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वार्षिक प्रतिवेदन
ANNUAL REPORT
2015-16

भा.कृ.अ.प.–भारतीय सोयाबीन अनुसंधान संस्थान
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PREFACE

India has 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. However, the country is meeting its edible oil demand by importing more than 50% of its requirement. The per capita consumption of the vegetable oil is increasing very rapidly due to increase in population and improved economic status of the population. In this scenario, soybean has played and will continue to play pivotal role in meeting the edible oil requirement of the country. Currently, soybean contributes to 47% of the total oilseeds and about 26% of the total edible oil produced in the country. Soybean seed contains 40% protein and 20% oil and it is the cheapest source of good quality protein. It also contains many minerals and useful nutraceuticals like isoflavones which have immense health benefits. Therefore, the crop has a potential to provide nutritional security and eradicate protein malnutrition rampant among Indian masses.

Despite extraordinary 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. The impact of climatic variability in terms of delayed onset of monsoon, erratic rainfall, excessive rainfall, early withdrawal of monsoon, drought and high temperature led to considerable reduction in soybean productivity during the last three years. Last Kharif season was also characterized by drought at vegetative phase, high intense rainfall in a short span of 10-15 days at the flowering stage followed by long dry spell during seed filling stage. The temperatures were 4-5°C above normal and this led to the incidence of biotic stresses particularly outbreak of whitefly that caused yellow mosaic disease which was not a major threat to soybean in central India. This has taken heavy toll on soybean production and as per DAC III Advance Estimates for 2015-16 the production of soybean is at 8.91million tonnes as against the target of 12.6 million tonnes.

Scientists at ICAR-IISR are making all out efforts to overcome these problems and continue to strive for increasing productivity in the face of considerable climatic variability. In order to tackle the spread of YMV and for the better disease management, DAC sponsored 'Workshop on selection of resistant varieties of soybean against yellow mosaic and other biotic & abiotic stresses' was organized on 15th February 2016 at this Institute. The efforts are also on to enhance input use efficiency, minimize risks and improve the quality of end use commodity through conventional techniques as well as new science and tools. These researchable issues are being taken up on priority and have been the priority areas of IISR. Upgradation of this Directorate in to a full-fledged Institute by the governing body of the ICAR strongly emphasizes the significance of soybean research in the country.

I am glad to present the Annual Report of ICAR-Indian Institute of Soybean Research (ICAR-IISR), Indore for the year 2015-16. A glance at this report will give the panoramic scenario of research and development activities undertaken during the period under report.

I take this opportunity to state my deep sense of gratitude to Dr. S. Ayyappan, Ex Secretary, DARE, Govt. of India and Director General, ICAR and 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, Assistant Director General, (O&P) for his support and guidance.

All the scientific, technical, administrative, account and service staff of IISR 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

(V.S. Bhatia)
Director

C O N T E N T S

Executive Summary

- Under augmentation and management of soybean genetic resources (Agro-biodiversity project) 900 accession received from NBPGR were evaluated and characterized for eleven quantitative traits
- Under Consortium Research Platform on Agrobiodoversity, 570 germplasm accessions were evaluated and characterized
- A core set of 710 soybean germplasm accessions has been developed which constituted about 20.62% of total collections *i.e.* 3443 accessions
- One hundred twenty six accessions of soybean germplasm were evaluated for phenotypic variability, and resistance against biotic factors across six locations namely Pantnagar, Jabalpur, Parbhani, Pune, Imphal and Indore
- A Web-based Germplasm Data Management System has been developed to facilitate easy management of huge germplasm data
- In order to exploit the wild gene pool and to enhance the genetic variability in the cultivated soybean, wild soybean *Glycine soja* was crossed with JS 9560 and NRC 86
- Nested association mapping (NAM) population in soybean is being developed by hybridizing 20 genotypes with a common parent (popular variety JS 335) to achieve traits such as drought tolerance, YMV résistance and water logging tolerance
- Eight parent based multiparent advanced generation intercross (MAGIC) population is created by employing 2-way, 4-way and 8-way intercross hybridization.
- An entry NRC 117 in AICRPS breeding trials performed well in IVT in Central, Southern and North-Eastern Zones showing 9.7, 4.2 and 4.0 % increase in yield over the best check respectively
- Validation of yield attributing QTLs in soybean, identified four QTLs for 100 seed weight, one QTL for number of pods and one QTL for seed yield per plant
- Eleven drought tolerant soybean lines have been identified based on less canopy air temperature differential (δ^0C)
- Ninety six varieties / genotypes were genotyped for *E1* locus (conferring early maturity) using CAPS marker
- Forty popular varieties have been evaluated for their ability to fix atmospheric nitrogen and yield and it was found that the genotypes that showed high leghemoglobin (µg/g fw) were also found to show high ARA (nanomoles C_2H_4/mg/nodules/hr)
- Transcriptome sequencing of rust resistant line EC 241780 and susceptible cultivar JS 335 and their comparative analysis identified genic SNPs for use in genetic mapping and for identification of molecular markers linked to rust resistance genes
- PCR based assay has been devised to detect major begomoviruses (Mungbean yellow mosaic virus and Mungbean yellow mosaic India virus) infecting soybean in India
- Hairpin RNA mediated suppression of MYMIV derived replication initiator protein gene was proven in transient assays
- Breeding for food grade characters and high oil content identified eight soybean genotypes with optimal combination of protein ($\geqslant$35%) and oil content (>20%)
- Polymer coating of seeds (JS 95-60, JS 93-05) with micronutrients such as molybdenum (0.5g/Kg and 1.0g/kg), boron (100mg/kg and 200mg/kg), salicylic Acid (50, 75 and 100 ppm) improved seed viability, germination, field emergence,

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- Rotational tillage for soybean based cropping systems have been optimized to maximize the yields
- Co-inoculation of *B. aryabhattai*

MDSR14 (JF792521) and AM fungi significantly improved rhizosphere properties, increased dry matter accumulation, seed yield and phosphorus use efficiencies in intercrop soybean and maize

- Potting mix and host combinations have been optimized for mass multiplication of predominant niche AM fungi utilizing soybean processing mill wastes
- AMF inoculation in the soybean-maize intercropping system under organic farming system enhanced C-stocks, microbial biomass carbon over the uninoculated plants thus AMF effectively functions as C-sequestrator
- A tractor drawn ridge fertilizer cum seed planter hitched to pyramid assembly system on tractor was designed, manufactured and farm validated
- Geoinformatic analysis of major *kharif* crops (since 1982) revealed that soybean has not only replaced less profitable crops like sorghum, cotton, groundnut, *bajra* but also occupied *kharif* fallow area
- Soybean production technology adoption index indicated that level of technology adoption ranged from 30.4 to 66.1 per cent and factors affecting the level of technology adoption were identified
- Soybean + *Anethum graveolens* (Suva) (12:2 rows) combinations have been identified for management of soybean defoliators
- Seed treatment with carboxin+ thiram @ 0.3% and spraying of thiophanate methyle or benomyl @ 0.2% at 25 and 45 DAS is recommended to control stem blight disease caused by *Colletotrichum truncatum.*
- *Heterodera cajani*, a pigeon pea cyst nematode population was found to be associated with soybean cultivation in India
- The optimized product of mango soy *shrikhand* was developed which had acceptable sensory characteristics without use of animal milk
- Seven soybean cultivars [JS 20-29, JS 20-34, MAUS 162, MACS 1188, Pratap Soya 45 (RKS 45), Pratap Soya 2 (RKS 18) and RAUS 5 (Pratap Soya 1)] representing different growing zones have been protected under PPV&FR Act-2001
- Scientists of this institute have authored 34 research articles in the refereed journals of international and national repute
- 46th Annual Group Meet of All India Coordinated Research Project on Soybean (AICRPS) was organized by the institute and University of Agricultural Sciences, Dharwad from April 5-7, 2016, which was attended by soybean scientists from various states of the country
- Exploiting wild gene pool through pre-breeding for introgression of yellow mosaic disease resistance in soybean, RNA interference (RNAi) and Virus Induced Gene Silencing (VIGS) approaches to Enhance Drought and Heat Stress Tolerance in Soybean and Alleviation of moisture-deficit stress in soybean by application of endophytic bacteria are the new ICAR sponsored Extramural research projects in the institute
- The institute has successfully organized Agricultural Fair-cum-Exhibition sponsored by Department of Agriculture and Cooperation, Ministry of Agriculture, on 25th Aug 2015. Nearly 1000 progressive farmers and farm women from Madhya Pradesh, Maharashtra, Rajasthan and Gujarat participated in this one day event
- ICAR sponsored one day workshop was held at the institute on 4th Nov, 2015 for preparing road map for agriculture development in Agro-Climatic Zone IX-Western Plateau and Hills
- ICAR-IISR organized 'Workshop on selection of resistant varieties of soybean

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 DSR

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 successfully. A number of genetic sources have been identified for various traits like photoperiod insensitivity, drought tolerance, diseases such as rust and YMV and insect resistance (Rust: EC 241778, YMV: PLSO 84 etc Rhizoctonia root rot: AGS 48, Girdle beetle: TGX 863-26E etc, Defoliators: EC 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, JS 97-52 and NRC 86) 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. Thus 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 sustain ability 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

- To serve as National Repository of soybean germplasm and its utilization in basic, strategic and applied research.
- To conduct basic, strategic and applied research on environmentally eco-friendly technologies and value addition
- To coordinate multilocation interdisciplinary soybean research through AICRP for soybean
- To facilitate transfer of research emanated technologies and to conduct impact analysis through socio-economic research
- To produce breeder seed of improved varieties of soybean

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 2999 books, bound journals 2235 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 IISR as on 31 March 2016 is 93 comprising 35 scientific, 29 technical, 13 administrative and 16 supporting positions. Out of which a total of 70 persons were in position as on 31 March 2016 (Details given in Chapter 15)

The budget allocation and expenditure of the IISR for 2015-16 is shown below (Table 1).

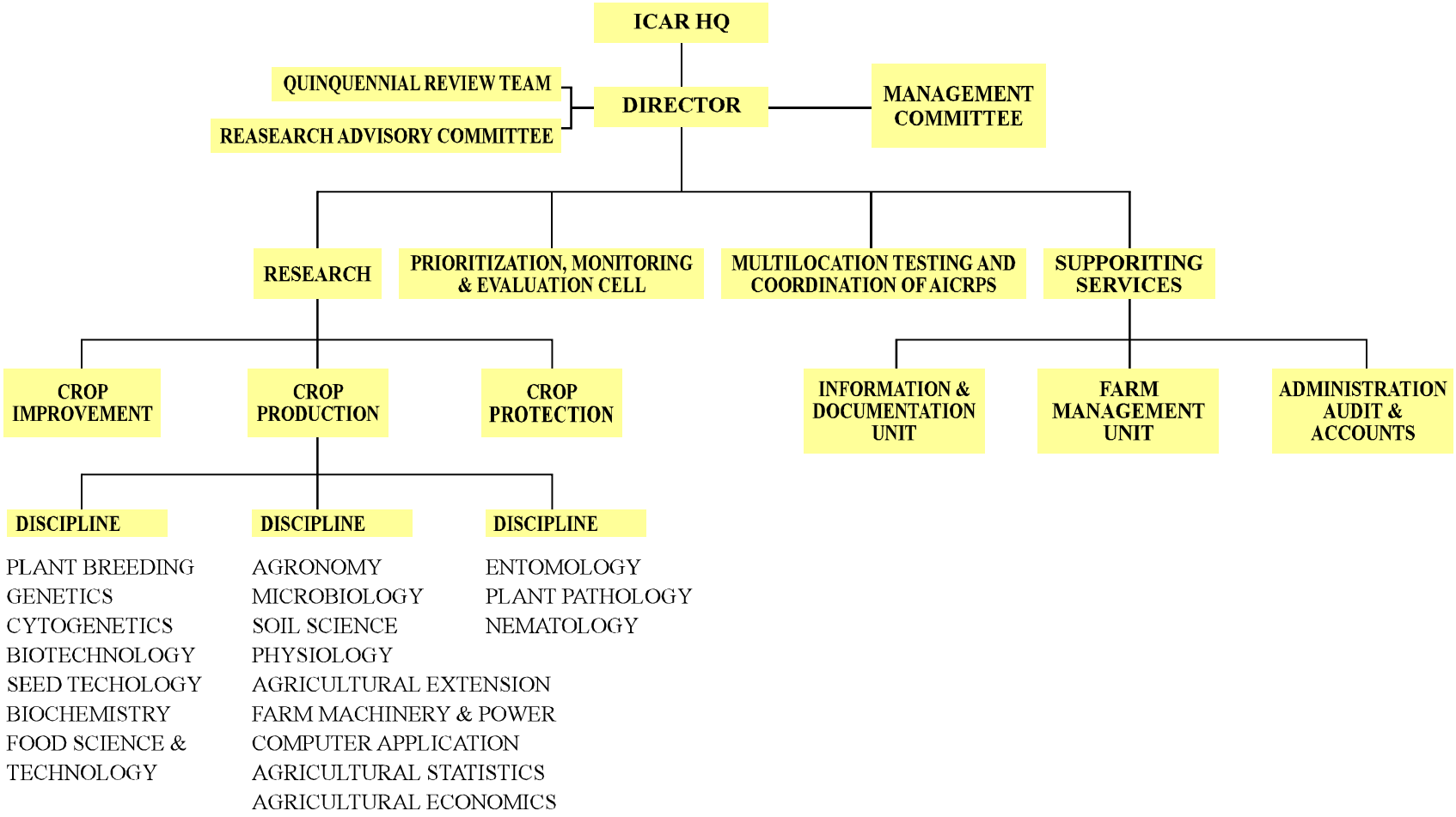


Fig. 1 : Organogram of IISR

Table 1 : Budget and expenditure of ICAR-IISR for the year 2015-16

(Rs. in lakhs)

	Plan		Non Plan	
Head	**R. E.**	**Actual Exp.**	**R. E.**	**Actual Exp.**
Pay & Allowances	-	-	650.51	650.51
Wages	-	-	21.09	21.08
T.A.	4.75	4.75	7.00	6.98
O.T.A.	-	--	-	-
Other Charges Recurring	149.75	149.75	101.71	101.71
(a) Information Technology	11.34	11.34	-	-
(b) Equipments	17.54	17.54	3.00	2.47
(c) Works	62.00	62.00	13.20	13.20
(d) Library	8.09	8.29	-	-
(e) Livestock	-	-	-	-
(f) Others Items			-	-
(g) HRD	2.50	2.50	-	-
(h) TSP	17.25	17.25	-	-
(i) Furniture & Fixtures	0.83	0.83	2.00	1.13
(J) Pension & Retirement Benefits			43.80	43.80
(k) Loans & Advances			1.35	1.35
Total	**274.25**	**274.25**	**848.00**	**842.17**

2. RESEARCH ACHIEVEMENTS

2.1 CROP IMPROVEMENT

2.1.1. Augmentation, Management and Documentation of Soybean Genetic Resources

2.1.1.1. Maintenance, evaluation and characterization of genetic resources

Soybean germplasm comprising 4591 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. Under Consortium Research Platform on Agrobiodoversity, 570 germplasm accessions were evaluated and characterized as per minimal descriptors of soybean including twenty one qualitative traits.

Substantial variability was present in the quantitative traits. Days to 50% flowering ranged from 23-84 (mean=47.7), days to 80% maturity from 74-120 (mean=105.5), number of pods per plant 1-155 (mean=14.4), number of seeds per pod 1-3 (mean=2.1), 100 seed weight 0.3-13.2 g (mean=3.7 g) and seed yield per plant 0.1-7.8 (mean=0.4 g). Coefficient of variation was recorded very high values for seed yield (124.5%) followed by number of pods per plant (83.0%), 100 seed weight (77.0%), and plant height (29.6%) with the least value of (7.5%) for days to 80% maturity. Frequency distribution data explained equally frequent accessions for medium (96-105d) and late (>105d) maturity duration than early types (<95d). Dwarf types (<40 cm) were more prominent than medium (40-60 cm) or tall (>60 cm). Accessions with less than 65 pods per plant, small seed size (<10 g) and seed yield less than 14 g were more common (Table 2)

Table 2 : Frequency of accessions in phenotypic classes of quantitative traits (percentage of accessions are mentioned in parenthesis)

S.No.	Quantitative traits	Phenotypic classes		
1	Days to 80% maturity	<95 days (9.0%)	96-105 days (45.3%)	>105 days (45.6%)
2	Plant height (cm)	<40 cm (73.5%)	40-60 cm (24.8%)	>60 cm (1.8%)
3	No. of pods/plant	≤65 (99.6%)	≥65 (0.4%)	
4	100 seed weight (g)	<10 g (98.8%)	10.1-13g (0.9%)	>13 g (0.8%)
5	seed yield / plant (g)	≤14 g (100.0%)	≥14 g (0.0%)	

Promising accessions with optimum combination of seed size, maturity and seed yield were identified. An accession with high seed yield per plant EC117902 (7.8 g) matured in less than 95 days. Accessions with high 100 seed weight (≥ 13 g) EC242099 (13.2 g) and EC39179 (13.0 g) matured in less than 95 days. Accessions EC39097, EC39142 and EC37081 matured in less than 80 days

2.1.1.2. Multilocation Evaluation of Soybean Germplasm

One hundred twenty six accessions of soybean germplasm were evaluated in augmented design with standard checks across six locations namely Pantnagar, Jabalpur, Parbhani, Pune, Imphal and Indore

Phenotypic variability in germplasm

Considerable phenotypic variability was observed in quantitative traits (Table 3). Days to 50 % flowering ranged from 34-57 (mean=45), days to maturity is from 88-112 (mean=99), number of pods per plant 12.40-74.43 (mean=33.41), 100 seed weight 5.19-19.47 g (mean=10.66 g) and seed yield per plant 2.64-15.49 g (mean=6.64 g). CV was found high for number of pods/ plant (34.94 %) and seed yield/ plant (34.13 %)

Table 3 : Phenotypic variability in soybean germplasm

Traits	Days to 50% flowering	Days to Maturity	Plant height (cm)	No. of pods/ plant	No. of Primary branches/ plant	100 Seed weight (g)	Seed yield/ plant (g)
Mean	44.87	99.48	47.12	33.41	2.74	10.66	6.65
Range	34.41-57.25	87.50-112.25	26.70-80.78	12.40-74.43	1.08-4.20	5.19-19.47	2.64-15.49
CV (%)	3.34	5.56	17.54	34.94	26.97	16.37	34.13
V(P)	24.37	48.00	207.43	188.63	0.77	8.17	7.78
V(G)	22.12	17.45	139.17	52.31	0.22	5.12	2.64
PCV (%)	11.00	6.96	30.57	41.10	31.92	5.12	2.64
CGV (%)	10.48	4.20	25.04	21.65	17.07	21.22	24.49
hB^2	90.78	36.36	67.09	27.73	28.60	62.70	33.98
GA	20.57	5.22	42.25	23.48	18.80	34.61	33.98
CD(5%)	1.86	6.85	10.24	14.47	0.92	2.16	2.81

Accessions for high seed yield and more number of pods [EC785506 with 15.49 g yield and 74.43 pods/plant; EC 242057 with 13.63 g yield and 66.76 pods], accessions for high oil content that matured in less than 95 days [EC 592214 (24.7%), VS 2011-119 (20.8), Nagaland Soybean (23.5 %), EC-391349 (20.6 %)] and promising accessions for high 100 seed weight [Manipur Soybean (19.47g)] were identified.

2.1.1.3. Evaluation of germplasm for biotic stresses

Screening of germplasm for disease reaction was done under natural disease pressure in field conditions at Indore

Table 4 : Disease reaction of germplasm against major diseases

S.No.	Soybean Genotypes	Screened against	Disease reaction
1	Cat 3470, Cat 3487, Cat 3280, F4P21, Cat 3502, Cat 2126-B, Cat 3476, Cat 2126A, Cat 2205B	Charcoal rot	Resistant
2	Harder	Charcoal rot	Susceptible
3	Cat 3480, Cat 2205b, Cat 2122, Cat 2114, Cat G 828, Cat 2097 B, Cat 3480, Cat 2503, VGM 70, 2114a, Cat 2205 B, G828, Cat 2122A	Bacterial pustule	Susceptible
4	EC 242060, EC 242062, PI 20049 (rust line), PI 23 970 (rust line)	Charcoal rot, YMV, Bacterial pustule	Resistant
5	PK262, JS 7546, B 37, JS 72-280, VLS 58, JS 72-44, NRC 94	YMV and Rhizoctonia aerial blight	Resistant
6	EC 241780, GP 448, AMS 4873, EC 457286, GP 48, GP 191, GB 305, GB 268, EC 17266323, AGS 218, NO. 339, EC 379152, GP 82, NO 487, AMS 50, AGS 69, JS 79-302,	Rhizoctonia aerial blight	Resistant
7	JS 20-69 and JS 20-29	YMV, charocal rot, bacterial Pustule, Myrothecium Leaf spot	Resistant
8	G5 P22, PS 1347, JS 20-34, IC 316172, IC 336819	YMV, bacterial pustule, Myrothecium leaf spot, Anthracnose	Resistant
9	Pusa-40, NRC-86, PK-327, JS-2, Pusa-22, Pusa-16	Powdery mildew	Susceptible
10	No 487, TGX 825-3F, GP82, GP resistant 93, GP 113, GP448, EC 457179, EC 457286, AM 48-73	Stem blight	Moderately Resistant

Disease reaction of germplasm accessions revealed that all the accessions were found to be susceptible to YMV at Jabalpur. However, on 1-9 rating scale, fifteen accessions were found to show high resistance reaction to YMV at Pantnagar. Accession C-2503 (EC 467282B) showed multiple disease resistance to YMV, RAB and CR. Resistant to RAB and CR were reported at Jabalpur in ten accession viz. C-1328, C-2115B, C-2134A, C-492A, GP-P15, HARDER, EC-538828, G5 P22, G4 P17 and AGS-25

2.1.1.4. Screening of germplasm accessions for resistance against major insect-pests

Screening of selected fifty accessions from MLT was performed at ICAR-IISR, Indore and AICRPS Centre, Sehore to identify promising accessions against major insects of soybean. Two accessions viz. C-2126A and C-3460 showed no infestation and no damage due to girdle beetle, whereas in three accessions viz. C-3480, C-2122A and G-11 though infestation was observed at either /both the centers, no typical damage symptoms were found at Indore. Ten accessions viz. C-3480, C-1641B, C-2122A, C-2125B, VGM-70, G11, F4 P21, G-828, C-2122A, C-3467 were reported with the larval population of defoliators less than ETL i.e. 3 larvae/m row at Indore and Sehore

Total 50 germplasm lines / genotypes were screened for insect resistance under natural field conditions during kharif 2015. Observations on major insects viz. girdle beetle (infestation and damage), stem fly (stem tunnelling), green semiloopers (larvae/m) and tobacco caterpillar (larvae/m) were recorded following standard procedures (Table 5). Girdle beetle infestation and damage ranged from 0.00 to 62.50 % and 0.00 to 38.46 % respectively. Five genotypes showed no infestation and no damage due to girdle beetle, where as in 6 soybean lines though infestation was observed ranging between 9.09 and 33.33 % but not typical damage symptoms were found. Such lines will be further tested for girdle beetle reaction during next season. Stem fly infestation was very severe during the season as reflected by high level of stem tunneling ranging from 47.02 to 91.89 %. It may be noted that the ETL for stem fly is 26 % stem tunneling. Accordingly all the lines were found to be highly susceptible to stem fly. Populations of green semiloopers (*G. gemma*, *C. acuta* and *D. orichalcea*) were also high during the season ranging from 13 to 44 larvae per m row length. It may be noted that the ETL for green semiloopers is 2-4 larvae /m row length. Accordingly all the lines were found to be highly susceptible to green semiloopers. Population of *S. litura* varied from 0 to 32 larvae / m row. In twenty two lines, the larval population was more than ETL i.e. 4 larvae/m row

Table 5 : Screening of Germplasm lines for insect resistance

S. No.	Soybean Genotypes	% Girdle Beetle infestation	% Girdle Beetle damage	% Stem tunneling due to stem fly	Semiloopers / m	*S.litura* /m
1.	Cat 2205B	62.50	25.00	47.02	21	5
2.	Cat 3470	50.00	25.00	79.84	31	12
3.	Cat 365	25.00	16.67	80.77	28	12
4.	Cat 3476	25.00	8.33	73.86	34	9
5.	Cat 3502	45.45	0.00	50.64	26	6
6.	Cat 2237B	57.89	31.58	57.65	26	10
7.	Cat 3293	0.00	0.00	55.68	27	19
8.	Cat 2126A	0.00	0.00	55.68	27	32
9.	Cat 1267A	50.50	27.78	50.29	34	19
10.	Cat 2126B	9.68	3.26	57.05	42	9
11.	Cat 3460	0.00	0.00	85.53	11	7
12.	Cat 2057B	35.71	14.29	56.84	28	13
13	Cat 2503	25.64	15.38	79.67	34	6
14.	Cat 700A	17.39	13.04	82.05	27	7
15.	Cat 833	13.64	4.55	55.63	17	5
16.	Cat 3487	6.25	6.25	51.68	29	2
17.	Cat 411A	15.38	0.00	55.56	18	5
18.	Cat 2122A	33.33	0.00	68.82	27	3
19.	Cat 1641B	10.00	3.33	67.26	27	3
20	Cat 872B	30.77	7.69	81.67	13	3

21.	Cat 3262	18.75	12.52	81.11	15	1
22.	Cat 3480	0.00	0.00	55.45	15	0
23.	Cat 3437	45.45	18.18	64.89	33	2
24.	Cat 1508B	0.00	0.00	53.90	37	7
25.	Cat 3467	33.33	33.33	91.89	19	2
26.	Cat 3284	12.50	12.50	67.79	33	27
27.	Cat 3439	27.00	0.00	70.37	13	1
28.	Cat 3442	33.33	16.67	69.01	21	4
29.	Cat 2125B	57.14	14.29	51.74	23	3
30.	Cat 2120A	9.09	0.00	61.33	22	4
31.	Cat 3438	27.27	9.09	73.75	44	4
32.	Cat 140A	41.67	25.00	63.74	28	4
33.	Cat 1935B	42.86	7.14	65.85	39	8
34.	Cat 412	33.33	13.33	55.35	31	8
35.	Cat 3401	41.67	8.33	73.08	21	4
36.	Cat 2114A	50.00	8.33	53.19	28	6
37.	VGM-70	61.54	38.46	47.10	21	3
38.	GP-15A	9.09	9.09	48.63	28	0
39.	G-11	25.00	0.00	71.15	35	2
40.	F4P21	46.67	13.33	76.44	31	3
41.	HARDER	41.67	16.67	80.49	19	7
42.	G-828	25.00	8.33	66.67	24	2

In another experiment, 16 soybean genotypes were evaluated under insect – protected and unprotected conditions for their reaction against insect incidence and yield and compared with zonal checks. Among the genotypes, Cat. No. 127-A, Cat. No. 139 and Cat.No.143 were found to be resistant against girdle beetle with least infestation and superior over checks (Table 6)

Table 6 : Evaluation of promising soybean genotypes for insect resistance

S. No.	Genotypes	Green semiloopers/m	*S. Litura* /m	Girdle beetle		Stem fly
				% Infestation	% Damage	% stem tunneling
1.	EC333902	13.89 (3.71) LR	3.33 (1.48)	13.37 (21.20) LR LR	5.45 (13.04)	53.61 (47.09) LRHS
2.	VP1165	15.11 (3.88) LR	2.22 (1.44) LR	9.52 (17.87) LR	4.59 (12.23) LR	62.63 (52.38) HS
3.	TGX814-35E	14.55 (3.81) LR	0.89 (0.76)	8.23 (15.39) MR	4.30 (9.11)	59.44 (50.59)
4.	TGX854-42D-1	16.89 (4.12) LR	3.11 (1.70) LR	20.61 (26.78) S	9.95 (18.31) LR	74.91 (60.23) HS
5.	SREC-56A	13.89 (3.70) LR	1.89 (1.37) MR	10.33 (18.56) LR	5.92 (13.94) LR	59.23 (50.35) HS
6.	Cat.No.47	9.56 (3.04) MR	1.11 (0.86) MR	10.95 (18.95) LR LR	7.79 (15.79) LR	66.40 (54.62) HS
7.	Cat.No.52	11.56 (3.40) MR	6.11 (2.47) S	4.12 (11.46) MR	0.74 (2.86) HR	61.86 (51.92) HS
8.	Cat.No.87	12.78 (3.54) MR	2.11 (1.39) MR	8.23 (16.57) MR	4.08 (11.49) MR	78.56 (63.11) HS
9.	Cat No.127-A	13.78 (3.67) LR	2.22 (1.47) MR	6.14 (10.72) MR	1.28 (3.77) R	68.03 (55.68) HS

10.	Cat. No. 139	12.78 (3.57) MR	1.33 (1.11)	2.18 (8.08) R	1.29 (5.26) R	82.78 (65.60)
11.	Cat. No. 146	10.22 (3.19) MR	3.33 (1.82) LR	11.07 (19.08) LR	6.67 (14.37) LR	68.09 (55.93) HS
12.	Cat. No. 147	11.44 (3.38) MR	1.33 (0.94) MR	20.82 (27.09) S	11.88 (20.02) S	49.70 (44.83) HS
13.	Cat. No. 612	17.78 (4.21) LR	2.33 (1.51) LR	5.90 (13.61) MR	2.57 (9.03) LR	55.96 (48.42) HS
14.	Cat. No. 1616	14.66 (3.82) LR	3.66 (1.91) LR	16.69 (24.05) LR	9.80 (18.20) LR	53.63 (47.08) HS
15.	Cat. No. 1818	12.00 (3.44) MR	1.11 (1.04) MR	10.67 (18.03) LR	7.23 (15.12) LR	71.76 (58.05) HS
16.	Cat. No. 143	11.67 (3.37) MR	0.89 (0.74) MR	3.55 (8.74) R	1.05 (4.80) R	72.19 (58.33) HS
17.	JS 93-05 (C)	15.44 (3.90) LR	2.00 (1.39) MR	15.99 (23.40) LR	11.95 (20.00) S	53.35 (46.92) HS
18.	JS 97-52 (C)	14.33 (3.78) LR	1.67 (1.29) MR	10.15 (18.47) LR	4.42 (12.13) MR	57.79 (49.66) HS
19.	JS 335 (C)	13.44 (3.67) LR	11.00 (3.32) S	9.841 (18.00) LR	4.89 (12.76) LR	59.60 (50.60) HS
20.	Bragg (C)	12.89 (3.58) MR	2.22 (1.49)	10.51 (18.11) LR	4.55 (12.29) LR	66.54 (54.67) HS
	SEM ±	**(0.25)**	**(0.31)**	**(2.98)**	**(2.43)**	**(2.70)**
	CD at 1%	**(0.96)**	**(1.17)**	**(11.41)**	**(9.28)**	**(10.32)**
	CD at 5%	**(0.72)**	**(0.87)**	**(8.53)**	**(6.93)**	**(7.72)**

Considering the yield under insect-protected and un-protected conditions and the prevailing insect-pest complex, VP 1165 and Cat.No. 127-A was found resistant (Table 7). However, the check variety JS 97-52 gave highest yield under both unprotected (1114 kg/ha) and protected (1285 kg/ha) conditions

Table 7 : Categorization of soybean genotypes based on Maximin-Minimax method

S. No.	Genotypes	Grain Yield (kg/ha)		% Yield loss	Relative % yield loss	Relative yield	Category
		Unprotected	Protected				
1	EC333902	389	954	59.22	67.45	34.92	S-LY
2	VP1165	139	163	14.72	16.76	12.48	R-LY
3	TGX814-35E	171	293	41.64	47.42	15.35	S-LY
4	TGX854-42D-1	267	533	49.91	56.85	23.97	S-LY
5	SREC-56A	361	582	37.97	43.25	32.41	S-LY
6	Cat.No.47	321	466	31.12	35.44	28.82	S-LY
7	Cat.No.52	135	190	28.95	32.97	12.12	S-LY
8	Cat.No.87	147	271	45.76	52.12	13.20	S-LY
9	Cat No. 127-A	199	223	10.76	12.23	17.86	R-LY
10	Cat. No. 139	150	350	57.14	65.08	13.46	S-LY
11	Cat.No.146	301	526	42.76	48.70	27.02	S-LY
12	Cat.No.147	168	638	73.67	83.91	15.08	S-LY
13	Cat.No.612	200	339	41.00	46.70	17.95	S-LY
14	Cat.No.1616	65	533	87.80 (SC)	100.00	5.83	S-LY
15	Cat.No.1818	166	309	46.28	52.71	14.90	S-LY

16	Cat.No.143	159	242	34.30	39.07	14.27	S-LY
17	JS 93-05 (C)	261	580	55.00	62.64	23.43	S-LY
18	JS 97-52 (C)	1114 (RC)	1285	13.31	15.16	100.00	R-HY
19	JS 335 (C)	184	380	51.58	58.75	16.52	S-LY
20	Bragg (C)	170	295	42.37	48.26	15.26	S-LY

2.1.1.5. Development of core collection in Indian soybean germplasm

Eight agro-morphological traits of 3443 soybean germplasm were analysed for the development of core collection using the principal component score (PCS) strategy and the power core method. The PCS strategy yielded core collection (CC1) of 576 accessions, which accounted for 16.72% of the entire collection (EC). The analysis based on the power core programme resulted in CC2 of 402 accessions, which accounted for 11.67% of the EC. Statistical analysis showed similar trends for the mean and range estimated in both core collections and EC. In addition, the variance, standard deviation and coefficient of variance were in general higher in core collections than in the EC. The correlations observed in the EC in general were preserved in core collections. A total of 311 and 137 unique accessions were found in CC1 and CC2 in addition to 265 accessions that were found to be common in both core collections. These 265 common accessions were the most diverse core sets, which accounted for 7.64% of the EC

2.1.1.6. Pre-breeding

To augment the genetic variability in the cultivated soybean, wild type soybean *G. soja* was crossed with JS 9560 and NRC 86. The F2 seeds from JS9560 x *G. soja*, NRC86 x *G. soja* were advanced to F3 generation

2.1.1.7. Development of nested association mapping (NAM) population in soybean

Nested association mapping population is being created by using JS335 a popular variety of central India and was used as common parent to hybridize with 20 genotypes. The traits targeted from 20 genotypes were drought tolerance, YMV résistance and water logging tolerance. F2 generation of twenty cross combinations will be further advanced for the genetic dissection of quantitative traits.

2.1.2. Genetic improvement for yields and associated characters in soybean

2.1.2.1. Promising entries in AICRPS breeding trials

Entry NRC 117 performed well in IVT in Central, Southern and North-Eastern Zones showing 9.7, 4.2 and 4.0 % increase in yield over the best check respectively. It is a medium duration line maturing in 100 days. In AVT-I trail NRC 99 a progeny of cross EC546882 x PS1044 performed on par with the best check (1493 Kg/ha) and it is matured in 98 days (Table 8)

Table 8 : Yield performance of NRC 117

Zone Trial	Trial	Yield (Kg/ha)	Per cent increase over best check	Maturity (days)
Central Zone	IVT	1913	9.70	97
North Eastern Zone	IVT	2265	4.23	102
Southern Zone	IVT	2151	4.01	96

2.1.2.2. Evaluation of advanced breeding lines

Thirty advanced progenies of different crosses were evaluated in three separate trials along with checks. Some of the lines recorded yields upto 2.23 t/ha. The highest yielding three entries namely NRC 2014- C-1-9-1, NRC 2014-C-1-2-3-3, NRC2014-C-1-6-1-1 and have been found resistant to yellow mosaic disease (YMD) under field conditions (Table 9)

Table 9 : Performance of selected advanced breeding lines

Name of the entry	Yiels kg/ha	Maturity days	Per day productivity (kg/ha/day)	YMD reaction
NRC 2014- C-1-9-1	2298	110	20.89	Resistant
NRC 2014- C-1-2-3-3	1914	109	17.55	Resistant
NRC2014-C-1-6-1-1	1910	111	17.20	Resistant
NRC 2014- C-1-9-2-6	1802	114	15.80	Resistant
NRC 2014- F-1-22-1-1-6	1707	104	16.41	Resistant
NRC 2014 - F-1-25-2-1-1	1991	104	19.14	Moderately resistant
NRC 2014- C-1-6-1-3	1643	114	14.41	Resistant
NRC 2014- C-2-1-13-1	1820	112	16.25	Resistant
NRC 86	866	100	8.66	Susceptible

In addition to these three lines, several breeding lines showed superior performance compared to check besides showing high level of filed resistance yellow mosaic disease

2.1.2.3. Evaluation of mid-generation breeding stocks

In an augmented trials 50 advanced progenies (F5/F6) generation of different crosses were planted with five checks. Data on yield and associated characters was recorded. Lines from cross JS9752 x PBM out performed checks by huge margins. The highest yielding line JS9752 x PBM-1-1-2-3-1-4 yielded 2507 kg/ha (Table 10)

Table 10 : Performance of selected mid-generation progenies

S. NO	Entries	Yield Kg/ha	100 seed wt (g)	YMD reaction
1	JS9752x PBM-1-1--5-1	2167	14.13	Resistant
2	JS9752x PBM-1-1-9-2-6-1	2161	15.11	Resistant
3	JS9752x PBM-1-1-9-1-5-2	1751	13.76	Resistant
4	JS9752xPBM-1-1-2-3-1-3	2212	11.99	Resistant
5	JS9752x PBM-1-1-2-3-1-4	2507	11.03	Resistant
6	JS9752x PBM-1-1-9-2-10-1	1449	12.18	Resistant
7	JS9752x PBM-1-1-9-1-5-3	1384	9.67	Resistant
8	JS9305x PBM-1-1-9-13-3	1308	13.52	Resistant
6	NRC 37 (C)	452	6.78	Susceptible
7	JS 93-05 (C)	866	10.15	Susceptible
8	NRC 86 (C)	450	9.59	Susceptible

2.1.2.4.Supply of breeding materials to different co-operating centers

Advanced breeding lines (15) were supplied to co-operating centers by Indian Institute of Soybean Research, Indore (Table 11)

Table 11 : Promising Advancing breeding lines

S. NO	Promising advanced breeding lines	Traits of importance
1	NRC 2014-L-1-9-1-4 and NRC 2014-L-1-9-1-6	Insect resistance & drought resistance
2	NRC 2014-G-1-2-1-5	High yield & insect resistance
3	NRC 2014-M-2-1-3, NRC 2014-M-2-1-5 and NRC 2014-O-1-9-1-2	High yield & disease resistance
4	NRC 2014-N-3-10-4-4-1, NRC 2014-O-4-10-1-1-1 and NRC 2014-O-4-10-1-2-2	Early & high yielding
5	NRC 2014-K-1-7-2-3-2 and NRC 2014-K-3-9-1-3-2	Improved seed quality
6	NRC 2014-B-1-8-1-5-1-4-1	Bold seed & good plant type
7	NRD 2014-P-8-2-3-1-1	Early & insect resistance
8	NRC 2014-R-1-5-1-3-3	Good plant type
9	NRC 2014-N-2-7-3-1-1	Early & high yielding

2.1.2.5. Validation of yield QTLs in advanced backcross population of soybean

An interspecific advanced backcross population was developed from the wild species *Glycine soja* and cultivar JS 335 as recurrent parent. A total of 127 lines of BC2F2 mapping population along with recurrent parent JS 335 were planted in *kharif* 2014 for phenotyping of yield component traits. Single row plots of 2 meter row length were planted and ten plants from each progeny row were harvested at physiological maturity. Phenotypic data were recorded for three yield component traits viz. number of pods/plant, 100 seed weight (gm) and seed yield per plant (gm). The number of pods in BC2F2 population ranged from 31.7-113.3 per plant. The 100 seed weight ranged from 5.9-12.0 gm, whereas total seed yield per plant ranged from 2.7-17.8 gm

A total of 50 simple sequence repeat (SSR) markers were selected from six linkage groups of soybean with aim to identify polymorphic markers among parents of mapping population. These SSR markers were selected based on the presence of multiple yield QTLs in the same genomic region of genetic map (10-15 cM distance) of soybean chromosomes as identified in earlier studies (consensus QTLs). A total of 10 polymorphic SSR markers were genotyped in 125 BC2F2 lines. Phenotypic data of three yield component traits and genotyping data of 10 SSR markers were used for QTL analysis in BC2F2 population of the cross JS 335 X *G. soja*. Single marker analysis was performed between segregating markers and three yield component traits using Mapdisto1.7 software. Single marker analysis using F-test threshold of 5.0 identified QTL for all of the three traits (Table 12)

Table12 : Single marker analysis of three yield component traits with 10 polymorphic markers in BC2F2 population of the cross JS 335 X G. soja (*F-test threshold = 5.0)

S. No	Marker	Linkage group	Number of pods	*F*-test value (R2) 100 Seed weight	Seed yield/plant
1	satt 064	B2	0.02	0.42	2.35
2	satt 474	B2	2.43	6.90 ** (5.60)	6.97 ** (6.30)
3	satt 238	C2	4.42 * (4.0)	4.55 * (3.8)	1.82
4	satt 251	C2	4.40 * (4.0)	5.16 * (4.4)	2.73
5	satt 580	Dla	0.00	20.02 **** (14.4)	2.32
6	satt 179	Dla	0.00	20.02 **** (12.8)	1.04
7	satt 270	I	0.67	3.62	0.26
8	satt 055	K	0.35	2.48	0.60
9	satt 150	M	0.48	3.05	0.48
10	satt 316	M	1.99	4.46 * (3.7)	0.23

Four QTLs for 100 seed weight, one QTL for number of pods and one QTL for seed yield per plant have been identified using prior knowledge of consensus QTLs with minimum resources. The marker satt 474 from linkage group (LG) B2 was linked with 100 seed weight and seed yield / plant. This QTL explains 5.6% of phenotypic variance for 100 seed weight and 6.3% of phenotypic variance (R2) for seed yield per plant. The positive alleles for both the traits were contributed by recurrent parent JS 335. Two markers from linkage group C2 were linked with number of pods and 100 seed weight. Marker satt 251 explained maximum phenotypic variance of 4.0 for number of pods and 4.4% for 100 seed weight. The positive alleles for number of pods were contributed by *G. soja*, and by JS 335 for 100 seed weight. Two markers from LG D1a namely, satt 580 and satt 179 were associated with higher 100 seed weight. The satt 580 explains 14.4% of phenotypic variance whereas satt 179 explains 12.8% of total phenotypic variance. Positive alleles at this QTL were contributed by JS335. Satt 316 from linkage group M was also linked with 100 seed weight explaining 3.7% of phenotypic variance. The QTLs identified in this study will help in the speedy recovery of seed weight and other yield component traits from recurrent parent as well as incorporation of donor genes of interest from wild species

2.1.3. Breeding soybean for wider adaptability using photoperiod response and growth habits

2.1.3.1. Early maturing, high yielding genotypes

Eighteen superior F6 genotypes from photoperiodic and long juvenility experiments were evaluated in replicated trial. Mean seed yield varied from 224 kg / ha to 2240 Kg /ha with an average of 950 Kg / ha. Six of the seven genotypes from cross EC 390977 x EC 538828 and one genotype from cross JS 95-60 x AGS 25 significantly out yielded the check varieties (Table 13)

Table 13 : Field Evaluation of F6 genotypes from photoperiodic and long juvenility experiments

S. No.	Cross (Genotype No.) / Check	Yield (kg/ha)	S. No.	Cross Cross (Genotype No.) / Check	Yield (kg/ha)
1.	EC 390977 x EC 538828 (27)	2240	2.	EC 390977 x EC 538828 (29)	1833
3.	EC 390977 x EC 538828 (31)	1708	4.	EC 390977 x EC 538828 (40)	1643
5.	EC 390977 x EC 538828 (18)	1612	6.	JS 95-60 x AGS 25 (111/2)	1612
7.	EC 390977 x EC 538828 (43)	1536	8.	EC 538828 (check)	1085
9.	JS 20-34 (Check)	712	10.	JS 93-05 (Check)	291
11.	JS 95-60 (Check)	280	12.	JS 335 (Check)	224

2.1.3.2. Marker assisted backcross selection for photoinsensitivity

One hundred twenty eight BC3 plants from JS 97-52 (photosensitive) x [JS 97-52 x EC 390977 (photoinsensitive)] were screened through validated molecular markers for *E3* and *E4* genes and true backcross plants with donor alleles (*e3*, *e4*, *e3e4*) were identified. Fourteen plants for *E3* locus, thirty four plants for *E4* locus and fifteen plants for both *E3* and E4 loci carried recessive donor alleles *e3*, *e4* and *e3e4*, respectively. These plants have been used for generating BC4 generation for transfer of photoinsensitive alleles *e3* and *e4* to JS 97-52

2.1.3.3. Genotyping at *E1* locus

Ninety six varieties / genotypes were genotyped for this locus using CAPS marker and 4 varieties (MACS 450, MACS 58, MAUS 32 and MAUS 61) were identified with frame shift mutation resulting in dysfunctional allele at this locus

2.1.3.4. Inheritance of growth habit

Our earlier genotyping had identified JS 97-52 as *dt1dt1* and Lee putatively as *Dt1Dt1*. F2 population from JS 97-52 x Lee was phenotyped for growth habit. Plants with no increase in node number after R1 were categorized as determinate, those upto 50% increase as semi determinate and those with more than 50% as indeterminate. JS 97-52 x Lee population segregated in 3 semi-determinate to 1 determinate suggesting for *dt1dt1Dt2Dt2* and *Dt1Dt1Dt2Dt2* genotypes for JS 97-52 and Lee, respectively

2.1.4 Breeding for Drought Tolerance

2.1.4.1. Evaluation of RIL 107 (JS 97-52xNRC 37) in F5 generation for seed traits under simulated terminal drought stress

Evaluation of 76 lines in the RIL (JS 97-52xNRC 37) and parents was carried out under Potassium iodide (KI 0.4%) spray at R5 stage and compared with untreated control in *kharif* 2015. Significant difference was observed between treated and control populations for 100 seed weight and seed yield based on paired t- test. High significant positive correlation coefficients were estimated between these two populations for 100 seed weight ($r = 0.583$; $p < 0.01$) and seed yield ($r = 0.738$; $p < 0.01$). The genotype JS 97-52 showed less reduction in 100 seed weight (18.3%) and seed yield (38.9%) over control whereas, NRC 37 showed 31.7% and 58.3%, reduction respectively (Table 14)

Table 14 : Variability in seed traits in RIL population and its parents under KI induced terminal drought conditions

Seed Traits	Mean ± SE	Range	CV(%)	JS 97-52	NRC 37
100 seed wt. KI+ (g)	4.7±0.2	1.6-9.2	30.3	8.5	2.8
100 seed wt. KI- (g)	7.2±0.2	3.1-13.0	29.7	10.4	4.1
Percentage reduction in 100 seed wt.	34.8±1.9	0-65.4	49.4	18.3	31.7
Seed yield/ plant KI+ (g)	1.8±0.2	0.3-7.7	82.5	7.7	0.5
Seed yield/ plant KI- (g)	4.3±0.3	0.6-13.4	62.6	12.6	1.2
Percentage reduction in Seed yield/ plant	57.8±2.4	5.9-91.2	37.1	38.9	58.3

2.1.4.2. Canopy air temperature differential (δT^0C) trait in advance breeding lines

In summer 2015, field screening for low canopy air temperature differential (δT0C) trait was performed among high yielding advance generation selections (F4 - F7) in augmented design. In F4 generation, 62 selections from a cross (JS 97-52 x JS 335), and 21 selected lines in its reciprocal cross (JS 335 x JS 97-52) were found to show lower δT^0C (<-6.40 C for JS 97-52). In F5 generation, 14 lines in cross (JS 90-41x JS 97-52), 7 lines in (JS 335xYoung) and 4 lines in (JS 71-05 x JS 97-52) expressed considerably low δT0C. Three lines also showed less δT^0C values in a cross (NRC 37xJS 97-52) in F6 generation. Among 46 high yielding selections of summer 2013, one line each from crosses (NRC 37 x JS 97-52) and (JS 335 x C-2797) and two lines from (JS 93-05 x JS 97-52) in F7 generation possessed low δT^0C trait. Screening of 139 advance breeding (F7) lines identified eight advance breeding lines viz. 104-50, 104-11, 104-34, 104-3, 104-18, 104-4, 104-22 from cross (JS 90-41 x JS 97-52) and three lines viz. 105-75, 105-42, 105-39 from cross (JS 93-05 x JS 97-52)

2.1.4.3. Supply of drought responsive breeding materials to different AICRPS centers

Drought responsive advance breeding populations (4) derived from JS 335 x C-2797, EC 546882 x JS 335, JS 90-41 x JS 97-52 and JS 97-52 x NRC 37 were supplied to 30 co-operating centers to assess performance of individual plant selections for high seed yield and for drought tolerance traits like slow wilting, thick stem girth, long roots, leaf waxiness, canopy temperature, relative water content, transpiration efficiency etc

2.1.5. Breeding for water-logging tolerance in soybean

2.1.5.1. Hybridization and generation advancement

Water-logging tolerant genotype JS 20-38 was crossed with genotypes viz., JS 335, JS 90-41, JS 95-60 and Cat 3299 in cross combinations viz., JS 20-38 x JS 90-41, EC 589398 x JS 20-38, JS 20-38 x JS 95-60 and JS 335 x JS 20-38 and hybridity has been confirmed. F2 generation of the crosses performed previously has been maintained and F3 seed has been harvested (Table 15)

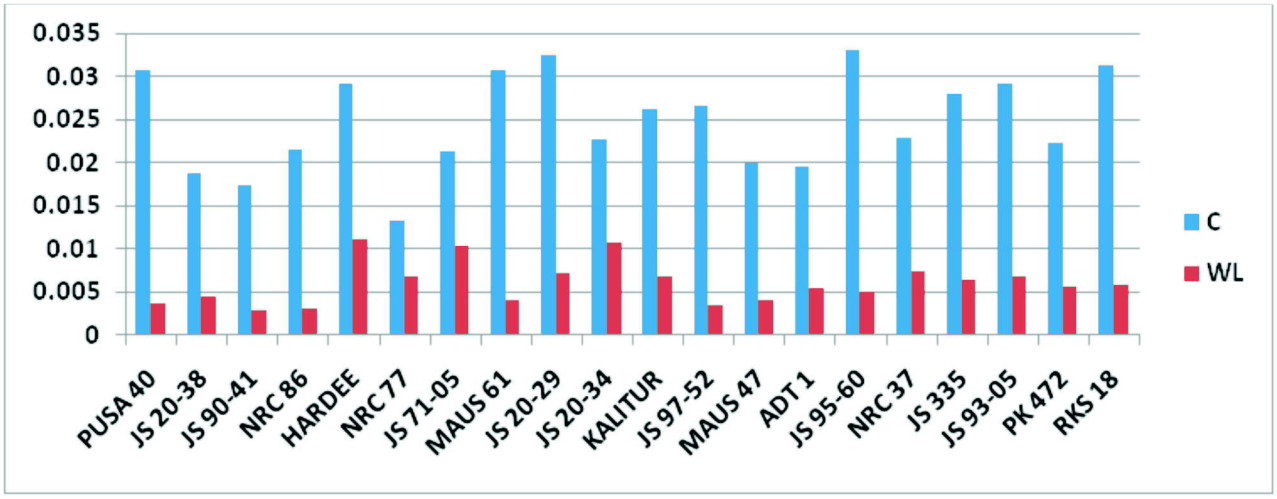
Table 15 : Breeding for water-logging tolerance- hybridization and generation advancement

S.No.	Crosses	No. of F_2 plants harvested
1.	JS 97-52 X JS 88-66	48
2.	JS 88-66 X JS 95-60	41
3.	JS 335 X JS 97-52	184
4.	JS 97-52 X JS 95-60	63
5.	PK 472 X JS 335	24
7.	PK 472 X JS 90-41	26
8.	PK 472 X JS 95-60	32
9.	PK 472 X JS 88-66	20

2.1.5.2. Physiological and biochemical characters under water logging stress

Twenty genotypes viz., JS 20-29, JS 95-60, JS 335, JS 90-41, RKS 18, PUSA 40, JS 97-52, NRC 37, JS 71-05, JS 93-05, MAUS 61, MAUS 47, ADT 1, PK 472, KALITUR, JS 20-38, HARDEE, JS 20-34, NRC 86 and NRC 77 were grown in pots and water logging treatment was given for 7 days at V1 stage. Analysis on physiological and biochemical parameters viz., chlorophyll content, proline content, MDA content, SOD, CAT and APX was done

Chlorophyll content was reduced in all genotypes whereas, proline levels increased under stressed conditions with variable levels for all genotypes. Under water logging stress, levels of super oxide dismutase (SOD) increased in all genotypes and the magnitude of its increase was inversely proportional to MDA levels. However, levels of peroxidases and catalases were decreased under water logging stress (Fig 2) suggesting that expression of APX and CAT is a dynamic process and change with time and genotype



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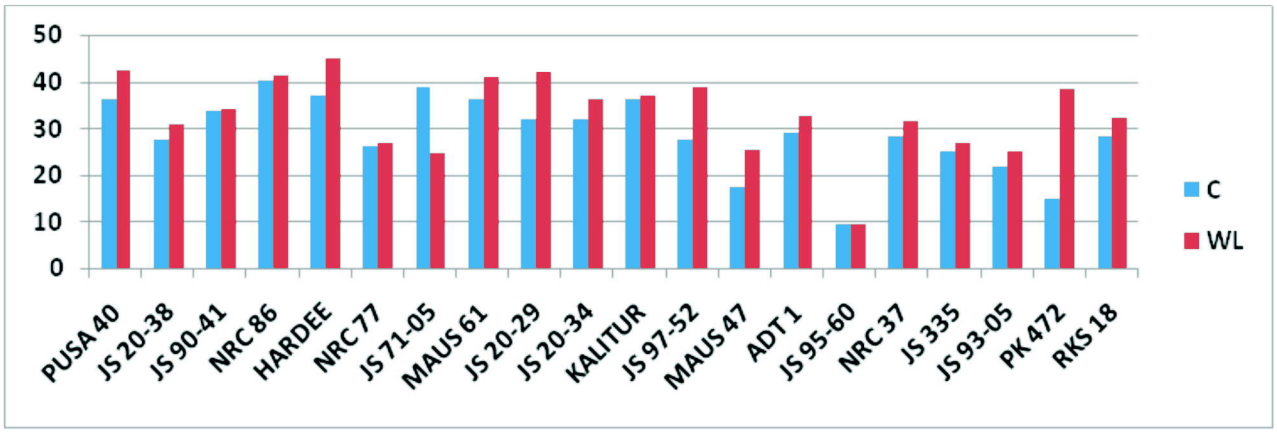

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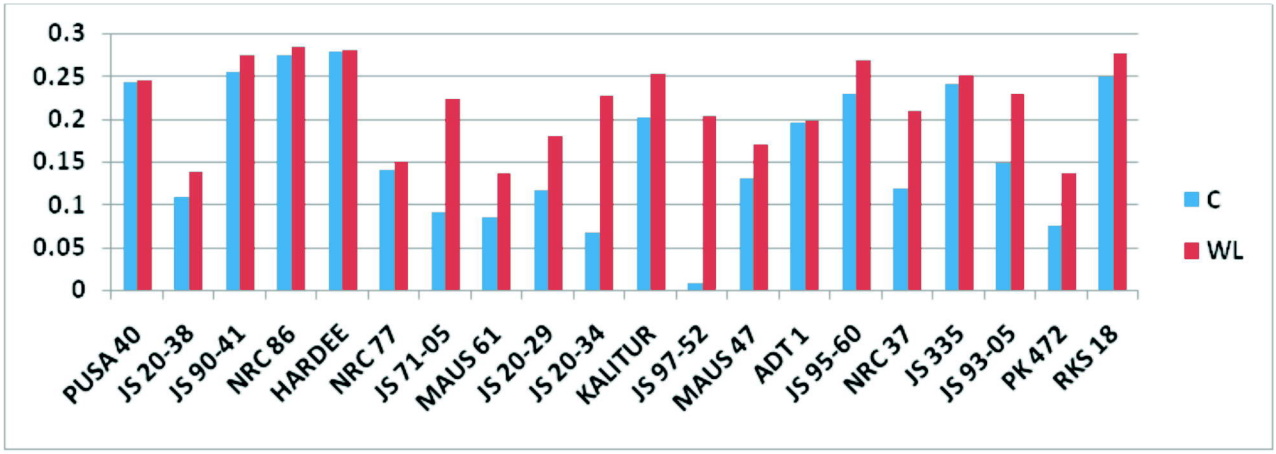
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HARDEE
NRC 77
JS 71-05
MAUS 61
JS 20-29
JS 20-34
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JS 335
JS 93-05
PK 472
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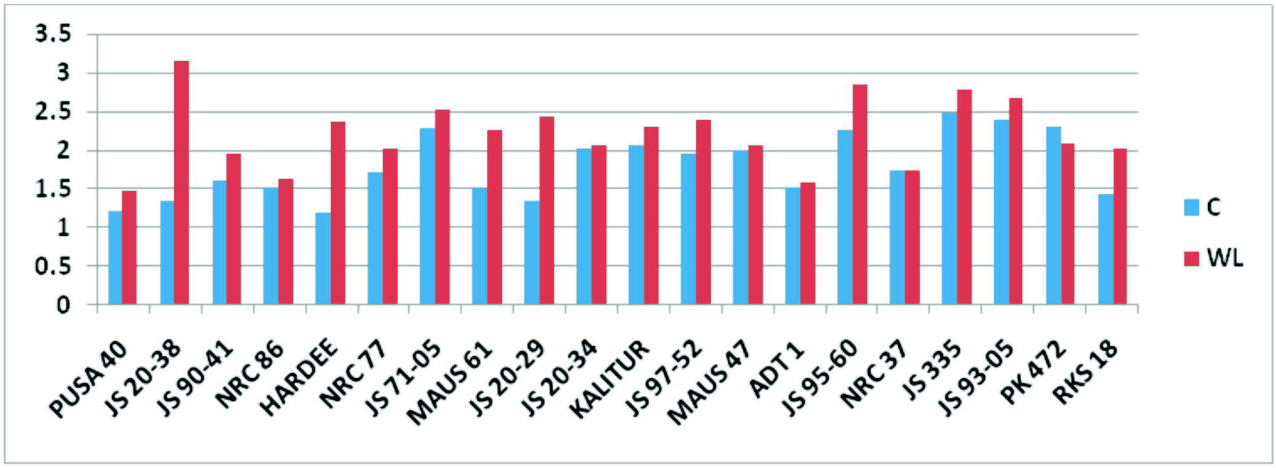
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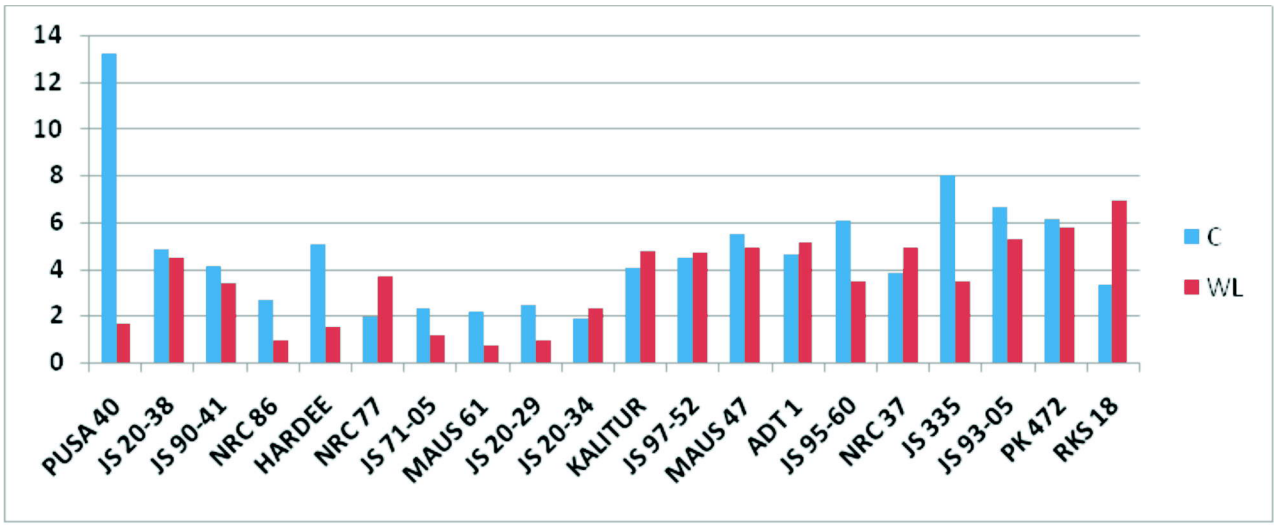
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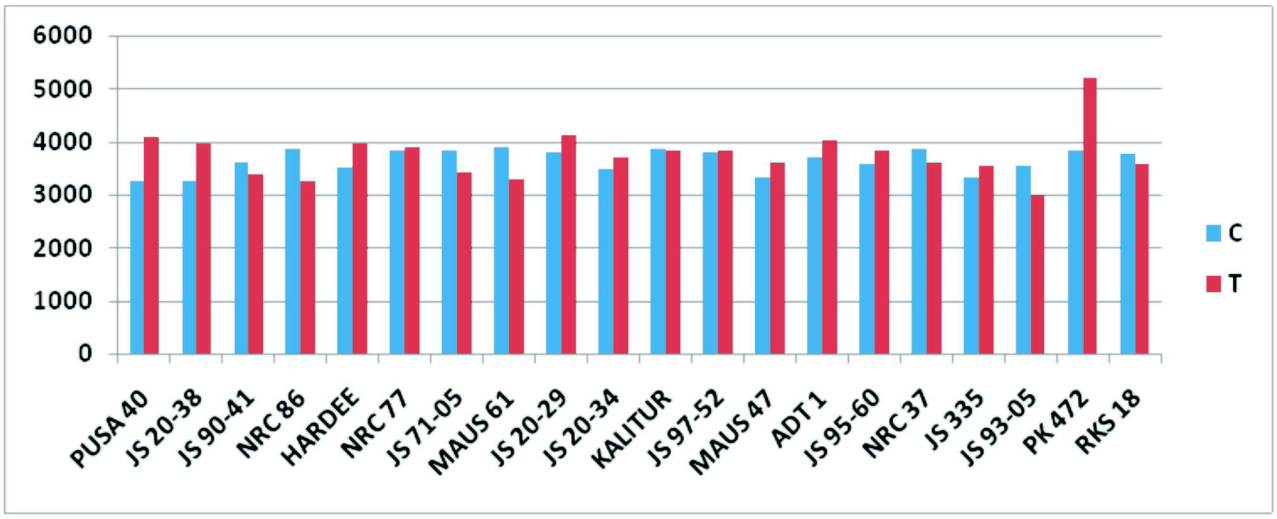

(f)

Fig. 2 : Changes in physiological and biochemical parameters under waterlogging stress in soybean genotypes. (a) Chlorophyll (b) Proline (c) SOD (d) MDA (e) APX (f) CAT

2.1.6. Soybean genotypes for increased nitrogen fixation efficiency and yield

Forty popular varieties have been evaluated for their ability to fix atmospheric nitrogen and yield. It was found that the genotypes that showed high leghemoglobin (µg/g fw) were also found to show high ARA (Nanomoles C2H4/mg/nodules/hr) (Table 16)

Table 16 : Efficiency of soybean genotypes for nitrogen fixation and yield

Variety	Harvest Index %	Yield/plot (g)	ARA (nm C_2H_4mg/ nodules/hr)	Leg Hb (ng/g fw)
ADT-1	8.34	33.90	0.237	6.940
Birsa Soy	6.66	25.25	0.271	5.221
CO-1	8.93	25.55	0.460	4.320
Gaurav	6.27	24.25	0.401	5.230
Guj Soy 1	13.88	68.50	0.406	4.630
Hara Soya	37.61	430.85	0.262	4.960

Hardee	11.98	110.45	0.267	7.869
JS 20-29	33.03	432.55	0.412	5.450
JS 20.34	19.78	122.00	0.445	3.342
JS 335	11.07	55.65	0.295	6.481
JS 71-05	6.89	29.70	0.046	5.460
JS 76-205	4.86	13.60	0.477	5.930
JS 80-21	22.72	82.75	0.536	3.970
JS 95-60	17.40	49.70	0.441	9.317
JS 97-52	32.15	433.30	0.346	5.787
MACS 57	17.81	101.50	0.421	3.748
MAUS 47	11.16	54.50	0.291	7.012
MONNETTA	9.43	53.45	0.662	3.850
NRC 37	11.92	29.70	0.560	5.338
NRC 86	6.53	37.00	0.792	7.605
PS 1029	32.65	461.50	0.851	5.760
PS 1225	32.65	461.50	0.851	5.760
Punjab 1	16.21	72.45	0.377	3.220
RVS 2001-4	7.55	47.00	0.370	5.408
VLS 65	7.12	30.50	0.355	6.870
RANGE	4.86-37.61	13.6-461.5	0.046-0.851	3.220-9.317
SD	9.649	146.609	0.186	1.483
MEAN	15.30	117.88	0.43	5.56
CV (%)	63.07	124.37	43.21	26.69

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

2.1.7.1. Screening of genotypes for YMV resistance

Soybean genotypes (total 92) maintained at ICAR-Indian Institute of Soybean Research, Indore were evaluated at YMV hot spot at Ludhiana under field conditions. The scoring of the disease was done at pod filling stage, using standard 0-9 scale based on the percent area of leaf and pods infected, where 0 denotes no disease and 9 denotes 90% areas covered due to yellow mosaic. Sixteen genotypes viz., Bragg, DS 228, Pusa 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 and SL 525 were found to be resistant. These genotypes will be used in breeding programmes as donor parents for YMV resistance

2.1.7.2. PCR assay to detect begomoviruses infecting soybean in India

Simple, efficient PCR based begomovirus detection is desired for diagnostics of yellow mosaic viruses infecting soybean. Despite the conserved nature of coat protein (CP) gene sequence, a stretch of nucleotide sequences were identified that differentiates both the species of the begomoviruses infecting soybean. DNA extracted from infected samples was subjected to PCR amplification to detect Begomovirus species. Each DNA sample was used as template simultaneously in two PCR reactions each specific for detection of Begomovirus species infecting soybean. Soybean samples collected from Indore, Jabalpur, Kangra, Ludhiana, New Delhi, and Pant Nagar showed positive amplification specific for MYMIV, whereas soybean samples obtained from Amravati, Adilabad, Bengaluru, Coimbatore, Dharwad and Pune were positive for MYMV infection. Thus soybean samples obtained from Northern and Central India showed presence of MYMIV infection whereas samples from Southern and Western region of the country showed MYMV infection

2.1.7.3. RNA silencing of MYMIV in soybean

Soybean cultivar JS335 (susceptible to Yellow mosaic disease) was infected with *Mungbean yellow mosaic India virus* (MYMIV-sb) through *Agrobacterium tumefaciens* harboring binary plasmids containing head to tail tandem repeats of MYMIV-sb genome. After the appearance of yellow mosaic symptoms, leaves were super-infiltrated with *Agrobacterium* containing ihp-rep plasmids (RNAi vectors targeting rep gene of MYMIV). The phenotypic study for yellow mosaic symptoms of un-inoculated, emerging new leaves in ihp-rep plasmid infiltrated plants reveal alleviation of mosaic symptoms compared to untreated controls. Viral titre in treated and untreated leaf samples were ascertained by quantifying coat protein gene of MYMIV-sb through real time PCR assay. Thus effectiveness of hairpin RNA mediated suppression of replication initiator protein encoded by MYMIV-sb was proven through transient gene silencing assays

2.1.7.4. Transcriptome Sequencing of rust resistant line EC 241780 and susceptible cultivar JS 335

Transcriptome sequencing of rust resistant line EC 241780 and rust susceptible cultivar JS-335 was conducted using Illumina Hi Seq 2500 sequencer. The pre-processed reads were used for reference based pair-wise alignment and reads were aligned against soyabean genome Williams 82 sequence (Ensembl) using Tophat program. After aligning the reads with reference gene model, the aligned reads were used for estimating expression of the genes and transcripts. The gene expression

estimation was performed and differentially expressed genes were identified. Total up and down regulated genes & isoforms (p-value <= 0.05) found using cuffdiff analysis indicated that 757 genes were upregulated while 250 genes were down regulated. Splice junction information of the two samples JS335 and EC 241780 were also annotated. Single nucleotide polymorphisms were identified from the transciptome sequences of EC 241780 and JS 335. Figure 3 shows chromosome wise distribution of SNPs & InDels at read depth 10 (RD10) identified from WGS of JS335. Chromosome 14 showed highest number of SNPs at RD10. These SNPs are being analysed for their use in genetic mapping and for identification of linked markers associated with rust resistance genes

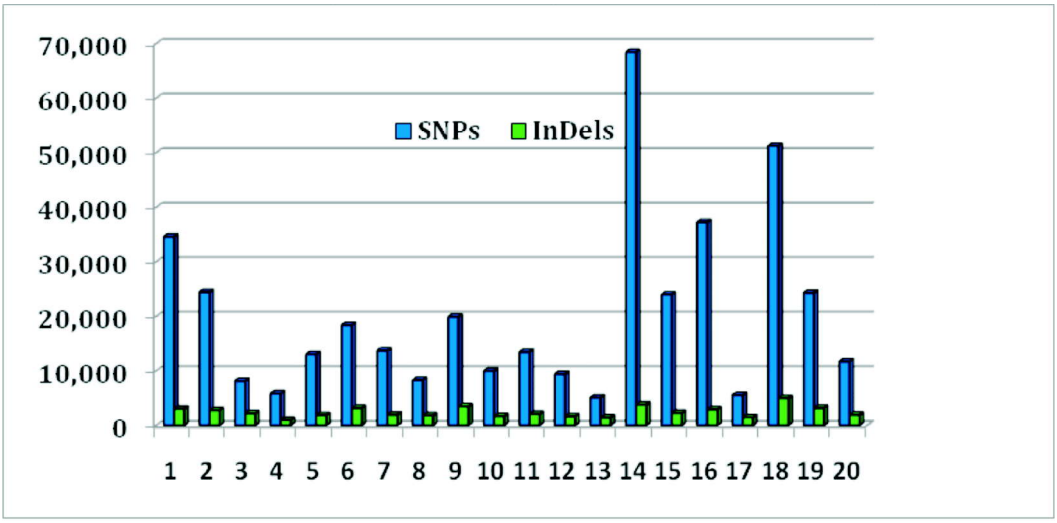

Fig. 3 : Chromosome-wise distribution of genic SNPs (RD 10) and InDels in JS335 with reference to Williams 82 genome

2.1.7.5. Inheritance studies of rust resistance genes

New crosses were attempted using other resistance sources KDS344 and DSb 21 for the development of F2 mapping population.F2 mapping population from a cross between susceptible parent (JS-335) and resistant parent (EC241780) was grown at Sangli Regional research station, Mahatma Phule Agriculture-University, Rahuri for phenotyping of rust resistance. Phenotyping for rust was done on 110 F2 lines

2.1.7.6. Molecular characterization of rust resistance and susceptible lines :

DNA was extracted from the rust resistant and susceptible parents and selected lines from F2 mapping population. SSR markers were used to identify the polymorphic markers between JS-335 and resistant parent EC241780. Low level of polymorphism was observed between the parental lines using SSR markers. NBS-LRR gene associated with rust resistance was obtained from the previous reports and compared with other soybean NBS-LRR genes

2.1.8. Multiparent Advanced Generation Intercross (MAGIC) population in soybean

Eight parent based (four popular varieties namely, JS335, JS9560, NRC37, NRC86 and four promising exotic lines EC546882, EC333901, EC572109 and EC572136) multiparent advanced generation

intercross (MAGIC) population was developed by employing 2-way, 4-way and 8-way intercross hybridization. The final fifteen combinations of 8-way intercross hybrids (Table 17) along with six combinations of 4-way intercrosses further advanced to generate multi-parent advanced generation inter-cross recombinant inbred lines (MAGIC-RILs)

Table 17 : Summary of development of 8- way intercross F_1 hybrids.

S. No	8-way hybrid combinations	No. of seeds
1	[EC546882 x NRC37] X [EC572136 x JS335] X [EC546882x NRC37] X [EC333901 x NRC86]	64
2	[EC546882 x NRC37] X [EC572136 x JS335] X [EC546882x NRC37] X [EC572109 x JS9560]	24
3	[EC546882 x NRC37] X [EC572136 x JS335] X [EC333901x NRC86] X [EC572136 x JS335]	40
4	[EC546882 x NRC37] X [EC572136 x JS335] X [EC572109 x JS9560] X [EC572136 x JS335]	15
5	[EC546882 x NRC37] X [EC572136 x JS335] X [EC572109x JS9560] X [EC333901 x NRC86]	48
6	[EC546882x NRC37] X [EC333901 x NRC86] X [EC546882x NRC37] X [EC572109 x JS9560]	127
7	[EC546882x NRC37] X [EC333901 x NRC86] X [EC333901x NRC86] X [EC572136 x JS335]	40
8	[EC546882x NRC37] X [EC333901 x NRC86] X [EC572109 x JS9560] X [EC572136 x JS335]	47
9	[EC546882x NRC37] X [EC333901 x NRC86] X [EC572109x JS9560] X [EC333901 x NRC86]	81
10	[EC546882x NRC37] X [EC572109 x JS9560] X [EC333901x NRC86] X [EC572136 x JS335]	68
11	[EC546882x NRC37] X [EC572109 x JS9560] X [EC572109 x JS9560] X [EC572136 x JS335]	42
12	[EC546882x NRC37] X [EC572109 x JS9560] X [EC572109x JS9560] X [EC333901 x NRC86]	46
13	[EC333901x NRC86] X [EC572136 x JS335] X [EC572109 x JS9560] X [EC572136 x JS335]	14
14	[EC333901x NRC86] X [EC572136 x JS335] X [EC572109x JS9560] X [EC333901 x NRC86]	44
15	[EC572109 x JS9560] X [EC572136 x JS335] X [EC572109x JS9560] X [EC333901 x NRC86]	54
	Total	764

2.1.9. Breeding for food grade characters and high oil content

In order to incorporate 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 the following crosses were made

1. Karune X null KTi line developed from LSb1 X PI1542044
2. SL525 X F1(SL525 X NRC101)
3. JS95-60 X F1(JS95-60 X NRC101)
4. KDS344 X NRC101(recently developed KTi free soybean line)
5. G83(High protein line)X NRC101
6. Dadachamame X NRC101
7. Dadacha2000X NRC101
8. JS335 X NRC101
9. (JS335XPI PI205085) X (JS97-52 X PI596540)
10. PI408251,source of null allele of Lox1 X IC210
11. JS335 X NRC109(a recently developed Null Lox2 line)
12. JS95-60 X NRC109
13. Null lox3 line from (JS335XPI PI205085)X NRC109
14. JS93-05 XBC2F1 (JS93-05 X PI596540,source of null allele of lipoxygenase2)
15. (IC210XNRC108)XNRC109
16. P7-31(High oleic line) XNRC109
17. P7-31(High oleic line)XD373(null lox2 line from JS97-52 X PI542044)

F1 and lines segregating for null KTi allele were analyzed using gene specific and linked marker Satt228 to confirm the status of null KTi allele (Fig. 4 & Fig. 5)

Five hundred advanced and segregating lines developed for high oil content were analysed for oil and protein content. Some of the lines with optimal combination of protein and oil content are identified (Table 18)

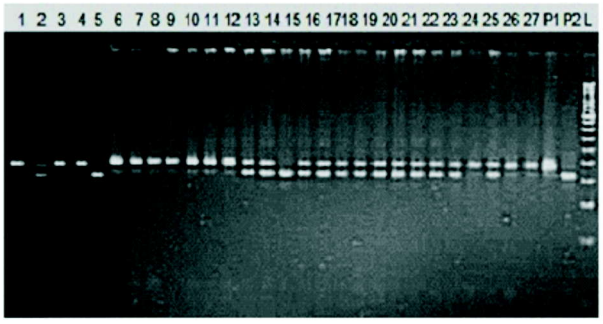

Fig. 4 : Genotyping of segregating lines for null KTi allele using Satt 228

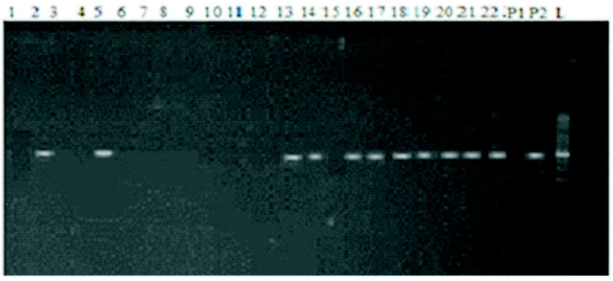

Fig. 5 : Genotyping of segregating lines for null KTi allele using gene specific marker

Table 18 : Proteion and Oil Content in Advanced Breeding Lines

Line No.	Pedigree	Oil content	Protein Content
NAG145	NRC7 x AGS191	23.00	39.80
JSG32	JS93-05 X G76	21.00	40.68
HG14	Hardee X G76	21.28	39.37
HN44	Hardee X NRC7	20.96	39.81
NG101	NRC7 X G76	22.5	41.65
HN87	Hardee X NRC7	23.23	38.06
JG109	JS93-05 X G76	22.78	40.85
JG23	JS93-05 X G76	24.00	37.60

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

Fatty acid composition of oil extracted from the seeds of 108 recombinant inbred lines (raised in cropping season 2014) was determined through Gas Chromatography. Nine recombinant inbred lines exhibited oleic acid content > 50% oleic acid and α-linolenic acid less than 4.2%. Regular soybean contains 19-23% oleic acid and 6-9% α-linolenic acid. Fig 6 exhibits the fatty acid profile of regular soybean and high oleic acid soybean genotype. Crosses effected between high oleic acid RIL and other high oleic acid sources were: P3-35 (RIL) x IC210; IC210 x P4-19 (RIL); NRC106 xIC210; IC210 x NRC105; NRC106 x NRC105

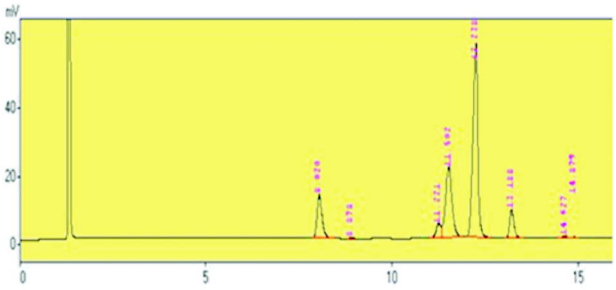

Fig. 6 a) : Fatty acid profile of a regular soybean

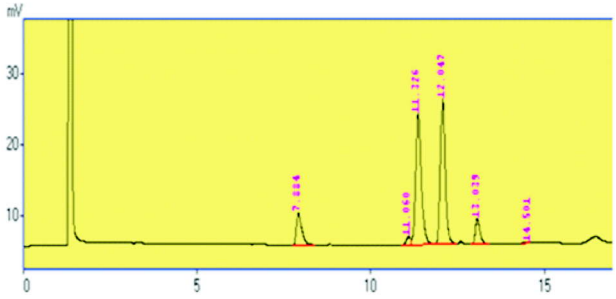

Fig. 6b) : Fatty acid profile of high oleic acid soybean

DNA was extracted from 108 recombinant inbred lines and genotyped using 106 polymorphic markers. Fig. 7 shows the representative gel of genotyping of RIL population using Satt285

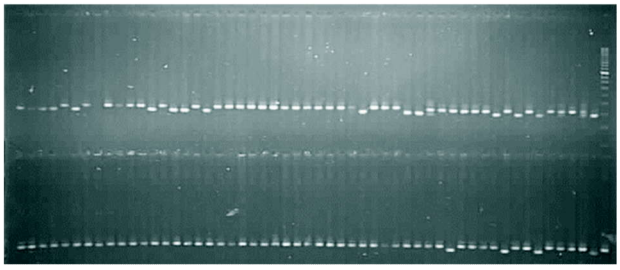

Fig. 7 : Genotyping of RIL population (derived from LSb1 x NRC7) with Satt285

2.1.10. Studies on impact of field weathering on soybean seed quality and its management

Polymer coating based soybean seed treatment with molybdenum and boron was done in cultivars JS 9560 and JS 93 05. Molybdenum in combination with boron at the rate of 1:30mg/kg of seed also had significant higher yield over the control and there was no harmful effect on seed germination and plant growth in both the cultivars

2.1.10.1. Interaction of treatment and field weathering and viability of soybean seed

Seed treatment with Molybdenum and Boron both had a positive effect on seed viability initially as well as after six month of storage. It was found that due to field weathering 10-11% germination loss was observed in control plots. Minimum loss due to field weathering was observed when seeds treated were with Boron 20mg/kg seeds. After six month of storage the seed treatment effect was more significant. In harvest matured seed lot, more than 80% germination was observed after the treatment, whereas in control plots seed germination was at 72%. In the field weathered seed lot, germination percentage of control seeds were reduced up to 67% whereas treatment increased germination percentage to 78-81%. Effect of field weathering was not much on treated seeds even after storage as most of the treatment maintained 78-81 percent germination (Table 19 & 20)

Table 19 : Polymer coating of molybdenum and boron in post storage seeds (cv JS 9560)

Treatment	Initial Germination (%)			Post-storage (6month) germination (%)		
Variety JS 9560	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in (HM)	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in HM
Mo 0.5 g	88	87	81	86	82	79
Mo 1.0 g	90	85	83	84	82	80
Boron 20 mg	88	87	84	84	83	80
Boron 30 mg	90	87	83	85	84	80
Mo:Bo 0.5:20	90	86	84	86	83	80
Mo:Bo 0.5:30	87	83	81	83	80	78
Mo:Bo 1.0:20	88	86	83	84	82	81
Mo:Bo 1.0:30	92	87	84	85	83	80
Control	84	81	73	77	72	67

Table 20 : Effect of polymer coating of molybdenum and boron on germination of post storage seeds (cv JS 9305)

Treatment	Initial Germination (%)			Post-storage (6month) germination (%)		
Variety JS 9305	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in (HM)	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in HM
Mo 0.5 g	81	79	73	74	73	68
Mo 1.0 g	82	80	73	75	74	67
Boron 20 mg	86	80	79	79	76	74
Boron 30 mg	84	81	79	80	79	76
Mo:Bo 0.5:20	83	80	77	81	79	75
Mo:Bo 0.5:30	86	83	80	82	75	73
Mo:Bo 1.0:20	89	80	83	85	82	80
Mo:Bo 1.0:30	92	87	84	85	83	80
Control	80	77	70	75	70	64

2.1.10.2. Effect of Salicylic acid on seed germination

Table 21 : Effect of Salicylic acid and their interaction with Molybdenum and Boron on seed germination of soybean

Treatment	Initial Germination (%)			Post-storage (6month) germination (%)		
Variety JS 9560	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in (HM)	Physio. maturity (PM)	Harvest Maturity (HM)	15 days delay in HM
SA25ppm+MO1 g	91	88	84	87	82	76
SA25ppm+B20 mg	90	86	84	88	80	76
S25ppm+M1+B20 mg	89	84	75	84	79	74
SA 25mg	89	85	82	87	79	73
SA50ppm+MO1g	86	84	79	80	79	72
SA50 ppm +B20mg	86	81	83	82	79	75
SA50pp+MO1g+B2mg	92	88	80	88	83	74
SA 50ppm	86	83	76	80	78	71
SA75ppm+MO1g	92	88	80	86	84	79
SA75ppm+B20mg	96	90	86	91	85	80
SA75ppm+MO1g	93 +B20mg	87	85	90	84	80
SA 75ppm	92	90	86	87	85	80
Control	84	78	73	78	71	62

Seeds of both the varieties were treated with different salicylic acid concentration along with boron and molybdenum to see the compatibility of the different chemicals on seed germination. It was found that there was no toxic effect on seeds due to the applied chemicals. Further, higher concentration of salicylic acid 75mg/kg resulted in significantly higher seed yield as well as seed germination even after field weathering and storage

Physiologically matured seeds had highest seedling vigour initially (2564). Significantly low seedling vigour was found with field weathered seeds initially and after

storage. Membrane integrity of soybean seed is an important parameter for maintaining the seedling vigour. Lower electrical conductivity signifies the greater membrane integrity of the seed. After six month of storage, of seeds harvested at physiological maturity electrical conductivity was found to increase in variety from 0.375 to 0.978µSiemens/cm/g seed. Field weather seed showed highest deterioration in terms of membrane degradation due to higher electrical conductivity (Table 21)

2.1.10.3. Effect of different foliar spray on seed yield and seed quality during storage

To improve the seed quality, shelf -life and seed health, foliar application of different chemicals at different concentrations were given at different crop growth stage as mentioned in Table 22. Salicylic acid @ 100ppm gave significantly higher yield over the control as well as good seed quality at initial stage and after storage as well. The seed germination was 91 percent and seedling vigour (48.41) was high after six month of storage. Reduction in germination was only 3 percent after storage with this treatment. Boric acid @ 25ppm at flowering and pod filling stage was found to be best. Brassinolides @150ppm maintained higher seed germination even after storage

Table 22 : Foliar spray on seed yield and seed quality during storage

S.No.	Treatment	Seed yield (g/2.7 m^2)	Germination (%)		Vigour index II	
			Initial	Post storage	Initial	Post storage
TI	SA 50ppm	0.670	96.5	91	65.33	42.58
T2	SA 100ppm	0.716	94	91	66.6	48.41
T3	SA200ppm	0.619	97	93	67.76	49.23
T4	SA 25ppm	0.690	91.5	88.5	63.13	43.54
T5	BA 35ppm	0.581	89.5	84	46.4	33.51
T6	BA50ppm	0.549	85	80	49.13	32.08
T7	BRASS 5ppm	0.525	86	81	48.56	30.94
T8	BRASS 100ppm	0.549	85.5	80	49.68	28.88
T9	BRASS 150ppm	0.569	95.5	90	54.33	38.43
T10	Control	0.500	82.5	76	33.12	20.31

2.1.10.4 Screening of varieties for resistance to field weathering

Ninety varieties were harvested 15 days after attaining the harvest maturity and varieties were sprayed with water. It was found that variety MAUS 61-2, JS2034, NRC 37 , RVS 2001-4 and kalitur were least affected due to field weathering and maintained higher germination (more than 80%). The susceptible varieties for field weathering are Davis, SL 295, PS564, PS1024, PK416, PS262 and NRC 7

Table 23 : Effect of field weathering on germination percentage of soybean varieties

> 70% germination (16 varieties)	50-70 % germination (20 varieties)	<50 % germination (20 varieties)
MAUS 61-2, RVS2001-4,	Pusa 24, MACS 13, MACS	NRC 7, NRC 2, Pusa98-14,
JS20-34, Kalitur, RKS 24,	124, Birsa Soya 1, MAUS 158,	Bragg, INDIRA SOYA,
NRC 86, JS93-05, MAUS 61,	VLS 63, JS335, JS76-205, Lee	Ankur, PS1042, JS79-81,
JS8021, PK 471, Co 3, MAUS	AK 12, Gujrat Soya 1, SL 96,	VLS 1, JS 2, PS 1092,
1, Pusa 40, MAUS 71, HARA	Durga, RAUS 5, NRC 12,	59, PK 262, PS 1024, PK
SOYA and VLS 65	MAUS 32 and JS 75-46	416, SL 295, PS 564 and DAVIS

2.1.10.5. Studies on storability of polymer coated soybean seed on its seed quality

Treatment	Seed germination during storage		
	2013	2014	2015
Vitavax 1.5 g/kg seed	**82**	**69**	**19**
Acronis (Xelora) 2 g/kg seed	**82**	**71**	**21**
Salicylic acid 25mg / kg seed	**82**	**74**	**29**
Control	**82**	**55**	**0**

Kharif 2012 harvest seeds of JS9560 were treated (on Jan 2013) with polymer along with fungicides and kept for two year in the glass bottle to see the effect of polymer coating on viability /storability of soybean. It was found that no adverse effect of polymer coating on viability during storage. Seed treatment with Salicylic acid and Acronis maintained more than 70 % germination for longer duration and there was no insect and fungal attack on the treated seed

2.1.10.6. Application of nano particles to soybean seed to improve seed germination

The present work was planned with the objective to efficiently apply different nanoparticles (nano-ZnO and MgO) to soybean seed. In the initial evaluation, none of the concentrations were found to be toxic for seedling growth. The effect was more visible in seedling growth at higher concentrations of 20, 30, 40, and 50 ppm. The diameter of seedlings increased with increasing concentrations of nano-particles. SDS-PAGE analysis revealed differential protein expression pattern of seeds during germination due to nanoparticles treatment (nano-ZnO and MgO) (Fig 8.). In addition, a modified hydroponic medium was tried to study the effect of nano particle solutions on seed germination and seedling growth (Fig. 9)

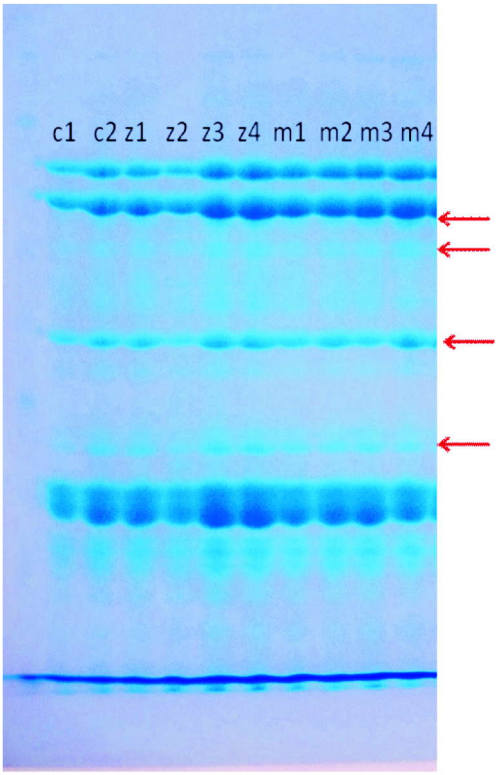

Fig. 8 : SDS-PAGE protein profiling ofnano-particles treated seeds during germination

Fig. 9 : Modified hydroponic nano-particle medium for seedling growth

2.1.11 **Optimization of mango soy *shrikhand* and determination of its nutritional and rheological properties**

The optimized product of mango soy *shrikhand* was developed using Response Surface Methodology. It had acceptable sensory characteristics without use of animal milk and soy flavor was masked by use of mango pulp. Processing methods viz. soaking, germination and cooking were used to assure maximum removal of antinutritional components from soy milk. The mango soy *shrikhand* contained sugar syrup in place of crystallized sugar and yet the texture was maintained. The process of inversion gave an innovative method of preparation of *shrikhand*. The optimized product had zero cholesterol due to omission of animal milk usage and contained lower fat than regular *shrikhand*, thus can be consumed by hyper-cholesterolemic people. The ICPOES elemental analysis revealed that mango soy *shrikhand* prepared was a good source of calcium and potassium (Table 24). The product showed non-Newtonian behavior (Fig.10)

Table 24 : Proximate composition of mango soy *shrikhand*

Composition	Value[a]
Total solids (%)	58.99±1.3
Protein (%)	7.05±0.2
Fat (%)	5.45±0.23
Ash (%)	0.461±0.13
Reducing sugur (%)	33.86±0.77
Total sugar (%)	35.92±0.7
Carotenoids (mg/100g)	3.97±0.78
Ascorbic acid (mg/100g)	24.65±0.97
Potassium	2283
Calcium	641.4

[a]Average of 3 determinations ± S.D

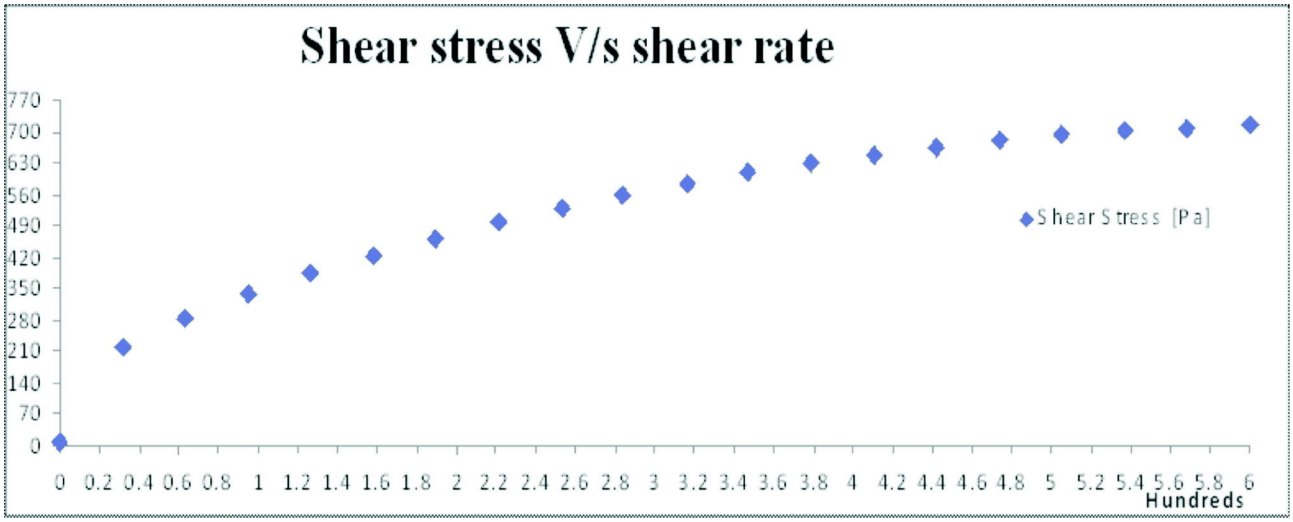

Fig. 10 : Rheological graph for optimized mango blended soy-*shrikhand*

2.2. CROP PRODUCTION

2.2.1. System efficiency enhancement through conservation technologies (Optimization of rotational tillage for soybean based cropping systems)

Soybean plant height was significantly highest in CR-CR-CR-CR (C-Conventional and R-Reduced tillage) and remained at par with CR-RR-RR-RR and RR-RR-RR-RR. The maximum number of branches/plant was observed in SR-SR-SR-SR and showed their superiority over CR-RR-CR-RR and CR-RR-RR-CR. The number of pods/plant remained unaffected due to different tillage systems. The maximum seed index was recorded with CR-RR-RR-CR and closely followed by SR-SR-SR-SR while the highest seed yield/plant was with CR-CR-CR-CR. The highest seed and straw yield was noted with CR-RR-RR-RR which remained at par with CR-CR-CR-CR and CR-RR-RR-CR. Significantly highest harvest index was associated with CR-CR-CR-CR

Soybean plant height, branches/plant, pods/plant, seed yield/plant and harvest index remained unaffected due to previous *rabi* crops. The maximum seed index was recorded when soybean crop was grown after chickpea and wheat. The highest soybean yield was recorded when previous crop was wheat and closely followed by chickpea. However, the highest straw yield was observed when soybean grown after chickpea and followed by wheat

2.2.2. PGPR and AM Fungi on P-mobilization and P-uptake in soybean:maize intercropping system

Co-inoculation of *B. aryabhattai* (MDSR14) and AM fungi significantly increased dry matter accumulation (root and shoot), nodule numbers, and dry weight in intercrop soybean and maize. Co-inoculation of *B. aryabhattai* (MDSR14) and AM fungi also improved rhizosphere properties pertaining to phosphorus availability such as acid and alkaline phosphatase in intercrop soybean and maize as compared to sole cropping. Highest soybean and maize yield and phosphorus uptake was also registered with co-inoculation of *B. aryabhattai* (MDSR14) and AM fungi. There was concomitant depletion in native organic P ($NaHCO_3$-Po and NaOH-Po) and acid extractable–P (HCl-P) and increase in inorganic P ($NaHCO_3$-Pi and NaOH-Pi) in rhizosphere soil with co-inoculation of *B. aryabhattai* (MDSR14) and AM fungi indicating their role in mobilization of native unavailable organic P and inorganic insoluble-P pool of soil to available P

2.2.3. AM fungi mass production technology and its utilization in soybean production and mitigating CO2 emission

Mass multiplication of predominant niche AM fungi in pot cultures using soybean processing mill wastes and employing root organ culture (*in vitro* method) for it's utilization in soybean for enhanced carbon sequestration in soil, drought tolerance is being developed.

2.2.3.1. Hosts and Potting mix for AMF production

Sorghum was found to be the most suitable host in terms of higher AMF (10.5 spores/g substrate) production. 100% organic (10 t/ha FYM) or 3 parts of integrated soil [(5 t/ha FYM + 10, 30, 25 (NPK Kg/ha)] amended with 1 part of soybean hulls (soybean processing mill waste) was found to be the best substrate mix for producing higher AM propagules. Different types of AM fungal spores belonging to genera *Glomus, Rhizophagus, Fenneliformis, Gigaspora* were observed in traps raised in

substrates amended with hulls (soybean processing mill waste) (Fig. 11)

2.2.3.2. *In vitro* hairy root cultures for AMF production

Agrobacterium rhizogenes strains namely MTCC 2364 (DSM 30200) & MTCC 532 (ATCC 15834) were procured from IMTECH Chandigarh. Among these two, the strain no. MTCC 532/ATCC 15834 was found to be virulent and is now being used to develop hairy root cultures using carrot, *Amaranthus* and other C4 dicot plants

2.2.3.3. C-sequestration and AM fungi

AMF inoculation in the soybean-maize intercropping system under organic farming system enhanced C-stocks (14.27 Mg C ha-1 yr-1), microbial biomass carbon (313.89 mg C kg-1) over the uninoculated plants. AMF application also enhanced glomalin (glycoprotein secreted by AM fungi) (964 to 1092 g/g soil) production under soybean-maize intercropping either managed with organic or inorganic practices when compared to un-inoculated plants. Carbon emissions in AMF applied plots (organic with maize intercropping) recorded 18.78 mg/CO2 Kg-1 day-1 as CO2 (basal) respiration and 18.78 mg/CO2 Kg-1 hr-1 in SIR assay. On the other hand, non AMF plots showed 22.35 mg/CO2 Kg-1 day-1 in CO2 (basal) respiration and 21.02 mg/CO2 Kg-1 hr-1 in case of SIR assay

It is concluded that continuous multiplication of native AMF on perennial grass under no-till and *Trigonella* or maize enhances glomalin production and C-sequestration (Figure 12 & 13). The carbon stocks and total glomalin pools indicate that the formation of stable soil aggregates in soil through glomalin production captured additional carbon in the niche and could act as potential C-sequestrator.

The ratio of total glomalin to soil organic carbon was found to be in the range of 45.03 to 53.10% in zero tillage and *Trigonella* plants

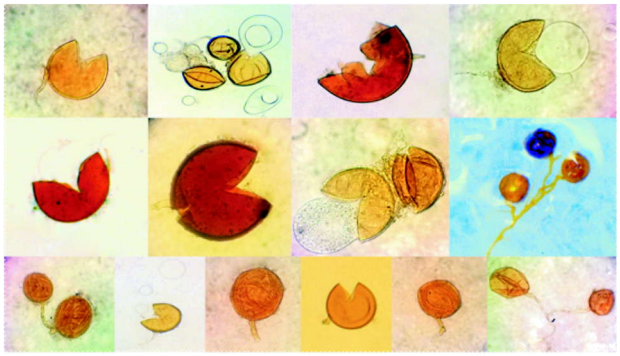

Fig. 11 : Various types of AM fungal spores recovered in AMF traps raised in substrates amended with soybean processing mill wastes.

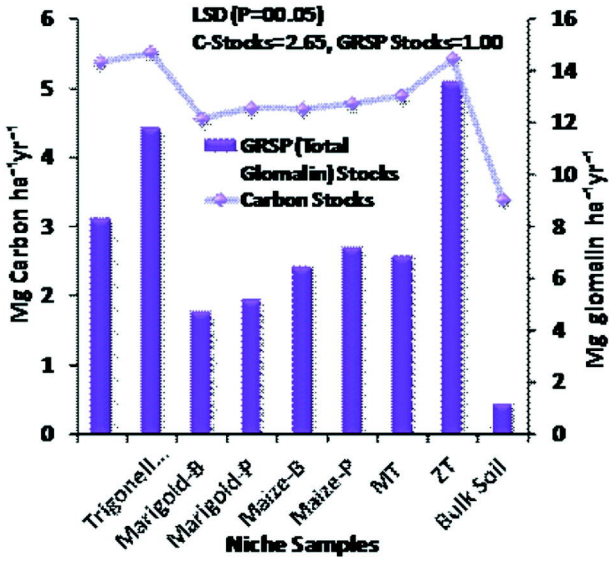

Fig. 12 : Total GRSP stocks and C-stocks in different rhizosphere samples

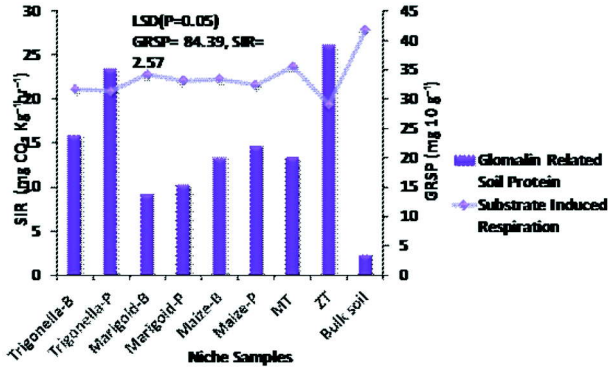

Fig. 13 : GRSP and substrate induced respiration in the soils of different rhizosphere samples

2.2.4. Design, development and validation of Tractor operated seed planter for soybean

Under the unpredictable behavior of monsoon in Central India, quick seedbed preparation and timely sowing are critical factors to achieve higher soybean yield. Therefore, a tractor drawn ridge fertilizer cum seed planter (inclined plate type) hitched to Pyramid assembly system on tractor was conceived, manufactured and farm validated. It facilitates development of ridge of soil along with placement of fertilizer under the ridge and sowing of seeds. The performance comprised of two treatments normal fertilizer drill cum seed planter and tractor operated ridge fertilizer drill cum seed planter (with inclined plate type metering device) with ten replications. Planting of soybean using ridge fertilizer drill cum seed planter resulted in 18.5% increased plant population and consequently seed yield by 32.6 %.

2.2.5. Geo-informatics analysis of area, production and productivity change sinsoybean

The analysis has been done for all the major *kharif* season crop in relation to soybean and its percentage change in area, production and productivity during the last 29 years. The districts were categorized as Major districts (>50%) contributing more than 50% area of soybean in the country, Minor districts (> next 30%) contributing 30-50% area of soybean in the country and Least (< next 20%) contributing districts which contributes less than 20% area under soybean. In 1982-84 the mean yield of major and minor districts are 0.71 ton/ha and 0.75 ton/ha respectively; whereas in 2008-10 the mean yield has increased to 1.1 ton/ha and 1.07 ton/ha in the major and minor districts respectively. The area under major districts category had increased from 0.45 mHa (1982-84) to 4.97 mHa (2008-10) which is about 1005.35% increase. It has also been analyzed that soybean has replaced mainly less profitable crops like sorghum, cotton, groundnut, *bajra*, etc. in the region. In major districts from 1982 to 2010 the decrease in sorghum was about 83.72%, cotton 34.54%, groundnut 92.84%, and *bajra* was about 86.69%. Initially in 1982-84, the area of soybean was mainly concentrated in western MP (0.708 mHa), Chhattisgarh (CG) (0.004 mHa) and some adjoining districts of Rajasthan (RJ) (0.021 mHa). Later in 2008-10 it has spread as MP (5.4 mHa), Maharashtra (2.94 mHa), RS (0.74 mHa), Andhra Pradesh (0.14 mHa), Karnataka (0.13 mHa) and CG (0.08 mHa). The Land Use Scheme data is collected for last 29 years for major states of soybean to analyze the land use pattern of soybean and other major crops and to further calculate the *kharif* fallow land of major category districts from these land use data. After calculating the *kharif* fallow it has been analyzed that the soybean not only occupied other major crops (given above) area of these districts area but also the *kharif* fallow area which is about 2.18 mHa (MP and RJ) in 1982-84 and decreased to 1.12 mHa (MP and RJ) in 2008-10. The maximum area of major districts falls under the range of about 650 mm – 950 mm annual rainfall and it has been analyzed that the

rainfall is continuously decreasing in all the states and districts

2.2.6. Germplasm Information Retrieval System

To facilitate easy management of huge germplasm data a Web-based Germplasm Data Management System was developed (Fig 14). The passport data of germplasm accession was entered into the system. Old soybean germplasm data was also exported to the new format of database. Advanced searching techniques were included in the new Germplasm Information Retrieval System. The system was developed using latest ASP .NET technology. It has modules to generate attractive reports in different formats-excel and word documents. It has different search menu-options-Simple search, Complex search, Advanced search and Selective search (Fig 15). It also facilitates Graphical representation of information

Fig. 14 A : new version of the Germplasm Information Retrieval System

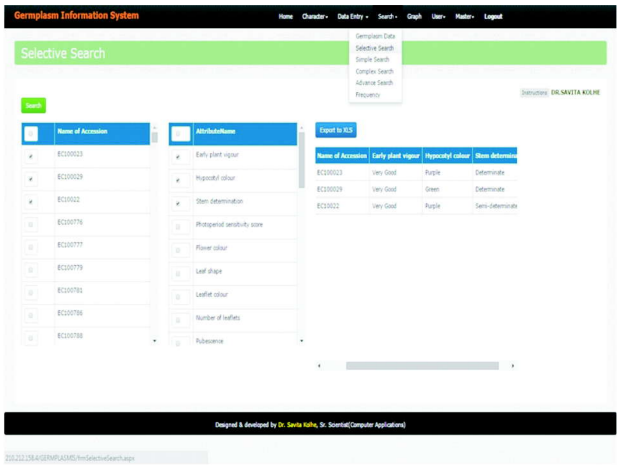

Fig. 15 : Germplasm Information System with different types of search menu-options

2.2.7. Soybean yield improvement and socio-economic impact in India

2.2.7.1. Technology adoption and yield gap

Soybean production technology adoption index indicated that level of technology adoption ranged from 30.4 to 66.1 per cent. Majority of the farmers were medium adopters (44% of sample farmers), followed by low adopters (38%) and high adopters (18%). The level of adoption by the selected farmers positively affected the soybean yield. The high adopters achieved average yield to the tune of 1138 q/ha whereas low adopters achieved only 893 q/ha in the study area. The factors affecting the level of technology adoption were age of the head of household turned out to be negative and significant; education, extension contact, family size and per capita income of the family had positive and significant effect on the level of soybean production technology adoption. This implies that proper extension of package of soybean production technology leads to higher technology adoption resulting in higher yields.

2.2.7.2. Total Factor Productivity (TFP) Growth of Soybean in India

The input use, output and TFP index of soybean in India revealed higher growth in output index. Similarly, parallel growth in inputs use index led to moderate growth in total factor productivity of soybean in India. The decade-wise analysis indicated that the growth in output index was higher than the inputs use index leading to positive growth in TFP for soybean. Overall, the growth in TFP index of soybean in India was found to be moderate (1.20 per cent per annum). The contribution of TFP in total output growth has increased fast and reached to 29 per cent in the recent decade, implying that the contribution of productivity growth in increasing during recent periods. For the overall period under analysis, merely 10.5 per cent of the total soybean output growth was contributed by TFP in India

2.2.7.3. Returns from Research Investment in Soybean in India

The marginal returns to soybean research investment in India were found to be very low. For the full period, 1980-81 to 2011-12, one rupee increment in research stock generated, on an average, additional income of Rs. 0.26 only. The decade-wise analysis indicated that, the marginal rate of returns from soybean research has improved in the recent decades. Similarly, the internal rates of returns to soybean research investment are moderate (10 per cent). The returns to research have increased over time. The results suggest that further higher investment on soybean research will generate soybean supply at a faster rate. Invest more on research and create irrigation infrastructure may be through localized water harvesting to boost the domestic production of the crop and the edible oil pool. The lower growth in total factor productivity for oilseeds can be attributed to lower investment in oilseeds research

2.3. CROP PROTECTION

2.3.1. Soybean+*Anethum graveolens (Suva)* combinations for management of soybean defoliators

Anethum graveolens (Suva) was found to be the most ideal crop for trapping the larval populations of major defoliators viz. *Gessonia gemma, Chrysodeixis acuta* and *Diachrysia orichalcea. Suva* was intercropped with soybean in different row combinations (soybean+ *suva* – 6:1, 12:1, 6:2 and 12:2) (Fig. 16). At peak incidence, population of semilooper and *S. litura* larvae on sole soybean was 15.50 and 17.00 larvae / m respectively, whereas in intercrop plots it ranged from 3.00 to 8.00 and from 3.5 to 8.5 respectively (Table 25)

All the intercrop combinations recorded significantly less populations of major defoliators. Among different intercrop combinations, except for intercropping soybean with one row of *suva*, all the treatments were on par with respect to incidence of semiloopers and *S. litura.* In sole soybean, Chlorantraniliprole 18.5 SC @ 100 ml/ha and Quinalphos 25 EC @ 1500 ml/ha were required for managing larval populations, whereas in case of different combinations of intercrop, where the population was restricted to *suva* hence insecticides requirement was reduced to only 4.35 ml/ha to 26.09 ml/ha and 65.25 to 260.85 ml/ha respectively. Considering the total area occupied by s*uva,* for effective trapping of defoliators and their management a combination of 12 rows of soybean followed by 2 rows of *suva* was found to be most suitable

Fig. 16 : Effect of *Anethum graveolens (Suva)* used as trap crop for lepidopteran defoliators

2.3.2. Stem blight disease of soybean

2.3.2.1. Morphological characters of causative pathogen *C. truncatum*

On the basis of growth pattern the isolates of causative organism, *C. truncatum* can be divided in to three groups like slow, medium and fast growing (Table 26)

Table 25 : Effect of intercrop on incidence of major defoliators and quantity of insecticide required for their management in sole soybean v/s intercrop with *Suva*

Treatment	Semiloopers/mon Soybean	*S. litura*/mon Soybean	Chlorantraniliprole (ml/ha)	Quinalphos (ml/ha)
1. Sole Soybean	15.5 (3.94)	17.0 (4.12)	100.00	1500.00
2. Soybean + *Suva* (6:1)	3.5 (1.87)	4.0 (2.00)	10.87	163.05
3. *Suva* + Soyabean	3.0 (1.72)	3.5 (1.87)	15.22	228.30
4. Soybean + *Suva* (6:2)	3.0 (1.71)	5.5 (2.34)	10.87	163.05
5. *Suva* + Soybean (2:6)	3.5 (1.87)	4.5 (2.12)	36.09	391.35
6. Soybean + *Suva*	7.0 (2.64)	8.0 (2.82)	4.35	65.25
7. *Suva* + Soybean (1:12)	8.0 (2.82)	8.5 (2.91)	8.70	130.50
8. Soybean + *Suva*	3.0 (1.71)	5.0 (2.24)	8.70	130.50
9. *Suva* + Soya (2:12)	3.0 (1.73)	3.5 (1.87)	17.39	260.85
CD at 5%	(0.36)	(0.39)	--	--
SEm ±	(0.11)	(0.12)	--	--

Table 26 : Morphological characters of causative pathogen *C. truncatum*

Character	Group I	Group II	Group III
Colony Growth	Fast	Medium	Slow
Colony Shape	Circular, flat	Centre raised circular	Raised Shiny
Margin	Irregular	Regular	Regular
Colour	Dark black	Grayish black	Grayish black
Reverse pigmentation	Dark black	Light grey	off white
Colony zonation	present	absent	absent
Colony diameter	60mm	51.6mm	48.3mm
Conidia size	24x4µm	20.4 x 4.1 µm	17.2 x 3.5 µm
Presence of setae	present	present	present
Mycelial growth	no	Grey white mycelium	little cottony mycelium

2.3.2.3. Pathogenic variability

For pathogenic variability studies 15 isolates of *C. truncatum* from different soybean growing regions were employed. Each isolate was inoculated on a set of varieties having different degree of resistance. 5 mm diameter of 7-10 days old culture was inoculated to petioles of every plant (detached leaf method) and incubated at room temperature in a sterile wet plate. On the basis of pathogenicity, isolates were grouped in to 6 pathotypes. The pathotype I was highly virulent and pathotype VI was least virulent (Table 27)

Table 27 : Pathogenic variability of *C. truncatum* isolates

SNo	Isolates	GP118-275 (S)	PS1225 (S)	AMS-25-11 (MR)	GP109 (MR)	Bragg-13 (MS)	JS 20-49 (R)	GP 339 (R)	P*
1	Dhar seed	S	S	S	S	S	S	S	I
2	Anth -2	S	S	S	S	S	S	S	I
3	Indore coll	S	S	S	S	S	S	S	I
4	Dharwad Collet	S	S	S	S	S	S	S	I
5	Anth (G)	S	S	S	S	S	S	S	I
6	Anth-Indore	S	S	S	S	S	S	S	I
7	Amrawati-2	S	S	S	R	R	R	R	II
8	Umiam	S	S	S	R	R	R	R	II
9	Nagaland	S	S	S	R	R	R	R	II
10	Amrawati	R	R	S	S	R	R	R	III
11	JBP	R	R	S	S	R	R	R	III
12	Palampur	R	R	R	R	R	S	S	IV
13	Ugar Khurd	S	S	S	S	S	R	R	V
14	Dharwad-1	S	S	S	S	S	S	R	V
15	Raipur-1	S	S	R	R	R	R	R	VI

***Pathotypes**

2.3.2.4. Molecular analysis of *Colletotrichum truncatum*

Seven isolates of *Colletotrichum truncatum* were collected from different regions of India [Jabalpur, Dhar, Palampur, Col A, Amravati, U 335 and C.Gl.A]. Genomic DNA was isolated and PCR amplified ITS region was sequenced and used for multiple sequence alignment and phylogenetic studies. ITS region was used for BLASTN analysis and related ITS sequences of *Colletotrichum* sp. were obtained from NCBI. DNA sequence variations were observed between various isolates. Phylogenetic tree was constructed based on the variable ITS region from Indian isolates and compared with

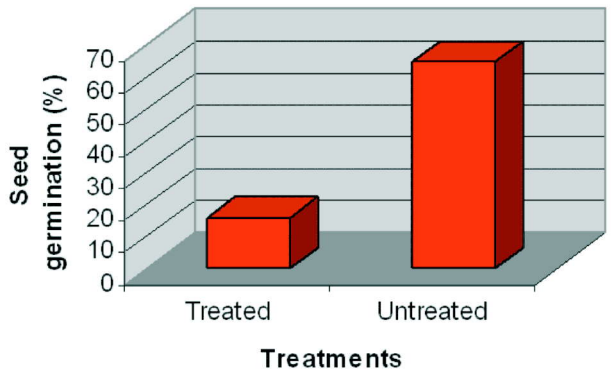

Fig. 17 : Effects of disease infection on seed germination

the other *Colletotrichum* species. Two major groups were formed and all the *Colletotrichum truncatum* isolates from Indian origin clustered in clade 1. Isolate obtained from Amravati showed sequence variation in ITS region and it separates from other Indian isolates of *Colletotrichum truncatum.*

2.3.2.5. Effect of disease on Seed germination

Inoculated and un-inoculated seed samples were used to determine the seed germination. The un-inoculated seeds showed 65% germination, whereas inoculated seeds only 16% thus, pathogen inoculation in seeds significantly reduced seed germination (Fig 17)

2.3.2.6. Yield loss assessment

A field experiment was conducted with variety NRC 7 to find out the losses caused by the pod/stem blight caused by *C. truncatum*. Seeds were treated with a mixture of caboxin + thiram @3 g /kg seed followed by two sprays of Benlate (Benomyl) 50WP @ 0.2% at 25 and 45 DAS. The yield per plot and disease incidence was recorded and the yield loss was compared with control plots. The data revealed that there was 3.9 per cent disease incidence as compared to 12.5 % in control. The disease has caused 64% yield loss in field conditions (Fig 18)

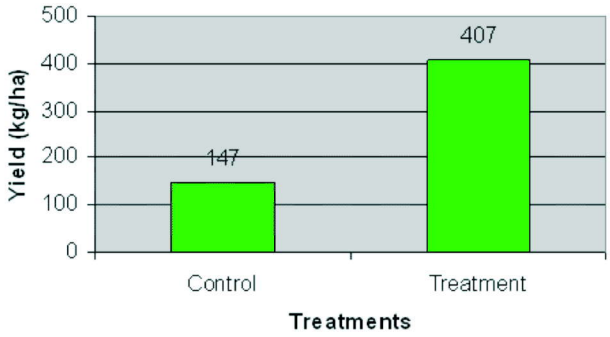

Fig.18 : Yield loss due to stem blight caused by *C. truncatum*

2.3.2.7. Management of stem/pod blight :

A field experiments was conducted in randomized design with three replicates using soybean variety NRC 7 under natural field conditions. A conidial spray was done at R2 stage to create the disease pressure. An untreated and unsprayed control was also 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. As compared to control all the treatments were effective; however seed treatment (St) with either fungicide or bioagents + spraying of Benlate at 25 and 45 DAS produced minimum disease incidence (T4 and T8) followed by St + spraying of thiophanate methyl (T3 and T7) (Table 28)

Table 29 : Effectiveness of various treatments for management of stem/pod blight

SNo	Treatment	Emergence (%)	Mortality (%)*	No of filled pods/ plant	No. of unfilled pods/ plant	PDI	Seed Index	Yield (kg/ha)	Yield increase over control
1	Untreated control	47.9	23.6	15.8	9.3	12.5	8.30	147	-
2	St with carboxin 37%+thiram 37% @ 0.3%+ spray of kasuga+coc @0.3%	65.21	15.2	21.7	3.2	7.0	9.85	252	71.4
3	St with carboxin 37%+thiram 37% @ 0.3%+spray of thiophanate methyl@0.2%	70.0	12.7	21.4	6.2	4.4	9.80	329	123.8
4	St with carboxin 37%+thiram 37% @ 0.3%+spray of benlate @0.2%	65.5	12.6	22.7	3.7	3.63	10.28	406	176.1
5	St with carboxin	57.5	16.4	16.0	3.1	13.18	9.25	253	72.1
6	St with TV @0.5%+spray of Tv @0.3%	50.0	22.6	16.5	8.2	11.8	8.72	169	14.9

7	St with TV @0.5%+spray of thiophanate methyl@0.2%	64.7	15.4	19.2	5.8	5.1	10.30	248	68.7
8	St with TV @0.5%+spray of benlate @0.2%	66.5	17.2	23.7	6.5	3.9	10.50	260	76.8
9	St with TV @0.5%+spray spray of kasuga+coc @0.3%	66.2	16.7	22.7	4.4	7.3	9.48	248	68.7
10	St with Tv @ 0.5%+Maize intercropping (4:2)	58.4	17.3	15.4	6.8	14.8	8.65	258	75.5
	CD at 5%	7.10	2.59	2.77	1.83	-	0.73	0.43	-

2.3.4. Studies on economically important plant parasitic nematodes associated with soybean cultivation

2.3.4.1. Cyst nematodes associated with soybean cultivation

Soil and root samples were collected from different locations of soybean cultivation with the help of AICRP on Soybean during *Kharif* 2015. Out of 24 samples received from 9 states, the samples from Ugarkhurd, Raipur, Pantnagar, Sehore, Coimbatore, Amravati and Kota yielded cyst nematodes. The highest cyst nematode population of 41 cysts/100 g soil was observed in sample from Coimbatore. The cysts isolated from all these locations were preliminarily identified to be *Heterodera cajani* on the basis of morphological characters

2.3.4.2. Varieties resistant to Reniform Nematode, *Rotylechulus reniformis*

Reniform nematode *(Rotylenchulus reniformis)* is the most prevalent plant parasitic nematode in the soybean growing areas of India. A total of 12 commonly cultivated soybean varieties namely, JS-9560, JS-335, JS-9305, JS-9752, JS-2029, JS-2034, PS-1225, NRC-37, MAUS-158, Hardee, Punjab-1 and Improved Pelican were screened for resistance/ susceptibility to reniform nematode under microcosm conditions. Among these varieties, PS-1225 was found to be the most resistant with RI (Reproductive Index = final population/initial population) value of 2, followed by Punjab-1 (RI: 4), Improved Pelican (RI: 5), NRC-37 (RI: 8), JS-9305 (RI: 8), JS-9560 (RI: 10), JS-2034 (RI: 12), Hardee (RI: 21), MAUS-158 (RI: 22), JS-335 (RI: 24) and JS-2029 (RI: 48) in the descending order of their resistance. The variety JS-9752 was found to be the most susceptible with RI value of 54

2.3.4.3. Varieties resistant to Cyst nematode *(Heterodera cajani)*

Heterodera cajani is the most economically important plant parasitic nematode in the soybean growing areas of India. A total of 20 commonly cultivated soybean varieties namely, JS-9560, JS-335, JS-9305, JS-9752, JS-2029, JS-2034, JS-7105, JS-2069, NRC-37, NRC-7, NRC-94, Khsb-2, Hardee, Punjab-1, MACS-57, Monetta, Birsa Soya-1, Bragg, Kalitur and Improved Pelican were screened for resistance/susceptibility to *H. cajani* under field conditions. Among these varieties, JS-2069 was found to be the most resistant with lowest final nematode population of 30 cysts in 100 g soil, followed by JS-9560 (33 cysts), Birsa Soya-1 (34 cysts) and Bragg (34 cysts). The varieties Punjab-1 and JS-2034 were found to be the most susceptible with highest final nematode population of 73 and 69 cysts respectively in 100 g soil.

2.3.4.4. Soil texture and population of Cyst nematode *(Heterodera cajani)*

The present study was initiated to ascertain the development of *H. cajani* on soybean in different soil textures under microcosm conditions. Different levels of sand (0 %, 25 %, 50 % and 75 %) was added to the natural soil collected from Research farm, Indian Institute of Soybean Research, Indore, to obtain four different textural classes namely, clay, clay loam, sandy clay loam and sandy loam. The number of cysts and juvenile population in different treatments were observed after 60 days of inoculation. Maximum population of 219 cysts/100g soil was observed in sandy loan soil followed by 203 cysts/100 g in clay and 187 cysts/100 g in sandy clay loam soils. However, the lowest cyst population of 181 cysts/100 g was recorded in clay loam soil.

2.3.4.5. Organic and inorganic management practices on cyst nematode population in soybean based cropping system

Soil samples were collected from the agronomy–microbiology combined experimental field on 'effect of organic and inorganic management on productivity of soybean based cropping system' after the harvest of soybean crop during *Kharif* 2015, 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 15 cysts/100 g soil followed by organic treated fields of Soybean-Wheat cropping system (18 cyst/100 g soil). The highest nematode population of 25 cysts/100 g soil was recorded in the fields of Soybean-Wheat cropping system with inorganic fertilizer application

2.4. Externally funded Projects

2.4.1. Central Sector Scheme for Protection of Plant Variety and Farmers' Right Authority (DUS Testing)

All the released and notified soybean varieties (102 varieties) and 71 collections from farmers' field of Madhya Pradesh were maintained and characterized as per Guidelines of "Distinctiveness, Uniformity and Stability Testing in Soybean" during *Kharif* 2015. One new variety and two farmer's varieties were tested for DUS characteristics at IISR, Indore; UAS, Dharwad and VPKAS, Almora during *Kharif* 2015. Twenty one soybean varieties had been protected till date under PPV&FR Act-2001. During 2015-16 seven varieties namely JS 20-29, JS 20-34, MAUS-162, MACS 1188, Pratap Soya 45 (RKS 45), Pratap Soya-2 (RKS-18) and RAUS-5 (Pratap Soya-1) have been protected

Table 29 : List of Soybean Varieties Protected Under PPV & FRA (2001) during 2015-16

S No.	Variety	Notification no. and date	PPV&FRA Registration no.	Centre of development	Area of adaptation	Breeders and associates
1	MAUS 162	S. O. 1919 (E) 30.07.2014	244/2015	VNMKVV Parbhani	Marathwada region of Maharashtra	Dr. K.S. Baig, Dr. P.R. Khapre, Dr. I.A. Singh Madrap, Dr. A.R. Singh
2	MACS	S.O. 1188 19/9/2013	245/2015 2817 (E)	MACS's ARI, Pune	Southern Zone	Dr. Philips Varghese, Dr. S.P. Taware, Dr. G.B. Halvankar,
3	JS 20-29	S.O. 1146(E) 24.04.2014	246/2015	JNKVV, Jabalpur	Central Zone	Dr. A.N. Shrivasrava, Dr. M.K. Shrivastava, Dr. R.K. Verma Dr. D.K. Mishra
4	JS 20-34	S.O. 1146(E) 24.04.2014	247/2015	JNKVV, Jabalpur	Central Zone	Dr. A.N. Shrivastava, Dr. M.K. Shrivasrava, Dr. R.K. Verma, Dr. D.K. Mishra
5	RKS 45	S.O. 2815 19.09.2013	248/2015	Agriculture University, Kota.	Rajasthan	Dr. Mashiat Ali, Dr. Rajesh Mahawar
6	RKS 18	SO. 122(E) 6/2/07	249/2015	Agriculture University Kota.	Southern & North Zone	Dr. Mashiat Ali, Dr. Pratap Singh,
7	RAUS 5	1703(E) 5.10.07	250/2015	Agriculture Raj.	North Zone	Dr. Mashiat Ali

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

Under this project, 200 lines of F5 interspecific lines derived from cross JS335 x G. soja were advanced at IISR Indore along withBC1F2 *(Glycine soja* x JS9560 and *Glycine soja* x NRC86), BC3F2 (JS335 x *G. soja*) and BC1F5 (JS335 x *G. soja*) populations. Two BC2F4 YMV resistant families derived from JS335 x *G. soja* (based on Ludhiana screening data) were planted under poly house and crossed back to recurrent parent JS335. The BC3F1 seeds from this population will be further used as donor source for YMV resistance breeding

2.4.3. RNA interference (RNAi) and Virus Induced Gene Silencing (VIGS) approaches to Enhance Drought and Heat Stress Tolerance in Soybean

(Collaborative project with National Institute for Abiotic Stress management, Malegaon, Maharashtra and University of Delhi)

The molecular mechanisms that are involved in drought stress tolerance remain unclear in soybean. In this project, the genes which play important role in enhancing drought tolerance are being studied. Soybean genome database was used to search for the gene families involved in abiotic stresses and drought resistance. Selected gene families were identified and their comparative analysis was performed. Molecular studies have been initiated to identify function of these genes using RNAi and VIGS approaches

2.4.4. Alleviation of moisture-deficit stress in soybean by application of endophytic bacteria

The objectives of this project involve identification of candidate endophytic bacteria of soybean (from drought tolerant lines) for alleviation of moisture-deficit stress and to understand the underlying mechanism (s). Further, to scale up production of identified endophyte(s), and developing suitable formulation, delivery system(s) including multilocation evaluations

2.4.5. Marker assisted elimination of lipoxygenase 2 *(lox 2)* gene from Kunitz trypsin inhibitor gene free soybean lines

It is a DBT funded collaborative project that aims at elimination lipoxygenase 2 *(lox2)* a principal contributor to off-flavour from Kunitz trypsin inhibitor (KTi) free genotypes already developed in this institute

2.4.6. Contract Research Projects

a) Bio-efficacy of Spinetoram 60 g/L w/v (5.66 % w/w) + Mthoxyfenozide 300g/L w/v (28.3 % w/w) SC against lepidopteran insect pests in Soybean" (sponsored by M/s Dow Agro Sciences)

b) Bio-efficacy of RDS63 20% w/w SC (Dicloromezotiaz) against lepidopteran insects *(Chrysodeixis acuta*, *Gesonia gamma*, *Spodoptera litura* and *Helicoverpa armigera*) along with crop safety (sponsored by M/s DuPont India Ltd.) were conducted

3. TECHNOLOGY TRANSFER

3.1 Organization of Agricultural Fair cum-Exhibition

The institute has successfully organized Agricultural Fair-cum-Exhibition at its campus on 25th Aug 2015 with the financial support from Department of Agricuture and Cooperation, Ministry of Agriculture, Government of India. Nearly 1000 progressive farmers and farm women from Madhya Pradesh, Maharashtra, Rajasthan and Gujarat participated in this one day event

Farmers' Fair-cum-Exhibition on Soybean at ICAR-IISR on 25th August 2015

FLD on Soybean under Tribal Sub-Plan

3.2 Participation in Agricultural Exhibitions :

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

No	Day	Event	Organized by	Venue
1	25-27 May, 2015	*Krishi Vikas* 2015	Confederation of Indian Industries	Dashahara Maidan, Indore
2	13-15 Oct, 2015	*Jan Suchana Abhiyan*	Press Information Bureau, Ministry of I&B, Indore	Sonkucchh, Dist-Dewas, M.P.
3	3 Dec, 2015	*Krishi Pradarshini*	Deptt. of Agriculture, Govt of MP	ICAR-Indian Institute of Soil Science, Bhopal
4	19-21 March, 2016	*Krishi Unnati Mela*	Confederation of Indian Industries	ICAR-Indian Agricultural Research Institute, New Delhi

3.2 (a) ICAR-IISR Participation in *Krishi Pradarshini*

3.2 (b) ICAR-IISR Participation in *Krishi Unnati Mela*

3.3 *Mera Gaon Mera Gaurav*

Under this scheme, six team of scientists have been constituted for establishing and maintaining close contact with farmers. Each team has selected five villages thus establishing contact with 30 villages on regular basis for inroads of technological information among the farmers. The baseline survey of these villages has also been conducted to know the cropping systems, general problems and other relevant information

3.3 (a) *Mera gaon & Mera gaurav* Farmer-Scientists Interaction

3.3 (b) *Mera gaon & Mera gaurav* Farmer-Scientists Interaction

3.3 (c) ICAR-IISR Participation in Field Day Under *Mera gaon & Mera gaurav*

3.3 (d) ***Mera gaon & Mera gaurav***
Farmer-Scientists Interaction

3.4. Frontline demonstrations

Twenty Frontline Demonstrations were conducted on Improved Soybean Production Technology in Village- Kogawa, Dist-West Nimar. Similarly, the ICAR-IISR has adopted village Medapani (Block Khalwa, Dist-Khandwa) during the year and conducted 250 frontline demonstrations on farmers' field. In 20 frontline demonstrations with newly released varieties viz., JS 20 29, JS 20 34, NRC all 86, JS 95 60 and JS 97 52 were laid out in the Village-Kogaon district West Nimar. All the inputs under improved production technologies were supplied to the farmers for 0.4 ha. The improved production technology was compared with farmer's practice. The adoption of improved production technology increased the soybean yield to the tune of 84.99% as compared to farmer's practice (678 kg/ha) which resulted in additional returns Rs. 19536/ha at the additional expenditure of Rs. 2396/ha only. The estimated yield gap II was 543 kg/ha

4. TRAININGS

4.1 Trainers' Training Programmes

4.1.1 Model Training Course (MTC)

Model Training Course on "Strategies for Increasing Soybean Productivity Through Integrated Approaches" organized during September 7-14, 2015. The participants included 22 officers from state department of agriculture belonging to six states viz. Madhya Pradesh, Maharashtra, Rajasthan, Haryana, Chhatisgarh and Punjab

4.1.2. Other Training Programmes

The institute organized two trainers' training programmes on Improved Soybean Production Technology involving 97 field level officers of Solidaridad, a NGO engaged in promoting quality soybean production during *Kharif* 2015

4.2 Farmers' Training Programmes

4.2.1. Farmers' Training Programmes on Improved Soybean Production Technology

During this year, 84 Farmers' Training Programmes of day long duration were organized with the cumulative participation of 3198 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

4.2.2. Women's Training Programme on Processing and Utilization of Soybean

Thirty three training programmes on "Processing and Utilization of Soybean for Food Uses at household level" were organized with the participation of 894 women belonging Madhya Pradesh and Rajasthan respectively

4.3. Workshops : A two day Review workshop was organized at ICAR-IISR for the scientists belonging to *Krishi Vigyan Kendras* located in Madhya Pradesh, Chhattisgarh & Orissa in association with ATARI, Zone VII, Jabalpur during 22-23 April 2015. 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

4.4. Soybean Germplasm Day and Hands on Training on Conventional and Molecular Soybean Breeding

A three day "Germplasm Day and Hands on Training on Conventional and Molecular Soybean Breeding" was organized for AICRP on Soybean Breeders at ICAR-Indian Institute of Soybean Research, Indore from September 1 – 3, 2015. Thirty five scientists including soybean breeders from AICRPS Centres across the country and Scientist from ICAR-IISR participated in the event at the Directorate. Dr. A.N. Sharma, Principal Investigator, AICRPS ICAR-IISR delivered the welcome address. Hon'ble chief guest of this programme, Dr. S.P. Tiwari, Ex-DDG (Edn.) urged soybean breeders to exploit the available useful genetic resource at ICAR-IISR, Indore. Dr. V.S. Bhatia Director, ICAR-IISR, Indore outlined the different research activities being taken up under various research projects to the chief guest and emphasized the need of germplasm collection under climate change scenario to the participating breeders and ICAR-IISR scientists. Dr. S.M. Husain, Principal Scientist & Head, Crop Improvement elaborated on the importance

training programme. Dr. G.K. Satpute, Sr. Scientist and Principal Investigator, Germplasm Project facilitated the field visit and also apprised the guests and visiting scientist with soybean germplasm holdings, PGR activities and its utilization status in the country. From second day onwards, hands on training on various conventional (hybridization technique) and molecular breeding aspects of soybean improvement was extended by Scientists Dr. Shivakumar M., Dr. G. Kumawat, Dr. Mamta Arya, and Dr. M. Ratnaparkhe. Lectures on relevant topics were delivered by Principal Scientists Dr. Sanjay Gupta, Dr. Anita Rani and Scientist, Dr. G. Kumawat and Dr. Shivakumar M

4.4 (a) Soybean Germplasm Day and Hands on Training on Conventional and Molecular Soybean Breeding

4.4 (b) Inauguration of Germplasm Day and Training on Conventional and Molecular Soybean Breeding

4.4 (c) Field Visit of Dr. S.P. Tiwari (Ex. DDG, CS) on Germplasm Day

5. AWARDS AND RECOGNITIONS

5. 1. Awards to Institution

Nil

5. 2. Award to Individuals

• **Dr. Vineet Kumar**, Principal Scientist (Biochemistry) and Dr Anita Rani, Principal Scientist (Plant Breeding) were jointly awarded Department of Biotechnology (DBT) sponsored 'Biotech Product And Process Development and Commercialization Award- 2015', during Technology Day Function on 11th May 2015 at Vigyan Bhawan, New Delhi

• **Dr. Vineet Kumar**, Principal Scientist (Biochemistry) has been nominated on the "Scientific panel of Cereals, Pulses and Legumes and their Products" of Food safety and Standards Authority of India (FSSAI)

• **Dr. M.P Sharma**, Principal Scientist (Microbiology), secured travel award from SERB, DST, New Delhi, MPCST, Bhopal and CICS, Chennai and participated in 8th International Symbiosis Congress held in University of Lisbon, Lisbon (Portugal) from July 12-18, 2015

• **Dr. M.P Sharma**, was nominated as expert member of project approval committee for 3 years by Department of Science and Technology, Government of Madhya Pradesh, to review the project and other research activities of MP Biotechnology Council, Bhopal

• **Mr. Avinash Kalanke** (UDC) was conferred with cash award under Cash Award Scheme for Administrative/Technical/Supporting category employees of ICAR research institutes during ICAR Foundation Day award ceremony on 25th July, 2015

• **Mr. Prahlad Singh** (SSS) was conferred with Certificate of Distinction under Cash Award Scheme for Administrative/Technical/Supporting category employees of ICAR research institutes during ICAR Foundation Day award ceremony on 25th July, 2015

• **Shri S.K. Verma**, Technical Officer and **Dr. B.U. Dupare**, Principal Scientist (Agricultural Extension) received Third Prize for Best Hindi Article which was conferred upon by the Honorable Shri Pranab Mukherjee, the President of India at *Rashtrapati Bhawan* on the occasion of *Hindi Diwas* celebration on 14th Sep, 2015

• **Dr. Ramesh SV**, Scientist (Biotechnology), was conferred Young Plant Biotechnologist Award by Association for the Advancement of Biodiversity Science (AABS), in an International symposium on Biodiversity, Agriculture, Environment and Forestry held at Ooty, Tamilnadu from Dec 11-12, 2015

• **Dr. Kuchlan P.**, awarded Best poster presentation for the research paper "Efficient application of *Trichoderma Viride* on soybean seed using thin layer polymer coating" authored by Kuchlan P., Kuchlan, M.K., Husain S.M. and. Ansari M. M at National conference on Global research initiatives for sustainable agriculture & allied sciences12-13th December,2015 held at Gwalior

6. LINKAGES AND COLLABORATION

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

International

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

National

1.	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.
2.	ICAR-National Bureau of Plant Genetic Resources, New Delhi
3.	ICAR-Indian Institute of Oilseeds Research, Hyderabad
4.	ICAR-Central Research Institute for Dryland Agriculture, Hyderabad
5.	ICAR-Indian Institute of Pulses Research. Kanpur
6.	ICAR-Central Institute of Agricultural Engineering, Bhopal
7.	ICAR-National Research Centre for Plant Biotechnology, New Delhi
8.	ICAR-National Reserch Centre for DNA Finger Printing, New Delhi
9.	Directorate of Oilseed Research & Development, Hyderabad
10.	ICAR-Indian Agricultural Research Institute, New Delhi
11.	ICAR-National Academy of Agricultural Research Management, Hyderabad
12.	National Bank for Agriculture and Rural Development
13.	National Fertilizer Limited
14.	Agharkar Research Institute, Pune
15.	Indian Institute of Technology, Indore
16.	ICAR-National Institute of Abiotic Stress Management, Baramathi, Maharashtra
17.	ICAR-Directorate of Groundnut Research, Junagadh, Gujarat
18.	University of Delhi, New Delhi

Regional

1.	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.
2.	NGOs like SOPA, OILFED
3.	State Cooperative Development Banks of respective States
4.	State Seed Corporation
5.	Department of Seed Certification

7. INTELLECTUAL PROPERTY MANANAGEMENT AND TECHNOLOGY TRANSFER/COMMERCIALIZATION

1. The Institute issued 03 non-exclusive license and singed MOA for fabrication of nine agriculture implements *viz*. BBF machine, Furrow irrigated raised bed system planter / drill, Sweep seed drill machine, Subsoiler machine, BBF planter, Soybean seed planter, Ridge fertilizer drill cum seed planter, Soybean seed drill cum planter (IISR two in one) and Single ridge seed planter to M/s R.B. Agro Industries Rau, Indore (M.P), M/s SKB Agrotech Private Limited Indore (M.P.), M/s Prabhat Krishi Yantra Pvt. Ltd. Sehore (M.P.)

2. Submitted a proposal of seven soybean extant varieties viz. VL Soya 59, VL Soya 63, VL Soya 65, SL-688, SL 744, NRC 86 (Ahilya 6) and SL525 through ICAR-NBPGR, to PPV&FR Authority, for registration

3. The Institute has earned an amount of Rs 3, 42,370 as royalty for the commercialization of technologies during 2015-16

4. To encourage innovation in research, the royalty generated from the commercialization of specialty soybeans (KTI-free and high oleic acid lines) was distributed amongst the innovators and team members

5. To monitor the fabrication of commercialized agricultural implements (licensed under MOA) and their royalty accrued on number of machines fabricated and sold, a visit was made by ITMU members on 17/12/2015 to two fabrication units located in and around Indore (M/s New Patidar Iron Works, Rau, Indore and M/s RB Agro industries, City Centre, MG road, Indore)

Training

1. Mr. Yogesh Sohani, RA attend training program on "Patent filing, Processing Patent Drafting" at RGNIIPM, Nagpur (Maharashtra) from 01/02/2016 to 05/02/2016

Composition of Institute Technology Management Committee, (ITMC)

- Dr. V.S. Bhatia, Director (Chairman)
- Dr. M.M. Ansari, Principal Scientist (Member)
- Dr. P.C. Bargale, Principal Scientist & Head-ICAR-CIAE, Bhopal (External Member)
- Dr. S.D. Billore, Principal Scientist (Member)
- Dr. M.P. Sharma, Principal Scientist (Member Secretary)

Institute Technology Management Unit, (ITMU)

- Dr. M. P. Sharma, Principal Scientist- Nodal Officer
- Dr S.M. Husain, Principal Scientist- Member
- Dr. A.N. Sharma, Principal Scientist- Member
- Dr. M.K. Kuchlan, Scientist- Member Secretary
- Finance & Accounts Officer-Member
- Administrative Officer-Member

Fig. 7.1a : Single bottom BBF machine for Low HP tractors (30 HP to 40 HP)

Fig. 7.1b : Ridge fertilizer drill cum seed planter (Inclined plate type)

8. ALL INDIA COORDINATED RESEARCH PROJECT ON SOYBEAN

Since 1987 All India Coordinated Research Project on Soybean (AICRP on Soybean) is an integral part of the Indian Institute of Soybean though established in 1967 but subsequently it was reorganized in manpower, coordinating centers and budget in each five year plans. Presently, It is comprising of 22 regular centers (8 main center 14 sub-center) and 14 need based testing center, located in the states of Andhra Pradesh, Assam, Chhattisgarh, Bihar, Himachal Pradesh, Haryana, Jharkhand, Karnataka, MP Maharashtra, Meghalaya, Manipur, Nagaland, Orissa, Gujarat, Punjab, Rajasthan, Tamil Nadu, Uttarakhand and U.P. The Objective of AICRP on Soybean is to coordinate, monitor and guide the research activities on soybean at national level with the mandate of evaluation of soybean genetics resources, development of location specific high yielding varieties with other desirable traits and improved agronomical practices, maintenance of genetic purity and production of breeder seed, refinement and validation of integrated management of nutrients, insect pests, diseases, water and weeds, basic studies on physiological and molecular aspects and value addition in soybean and technology transfer through demonstration and trainings

8.1. XLVI Annual Group Meeting of AICRP on Soybean

XLVI Annual Group meeting of All India Coordinated Research Project on Soybean held at UAS, Dharwad. The AGM of AICRPS was organized jointly by ICAR-Indian Institute of Soybean Research, Indore and University of Agricultural Sciences, Dharwad during 5-7 April 2016. The AGM was inaugurated by Prof. D.P. Biradar, H'ble Vice Chancellor, UAS, Dharwad, with Dr. B.B. Singh, Asstt. Director General (O&P), ICAR, New Delhi. Prof. Biradar in his inaugural speech called upon soybean Scientists to address the emerging problems in soybean cultivation, particularly the issues related climate change. He assured to share the facilities available with the University. Dr. B.B. Singh stressed upon more commitment and sincerity of soybean scientists in executing research work and proper documentation. He categorically pointed out that research grants would be released based on the performances of the coordinating centres. During the AGM, research results of Plant Breeding, Agronomy, Entomology, Plant Pathology and Microbiology were presented by respective Principal Investigators and technical programmes for Kharif 2016 were formulated. A tentative target of 16645 q of breeder seed production of 31 soybean varieties was set for *kharif* 2016

The Varietal Identification Committee under the Chairmanship of Dr. B.B. Singh, Assistant Director General (O&P), ICAR scrutinized eleven proposals and identified six soybean varieties. Based on yield, maturity period, resistance against major insects and diseases, six soybean varieties were identified for different zones: MACS 1407 and RKS 113 for North Eastern zone, DSb 23-2 and KDS 726 for Southern zone, RVS 2002-4 for Central zone and SL 955 for North Plain zone

To address the issues of water stress demonstration on hydrogel in soybean for yield maximization were laid out at 17 centres with 18 soybean improved varieties. Over all, the application of hydrogel significantly increased soybean yield (0.3 to 22.0%)

In order to identify insect resistant donors, new approach based on digestibility indices was employed for the first time. The

results will be confirmed by repeating the experiments

Evaluation of Bradyrhizobial strains and their interactive effect on soybean varieties under elevated CO_2 and temperature conditions was done under Open Top Chamber (OTC) at Dharwad center. In general, elevated CO_2 levels had positive effect on plant height, chlorophyll content, dehydrogenase activity, nitrogen fixation and phosphate solubilization, whereas elevated temperature (20^0C) hampered microbial activity parameters

8.2. Breeder Seed Production

The indent for soybean breeder seed for 2016, to be produced in 2015 was 16941 q. The indent comprised of 30 varieties. The largest indent was 5352 q for JS 95-60 comprising of 31.6% of total indent. JS 335 (3893 q) and JS 93-05 (2997 q) had a share of 23% and 18% respectively. Against these indents, a target of 16614 q was allotted to different centres. The production data shows a shortage of 59% over indent and 58% over target. The production was severely affected due to drought and excess rain in a very short spell of time which caused drastic reduction in production in major production centres like JNKVV, Jabalpur; RVSKVV, Gwalior; UAS Dharwad and VNMKVV, Parbhani

8.3. Front Line Demonstrations

During the year, 28 centers have conducted a total of 1144 FLDs on farmer's fields against the target of 1100 FLDs in plot of 0.4 ha each. The results revealed that the adoption of research emanated improved soybean production technology led to an increase in yield and net returns to the tune of 34.90 and 63.63% over farmers practice which was achieved by the additional expenditure of only Rs. 4224/ha. The difference in gross returns due to improved technology and farmer's practice was 40.67%. Soybean yield as high as 3047 and 2294 kg/ha could be obtained in some farmer's field under the improved production technology and farmer's practice at Sangli and Pune, respectively. During 2016-17, total 1100 frontline demonstrations have been proposed to be conducted by research centres and NGOs across the country

8.4. Major Highlights

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

1. Based on yield, maturity period, resistance against major insects and diseases, six soybean varieties were identified for different zones : MACS 1407 and RKS 113 for North Eastern zone, DSb 23-2 and KDS 726 for Southern zone, RVS 2002-4 for Central zone and SL 955 for North Plain zone
2. Use of diverse and potential parents in breeding programmes
3. Breeders should attempt more flower buds per cross to obtain desirable number of seeds in F1
4. The centres having meager number of germplasm lines should enrich their collection so as to strengthen their breeding programmes
5. For strengthening the national crossing programme under the AICRP programme, it was decided that all the centers would contribute at least one cross (10-20 F1 seeds). The F1s will be raised at Pune/Bangalore and F2 will be raised at IISR, Indore. The pooled seed from each cross will be given to contributing centres for evaluation and selection
6. Parbhani centre will work on development of soybean varieties suitable for post rainy season
7. ISSR, Indore will test all the varieties in seed

chain for resistance against charcoal rot

8. Imphal centre will collect native soybean varieties and encourage the farmers who are growing native soybean varieties for protection under PPV&FR and award from IISR, Indore
9. Trial on vegetable soybean. The issue was discussed in the house and it was concluded that there are few germplasm lines suitable for vegetable purpose are available in the country. Therefore, it was suggested to first procure germplasm lines from AVRDC, Taiwan, ICAR research centre for north eastern region at Ranchi, ICRISAT and all other possible sources, before starting the breeding programme
10. The issue of inheritance of YMV in cultivated and wild type should be resolved through extra mural project funded to IISR, Indore by ICAR on breeding YMV resistance in varieties
11. Under late sown conditions of Assam, first week of August was recommended as the optimum time of soybean sowing
12. It was decided to create a separate Eastern zone comprising of Ranchi, Raipur, Bhawanipatna and Dholi centers, and delink them with present North Eastern zone. Umiam, Imphal, Medziphema and Biswanath Chari Ali would constitute North Eastern Hill zone
13. On the basis of multi-year and multi-location screening following genotypes were identified as potential sources for resistance / tolerance against insects /diseases (Table 30)

Table 30 : Soybean Genotypes Identified as Potential Sources for Resistance Against Insects /diseases:

Insect/Disease	Lines
Stem fly	DSb 25,Himso 1685, JS 20-89, MACS 1370, MACS 1410, NRC 97
Girdle beetle	MACS1410
Defoliators	DSb 23-2, KDS 726, PS1543
Pod borer	DSb 25
Leaf Miner	MACS 1370
Pest Complex	DS 2708, DSb 23-2, DSb 25, Himso 1685, JS 20-53, JS 2079, JS 20-89, KDS 726, MACS 1370, MACS 1410, NRC 97, SL 983
Charcoal rot	AMS 243, AMS 358, AMS 56, JS 20-29, SL-958, MACS 1336
RAB & YMV	DS 2614, DS 12-13, PS 1042, SL 688

9. PUBLICATIONS

9.1. Research Articles

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9.3. Popular article

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9.6. Newsletter : Nil

9.7. Institute Publications

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- बी.यू. दुपारे एवं एस.डी. बिल्लौरे. (2016). सोयाबीनः समेकित रोग प्रबंधन. विस्तार फोल्डर क्रमांक 15. भा.कृ.अनु.प. :सोयाबीन अनुसंधान निदेशालय प्रकाशन. 2016
- बी.यू. दुपारे एवं एस.डी. बिल्लौरे. (2016). सोयाबीनः स्वास्थ्य लाभ एवं घरेलू उपभोग हेतु प्रसंस्करण तकनीकी. विस्तार फोल्डर क्रमांक 16. भा.कृ.अनु.प. :सोयाबीन अनुसंधान निदेशालय प्रकाशन. 2016

10. ON-GOING PROJECTS

Project No.	Project Title	Name of P.I.	Duration
	CROP IMPROVEMENT		
Mega Project 1	**Soybean genetic resource management- Acquisition, conservation, characterization, documentation and utilization**	Dr. G.K. Satpute	
NRCS 1.1/87	Augmentation, Management and documentation of soybean germplasm	Dr. G.K. Satpute	1987-LT
Mega Project 2	**Genetic amelioration of soybean for yield, wider adaptability, nutrient use efficiency, resistance to biotic and abiotic stresses and improvement in quality of soybean seed**		
NRCS 1.6/92	Genetic improvement for yield and associated characters in soybean	Dr. S.M. Husain	1992-LT
DSR 1.18/10	Breeding soybean for wider adaptability using photoperiod response and growth habits	Dr. Sanjay Gupta	2010-17
DSR 5.6b/09	Breeding for drought resistance / tolerance varieties in soybean	Dr. G.K. Satpute	2008-19
DSR 5.6c/11	Breeding for water logging tolerance in soybean	Dr. Mamta Arya	2011-21
NRCS 1.9/99	Evaluation of germplasm and breeding for resistance to rust, YMV and Rhizoctonia root rot	Dr. R. Ramteke	1999-LT
DSR 1.25/13	Development of multiparent intercross population for quantitative traits improvement in soybean	Dr. M. Shivakumar	2013.20
DSR 1.27/14	Studies on impact of field weathering on application of nano particles to soybean seed to improve germination	Dr. P. Kuchlan Dr. M.K.Kuchlan	2013-17 2014-17
DSR 1.29/14	Breeding for increased nitrogen fixation efficiency in soybean	Dr. Mamta Arya	2014-19

DSR 1.29/15	Quality and shelf life enhancement of selected soy foods through protein polysaccharide interaction	Ms. Neha Pandey	2015-18
Mega Project 3	**Molecular breeding and transgenic approaches for soybean improvement**	Dr. Anita Rani	
DSR 1.23/12	Molecular mapping and genomics-assisted breeding for rust resistance in soybeanm	Dr. Milind B. Ratnaparkhe	2012-17
DSR 1.24/12	Genome diversity of soybean-infecting Begomoviruses in the major soybean cultivating areas in India and RNAi mediated viral gene silencing of Yellow mosaic virus (YMV)	Dr. S.V. Ramesh	2012-16
Mega project 4	**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	2005-LT
DSR 1.24/14	Mapping and pyramiding QTLS for high oleic acid soybean	Dr. Vineet Kumar	2014-21
	CROP PRODUCTION		
Mega Project 5	**Managing the impact of current and future climate variability in soybean**	Dr. S.D. Billore	
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**	Dr. S.D. Billore	
DSR 4.10/09	System efficiency enhancement through resource conservation technologies rotation in soybean based cropping system	Dr. S.D. Billore	2009-20
DSR 4.11/10	Growth, rhizosphere properties, P acquisition and mobilization of intercropped soybean and maize in soil amended with phosphate	Dr. A. Ramesh	2013-16

DSR 6.8/13	Inoculum development of niche AM fungi for application in soybean-based cropping system	Dr. M.P. Sharma	2013-18
DSR 9.8/13	Design, development and validation of tractor operated disc harrow and rotary weeder for soybean	Dr. D.V. Singh	2013-16
Mega Project 7	**Surveillance, forecasting and control strategies for insect pest complex in soybean**	Dr. A.N. Sharma	
DSR 2.10/13	Conservation and enhancement of natural enemies of insect pests of soybean	Dr. A.N. Sharma	2013-16
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	2015-18
DSR 3.12/15	Studies on economically important plant parasitic nematodes associated with soybean cultivation	Dr. K.M. Anes	2015-18
	EXTENSION & ALLIED SCIENCES		
Mega Project 9	**Information digitization, technology dissemination, impact analysis and socioeconomic research for soybean**	Dr. B.U. Dupare	
DSR 8.12./15	Decision support system for identification of soybean insects and their management	Dr. Savita Kolhe	2015-18
DSR 8.13/15	Determinants of farm level soybean yield variability and technical efficiency in Madhya Pradesh	Dr. P. Sharma	2015-18

S.No.	Sponsoring Agency	Project Title	P.I.	Duration
1.	DAC, Government of India	DUST Project	Dr. M. Kuchlan	Since 2002
2.	DST, New Delhi	Soil carbon sequestration through agricultural practices and Mycorrhizal fungi in soybean-based cropping system	Dr. M.P. Sharma	2013-15
3.	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
4.	DBT	Marker assisted elimination of lox2 gene from Kunitz trypsin inhibitor gene free soybean lines	Dr. Vineet Kumar	2015-20
5.	ICAR-EMRP	Exploiting wild gene pool through pre-breeding for introgression of yellow mosaic disease resistance in soybean	Dr. M. Shivakumar	2015-17
6.	ICAR-EMRP	RNA interference and virus induced gene silencing approaches to drought & heat tolerance in soybean	Dr. M.B. Ratnaparkhe	2015-17
7.	ICAR-EMRP	Alleviation of moisture-deficit in soybean by application of endophytic bacteria	Dr. M.P. Sharma	2015-17
8.	ICAR-NICRA	Integrated system modeling involving soybean for impact assessment & identification of adaptation strategies at regional level for near and long term downscaled scenarios	Dr. V.S. Bhatia	2015-17

11. IMPORTANT COMMITTEES

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

10.1 Research Advisory Committee ((w. e. f. 18.9.2013 to 17.9.2016)

Chairman	Dr. V.S. Tomar, Vice Chancellor Jawahar Nehru Krishi Vishwavidyalaya, 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, GV Campus Bangalore-560065 (karnataka)
Member	Dr. O.P. Singh, Ex. Professor (Entomology) JNKVV, Sehore President (R&D), M/s. Dhanua Agritek Ltd. Dhanuka House 861-862, Joshi Road, Karol Bag New Delhi-110005
Member	Dr. Shatrughan Pandey, Principal Scientist (Retd.) D-13A/6, 1st Floor, Platinum Green, Ardee City Colony Sector-52, Gurgaon-122002 (Haryana)
Member	Dr. B.B. Singh, ADG (Oil Seeds & Pulses), ICAR Krishi Bhawan, New Delhi
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. V.S. Bhatia, Director Indian Institute of Soybean Research Khandwa Road, Indore 452001 (M.P.)
Member Secretary	Dr. S.M. Husain, Principal Scientist (Plant Breeding and Genetics) Indian Institute of Soybean Research, Khandwa Road, Indore 452001 (M.P.)

10.2 Institute Management Committee (2015-16)

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. S.D. Kulkarni, Project Director, APPD Central Institute of Agricultural Engineering (CIAE) Nabi Bagh, Bersia Road, Bhopal
Member	Dr. N.P. Singh, Project Coordinator, AICRP on Chickpea Indian Indtitute of Pulses Research, Kanpur
Member	Dr. M. Maheshwari, Principal Scientist & Head Division of Crop Sciences, Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad
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 Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)
Member	Finance and Account Officer Indian Institute of Soil Science (IISS), Bhopal
Member Secretary	Administrative Officer Indian Institute of Soybean Research Khandwa Road, Indore-452 001 (M.P.)

10.3 Institute Joint Staff Council

Chairman	Dr. V.S. Bhatia, Director
	Official Side
Member	Dr. A.N. 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 (T-5)
Member	Shri O.P. Vishvakarma, Tractor Driver (L/V) (T-5)
Member	Shri R.N. Kadam, Junior Clerk

10.4. Other Committees of the Institute (2015-16)

1.	**Official Language Implementation Committee** Director, IISR (Chairman) Dr. A.N. Sharma, Dr. Savita Kolhe Shri S.S. Vasuniya Shri S.K. Pandey Shri S.K. Verma Administrative Officer Finance & Accounts Officer	2.	**Institute Technical Management Unit (ITMU) Committee** Dr. M.P. Sharma (Chairman) Dr. S.M. Husain Dr. A.N. Sharma Finance & Accounts Officer Administrative Officer
3.	**Priority Setting Monitoring and Evaluation (PME) Cell** Dr. S.M. Husain (In Charge) Dr. S.D. Billore Dr. B.U. Dupare Dr. Purushottam Sharma Dr. S.V. Ramesh	4.	**Purchase Advisory Committee** Dr. A.N. Sharma (Chairman) Dr. S.D. Billore Dr. Giriraj Kumawat Dr. A. Ramesh Indenter Finance & Accounts Officer Administrative Officer
5.	**Human Resource Development Committee** Dr. Sanjay Gupta 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. Vineet Kumar Dr. Purshottam Sharma Finance & Accounts Officer Administrative Officer
7.	**Student Affairs Committee & Higher Study Committee** Dr. Vineet Kumar (Chairman) Dr. A. Ramesh Dr. M. Shivakumar	8.	**Higher Education Committee** Dr. S.M. Husain (Chairman) Dr. Anita Rani Dr. Sanjay Gupta Administrative Officer

9.	**Foreign Deputation and Higher Study Committee** Dr. S.M. Husain (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. M.B. Ratnaparkhe Dr. Ramesh S.V. Dr. M. Shivakumar Dr. Surendra Kumar
11.	**Library Advisory Committee** Dr. Anita Rani (Chairman) Dr. D.V. Singh Dr. Purshottam 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 Avinash Kalanke Shri. Vikas Keshari
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 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. Husain	20.	**Women Harassment Complaint Committee** Dr. Savita Kolhe (Chairperson) Dr. Punam Kuchlan Dr. S.V. Ramesh Ku. Priyanka Sawan Third party representative (As when Required) Administrative Officer
21.	**Nodal Scientist, Agro Biodiversity Consortium Project** Dr. S. M. Husain	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 R.M. Patel Shri O.P. Vishvakarma Shri Prahlad Singh Administrative Officer	26.	**Publicity Committee** Dr. B.U. Dupare (Chairman) Dr. Purushottam Sharma 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 Ratnaparkhe Dr. Punam Kuchlan Indenter		
28.	**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	**29.**	**Condemnation and Auction Committee** Dr. Vineet Kumar (Chairman) Dr. Giriraj Kumawat Store officer Shri R.N. Srivastava Finance & Accounts Officer Administrative Officer
30.	**Laboratory In Charges** Dr. M. M. Ansari - Pathology Dr. V. S. Bhatia - Physiology Dr. S. M. Husain - Plant Breeding, Seed Technology, DUS Testing, Germplasm Dr. M.B. Ratnaparkhe- Biotechnology Dr. A. N. Sharma - Entomology Dr. Anita Rani - Transgenics Dr. M. P. Sharma - Microbiology Dr. Vineet Kumar – Biochemistry Dr. S. D. Billore - Agronomy Dr. Savita Kolhe - Computer Dr. B. U. Dupare - Extension	**31.**	**Security Cell** Dr. Giriraj Kumawat Shri O. P. Vishwakarma
		32.	**Physical Verification Committee** Dr. Vineet Kumar (Chairman) Dr. P. Sharma Shri Charan Singh
		33.	**Estate Officer** Shri S.K. Verma
			Record Officer Assistant Administrative Officer
			Vehicle In charge Dr. Nikhlesh Pandya
			Store In charge Shri S.S.Vasuniya
			Tofu Plant In charge Dr. Neha Pandey Shri S.N. Verma

12. PARTICIPATION IN SEMINAR, SYMPOSIUM, CONFERENCE, WORKSHOPS 2015-16

Participant	Event	Venue and date
Dr. Ramesh SV	Workshop on Application of RNAi in Crop Improvement	ICAR-National Research Centre on Plant Biotechnology 05.05.2015
Dr. Kumawat G	Workshop on Monitoring Confined Field Trials of Regulated GE Plants organized by Ministry of Environment, Forest and Climate Change.	NASC, New Delhi 25.05.2015 to 26.05.2016
Dr. Sharma, M.P.	8th International Symbiosis Congress and also visited Research Institute of Organic Agriculture, FiBL, Switzerland and Institute of plant nutrition, Swiss Federal Institute of technology (ETH), Switzerland	University of Lisbon, Lisbon (Portugal) 12.07.2015 to 18.07.2015
Dr. Anes K.M.	First Nodal Officers Workshop on "KRISHI-Research data management portal"	NASC Complex ,IASRI New Delhi 04.08.2015- 05.08.2015
Dr. Savita Kohle	Work shop of Nodal Officers of ICAR "Research Data, Repository for Knowledge management programme"	IASRI, New Delhi 04.08.2015- 05.08.2015.
Dr. Anes, K.M.	First "International Young Scientists Congress, 2015", organized by International Science Congress Association.	DAVV Indore, Madhya Pradesh 08.08.2015-09.08.2015.
Dr. Anes ,K.M.	International Workshop on Statistical Skills, organized by International Science Congress 09.08.2015.Association	Indore, Madhya Pradesh 08.08.2015-
Dr. Sharma, M.P.	Application in Plant Production Systems and Monitoring its Quality Parameters during Popular Series in Biotechnology	CG Bhakta Institute of Biotechnology, Bardoli Surat. 01.10. 2015.

Dr. M. B. Ratnaparkhe	Next Gen Genomics, Biology, Bioinformatics and Technologies (NGBT) Conference	Hyderabad. 01.10. 2015 to 03.10.2015
Dr. Surendra Kumar	11th International Conference on Webome trics, Informaterics, Scientometrics, Science & 16th COLLNET meeting.	Institute of Economic Growth, University of Delhi, Delhi. 26.11.2015 to 28.11.2015
Dr. Ramesh S.V.,	International symposium on Biodiversity, Agriculture, Environment and Forestry.	Ooty, Tamil Nadu, 11.12.2015 to 12.12.2015
Dr. Kuchlan P	National conference on Global research initiatives for sustainable agriculture & allied sciences	Rajmata Vijaya Raje Sindiya Agricultural University, Gwalior. 12.12.2015 to 13.12.2015
Dr. M. B. Ratnaparkhe	International Conference on “Scenario of Biotechnology in 21st Century”	School of Biotechnology, Devi Ahilya University, Indore, 10.03.2016 to 12.03.2016

13. TRAINING AND CAPACITY BUILDING

Category : RMP

S. No.	Name of employee	Designation	Discipline/Section	Name of training attended	Duration (days)	Organizing institution
1.	Dr. V.S. Bhatia	Director	-	Executive management development programme	5 Days	ICAR-NAARM

Category : Scientist

S. No.	Name of employee	Designation	Discipline / Section	Name of training attended	Duration (days)	Organizing institution
1.	Dr. Neha Pandey	Scientist	Food Science and Technology	Instrumentation involved in quality assurance of mild & milk products	21 Days	ICAR-NDRI
2.	Dr. Shivakumar M	Scientist	Plant Genetics	Summer school training on Genomics and phenomics assisted Crop Breeding Principles & Practices	21 Days	ICAR-IARI
3.	Dr Sanjay Gupta	Principal Scientist	Genetics and Cytogenetics	Quantitative techniques for analysis of breeding experiments	6 Days	ICAR-NAARM
4.	Dr K M Anes	Scientist	Ag Nematology	Winter school on Designing modern crop pest combat strategies with nematodes and against nematodes	21 Days	ICAR-IARI

5.	Dr Milind Ratnaparkhe	Senior Scientist	Plant Biotechnology	Training programme on recent advances in next generation sequencing data analysis	11 Days	ICAR-IASRI
6.	Dr Sanjay Gupta	Principal Scientist	Genetics and Cytogenetics	Training Workshop on Competency Development for HRD Nodal Officers of ICAR	3 Days	ICAR-NAARM

Category : Technical

S. No.	Name of employee	Designation	Discipline / Section	Name of training attended	Duration (days)	Organizing institution
1.	Dr Nikhilesh Pandya	Chief Technical Officer	Crop Production	Capacity building programme for technical personnel	12 Days	IIPA, New Delhi
2.	Sri I R Khan	Senior Technical Assistant	Crop Production	Advanced level training in testing, plant analysis and water quality assessment announcement	21 Days	ICAR-IARI
3.	Shri Ramendra Srivastava	Chief Technical Officer	Crop Improvement	Capacity building programme for technical personnel	12 Days	IIPA, New Delhi
4.	Shri S K pandey	Assistant chief technical officer	Crop Improvement	Competency Enhancement Programme for Technical Officers of ICAR.	10 Days	ICAR-NAARM
5.	Shri R N Singh	Assistant chief technical officer	Crop Protection	Competency Enhancement Programme for Technical Officers of ICAR	10 Days	ICAR-NAARM

6.	Shri Yogendra Mohan	Assistant chief technical officer	Crop Improvement	Competency Enhancement Programme for Technical Officers of ICAR	10 Days	ICAR-NAARM

Category : Administrative

S. No.	Name of employee	Designation	Discipline/Section	Name of training attended	Duration (days)	Organizing institution
1.	Dr. Sri A K Maheshwari	FAO	Administration	Management Development Programme on 'Analysis of Financial statements'	3 days	NIFM, Faridabad
2.	Sri A K Maheshwari	FAO	Administration	Management Development Programme on Public Procurement	6 days	NIFM, Faridabad

HRD Fund Allocation and Utilization

Total HRD allocation as per RE (Lakh Rs.) 2015-16 for HRD			Actual Expenditure 2015-16 for HRD	% Utilization 2015-16
Plan	Non Plan	Total		
2.5	-	2.5	2.5	100%

14. DISTINGUISHED VISITORS

The following are the eminent persons visited this Institute during the year 2015-16

S. No.	Name and Affiliation	Date of Visit
1.	Dr. V.S. Tomar, Vice Chancellor, Jawaharlal Nehru Krishi Vishwavidhyalaya (JNKVV) Jabalpur	30.04.2015
2.	Shri Om Prakash Dhankhar, Agriculture Ministry, Govt. of Haryana , Chandigarh	02.08.2015
3.	Dr. R.R. Hanchinal, Chairman, Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), Govt. of India, Ministry of Agriculture & Farmers Welfare	05.09.2015
4.	Shri D.S.Raghu, Member, Commission of Agricultural Costs and Price, Govt. of India, New Delhi	17.09.2015
5.	Dr. J.S. Sandhu, DDG (Crop Science), ICAR, Krishi Bhawan, New Delhi	03.10.2015
6.	Dr. Alagu Sundaram, DDG (Agrl. Engineering), ICAR, Krishi Bhawan, New Delhi	04.11.2015
7.	Dr. B. Venkateswarlu, Vice Chancellor, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKVV), Parbhani	04.11.2015
8.	Dr. R.G. Dani, Vice Chancellor, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV), Akola	04.11.2015

15. PERSONNEL

(As on 31 March 2016)

A.	**Research Management**		
1.	Dr. V.S.Bhatia	Director	
		Scientific	
2.	Dr. S. M. Husain	Principal Scientist	Plant Breeding
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. M. P. Sharma	Principal Scientist	Microbiology
9.	Dr. Vineet Kumar	Principal Scientist	Biochemistry
10.	Dr. B. U. Dupare	Principal Scientist	Agricultural Extension
11.	Er. (Dr.) D. V. Singh	Senior Scientist	Farm Machinery and Power
12.	Dr. A. Ramesh	Senior Scientist	Soil Science
13.	Dr. Savita Kolhe	Senior Scientist	Computer Application
14.	Dr. Y. Sridhar	Senior Scientist	Entomology (Up to 22.4.2015)
15.	Dr. Milind B. Ratnaparkhe	Senior Scientist	Biotechnology
16.	Dr. Gyanesh Satpute	Senior Scientist	Genetics
17.	Dr. Purushottam Sharma	Senior Scientist	Agricultural Economics
18.	Dr. R. K. Ramteke	Scientist (Senior Scale)	Genetics
19.	Dr. Poonam Kuchlan	Scientist (Senior Scale)	Seed Technology
20.	Dr. S. V. Ramesh	Scientist	Biotechnology

21.	Dr. Mrinal K. Kuchlan	Scientist	Seed Technology
22.	Shri Ram Manohar Patel	Scientist	Agril. Statistics
23.	Dr. K. M. Anes	Scientist	Nematology
24.	Dr. Giriraj Kumawat	Scientist	Biotechnology
25.	Dr. Mamta Arya	Scientist	Genetics
26.	Dr. M. Shivakumar	Scientist	Genetics and Plant Breeding
27.	Dr. Neha Pandey	Scientist	Food Technology
C.	**Technical**		
28.	Dr. Surendra Kumar	Chief Documentation Officer	Library & Documentation
29.	Shri R. N. Singh	Chief Technical Officer	Field & Farm
30.	Dr. Nikhlesh Pandya	Chief Technical Officer	Field & Farm
31.	Shri S. K. Pandey	Asst. Chief Technical Officer	Field & Farm
32.	Shri Charan Singh	Asst. Chief Technical Officer	Field & Farm (Upto 31 January 2016)
33.	Dr. V. P. S. Bundela	Asst. Chief Technical Officer	Field & Farm (Farm Manager)
34.	Dr. Yogendra Mohan	Asst. Chief Technical Officer	Field & Farm
35.	Shri S. S. Vasunia	Asst. Chief Technical Officer	Field & Farm
36.	Dr. Sushil Kumar Sharma	Asst. Chief Technical Officer	Field & Farm
37.	Shri R. N. Srivastava	Asst. Chief Technical Officer	Field & Farm
38.	Shri D. N. Baraskar	Senior Technical Officer	Artist & Photograpy

39.	Shri S. K. Verma	Technical Officer	Field & Farm
40.	Shri O. P. Vishwakarma	Technical Officer (L/V)	Tractor Driver
41.	Shri Mahaveer Singh	Senior Technical Assistant	Field & Farm (Upto 31 July 2015)
42.	Shri I. R. Khan	Senior Technical Assistant	Field & Farm
43.	Shri Gorelal Chouhan	Senior Technical Assistant	Field & Farm
44.	Shri R. C. Shakya	Senior Technical Assistant	Field & Farm
45.	Shri Devendra Singh Yadav	Technical Assistant	Field & Farm
46.	Shri Francis Yunis	Technical Assistant (L/V)	Staff Car Driver
47.	Shri Vikas K. Keshari	Technical Assistant	Hindi Translator
48.	Shri Bilbar Singh	Senior Technician (L/V)	Staff Car Driver
49.	Shri Shambhu Nath Verma	Senior Technician	Field & Farm
D.	**Administration and Accounts**		
50.	Shri A. K. Maheshwari	Finance and Account Officer	
51.	Shri Rakesh Dubey	Administrative Officer	w.e.f. 16.10.2015
52.	Shri Ajay Kumar	Assistant Administrative Officer	w.e.f.09.10.2015
53.	Shri S.P.Singh Shri S.P.Singh	PA to Director PS to Director	Upto 12.4.2015 w.e.f.12.04.2015
54.	Shri. Ajay Kumar	Assistant	Upto 08.10.2015
55.	Ku. Priyanka Sawan	Assistant	
56.	Shri. Ravishankar Kumar	Assistant	
57.	Shri Avinash Kalanke	Senior Clerk	
58.	Shri Anil Kumar Carrasco	Senior Clerk	

59. Shri R. N. Kadam	Junior Clerk	
60. Shri Sanjeev Kumar	Duplicating Operator	
Skilled Supporting Staff		
61. Shri Gulab Singh	SSG III	
62. Shri Dhan Singh	SSG III	
63. Shri Roop Singh	SSG II	
64. Shri Nirbhay Singh	SSG II	
65. Shri Bhav Singh	SSG II	
66. Shri Janglia	SSG II	
67. Shri Surla	SSG I	
68. Shri Sur Singh	SSG I	
69. Smt. Prakaswati Sura	SSG I	
70. Shri Balveer Singh	SSG I	
71. Shri Prahlad Singh	SSG I	

16. APPOINTMENTS, PROMOTIONS, TRANSFER, ETC.

16.1. Appointments

S.No.	Name	Post	Date of Joining
1.	Shri Rakesh Dubey	Administrative Officer	16.10.2015

16.2. Promotions

S.No.	Name	Promoted to the Post of	w. e. f.
1.	Shri Ajay Kumar	Asst. Administrative Officer	09.10.2015
2.	Shri R.C.Shakya	Senior Technical Asst.	13.03.2015
3.	Shri G.L.Chouhan	Senior Technical Asst.	26.09.2015

16.3. Deputations/ Selection

Nil

16.4. Appointments

S.No.	Name	From	To	Date of Joining
1.	Dr. Y.Sridhar	DSR, Indore	IIRR, Hyderabad	22.04.2015

16.5. Retirement

1. Shri Mahaveer Singh Sr. Technical Asst., W.E.F. 31st July 2015
2. Shri Charan Singh Asst. Chief Technical Officer, W.E.F.31st January 2016

16.6. Higher education

Nil

16.6. Obituary

Nil

17. INFRASTRUCTURAL DEVELOPMENT (2015-16)

17.1.Works

1. Crossing Block. Rs.4.73.00

17.2 Equipments

The following major equipment costing above Rs. 50, 000 were purchased

1. Refrigerator
2. Seed Treating cum Coating Machine
3. AUTO CLAVE
4. Dry heater block/module
5. 96-Well Plate Vacuum Manifold with universal/vacuum gauge
6. Muffle Furnace (3468 euro)
7. BOD Incubator
8. Electronic Multichannel Pipette 8 Channel
9. TRAY DRYER
10. Ultra Pure Water Purification System
11. Fine weighing balance
12. MS Software
13. Library Software

18. राजभाषा कार्यान्वयन (2015-16)

संवैधानिक प्रावधानों के अनुसार राजभाषा कार्यान्वयन हेतु सरकारी एवं सरकार के अधीनस्थ या संबद्धकार्यालयों , सार्वजनिक उपक्रमों एवं प्रतिष्ठानों में कार्यरत प्रत्येक कर्मचारी प्रतिबद्ध है। उसी संकल्प को व्यवहारिक रुप प्रदान करने हेतु भा.कृ. अनु.परि.-भारतीय सोयाबीन अनुसंधान संस्थान इंदौर में भी विगत वर्षों से इस दिशा में अनेकानेक कदम उठाए। जिनके फलस्वरुप 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 सिद्धहो रहे हैं। इस क्षेत्र में किए जा रहे क्रिया कलापों का संक्षिप्त विवरण निम्नवत् हैं :-

क) प्रोत्साहन योजनाएं : संस्थान में सर्वप्रथम राजभाषा संबंधित गतिविधियों के प्रचार प्रसार हेतु प्रोत्साहन योजनाओं पर ध्यानाकर्षित किया गया। चूँकि यह ''क'' स्थित क्षेत्र है फिर भी कर्मचारियों, अधिकारियों एवं वैज्ञानिकों में हिन्दी सम्बंधित जागरुकताओं की वृद्धिकरने हेतु समयानुसार प्रोत्साहन योजनाओं का आयोजन किया जाता है, ताकि सभी संवर्गो को हिन्दी में कार्य करने हेतु प्रेरणा मिलता रहे। अतेव प्रोत्साहन योजना के माध्यम से इस कार्य में अत्याधिक सार्थकता प्रदान करने की कोशिश की जा रही है।

ख) प्रशिक्षण : संस्थान में राजभाषा के प्रचार प्रसार हेतु कृषकों एवं प्रशिक्षणार्थियों को प्रशिक्षण संबंधित सारी सामग्रियाँ हिन्दी में भी प्रदान की जा रही है। इस दृष्टिकोण से सम्पूर्ण वर्ष में प्रतियाँ प्रसार बुलेटिन हेतु प्रदान 5000 प्रतियाँ प्रसार फोल्डर हेतु एवं 30000 की गई।

ग) राजभाषा नीति पर जागरुकता कार्यक्रम : उक्त प्रशिक्षणों के अतिरिक्त संस्थान में कर्मचारियों, अधिकारियों एवं वैज्ञानिको हेतु राजभाषा नीति के संवैधानिक प्रावधनों से अवगत कराने तथ इसके प्रति जागरुक करने हेतु समय समय पर राजभाषा नीति विषय पर-विचारों का आदान प्रदान किया जा रहा है।

घ) अनुवा द्विभाषी प्रपत्र : संस्थान में कार्यालयीन कार्य में प्रयुक्त होने वाले विभिन्न पत्रों, प्रपत्रों आदि का अनुवाद कार्यभी प्रगति पर है, जिससे दैनिंदिन के साथ ही प्रायः प्रयुक्त होने वाले सभी पत्रों, प्रपत्रों के द्विभाषी मुद्रित रुप को प्रभावी किया जा सके। यह कार्य राजभाषा क्रियान्वयन की दिशा में स्थाई एवं आधरभूत उपलब्धि है।

ड.) हिन्दी में कार्य हेतु साफ्टवेयर एवं अन्य सुविधाएं : राजभाषा हिन्दी के अ धिकाधिक प्रयोग के साथ कर्मचारियों, अधिकारियों एवं वैज्ञानिकों की सहभागिता में लगातार वृद्धि हेतु समस्त कम्प्यूटरों पर हिन्दी संबंधित साफ्टवेयर को ''यूनिकोड'' भी उपलब्ध कराया गया है, जिसके माध्यम से कर्मचारियों, अधिकारियों एवं वैज्ञानिकों अति सरलता से अपने दैनिंदिन के कार्यों हिन्दी प्रयोग कर सकते हैं।

च) हिन्दी कार्यशालाएं : इसी 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 इकाई के सभी सवेर्गो को आमंत्रित किया जाता है तथा संबंधित विषयानुसार कार्यशालाएं सम्पन्न की जाती है। वर्ष 16-2015 में कार्यशालाओं 04 का आयोजन किया गया, जिसकी सूचि निम्नवत है :

क्र.	दिनांक	विषय	अतिथि वक्ता
1.	16 जून 2015	जनभावना में भाषा का विकास	डॉ.पुष्पेन्द्र दुबे (प्रोफेसर हिन्दी) महाराजा रणजीत सिंह कॉलेज, इन्दौर
2.	16 सितम्बर	हिन्दी भाषा का विस्तार एवं संभावनाएँ	डॉ.राजेन्द्र मिश्र समंवयक भाषा साहित्य पुनःश्चर्या पाठ्यक्रम देवी अहिल्या विश्वविद्यालय, इन्दौर।
3.	30 दिसम्बर 2015	कम्प्यूटर पर हिन्दी का आसान प्रयोग	डॉ.अमरनाथ शर्मा प्रधान वैज्ञानिक एवं प्रभारी अधिकारी राजभाषा, भा.कृ.अनु.प.-भारतीय सोयाबीन अनुसंधान संस्थान, इन्दौर
4.	18 मार्च 2016	कार्यालय में धारा (3)3 के प्रयोग की अनिवार्यता	श्री हरेराम बाजपेयी प्रबंध सम्पादक, वीणा, श्री मध्य भारत हिन्दी साहित्य समिति इन्दौर।

छ) राजभाषा कार्यान्वयन समिति की तिमाही बैठक :

- ✻ प्रथम बैठक : दिनांक 06 जून 2015
- ✻ द्वितीय बैठक : दिनांक 10 अगस्त 2015
- ✻ तृतीय बैठक : दिनांक 15 दिसम्बर 2015
- ✻ चतुर्थ बैठक : दिनांक 15 मार्च 2016

ज) मौलिक लेखन कार्य का प्रादुर्भाव : संस्थान में राजभाषा संबंधी विभिन्न क्रियाकलापों के साथ मौलिक लेखन कार्य को द्रुतगामी आयाम प्रदान करने में श्री श्याम किशोर वर्मा, तकनीकी अधिकारी लेखक एवं डॉयू.दुपारे.बी., वरिष्ठ वैज्ञानिक सह लेखक को उत्कृष्ट लेखन हेतु राजभाषा विभाग, गृह मंत्रालय का प्रथम पुरस्कार महामहिम राष्ट्रपति श्री प्रणव मुखर्जी के करको राष्ट्रपति भवन में प्रदान 2015 सितम्बर 14 कमलों से दिनांक किया गया। श्री श्याम किशोर वर्मा जी को रक्षा अनुसंधान एवं विकास संगठन रक्षा मंत्रालय, दिल्ली द्वारा आयोजित वैज्ञानिक तकनीकी अंर्तराष्ट्रीय राजभाषा सम्मेलन में भाग लेकर शोध-पत्र एवं पोस्टर प्रस्तुतीकरण किए तथा उनके द्वारा लिखित आलेख छः पुस्तकों में बुक चेप्टर के रुप में प्रकाशित किया गया,

जो राजभाषा कार्यान्वयन के क्षेत्र में एक दस्तावेजी कार्य।

झ) हिन्दी में कार्य हेतु यूनीकोड सुविधा : यद्यपि संस्थान के सभी कम्प्यूटर्स पर हिन्दी फान्ट की सुविधा उपलब्ध है, इसके अतिरिक्त संपूर्ण भारत में प्रचलित यूनिकोड फान्ट की भी सुविधा समस्त कम्प्यूटर्स पर उपलब्ध की गई है। इसी श्रृंखला में प्रतिदिन एक शब्द हिन्दी एवं अंग्रेजी को द्विभाषी रुप में के रु प में प्रदर्शित किया जा रहा है ''आज का शब्द'', ताकि कर्मचारियों, अधिकारियों एवं वैज्ञानिकों के हिन्दी शब्द ज्ञान में वृद्धि करने के साथ ही साथ हिन्दी के कार्यालयीन उपयोग में भी सहायता प्रदान कर सके।

राजभाषा कार्यान्वयन के क्षेत्र में भारतीय सोयाबीन अनुसंधान संस्थान की प्रगति आख्या का एक स्वर्णिम झलक आपके समझ प्रस्तुत है। उपरोक्त गतिविधियों पर यदि दृष्टिपात करें तो ज्ञात होता है कि संस्थान में राजभाषा कार्यान्वयन की दिशा में एक सकारात्मक एवं सार्थक कार्य हो रहा है, जो संस्थान में हिन्दी के सुनहरे भविष्य का आभास कराती है।

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation Report in respect of RFD 2014-2015 of RSCs i.e. Institutes

Name of the Division : Crop Science

Name of the Institution : ICAR-Indian Institute of Soybean Research

S. No.	Objective(s)	Weight	Action(s)	Success Indicator(s)	Unit	Weight	Target / Criteria Value					Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for short falls or excessive achievements, if applicable
							Excellent 100%	Very Good 90%	Good 80%	Fair 70%	Poor 60%		Raw Score	Weighted Score		
1	Genetic enhancement and development of improved cultivars	45	Evaluation fo genetic material	i. Breeding and germplasm lines evaluated	No.	4	840	700	560	420	280	710	90.07	3.60	101.4	
				ii. Lines tested under multi location testing	No.	4	144	120	96	72	48	134	95.83	3.83	111.7	
				iii. Lines identified for unique traits	No.	4	17	14	11	8	5	14	90	3.60	100.0	
			Development of improved cultivars	i. Entries contributed for multi-location trial	No.	13	48	40	32	24	16	32	80	10.4	80.0	
				ii. Varieties identified for release	No.	10	3	2	1	0	0	3	100	10	150.0	As three soybean entries performed better than checks, therefore identified for release
			Seed production programme	Breeder seed produced	Tonnes	10	2400	2000	1600	1200	800	927	63.18	6.32	46.4	Major deficit at JNKVV, Jabalpur and

																RVSKVV, Gwalior due to inclement weather
2	Development & identification of appropriate crop production & protection technologies	21	Development of ew n technologies	i. New technologies tested	No.	11	7	6	5	4	3	6	90	9.9	100.0	
				ii. Technologies recommended	No.	10	3	2	1	0	0	2	90	9	100.0	
3	Technology dissemination and Capacity building	14	Demonstration s conducted	Front line demonstrations conducted	No.	8	840	700	560	420	280	700	90	7.2	100.0	
			Farmers/ Extension officials training programmes organized	Trainings organized	No.	6	73	61	49	37	25	73	100	6	119.7	
*	Publication/D ocumentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	No.	3	16	13	10	7	4	22	100	3	169.2	
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Dat e	2	30.06. 2014	02.07. 2014	04.07. 2014	07.0 7.20 14	09.0 7.20 14	30.06.2 014	100	2		
*	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	99.8	100	2		
*	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Dat e	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014	30.4.20 14	100	2		

			Timely submission of Results for 2013-2014	On-time submission	Date	1	May 1 2014	May 2 2014	May 5 2014	May 6 2014	May 7 2014	30.4.2014	100	1		
*	Enhanced Transparency / Improved Service delivery of Ministry/Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	100	100	2		
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1		
*	Administrative Reforms	7	Update organizational strategy t o align with revised priorities	Date	Date	2	Nov.1 2014	Nov.2 2014	Nov.3 2014	Nov. 4 2014	Nov. 5 2014	Nov. 2, 2014	90	1.8		
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC)	% of implementation	%	1	100	90	80	70	60	100	100	1		
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80	100	100	2		

Total Composite Score : 87.65

Rating : Very Good

Actual Scientific Staff in position in the Institute and their research articles published in International and National Journals having NAAS rating 6.00 or more during April 1, 2014-March 31, 2015

Name of the Division: **Crop Science**

Name of the Institute: **ICAR-Indian Institute of Soybean Research**

S.No.	Category of Scientific Staff	Actual Scientific Staff in position (Nos.)	Research articles publications as first /corresponding author (Nos.)	Publication productivity (Number of research articles divided by number of Scientists)
1.	Principal Scientist	09	08	0.89
2.	Senior Scientist	08	04	0.50
3.	Scientist	10	10	1.00
	Total	**27**	**22**	**0.81**