 40 EC 800 ml/ha
Spodoptera litura	Thiacloprid 21.7 SC @ 650 ml/ha, Quinalphos 25 EC @ 1500 ml/ha
Leaf webber	Quinalphos 25 EC @ 1500 ml/ha, Imidacloprid 48 FS @ 1.25 ml/kg seed, Indoxacarb 15.8 SC @ 300 ml/ha, Thiacloprid 21.7 SC @ 650 ml/ha, Triazophos 40 EC 800 ml/ha, Thiamethoxam 30 FS @ 10 ml/kg seed
Other defoliators aphids	Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha, Quinalphos 25 EC @ 1500 ml/ha Thiacloprid 21.7 SC @ 650 ml/ha, Thiamethoxam 30 FS @ 10 ml/kg seed, Imidacloprid 48 FS @ 1.25 ml/kg seed
Blister beetle	Thiacloprid 21.7 SC @ 650 ml/ha, Chlorantraniliprole 18.5 SC @ 100 ml/ha, Indoxacarb 15.8 SC @ 300 ml/ha

4. Based on consistency in previous three years' field screening trials, following genotypes were found to be promising with respect to insect resistance and are recommended as potential donors:

Insect	Genotypes
Stem fly	DSb 21, DSb 28-3, KBS 22-2009, KDS 780, MACS 1370, MACS 1460, NRC 94, RKS 113, RVS 2007-6, RVS 2010-1
Girdle beetle	MACS 1410, RVS 2001-18, RVS 2010-1
Defoliators	KBS 22-2009, MACS 1370, MACS 1410, RVS 2001-18, RVS 2010-1
Pod borer	DSb 21, RKS 113
Leaf Miner	KBS 22-2009, KDS 693
Pest Complex	DSb 21, DSb 25, DSb 28-3, JS 20-89, JS 20-96, KBS 22-2009, KDS 693, KDS 753, KDS 780, MACS 1370, MACS 1410, MACS 1442, MACS 1460, NRC 94, RSC 10-46, RVS 2001-18, RVS 2002-4, RVS 2007-6

5. Sources for resistance against major diseases like Charcoal rot (MACS 1336) and RAB (SL 983, SL 979), DSb 23-2 and DSb 28-3 (multiple disease resistance against rust, purple seed stain and pod blight) were identified and recommended for use in domestic hybridization programme to develop disease resistant varieties.

9.2. Research recommendations for *Kharif* 2017

i. Fresh seed of check varieties is to be used in IVT and its multiplied seed to be used in AVT I and AVT II. Originating breeder would supply fresh seed directly to the centers. Due to non-availability of the seed of JS 97-52, its seed would be replaced from the IVT 2018.

ii. To encourage the development of early maturing varieties in Central Zone, entries would be compared with the earliest maturing check variety JS 20-34 and promoted when yield is at par or more than the same check.

iii. Check variety SL 688 to be replaced with SL 958 in Northern Plain Zone.

iv. In 2016 NEZ was divided into EZ and NEHZ. Zonal means were recalculated and given to centers. Varietal identification committee has suggested to keep the NEZ means upto 2015 and take separate means of EZ and NEHZ from 2016 onwards. AVT Zonal mean tables of EZ and NEHZ given in summary report of breeding trials would change and new tables would be provided soon. New calculations have been made and entries promoted accordingly. Any discrepancy in calculation and varietal promotion may please be brought to the notice.

v. In National Hybridization Programme female parent should preferably be from the same zone.

10. राजभाषा–कार्यान्वयन 2016–17

राजभाषा विभाग, गृह मंत्राालय, भारत सरकार के दिशा–निर्देश के अनुसार भा.कृ.अनु.परि – भारतीय सोयाबीन अनुसंधान संस्थान, इंदौर में भी इस दिशा में राजभाषा के प्रसार–प्रचार हेतु अनेकानेक कार्यक्रम किए जा रहे हैं। जिनके फलस्वरूप भारतीय सोयाबीन अनुसंधान संस्थान में राजभाषा कार्यान्वयन के क्षेत्र में उत्तरोत्तर प्रगति के साथ अनेक आधारभूत कार्य हुए हैं, जो राजभाषा के प्रगामी प्रयोग में अत्यंत सार्थक सिद्ध हो रहे हैं। इस क्षेत्र में किए जा रहे क्रियाकलापों का संक्षिप्त विवरण निम्नवत हैं :

क) हिन्दी कार्यशालाएं : इस दिशा में संस्थान में हिन्दीमय वातावरण विनिर्मित करने हेतु प्रत्येक तिमाही में कम से कम एक हिन्दी कार्यशाला का आयोजन किया जा रहा है। जिसमें संस्थान के सभी सवंर्गो को आमंत्रित किया जाता है तथा संबंधित विषयानुसार कार्यशालाएं सम्पन्न की जाती हैं। अप्रैल–मार्च 2017 में अब तक **04** कार्यशालाओं का आयोजन किया गया, जिसकी सूची निम्नानुसार है :

दिनांक	विषय	अतिथिवक्ता
30 मई 2016	कार्यालय में राजभाषा के प्रयोग की सुगमता	डॉ. अमरनाथ शर्मा प्रधान वैज्ञानिक एवं प्रभारी अधिकारी राजभाषा भा.कृ.अनु.प.–भारतीय सोयाबीन अनुसंधान संस्थान, इंदौर।
03 सितंबर 2016	हिन्दी वर्तनी एवं उसका उचित प्रयोग	श्रीमती डॉ. मीनाक्षी जोशी अध्यक्ष–भाषा अध्ययनशाला, महारानी लक्ष्मीबाई शासकीय कन्या स्नातकोत्तर महाविद्यालय, इंदौर।
05 दिसंबर 2016	राजभाषा नीति एवं कार्यान्वयन	श्री जयनाथ यादव हिन्दी अधिकारी भारतीय प्रबंध संस्थान इंदौर।
06 मार्च 2017	हिन्दी का सरलतापूर्वक उपयोग	श्री मोहनलालजी शर्मा सेवानिवृत्त प्राध्यापक (हिन्दी)

ख) प्रशिक्षण : संस्थान में राजभाषा के प्रचार–प्रसार हेतु कृषकों एवं प्रशिक्षणार्थियों को प्रशिक्षण संबंधित सारी सामग्रीयॉ हिन्दी में भी प्रदान की जा रही है। इस दृष्टिकोण से 2016–17 के दौरान 10,000 प्रतियॉ प्रसार फोल्डर हेतु एवं 11,000 प्रतियॉ प्रसार बुलेटिन हेतु प्रदान की गई।

ग) राजभाषा नीति पर जागरूकता कार्यक्रम : उक्त प्रशिक्षणों के अतिरिक्त संस्थान में कर्मचारियों,

अधिकारियों एवं वैज्ञानिकों हेतु राजभाषा नीति के संवैधानिक प्रावधानों से अवगत कराने तथा इसके प्रति जागरूक करने हेतु समय–समय पर राजभाषा नीति विषय पर विचारों का आदान–प्रदान किया जा रहा है।

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

ड.) 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।

च) शब्दकोश में वृद्धि : संस्थान में प्रतिदिन एक शब्द हिन्दी एवं अंग्रेजी को द्विभाषी रूप ''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 कार्यालयीन उपयोग में भी सहायता प्राप्त हो सके।

छ) राजभाषा कार्यान्वयन समिति की तिमाही बैठक

- प्रथम बैठक : दिनांक 24 मई 2016
- द्वितीय बैठक : दिनांक 08 जुलाई 2016
- तृतीय बैठक : दिनांक 4 अक्टूबर 2016
- चतुर्थ बैठक : दिनांक 6 जनवरी 2017

ज) संसदीय राजभाषा समिति निरीक्षण : दिनांक 19 मई 2016 को संसदीय राजभाषा समिति की दूसरी उप–समिति द्वारा संस्थान में राजभाषा कार्यान्वयन संबंधी कार्यों का निरीक्षण इंदौर स्थित होटल 'रेडिसन ब्लू' में किया गया।

झ) प्रोत्साहन योजनाएँ : संस्थान में सर्वप्रथम राजभाषा संबंधित गतिविधियों के प्रसार–प्रचार हेतु प्रोत्साहन योजनाओं पर ध्यानाकर्षित किया गया। चूँकि यह ''क'' स्थित क्षेत्र है फिर भी कर्मचारियों, अधिकारियों एवं वैज्ञानिकों में हिन्दी के प्रति रूचि में वृद्धि करने हेतु समयानुसार प्रोत्साहन योजनाओं का आयोजन किया जाता है, ताकि सभी संवर्गों को हिन्दी में कार्य करने हेतु प्रेरणा मिलती रहे। प्रोत्साहन योजनाओं 2015–16 के दौरान प्रथम पुरस्कार श्री श्याम किशोर वर्मा, द्वितीय पुरस्कार कु. प्रियंका सावन, श्री रविशंकर कुमार तथा तृतीय पुरस्कार श्री अविनाश कलंके, डॉ. बी.यू. दुपारे, डॉ. मृणाल कुचलान, श्री राकेश चंद्र शाक्या तथा डॉ. एस.डी. बिल्लौरे जी को प्रदान किया गया। अतेव प्रोत्साहन योजना के माध्यम से इस कार्य में अत्यधिक सार्थकता प्रदान करने की कोशिश की जा रही है।

ञ) हिन्दी पखवाड़ा का आयोजन : सरकारी एवं सरकार के अधीनस्थ या संबद्ध कार्यालयों, सार्वजनिक उपक्रमों एवं प्रतिष्ठानों में हिन्दी पखवाड़ा का आयोजन अनिवार्य रूप से सम्पन्न करना अति आवश्यक है। इस

संदर्भ में वर्ष 2016–17 के दौरान संस्थान में ''हिन्दी पखवाड़ा 2016'' का आयोजन किया गया, जिसमें विभिन्न प्रकार की प्रतियोगिताओं का आयोजन किया गया एवं सभी प्रतियोगिताओं में संस्थान के वैज्ञानिक, अधिकारी एवं कर्मचारी के साथ–साथ सहायक वर्ग के कर्मियों ने भी अपनी सहभागिता को स्वछंद रूप से व्यक्त किया। ''हिन्दी – पखवाड़ा'' में हिन्दी भाषियों के साथ ही साथ हिन्दीत्तर भाषियों ने भी प्रतियोगिताओं में सम्मिलित होकर अपने उत्साह को व्यक्त किया।

राजभाषा के कार्यान्वयन के क्षेत्र में भा.कृ.अनृ. परि–भारतीय सोयाबीन अनुसंधान संस्थान की प्रगति आख्या का एक स्वर्णिम झलक आपके समक्ष प्रस्तुत है। उपरोक्त गतिविधियों पर यदि दृष्टिपात करें तो यह ज्ञात होता है कि संस्थान में राजभाषा कार्यान्वयन की दिशा में एक सकारात्मक एवं सार्थक कार्य चल रहा है, जो संस्थान में हिन्दी के सुनहरे भविष्य का आभास कराती है।

संस्थान की हिन्दी कार्यशाला को सम्बोधित करते हुए प्रभारी राजभाषा अधिकारी, डॉ. ए.एन. शर्मा ।

हिन्दी पखवाड़ा 2016 के दौरान दीप प्रज्जवलित करते हुए निदेशक, डॉ. वी. सिं. भाटिया।

हिन्दी पखवाड़ा 2016 के दौरान आयोजित होने वाली ''प्रश्न–मंच'' प्रतियोगिता में सम्मिलित अधिकारी एवं कर्मचारीगण।

हिन्दी पखवाड़ा 2016 के दौरान आयोजित होने वाली हिन्दी कार्यशाला प्रतियोगिता में सम्मिलित अधिकारी एवं कर्मचारीगण।

हिन्दी पखवाड़ा 2016 के 'पुरस्कार वितरण एवं समापन समारोह' में पधारे मुख्य अतिथि डॉ. कैलाश नाथ पाण्डेय को स्मृति–चिहन भेंट करते हुए संस्थान के निदेशक, डॉ. वी. सिं. भाटिया।

'पुरस्कार वितरण एवं समापन समारोह' में पधारे मुख्य अतिथि डॉ. कैलाश नाथ पाण्डेय के करकमलों से पुरस्कार ग्रहण करते हुए हिन्दी पखवाड़ा 2016 के विजेता प्रतिभागी।

11.0 MISCELLANEOUS

- **On-going research projects**
- **Publications**
- **Awards & Recognition**
- **Linkages**
- **Important committees**
- **Participation in Conference/ Workshops/Training**
- **Infrastructure development**
- **Distinguished visitors**
- **Personnel**
- **Appointments, promotions, transfer, etc**

11.1. On-going research projects

11.1.1. In-house

Project No.	Project Title	PI	Duration
CROP IMPROVEMENT			
Mega Project 1	**Soybean genetic resource management-Acquisition, conservation, characterization, documentation and utilization**	**Dr Sanjay Gupta**	
NRCS 1.1/87	Augmentation, management and documentation of soybean germplasm	Dr Sanjay Gupta	1987- LT
Mega Project 2	**Genetic improvement of soybean for yield, wide adaptability. nutrient use efficiency, resistance to biotic and abiotic stresses and improvement in quality of soybean seed**	**Dr Sanjay Gupta**	
NRCS 1.6/92	Hybridization, Selection and Development of Multiparent populations for Genetic improvement of Yield potential in Soybean	Dr. M. Shivakumar	1992- LT
DSR1.18/10	Breeding soybean for wider adaptability using photoperiod response and growth habits	Dr Sanjay Gupta	2017
NRCS 1.9/99	Evaluation of germplasm and breeding for resistance to rust, YMV and Rhizoctonia root rot	Dr R Ramteke	1999-LT
DSR 1.26/13	Studies on impact of field weathering on soybean seed quality and its management	Dr P Kuchlan	2017
DSR 1.27/14	Application of nano particles to soybean seed to improve germination	Dr M Kuchlan	2017
Mega Project 3	**Managing the impact of current and future climate variability in soybean**	Dr G K Satpute	
DSR 5.6/08	Genetic and physiological enhancement for abiotic stresses	Dr G K Satpute	2019
DSR 5.6b/09	Breeding for drought resistance / tolerance varieties in soybean 5.6.a. Physiological basis of tolerance/ resistance to abiotic stresses in soybean 5.6.c. Breeding for Water logging Tolerance in Soybean		
Mega Project 4	**Molecular breeding and transgenic approaches for soybean improvement**		
DSR 1.23/12	Molecular mapping and genomics-assisted breeding for rust in soybean	Dr Milind Ratnaparkhe	2017

Mega Project 5	**Development of specialty soybean varieties for secondary agriculture and industrial uses**	**Dr Vineet Kumar**	
NRCS 1.12/02	Breeding for food grade characters and high oil content	Dr. Anita Rani	2002-LT
DSR 1.28/14	Mapping QTLs for oleic acid and development of high oleic acid soybean	Dr Vineet Kumar	2021
IISR 1.31/16	Development and validation of Multi-Trait allele specific SNP panel for high throughput genotyping of breeding populations in soybean	Dr G Kumawat	2018
IISR 1.32/16	Screening Soybean Germplasm for Vegetable -Type Characteristics and Optimization of Processing Parameters	Dr Neha Pandey	2018
CROP PRODUCTION			
Mega Project 6	**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**	
DSR 4.10/09	System efficiency enhancement through resource conservation technologies	Dr S D Billore	2020
DSR 6.8/13	Inoculum development of niche AM fungi for application in soybean-based cropping system	Dr M P Sharma	2018
DSR 9.8/13	Design and development and validation of tractor operated disc harrow and rotary weeder for soybean	Dr D V Singh	2016
IISR 4.12/16	"Nitrogen and sulphur management for sustainable soybean productivity"	Dr. A. Ramesh	2018
CROP PROTECTION			
Mega Project 7	**Surveillance, forecasting and control strategies for insect pest complex in soybean**	**Dr A N Sharma**	
IISR 2.11/16	Identification of defoliator resistant/ non- preferred soybean genotypes through food consumption and utilization indices	Dr A N Sharma	2018
Mega Project 8	**Developing plant protection modules for mitigating adverse effect of plant diseases in soybean**	**Dr M M Ansari**	
DSR 3.10/12	Biology Epidemiology and Management of stem blight disease in soybean	Dr M M Ansari	2017
DSR 3.12/15	Studies on economically important plant parasitic nematodes associated with soybean cultivation	Dr KM Anes	2018

EXTENSION			
Mega Project 9	**Mega theme- Information digitization, technology dissemination, impact analysis and socio-economic research for soybean**	**Dr. B U Dupare**	
DSR 8.13/15	Determinants of farm level soybean yield variability and technical efficiency in Madhya Pradesh	Dr P Sharma	2017
DSR 7.5/15	Decision support system for identification of soybean insects and their management	Dr Savita Kolhe	2018
IISR 7.6/16	Development of forewarning model for insect incidence in soybean based on weather parameters (Dr R M Patel)	Dr R M Patel	2018
IISR 8.14/16	Evaluation of Package of Practices of Improved Soybean Production Technologies and Economic Feasibility of Soybean Growers	Dr B U Dupare	2018

11.1.2. Externally Funded Projects

Sponsoring Agency	Project Title	P.I.	Duration
DAC, Government of India	DUST Project	Dr. M. Kuchlan	Since 2002
ICAR-Extramural network project	Exploiting wild gene pool through pre-breeding for introgression of yellow mosaic disease resistance in soybean	Dr. M. Shivakumar	2015-17
DBT	Marker assisted elimination of lox2 gene from Kunitz trypsin inhibitor free soybean lines.	Dr. Vineet Kumar	2015-2020
FSSAI	Kunitz trypsin inhibitor & Phytic acid in soybean: Assessment of various method of estimation & profiling of commercial varieties promising germplasm & soy based products in India.	Dr Vineet Kumar	2016-2018
DST, New Delhi	Soil Carbon Sequestration through Agricultural Practices and Mycorrhizal Fungi in Soybean-Based Cropping system	Dr. M.P. Sharma	2013-16.
ICAR-AMAAS	Identification of high-trehalose producing soybean rhizobia and their integration with AM for enhanced drought tolerance in Soybean	Dr. M.P. Sharma	2014-16
ICAR-Extramural network project	Alleviation of moisture-deficit stress in groundnut, soybean, chickpea, and pigeon pea by application of endophytic bacteria	Dr. M.P. Sharma	2016-17
ICAR-Extramural network project	RNA interference and virus induced gene silencing approaches to drought & heat tolerance in soybean	Dr. M.B. Ratnaparkhe	2015-17
ICAR-NICRA	Integrated system modeling involving soybean for impact assessment & identification of adaptation strategies at regional level for near and long trm downscaled scenarios	Dr. V.S. Bhatia	2015-17

11.2. Publication

11.2.1. Refereed Journals

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Dupare, B. U., Billore, S. D. and Sharma, P. (2016). Domestic Utilisation of soybean based food preperations in rural area: An action research. **Soybean Research** 14(1): 46-51.

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Kuchlan, Punam and Mrinal kuchlan (2016). Effect of Pyraclostrobin and Thiophenate methyl on seed germination, plant growth and disease control of soybean (Glycine Max(L)Merrill.) **Bhartiya Krishi Anusandhan Patrika** Vol 31 (1): 11-14.

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11.2.2. Popular article

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11.2.3. Book chapter

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Yogranjan, Lalit M. Bal, G.K. Satpute (2017). Plant stress signaling through nanobiotechnology. In Book titled, 'Nanotechnology Applications in Food: Flavor, Stability, Nutrition and Safety' Alexandru Grumezescu, Alexandra Elena Oprea (eds.) Publ. Academic Press, pp. 381 – 391.

1.2.4. Seminar/Symposium/Conference etc.

Agnihotri, Richa., Aketi Ramesh, Anil Prakash and Mahaveer P. Sharma (2016) Glomalin: A potential soil carbon sequestrator evaluated under organic and inorganic farming practices of soybean-based cropping system" In: Proceedings of National conference on fungal biotechnology and 43rd Annual Meeting of Mycological Society of India held at BISR, Jaipur from Nov 16-18, 2016 pp 132

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Kuchlan, P., M.K. Kuchlan, S.M. Husain and M.M.Ansari (2017). Efficient application of Trichoderma viride on soybean seed using thin layer polymer coating. (In) souvenir of XIV National Seed Seminar 'Food Security Through Augmented Seed supply Under Climate Uncertainities' January 28-30'2017 at New Delhi , IARI, India. Pp :218-219.

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Sharma, Mahaveer P (2016). Soil C-sequestration and CO2 mitigation by AM fungi assessed under soybean-based cropping system. A lead talk delivered during National conference on Fungal Biotechnology and 43rd Annual meeting of Mycological society of India held a BISR, Jaipur from November 16th -18th , 2016.

Sharma, Mahaveer P. (2016). Price transmission in pulse to split (dal) value chain in Delhi, India" in Conference on Pulses for Sustainable Agriculture and Human Health organised by International Food Policy Research Institute at NASC Complex, New Delhi from May 31st -June 1st , 2016. Sharma, Mahaveer P. (2016). Adoption of improved practices and impact of weather variations on yield and economics of soybean" in INSEE National Seminar held from 28th to 30th November, 2016, at RVSKVV, Gwalior.

Sharma, Mahaveer P. (2016). Development policies and performance of oilseed in India' on 26th February, 2017 in International Seminar on Oilseed Brassica (ISOB-2017) organised by SIAM, Jaipur and ICAR-DRMR, Bharatpur.

Sharma, Mahaveer P. (2016) Awareness creation of climate resilient practices for sustainable soybean production" in INSEE National Seminar held from 28th to 30th November, 2016, at RVSKVV, Gwalior.

Sharma P, Dupare B U and Billore SD. 2016. Adoption of improved practices and impact of weather variations on yield and economics of soybean. ISEE Seminar, RVSKVV, Gawalior on 28-30 November, 2016. Pp. 350.

Sharma, P, 'Development policies and performance of oilseed in India' on 26th February, 2017 in

International Seminar on Oilseed Brassica (ISOB-2017) organised by SIAM, Jaipur and ICAR-DRMR, Bharatpur.

Sharma, P, Price transmission in pulse to split (dal) value chain in Delhi, India" in Conference on Pulses for Sustainable Agriculture and Human Health organised by International Food Policy Research Institute at NASC Complex, New Delhi from May 31st -June 1st , 2016.

Singh, D.V. (2016). Operation repair and maintenance of farm machinery, HRD program of ICAR, New Delhi for technical personnel of ICAR institutes on "Selection, adjustments, operation and maintenance of agricultural implements for field and horticultural crops,16th -25th August 2016 at CIAE, Bhopal.

Singh, D.V. (2016). Soybean production for KVKs of Madhya Pradesh and Chhattisgarh Organized by Zonal officer ZPTO JNKVV, Jabalpur 2016, organized at ICAR-IISR, Indore.

Singh , D.V. (2016). Brain storming session workshop and two days national seminar 'Emerging technologies for enhancing water productivity' ETEWP-16 organized by IGKV,Raipur, ITRA, Media lab Asia, MOET Govt of India New Delhi,17th -18th Nov 2016 , IGKV,Raipur

Singh, D.V. (2016). Participated in conference on the subject "Innovations in Agricultural Mechanization" Vigyan Bhawan, New Delhi, 7th & 8th July 2016.

Singh, D.V. (2016). Farmers of on machines and specially RaisedBed technology machines organized by Government of Madhya Pradesh in village Pipliya Baksu (sonkatchch ,district Dewas) .This Kisan mela was also attended by Shri S.K.Patnaik ,Secretary ministry of Agriculture and farmer welfare, Agriculture commissioner, Government of India, Director of Agriculture Government of Madhya Pradesh on 11th March 2017.

Singh, D.V. (2016). Agricultural machines in Kisan Mela organized by Govt of Chattisgarh, 26th August 2016 at Department of Agriculture, cooperation and family welfare Government of Chattisgarh, Raipur .

Verma, Ankita, Sandeep Saini, Priyam Mehrotra, Pallavi, Megha Singh, Amrita Gupta, Abhishek Bharti, Mahaveer P. Sharma, Aketi Ramesh, Hillol Chakdar, Pawan K. Sharma, Rup Lal and Sushil K. Sharma (2016). Exploring plant growth promoting and hydrolytic activity of bacteria isolated from Jhum cultivation system of Manipur. In: IPS 6th International Conference on Plant, Pathogens, and People from Feb., 23-27, pp 580.

11.2.5. Institute Publication

- सोयाबीनः सस्य क्रियाए, उत्पादन तकनीकी एवं फसल प्रबंधन (2016). विस्तार बुलेटिन क्रमाकं 12 (संकलन एवं संपादनः बी.यू.दुपारे एवं एस.डी.बिल्लौरे), भा.कृ.अनु.प.–भा.सो.अनु.सं. प्रकाशन.

- Soybean: Package of practices for crop management (2016). Extension Bulletin No. 13 (Compiled & Edited by B.U. Dupare and S.D. Billore), ICAR-IISR Publication.

- Punam Kuchlan and Mrinal K. Kuchlan (2016). Soybean beej ki gunwatta parikshan.(In hindi) Vistaar folder kramank 18 (2016)

- Punam Kuchlan and Mrinal K. Kuchlan (2016). Soybean beej ka bhandaran. In hindi) Vistaar folder kramank 17 (2016)

11.3. Award to individuals

- Agnihotri, Richa (2016). Glomalin: A potential soil carbon sequestrator evaluated under organic and inorganic farming practices of soybean-based cropping system"during National conference on fungal biotechnology and 43rd Annual Meeting of Mycological Society of India held at BISR, Jaipur from Nov 16-18, 2016 pp 132 (Awarded Thirumalachar young scientist award for the best poster paper presentation made by SRF Ms. Richa Agnihotri et al.)

- Dr Vineet Kumar was awarded the Fellowship of Indian Society of Agricultural Biochemists on 7th Dec 2016 in International Conference on Nutraceutical and Functional Foods at Anand Agricultural University, Anand.

11.4. 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
National Research Centre for DNA Fingerprinting, New Delhi
ICAR-Indian Institute of Oilseed Research, Hyderabad
ICAR-Indian Agricultural Research Institute, New Delhi
ICAR-National Academy of Agricultural Research Management, Hyderabad
National Bank for Agriculture and Rural Development
National Fertilizer Limited
Agharkar Research Institute, Pune
Indian Institute of Technology, Indore

ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra
ICAR-Directorate of Groundnut Research, Junagadh, Gujarat
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 Cooperative Development Banks of respective States.
State Seed Corporation
Department of Seed Certification

11.5. Important committees

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

11.5.1. Research Advisory Committee (Up to 17.9.2016)

Chairman	Dr. V. S. Tomar, Vice Chancellor Jawaharlal Nehru Krishi Vishwa Vidyalaya, Krishi Nagar, Adhartal Jabalpur -482 004 (M.P.)
Member	Dr. V. D. Patil, Ex. Assistant Director General (O&P), ICAR Plot No. 5&6, Sanjeevani Hospital, Mahalaxmi Housing Society Near Kachore Lawn, Manish Nagar, Nagpur-440015 (Maharashtra)
Member	Dr. M. A. Shankar, Director of Research University of Agricultural Science, GKVK Campus Bangalore-560065 (Karnataka)
Member	Dr. O. P. Singh, Ex. Professor (Entomology) JNKVV, Sehore President (R&D), M/s. Dhanuka Agritek Ltd. Dhanuka House 861-862. Joshi Road, Karol Bag New Delhi-110005
Member	Dr. Shatrughan Pandey, Principal Scientist (Retd.) D-13A/6, Ist Floor, Platinum Green, Ardee City Colony Sector -52, Gurgaon- 122002 (Haryana)
Member	Dr. V.S. Bhatia, Director, Indian Institute of Soybean Research, Khandwa Road, Indore 452001 (M.P.)

Member	Dr. B. B. Singh, ADG (Oil Seeds & Pulses), ICAR Krishi Bhawan, New Delhi Member Shri G. P. Saxena, Secretary Society for Horti- Agro Environment Development & Research Programming, 1068, Scheme No. 114, Phase-I Vijay Nagar, Indore (M.P.)
Member	Shri J. S. Pangaria, Business Advisor & Facilitator 335, Saket Nagar, Indore- 452018 (M.P.)
Member Secretary	Dr. S.M. Husain, Principal Scientist (Plant Breeding) ICAR- Indian Institute of Soybean Research, Khandwa Road, Indore-452001(M.P.)

11.5.2. Research Advisory Committee (*w. e. f.* 14.12.2016 to 18.12.2019)

Chairman	Dr. S. P. Tiwari Ex-Vice Chancellor, SKRAU, Bikaner and Chairman, Research Advisory Committee 90-A, Shri Yantra Nagar, Near Asharam Bapu Ashram, Indore (M.P.)
Member	Dr. D.M. Hegde Ex-Project Director (DOR, Hyderabad), C-108, SMR Vinay Galaxy, Hoodi Circle, CPTL Road, Mahadevapura, Bangalore-560048 (Karnataka)
Member	Dr. S.K. Rao Director of Research J.N. Krishi Vishwavidyalaya, Adhartal, Jabalpur-482004 (M.P.)
Member	Dr. D.C. Upreti Ex-Principal Scientist (Plant Physiology), IARI H.No.69, Vikaspuri, New Delhi – 110018
Member	Dr. V. Dinesh Kumar Principal Scientist, ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad-500030 (Telangana)
Member	Dr. A.K. Sharma Ex-Director (NBAIM, Mau), H.No.1686, Urban Estate, Sector-9, Karnal-131001 (Haryana)
Member	Dr. V.S. Bhatia, Director ICAR-Indian Institute of Soybean Research, Khandwa Road Indore 452001 (M.P.)
Member Member	Dr. B.B. Singh ADG. (Oil Seeds & Pulses), ICAR, Krishi Bhawan, New Delhi-110001 Dr. Raghuraj Kishore Tiwari Near Santosh Diesels, Ward-5,Padra, Reewa-486001
Member	Dr. Bharat Singh, 219, Sanjana Park, (Near Agrawal Public School),Bicholi Mardana, Indore-452016
Member Secretary	Dr. S.D. Billore, Principal Scientist (Agronomy) ICAR-Indian Institute of Soybean Research, Khandwa Road, Indore-452001

11.5.3. Institute Management Committee (2016-17)

Chairman	Dr. V.S.Bhatia, Director ICAR- Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)
Member	Joint Director (Agriculture) Government of Madhya Pradesh, Indore
Member	Director, Soil Conservation & Water Management Department of Agriculture, Government of Rajasthan, Jaipur
Member	Director of Research, JNKVV, Jabalpur
Member	Dr. Akshay Talukdar, Principal Scientist (Plant Breeding) Division of Genetics, ICAR- IA.R.I. New Delhi
Member	Dr. P.S. Shukla, Professor (Plant Breeding). Dept. Of Plant Breeding & Genetics, G.B.Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
Member	Dr. Raghuraj Kishore Tiwari, Near Santosh Diesels. Word 5, Padra, Rewa-486001 (M.P.)
Member	Dr. Bharat Singh, Senior Scientist, 219. Sanjana Park (Near Agrawal Public School), Bicholi Mardana, Indore-452016
Member	Dr. A. N. Sharma, Principal Scientist ICAR-IISR, Khandwa Road, Indore-452 001 (M.P.)
Member	Dr. Sanjay Gupta, Principal Scientist ICAR-IISR, Khandwa Road, Indore-452 001 (M.P.)
Member	Dr. Anita Rani, Principal Scientist ICAR-IISR, Khandwa Road, Indore-452 001 (M.P.)
Member	Dr. M.P. Sharma, Principal Scientist ICAR-IISR, Khandwa Road, Indore-452 001 (M.P.)
Member	Finance and Account Officer Indian Institute of Soil Science (IISS), Bhopal
Member Secretary	Administrative Officer ICAR- Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)

11.5.4. Institute Joint Staff Council

Chairman	Dr. V.S. Bhatia, Director, Official Side
Member	Dr. A. N. Sharma, Principal Scientist
Member	Dr. M. P. Sharma, Principal Scientist
Member	Dr. S. D. Billore, Principal Scientist
Member	Dr. Savita Kolhe, Senior Scientist
Member	Finance & Accounts Officer
Member Secretary	Administrative Officer
	Staff Side
Secretary	Shri S.K. Verma, Technical Officer
Member	Shri O. P. Vishwakarma, Tractor Driver (L/V) (T-5)
Member	Vacant

11.5.5. Other Committees of the Institute (2016-17)

1.	**Official Language Implementation Committee** Director, ICAR-IISR (Chairman) Dr. A. N. Sharma, Dr. Savita Kolhe Shri S. S. Vasuniaya Shri S. K. Pandey Shri S. K. Verma Shri Vikas Kumar Keshari Administrative Officer Finance & Accounts Officer	2.	**Institute Technical Management Unit (ITMU) Committee** Dr. M.P. Sharma (Chairman) Dr. S.M. Hussain Dr. A. N. Sharma Finance & Accounts Officer Administrative Officer
3.	**Priority Setting Monitoring and Evaluation (PME) Cell** Dr. S.D. Billore (In charge) Dr. B. U. Dupare Dr. Purushottam Sharma	4.	**Purchase Advisory Committee** Dr. A.N. Sharma (Chairman) Dr. S. D. Billore Dr. A. Ramesh Dr. Giriraj Kumawat Indenter Finance & Accounts Officer Administrative Officer

5.	**Human Resource Development Committee** Dr. Sanjay Gupta, (Chairman) Dr. Rajkumar Ramteke Dr. Giriraj Kumawat Dr. Mamta Arya Shri S.K. Pandey Administrative Officer	6.	**Consultancy Processing Cell (CPC)** Dr. A. N. Sharma (Chairman) Dr. Purushottam Sharma Finance & Accounts Officer Administrative Officer
7.	**Student Affairs Committee & Higher Study Committee** Dr. Vineet Kumar (Chairman) Dr. A. Ramesh Dr. M. Shivakuamr	8.	**Higher Education Committee** Dr. S. M. Hussain (Chairman) Dr. Anita Rani Dr. Sanjay Gupta Administrative Officer
9.	**Foreign Deputation and Higher Study Committee** Dr. S.M. Hussain (Chairman) Dr. Savita Kolhe Dr. S.V. Ramesh Dr. K.M. Anes Administrative Officer	10.	**Printing and Publication Committee (General)** Dr. A.N. Sharma (Chairman) Dr. S.D. Billore Dr. M.P. Sharma **Publication Committee** (Annual Report/Newsletter) Dr. Vineet Kumar Dr. Milind B. Ratnaparkhe Dr. Purushottam Sharma Dr. M.Shivakumar Dr. Surendra Kumar
11.	**Library Advisory Committee** Dr. Anita Rani (Chairman) Dr. D.V. Singh Dr. Purushottam Sharma Dr. Neha Pandey Finance & Accounts Officer Administrative Officer Dr. Surendra Kumar	12.	**Hindi Cell** Dr. A. N. Sharma (In charge) Shri S. K. Verma Shri Vikash Keshari Shri Avinash Kalenke

13.	**Works Committee** Dr. M. P. Sharma (Chairman) Dr. M. Shivakumar Dr. K.M.Anes Estate Officer Administrative Officer Finance & Account Officer	14.	**Estate Committee** Dr. Purushottam Sharma (Chairman) Dr. M. Shivakumar Shri R. C. Shakya Administrative officer Estate Officer
15.	**Public Information Officer** Dr. B.U. Dupare Dr. A. N. Sharma Administrative Officer	16.	**Public Relation Officer** Shri Rakesh Dubey, Administrative Officer Shri Ajay Kumar Assistant Administrative Officer
17.	**ARIS Committee** Dr. A. N. Sharma (Chairman) Dr. Savita Kolhe Shri Ram Manohar Patel	18.	**House Allotment Committee** Dr. M.M.Ansari (Chairman) Dr. M.P. Sharma Dr. Mamta Arya Secretary, IJSC Administrative Officer
19.	**Centralized Public Grievance Cell and Monitoring Systems (CPGCMS)** Dr. S. M. Hussain	20.	**Women Harassment Complaint Committee** Dr. Savita Kolhe (Chairperson) Dr. Poonam Kuchlan Dr. S.V.Ramesh Mrs. Priyanka Sawant Third party representative (As when Required) Administrative Officer
21.	**Nodal Scientist Agro biodiversity Consortium Project** Dr. G.K. Satpute	22.	**Nodal Officer, RFD Unit** Dr. Anita Rani (w.e.f. 31.01.2014)
23.	**Nodal Scientist IASRI-NAIP** **Statistics Project** Shri Ram Manohar Patel	24.	**Library In Charge** Dr. Surendra Kumar

25.	**Guest House /Management Committee** Dr. S.V. Ramesh Shri Om Prakash Vishwakarma Shri Prahlad Singh Administrative officer	**26.**	**Publicity Committee** Dr. B.U.Dupare (Chairman) Dr. Purushottam Sharmae Dr. R.N.Singh Shri S. K. Verma Shri D. N. Baraskar
27.	**Technical Specification Committee (above Rs. 50,000.00)** Dr. Sanjay Gupta (Chairman) Dr. M.P.Sharma Dr. Milind B. Ratnaparkhe Dr. Punam Kuchlan	**28.**	**Physical Verification Committee** Dr. Vineet Kumar (Chairman) Dr. P. Sharma
29.	**Farm Produce Disposal and Price Fixation Committee** Dr. S. D. Billore (Chairman) Dr. M.K.Kuchlan Dr. V. P. S. Bundela Store Officer Finance & Accounts Officer Administrative Officer	**30.**	**Condemnation and Auction Committee** Dr. Vineet Kumar (Chairman) Dr. Giriraj Kumawat Store officer Shri R.N.Srivastava Finance & Accounts Officer Administrative Officer
31.	**Security Cell** Dr. Giriraj Kumawat Shri O. P. Vishwakarma	**32.**	**Estate Officer** Shri Giriraj Kumawat **Record Officer** Shri Ajay Kumar **Vehicle In charge** Dr. Nikhlesh Pandya **Store In charge** Shri S.S.Vasuniaya **Tofu Plant In charge** Ms. Neha Pandy Shri S.N.Verma

11.6 Participation in Seminar, Symposium, Conference, Workshops, Training

Participant	Event	Venue and date
Shri RN Singh, CTO	Competence Enhancement Programme for Technical Officers of ICAR (T5&Above).	ICAR-NAARM, Hyderabad. March 1st -10th 2016
SK Pandey, ACTO	Competence Enhancement Programme for Technical Officers of ICAR (T5&Above).	ICAR-NAARM, Hyderabad. March 1st -10th 2016
Dr. Yogendra Mohan, ACTO	Competence Enhancement Programme for Technical Officers of ICAR (T5 & Above).	ICAR-NAARM, Hyderabad. March 1st -10th 2016
Dr. DV Singh	Innovations in Agricultural Mechanization" o be addressed by Honorable Minister Shri Radha Mohan Singh, Govt of India.	Vigyan Bhawan, New Delhi. 7th & 8th July 2016.
Shri. OP Vishwakarma, Tech. Assitt.	Selection, Adjustment, Operation & Maintanance of Agricultural Implements of Field and Horticultural Crops.	ICAR-CIAE, Bhopal August 16th -25th 2016
Shri RC Shakya, Sr. Tech. Assit.	Selection, Adjustment, Operation & Maintanance of Agricultural Implements of Field and Horticultural Crops.	ICAR-CIAE, Bhopal August 16th -25th 2016
Shri SK Verma, Tech. Off.	Competence Enhancement Programme for Technical Officers of ICAR (T5 & Above).	ICAR-NAARM, Hyderabad . August 17th -23th 2016
Shri RM Patel, Scientist.	Designing and Analysis of Cropping System Experiments.	ICAR-IASRI, N. Delhi September 7th -27th 2016
Dr. Savita Kolhe, Principal Scientist	Sensitization Programme on Prevention of Sexual Harassment of Women at Workplace	NIPC & CD, Indore September 8th – 9th 2016
Dr. Punam Kuchlan, Scientist (Sr. Scale)	Sensitization Programme on Prevention of Sexual Harassment of Women at Workplace	NIPC & CD, Indore September 8th – 9th 2016
Dr. VPS Bundela ACTO	Refresher Course on Farm Management.	ICAR-IIFSR, ICAR-IIFSR, Modipuram, Meerut September, 19th -24th 2016

Participant	Event	Venue and date
Shri Ram Mnohar Patel, Scientist	Geospatial Technologies and Applications"	NRSC, Balanagar, Hyderabad. 07th Nov. 2016 – 27th Jan 2017
Dr. Lokesh Kumar Meena, Scientist	Professional Attachment Training	ICAR- NCIPM, New Delhi. 7-11-2016 to 6-2-2017
Shri HS Maheswari, Scientist	Professional Attachment Training	ICAR- NBAIM, Mau. 26-11-2016 to 25-2-2017
Shri SK Pandey, ACTO	Principles of Seed Production, Processing, Storage & Quality Assurance``-	ICAR- IISS, Mau. November14th -23rd 2016
Dr. Savita Kolhe, Principal Scientist	National Workshop on Mobile Apps Development in Indian Languages (MOBILE-2016)	C-DAC, Hyderabad. November 15th -19th, 2016
Dr. B.U.Dupare, Principal Scientist	4th International Agronomy Congress	ICAR-Indian Agricultural Research Institute, New Delhi. 22th -26th November 2016
Dr. B.U.Dupare, Principal Scientist	Krishi Kumbh	ICAR-IIFSR, Modipuram Muzaffarnagar, U.P. th -30th November 2016
Dr. B.U.Dupare, Principal Scientist	World Soil Health Day	Krishi Vigyan Kendra, Kasturbagram, Indore. 5th December 2016
Dr. Shivani Nagar, Scientist	Professional Attachment Training	ICAR- NRCPB, New Delhi. 08-12-2016 to 08-03-2017
Dr. B.U.Dupare, Principal Scientist	Krishi Vigyan Mela	Office of DDA, Dist -Indore, Laxmibai Mandi Ground, Indore. 10th 12th December 2016
Dr. R.K.Verma, Scientist	Professional Attachment Training	ICAR-CRIDA Hyderabad, 14-12-2016 to 13-3-2017
Dr. VS Bhatia, Director	Management Effectiveness	IIM, Ahmadabad, January 9th -14th 2017

Participant	Event	Venue and date
Dr. Anes K.M. Scientistfor	National symposium on Climate smart Agriculture Nematode Managementt	ICAR- CCARI, Ela, Old Goa, Goa. January 11th -13th, 2017
Dr. Sanjay Gupta Principal Scientist	Brain Storming Workshop on Soybean Research and Cultivation in India vis a vis Brazil.	JNKVV, Jabalpur on 21st January 2017
Shri Francis Yunus, Sr. Tech. Assitt.	Automobile Maintenance, Road Safty & Behavioral Skills	ICAR-CIAE Bhopal February 20th -24th 2017
Dr. B.U.Dupare Principal Scientist	Wheat Day	ICAR- IARI Regional Station, Indore. 04.03.2017
Dr. GK Satpute, Sr. Scientist.	Physiological and Molecular aspects of Improving Crop Adaptation to Drought	UAS Bengaluru, Feb. 27th to March 11th 2017

11.7. Infrastructure development

Name of the facility	Cost (In Rs)
Green House	9,25000.00
Glass House	24,16500.00
Rainout Shelter	13,17087.00
Green House Utility House	3,58781.00
Poly House	8,37,527.00

A. Polyhouse

B. Glass house

C. Rainout shelter

11.8. Distinguished Visitors

The following are the eminent persons visited this Institute during the year 2016-17

Name and Affiliation	Date of Visit
Dr. V.S.Tomar, Vice Chancellor, JNKVV, Jabalpur	07.05.2016
Dr. B.B.Singh, Assitt. Director General (O&P), Indian Council of Agricultural Research, New Delhi	07.05.2016
Dr. M.Shankar.Retd. Director of Research, University of Agriculture Scieces, Bangalore	07.05.2016
Dr. S.Pandey, Retd. Principal Scienctist Indian Council of Agricultural Research, New Delhi	07.05.2016
Dr. O.P. Singh, President, R & D. Dhanuka Agritech Ltd. New Delhi	07.05.2016
Smt. Dr. Meenakshi Joshi, Head, Lanagvage Study Sentre, Maharani Lakshnibai Govt. Girls P.G. Collage, Indore	03.09.2016
Shri Jay Nath Yadav, Hindi Officer, IIM, Indire	05.09.2016
Dr. B.B. Singh, Assitt. Director General (O&P), Indian Council of Agricultural Research, New Delhi	19.12.2016
Dr. J.S.Chouhan, Assitt. Director General (Seeds), Indian Council of Agricultural Research, New Delhi	19.12.2016

11. 9. Personnel

(As on 31 March 2017)

A.	**Research Management**		
1.	Dr. V.S.Bhatia	Director	
B.	**Scientific**		
2.	Dr. S. M. Husain	Principal Scientist	Plant Breeding, (Up to 30th June 2016)
3.	Dr. M. M. Ansari	Principal Scientist	Plant Pathology
4.	Dr. A. N. Sharma	Principal Scientist	Entomology
5.	Dr. (Smt.) Anita Rani	Principal Scientist,	Plant Breeding
6.	Dr. Sanjay Gupta	Principal Scientist	Plant Breeding
7.	Dr. S. D. Billore	Principal Scientist	Agronomy
8.	Dr. Mahaveer P. Sharma	Principal Scientist	Microbiology
9.	Dr. Vineet Kumar	Principal Scientist	Biochemistry
10.	Dr. B. U. Dupare	Principal Scientist	Agricultural Extension
11.	Dr. A. Ramesh	Principal Scientist	Soil Science
12.	Dr. Savita Kolhe	Principal Scientist	Computer Application
13.	Dr. Maharaj Singh	Principal Scientist	Plant Physiology (w.e.f. 27.03.2017)
14.	Er. (Dr.) D. V. Singh	Senior Scientist	Farm Machinery and Power
15.	Dr. Milind B. Ratnaparkhe	Senior Scientist	Biotechnology
16.	Dr. Gyanesh Kumar Satpute	Senior Scientist	Genetics
17.	Dr. Purushottam Sharma	Senior Scientist	Agricultural Economics
18.	Dr. R. K. Ramtake	Scientist (Senior Scale)	Genetics
19.	Dr. Poonam Kuchlan	Scientist (Senior Scale)	Seed Technology
20.	Dr. Giriraj Kumawat	Scientist (Senior Scale)	Biotechnology
21.	Dr. K. M. Anes	Scientist (Senior Scale)	Nematology
22.	Dr. S. V. Ramesh	Scientist	Biotechnology (Up to 1st Oct.2016)
23.	Dr. Mrinal Kumar Kuchlan	Scientist	Seed Technology
24.	Shri Ram Manohar Patel	Scientist	Agril. Statistics
25.	Dr. Mamta Arya	Scientist	Genetics

26.	Dr. M. Shivakumar	Scientist	Genetics and Plant Breeding
27.	Ms. Neha Pandey	Scientist	Food Technology
28.	Dr. Lokesh Kumar Meena	Scientist	Entomology
29.	Shri Hemant Singh Maheshewari	Scientist	Microbiology
30.	Dr. Rakesh Kumar Verma	Scientist	Agronomy
31.	Dr. Shivani Nagar	Scientist	Plant Physiology
C.	**Technical**		
32.	Dr. Surendra Kumar	Chief Documentation Officer	Library & Documentation
33.	Shri R. N. Singh	Chief Technical Officer	Field & Farm
34.	Dr. Nikhlesh Pandya	Chief Technical Officer	Field & Farm
35.	Dr. V. P. S. Bundela	Chief Technical Officer (Farm Manager)	Field & Farm
36.	Dr. Yogendra Mohan	Chief Technical Officer	Field & Farm
37.	Shri S. K. Pandey	Assitt. Chief Technical Officer	Field & Farm
38.	Shri S. S. Vasunia	Assitt. Chief Technical Officer	Field & Farm
39.	Dr. Sushil Kumar Sharma	Assitt. Chief Technical Officer	Field & Farm
40.	Shri R. N. Srivastava	Assitt. Chief Technical Officer	Field & Farm
41.	Dr. D. N. Baraskar	Senior Technical Officer	Artist & Photography
42.	Shri S. K. Verma	Senior Technical Officer	Field & Farm
43.	Shri O. P. Vishwakarma	Technical Officer (L/V)	Tractor Driver
44.	Shri I. R. Khan	Senior Technical Assistant	Field & Farm
45.	Shri Gorelal Chouhan	Senior Technical Assistant	Field & Farm
46.	Shri R. C. Shakya	Senior Technical Assistant	Field & Farm
47.	Shri Francis Yunis	Senior Technical Assistant (L/V)	Staff Car Driver
48.	Shri Devendra Singh Yadav	Technical Assistant	Field & Farm
49.	Shri Vikas Kumar Keshari	Hindi Translator	Official Language Cell

50.	Shri Bilbar Singh	Senior Technician (L/V)	Staff Car Driver
51.	Shri Shambhu Nath Verma	Senior Technician	Field & Farm
D.	**Administration and Accounts**		
52.	Shri A. K. Maheshwari	Finance and Account Officer	Audit & Account
53.	Shri Rakesh Dubey	Administrative Officer	Administration
54.	Shri Ajay Kumar	Assistant Administrative Officer	Administration
55.	Shri S.P.Singh	PS to Director	Administration
56.	Ku. Priyanka Sawan	Assistant	Administration
57.	Shri. Ravishankar Kumar	Assistant	Administration
58.	Shri Avinash Kalanke	Senior Clerk	Administration
59.	Shri Anil Kumar Carrasco	Senior Clerk	Administration
60.	Shri R. N. Kadam	Junior Clerk	Administration (Up to 25th May 2016)
61.	Shri Sanjeev Kumar	Duplicating Operator	Administration
E.	**Skilled Supporting Staff**		
62.	Shri Gulab Singh	SSG III	
63.	Shri Dhan Singh	SSG III	
64.	Shri Roop Singh	SSG II	
65.	Shri Nirbhay Singh	SSG II	
66.	Shri Bhav Singh	SSG II	
67.	Shri Janglia	SSG II	
68.	Shri Surla	SSG I	
69.	Shri Sur Singh	SSG I	
70.	Smt. Prakaswati Sura	SSG I	
71.	Shri Balveer Singh	SSG I	
72.	Shri Prahlad Singh	SSG I	

11.10. Appointments, Promotions, Transfer, etc.

11.10.1. Appointments

Name	Post	Date of joining
Shri Hemant Singh Mahesewari	Scientist (Microbiology)	11.04.2016
Dr. Lokesh Kumar Meena	Scientist (Entomology)	11.04.2016
Dr. Shivani Nagar	Scientist (Physiology)	15.10.2016
Dr. Rakesh Kumar Verma	Scientist (Agronomy)	15.10.2016
Dr. Maharaj Singh	Principal Scientist	27.03.2017

11.10.2. Promotions

Name	Promoted to the post of	w. e. f.
Dr. A. Ramesh	Principal Scientist (Soil Science)	01.01.2014
Dr. Savita Kolhe	Principal Scientist (Computer Application)	22.12.2014
Dr.Milind B.Ratnaparkhe	Senior Scientist (PB-4)	06.06.2016
Dr. Purushottam Sharma	Senior Scientist (PB-4)	25.07.2015
Dr. Giriraj Kumawat	Scientist (Senior Scale)	01.09.2014
Dr. Anes, K.M.	Scientist (Senior Scale)	03.05.2015
Dr. V.P.S.Bundela	Chief Technical Officer / Farm Manager	22.01.2015
Dr. Yogendra Mohan	Chief Technical Officer (Field& Farm)	17.01.2016
Shri Shyam Kishore Verma	Senior Technical Officer (Field & Farm)	17.09.2015
Shri Francis Yunis	Senior Technical Assistant (L/V)	29.06.2016

11.10.3. Transfers

Name	From	To	w. e. f.
Dr. S.V.Ramesh	ICAR-IISR, Indore	ICAR-CPCRI, Kasargod	01.10.2016
Dr. Anes, K.M.	ICAR-IISR, Indore	ICAR-CPCRI, Kasargod	31.03.2017

11.10.4. Retirement

Dr. S.M.Hussain, Principal Scientist, w.e.f.30th June 2016

11.10.5. Higher education

Name	Name of Degree	University/ Institution
Shri D.N.Bharaskar	Ph.D. (Photography) "Pictorial Photography in India: A Critical Study"	Rastra Sant Tukdoji Maharaj Nagpur University, Nagpur (MS)

11.10.6. Obituary

Shri R.N. Kadam, Junior Clerk, 25.05.2016

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

ICAR-Indian Institute of Soybean Research

खण्डवा रोड़, इन्दौर 452001 (म.प्र.) ◆ Khandwa Road, Indore-452001 (M.P.)

Ph.: +91 731 2476188, F**ax:** +91 731 2470520,
E-mail: dsrdirector@gmail.com / dsraddmin@gmail.com, **Website:** iisrindore.icar.gov.in