PREFACE

I am highly delighted to present the ICAR-IIOR Annual Report 2015-16, highlighting the significant research achievements and activities of the Institute.

The salient achievements during the period under report include: release of sunflower hybrid, PSH 1962 for Punjab state; release of Alternaria leaf spot and powdery mildew resistant sunflower variety, Phule Bhaskar (SS-0808) for Maharashtra; in rainfed conditions of Tamil Nadu, seed treatment of castor with biophos improved the seed yield and economic returns; under clay loam soils of West Bengal, sunflower crop responded to application of 90:90:40 kg $N:P_2O_5:K_2O$/ha with 48% higher yield and a B:C ratio; release of wilt resistant castor hybrid, GNCH-1 for Gujarat; licensing of Bt-1 WP formulation to control pod borer in pigeon pea; development of genome wide SNP platform in castor for using in marker assisted breeding; mapping populations for wilt and nematode in castor and aphid tolerance in safflower; large scale evaluation in the farmers field of three high oleic safflower varieties under the contract research project; conduct of 2427 frontline demonstrations and 23 trainings on improved technologies of mandate oilseed crops for agricultural officers, extension workers and inputs dealers; voice based advisories on production, protection, harvest and post-harvest technologies apart from weather alerts and market information disseminated to 11237 farmers of 9 districts of Telangana State.

Organization of industry stakeholders meeting to showcase the commercial technologies available with IIOR; MOAs for collaborative research with MANAGE for disseminating improved technologies using ICT tools and NIPHM to initiate research on pesticide residue and management of biotic stresses through bio-resources; distribution of 279 soil health cards to farmers in collaboration with State Agriculture Departments of Karnataka and West Bengal are some of the other activities organized by IIOR.

I place on record my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. S. Ayyappan, Atal Bihari Vajpayee Chair, ICAR & Former Secretary, DARE & Director General, ICAR; Dr. J.S. Sandhu, Dy. Director General (CS); ICAR; Dr. B.B. Singh, Asst. Director General (OP), ICAR for their unstinted guidance and support in executing the mandate of the Institute. I express my gratefulness to the Chairman and Members of the IIOR-Research Advisory Committee for the critical assessment and improving the research programmes. My sincere appreciation goes to Dr. I.Y.L.N. Murthy and team of editors of the IIOR Annual Report and other staff members of the Institute for their efforts and cooperation in bringing out the publication. The contribution of Shri P. Srinivasa Rao, PA for editorial assistance, proof reading and final page setting is thankfully acknowledged.

IIOR, Hyderabad
June 22, 2016

(K.S. VARAPRASAD)
Director

EXECUTIVE SUMMARY

The salient findings of the research activities executed during 2015-16 at the Indian Institute of Oilseeds Research are presented crop-wise hereunder:

CASTOR

Crop Improvement

- A high yielding and wilt resistant hybrid, GNCH-1 developed by Navasari and suitable for late *kharif* or *rabi* season was released for castor growing regions of south and middle Gujarat.
- Two accessions namely RG-1494 (100 g/plant) and RG-1826 (95.5 g/plant) had higher *per se* yield performance than hybrid check, DCH-519 (83.2 g/plant) under natural drought condition.
- Seven accessions namely RG-272, RG-289, RG-373, RG-1582, RG-1667, RG-1759 and RG-1963 having good root traits had relatively low drought susceptibility index (DSI) ranging from 0.12 to 0.98 compared to checks, 48-1 (1.58) and DCH-519 (1.34) with poor root traits.
- Three accessions namely RG-2774, RG-2800 and RG-898 showed tolerance to capsule borer (<25% damage) in a multi-location trial conducted for two consecutive years under infester-row method.
- Seven accessions namely RG-631, RG-1621, RG-2093, RG-2301, RG-2661, RG-3060 and RG-3067 showed high level of resistance to leafhopper (hopper burn grade=0) in a multi-location trial conducted for two consecutive years.
- Seven accessions namely RG-3181, RG-3200, RG-3202, RG-3206, RG-3207, RG-3243 and RG-3257 showed low Botrytis severity (10-16%) under glass house condition using detached spike technique. RG-1060 showed 10% severity of Botrytis at Chintapally, a hot spot area for Botrytis and has been included in the inbred development programme.
- Seven accessions namely RG-3425, RG-3432, RG-3446, RG-155, RG-311, RG-3042 and RG-3070 showed resistance to wilt (0-20% incidence) in wilt sick plots and root tip inoculation technique at three locations (IIOR, SK Nagar, Palem).
- Seven accessions namely RG-392, RG-1834, RG-2035, RG-2719, RG-2722, RG-2746 and RG-2816 showed resistance to Macrophomina root rot (0-20% incidence) in root rot sick plots and stem-tape inoculation technique at Junagadh.
- Two advanced breeding lines CI-1 (DCS-9 x RG-1139) and CI-2 (DPC-9 x RG-1139) showed better resistance to Botrytis compared to check JC-12 in field and polyhouse screening with artificial inoculation of pathogen. These lines also showed delayed incubation period and less sporulation in the detached capsule screening *in vitro* method.
- DCS-107, a CVRDC released variety in 2011 was registered with PPV & FRA (Registration No. 123, Date of Grant 27-04-2015) with an exclusive right to produce,

sell, market, distribute, import, or export for an initial term of six years and further renewable.

- DCH-1720 (DPC-21 x DCS-107) showed yield increase over the checks, GCH-7 (8%), DCH-519 (12%) and DCH-177 (15%). It was resistant to wilt in sick plots of IIOR and SK Nagar, free from root rot in sick plot of Junagadh and resistant to leafhopper (hopper burn grade (0-1) at Yethapur and Palem.
- Thirteen hybrids (CEH-366, 365, 235, 231, 230, 250, 263, 329, 232, 346, 234, 355 and 363) showed higher seed yield (g/plant) (range 100.7-153.5 g) compared to check hybrid, GCH-7 (82 g) in a rainfed trial at IIOR, Hyderabad.
- Five hybrids (CEH-297, 273, 287, 268 and 279) showed increased seed yield (kg/ha) (range 4338-4643 kg) over the check hybrids, GCH-7 (3452 kg) and DCH-519 (3274 kg) in an irrigated trial at Anand.
- A cost-effective SNP genotyping assay based on 'Kompetitive Allele Specific PCR genotyping system (KASP)' a fluorescent endpoint genotyping technology of LGC genomics was developed for 300 SNP loci in castor. This genotyping system is highly robust, rapid, cost effective (~Rs. 10/data point) and will facilitate routine in-house genotyping applications in castor. The system can be extended to other crops as well.
- A linkage map with 1099 SNP loci was developed using a set of 240 recombinant inbred lines (RILs) derived from the cross: JC-12 x 48-1. The map covered 10 linkage groups of castor with the total length of map was 622 cM. Number of markers per linkage group ranged from 67 to 211 with an average inter marker distance of 0.57 cM. This is the first ever high density linkage map of castor, which is a useful resource for molecular breeding and genomics applications in castor.
- A *de novo* transcriptome of castor was generated by 'RNA-seq' using various tissues, which has enriched the transcriptome content of castor from the reported 31,221 gene models to 66,601. Currently, the transcriptome data is being used for deciphering molecular basis of induced systemic resistance (ISR) in castor by Trichoderma.

Crop Production

- In rainfed conditions of Tamil Nadu, seed treatment of castor with biophos @ 600g/kg seed + 60 kg P_2O_5 improved the seed yield (1768 kg/ha) and economic returns (B: C ratio 2.42).
- In clay loam soils under rainfed conditions of Karnataka , foliar application of 0.5% $ZnSO_4$ twice (at 50 and 90 DAS) was effective in realizing higher castor seed yield (12.3 %) with higher profitability (B: C ratio 3.4).
- Under loamy sands, adoption of 150 x 90 cm planting geometry with application of 20 kg K_2O/ha resulted in realizing higher seed yield and economic returns with GCH 7 castor hybrid in Rajasthan and DCH-177 in Haryana.
- Applying FYM for 25% N along with 75% NPK recorded significantly higher seed yield of sorghum (4338 kg/ha) and castor (2266 kg/ha) compared to either N alone or NP or NPK without FYM.
- Significantly higher seed yield was recorded in DCH-519 (2291 kg/ha) closely followed by GCH-7 (2617 kg/ha) and DCH-177 (2456 kg/ha). Among varieties, DCS-107 performed superior (2386 kg/ha) over 48-1 and GC-3.

- Drip-fertigation of *rabi* castor at 0.8 Epan along with supply of full amount of water soluble N and K through fertigation resulted in significantly higher castor seed yield (3786 kg/ha) and oil yield (1712 kg/ha) compared to surface irrigation control.
- Castor + Lucerne (harvested as dual purpose-green fodder followed by seed production) resulted in 50.3% higher net returns than only sole castor crop.
- Sunhemp as green manure in castor gave 20.6% higher net monetary return over sole castor, groundnut + castor as relay crop gave higher net returns (` 64,776/ha) over sole groundnut and relay cropping of castor in Bt cotton resulted in higher net monetary return (44.1%) than only Bt cotton.
- A seed yield of 1.74 t/ha with a B:C ratio of 2.83 was realized under integrated crop management in large plot demonstrations under irrigated condition.

Crop Protection

- Soil infestation method was identified as more appropriate for identification of resistance sources to wilt disease.
- The castor genotypes *viz.*, RG-1916, RG-155, RG-1647, AP-163, Ap-33, Ap-156, Ap-56, Ap-42, Ap-200, Ap-180, Ap-171 were resistant to wilt pathogen isolates of Palem, S. K. Nagar, Hyderabad.
- Six parental/advanced breeding lines *viz*., PVT-11-3, PVT-11-19, DPC-21, DPC-29, PMC-65, PMC -77, DCS-118, DCS 123 and M-57 were resistant at IIOR, Hyderabad.
- The accessions *viz.*, RG 3206 RG 3344, RG 1062, RG-3179, RG-3181, RG-3186, RG-3187, RG-3200, RG-3202, RG-3207, RG-3210, RG-3243, RG-3251, RG-3257, RG-2008 x 2787-P30 were found to be moderately resistant to gray mold under artificial epiphytotic conditions.
- Seed treatment with *T. harzianum* N_2, *T. harzianum* Th4d and *P. fluorescens* Pf 3 found to be effective in management of wilt in castor.
- Seed treatment with carbendazim recorded significantly low wilt incidence (24.4 %) with high seed yield of 1123 kg/h. Seed treatment and soil application of *T. harzianum* Th4d WP also recorded low wilt incidence (26%) and seed yield of 1016 kg/ha whereas in pathogen control the wilt incidence was 60.6% with seed yield of 905 kg/h.
- Seed treatment with combination of biopolymer chitosan and *T. harzianum* Th4d improved seed germination (95%), vigour index (3673) and also limited Fusarium wilt incidence compared to pathogen check.
- Pericarp extracts of two castor land races with pink spiny and non-spiny capsules and the cultivar 48-1 showed inhibition of *Botryotinia ricini* compared to no inhibition by extracts of susceptible cultivar DCH-519.
- *T. harzianum* Th4d and *T. harzianum* ThN2 able to induce systemic resistance against Phytophthora leaf blight recording low disease severity
- Efficacy of DOR Bt-127 powder containing 105µ particles increased through particle size reduction to 559 nm by milling for 60 minutes in a planetary ball mill
- Suspension concentrate formulations of DOR Bt-127 (559 nm) singly and in combination with *Nomuraea rileyi* were most effective against *Spodoptera litura* on castor at Palem, Yethapur and Hyderabad and *Helicoverpa armigera* on sunflower at

Nandyal, Latur and Hyderabad locations and on par with the insecticidal check Profenophos

- Monitoring of *S. litura* by sex pheromone traps showed two peak catches during 36th to 37th MW (3-16 September) and 41st to 42nd MW (8-21 October). Significant positive relation found between egg-masses in castor and current (r=0.91 to 0.93) and previous week (r=0.57 to 0.82) trap catches.
- Among poison baits evaluated against late instar larvae of *S. litura*, wheat bran + sugarcane jaggery + chlorpyriphos 20EC bait was effective and resulted in maximum per cent larval mortality of 43.3 to 56.7% under field conditions.
- In Electroantennogram, female moths of semilooper, spodoptera and capsule borer showed significant hyper sensitive reaction to benzaldehyde (-2.573 to -3.336 mV), phenyl acetaldehyde (-1.518 to -2.221 mV) and 2-phenylethanol (-2.563 to -3.152 mV), respectively. Kairomone blend of phenyl acetaldehyde + 2-phenyl ethanol (1:1 ratio) using water trap was effective in attracting spodoptera and capsule borer moths under field conditions.
- Off-season multiplication of capsule borer was recorded in guava fruits, mango inflorescence and shoot and capsules of perennial and self sown crop of castor.
- Among self-generation populations of RG-2661, RG-43 and RG-3060 screened against leafhopper, none of the plants exhibited hopper burn (Grade 0 on 0-4 scale) and confirmed resistance to leafhopper.
- Among six new castor parental lines screened against leafhopper, two parental lines (DPC-27 and DCS-123) were resistant to leafhopper (with hopper burn grade 0 to 1 on 0 to 4 scale).
- Out of 30 advanced breeding materials screened against leafhopper, 8 advanced breeding materials (PVT-11-5, PVT-11-11; PHT-11-47, 49, 51, 52, 53, 57) were found resistant to leafhopper (hopper burn grade 0 to 1).

Social Sciences

- The FLDs (80 aces) on castor were conducted during *kharif* (60) and *rabi* (20) in Anantpur and Mahabubnagar districts of Andhra Pradesh and Telangana respectively. In Anantapur during *kharif*, 20% increase in yield (1156 kg) was observed in improved technology (IT) as compared to farmers practice (FP) (963 kg/ha) with additional net returns (ANR) of `7569/ha and benefit cost ratio (BCR) of 2.50. In Mahabubnagar district, IT recorded 850 kg as compared to 595 kg/ha in FP with ANR of ` 7581/ha. The BCR was 2.98 in IT and 2.34 in FP. The demonstrations under irrigated conditions in Dindi of Nalgonda district, recorded seed yield of 2160 kg/ha in IT as compared to 1810 kg/ha in FP with ANR of `6253/ha. The BC ratio 2.24 in IT and 2.09 in FP respectively.
- Two hundred and sixty demonstrations were successfully conducted on castor and 60 on sunflower in Prakasam, Mahabubnagar and Nalgonda districts for tribal farmers of Andhra Pradesh and Telangana states. Two NGOs *viz.*, Agri-Biotech Foundation (ABF and Vikashith Rythu Sanksema Sangam (VRSS) were associated with IIOR for conduct of demonstrations. In Prakasam district the IT plots recorded seed yield of 958 kg/ha as compared to 758 kg/ha in FP plots while in Mahabubnagar district, the mean yield recorded was 764 kg/ha in IT as against 605 kg/ha in FP. The BCR was 3.7 in IT against 2.8 in FP respectively.

SUNFLOWER

Crop Improvement

- Germplasm lines, TSG-207 (EC-838712) (36 cm), TSG-108 (EC-762054 (40 cm), TSG-402 (EC-838667 (44 cm) and TSG-295 (EC-838665) (49 cm) were identified as dwarf genotypes.
- TSG-355 (EC-838692) (37-40 days) and TSG-331 (EC-838930) (43.4%) were identified as genotypes for earliness and high oil content, respectively.
- Genotypes with resistance to leafhopper – GMU-1, 243 and 504 with injury grade 1; GMU-4, 25, 112, 116, 255, 327, 339, 343, 405, 556, 595, 669, 696, 703, 713, 776, 782, 795, 914, 922, 937, 1029, 1093, GP6-50, GP6-1282, GP9-472-4-13 and AKSFI-46-2 with injury grade 2
- Three hybrids namely IOSH-15-1, IOSH-15-12 and IOSH-15-14 had higher seed yield (g/plant) (26.9-29.1 g) than checks: DRSH-1, KBSH-44, PSH-1962, LSFH-171, RSFH-130, Kaveri Champ, SB-207 (14.9-25.8 g).
- Transcriptomes of sunflower species *H. annuus*, *H. debilis*, *H. praecox* and *H. niveus* upon infection with powdery mildew were developed, which are used in a gene discovery programme concerning powdery mildew resistance.

Crop Production

- Under clay loam soils of West Bengal, sunflower crop responded better to application of 90:90:40kg $N:P_2O_5:K_2O$/ha with 48% higher yield (1774 v/s 1195kg/ha) and a B:C ratio of 1.95 v/s 1.44 was realised.
- Higher seed yield (4454 kg/ha) of *kharif* sorghum was recorded with 150% RDF to both the crops that was at par with all treatments with 100% NP or NPK combination.
- Seed yield was highest (1244 kg/ha) with supplementation of S, B, Zn along with NPK.
- The yield parameters were significantly higher with balanced nutrition of S, Zn and B along with NPK.
- Soil fertility after the sorghum-sunflower cropping system in 2014 indicated a significant buildup of soil P level of 9-10 kg/ha in treatments not receiving any P.
- Available S was highest in treatments receiving S. Moisture stress from thinning to star bud stage with or without N top dressing after relieving moisture stress is critical to trigger leaf axil branch formation in sunflower at field level (hybrid DRSH-1).
- Variation in seed yield reduction due to retaining leaf axil branches was not significant compared to removal of all leaf axil branches.
- Integrated crop management in Alfisols during *kharif* 2015, resulted in realizing the highest sunflower seed yield of 2 t/ha with a B:C ratio of 2.34.
- The highest P acquisition was noticed in genotype HOHAL-17 (7.2 mg P/g dry matter) under P stress situation and was followed by CSFI-5075 (5 mg P/g dry matter).

Crop Protection

- Application of Pendimethalin @ 1.0 kg a.i/ha (Pre emergence) + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha at 15 – 20 DAS (Post emergence) effectively controlled weeds and helped in realizing higher sunflower yields in Vertisols of Latur and Raichur (9 to 36% higher yield with B:C ratio of 2.2 Vs 1.82).
- The IPM and BIPM modules were effective against insect pests and diseases of sunflower over the farmers' practice with a higher seed yield of 519 and 543, 1092 and 1200,1475 and 1550 kg/ha with IBCR of 1.29 and 1.80, 1.07 and 2.00, 1.44 and 2.71 in Akola, Latur and Bengaluru, respectively and can be adopted for the management of major insect pests and diseases of sunflower in Telangana, Vidharba and Marathwada region of Maharashtra and Southern zone of Karnataka.
- Twelve isolates of *Alternariaster helianthi* the causal agent of leaf blight of sunflower were deposited in National Agriculturally Important Microbial Culture collection (NAIMCC), ICAR-NBAIM and the accession numbers NAIMCC F-03173 to NAIMCC F-03184 were obtained.
- The genotypes *viz.*, PS 2040, PS 2040-1, PS 2040-2, PS 2037, PS 4034, P 75 Wp, 10-9, 10-25, 10-30, EC 537925, SCG 28, SCG 99, GMU 520, 440, GP-679, GP6-564 confirmed as tolerant to *Alternariaster* leaf blight of sunflower.
- Seed priming with carbendazim @ 2 g/kg + thiamethoxam @ 4 g/kg + 2 foliar sprays of propiconazole @ 0.1%+ thiamethoxam @ 0.04% as soon as disease appeared and 15 days later or seed priming + 2 foliar spray sof propiconazole @ 0.1% + azadiractin @ 0.15% as soon as disease appeared and 15 days later reduced the Alternaria incidence up to 40% and 24% of SND.

Social Sciences

- The FLDs (200 acres) on sunflower were conducted in Haveri and Bagalkot districts of Karnataka (125 acres) and Prakasam district of Andhra Pradesh (75 acres) during rabi 2015-16. The seed yield ranged from 750 kg/ha to 2200 kg/ha indicating wide variation depending on the location.
- Demonstrations on best management practices (BMPs) of sunflower (279 farmers) were conducted in Bagalkot and Koppala districts of Karnataka and Bankura and West Medinapur districts of West Bengal. Eight trainings on best management practices for increasing production of sunflower and sesame and two workshops were conducted involving farmers, extension personnel and agricultural department personnel. Improved hybrids of sunflower *viz*., DRSH-1, RFSH-130, LFSH-171 and KBSH-55 were used for demonstrations. Soil health cards were distributed to 279 farmers in collaboration with state agricultural departments of Karnataka and West Bengal.
- A web-based application on prices and arrivals at major APMCs for castor (45 APMCs from Andhra Pradesh, 50 from Gujarat and 37 from Rajasthan) and sunflower (45 from Andhra Pradesh, 75 from Karnataka and 80 from Maharashtra) from 2001 to till date were compiled and a database was designed for retrieval of the required information. Developed and disseminated 25 voice based advisories to 1100 farmers on sunflower and castor using Reliance information services. An e-course on "Best Management Practices" in sunflower was developed in English.

SAFFLOWER

Crop Improvement

- Safflower variety, NARI-57 was notified and released for the states of Maharashtra, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh, Punjab, Jharkhand, West Bengal.
- Genotypes for important agronomic traits were identified : High seed yield (>30 g/plant): GMU-5338 and GMU-5865; High number of effective capitula (>60): GMU-5229, GMU-5613, GMU-5774, GMU-5804, GMU-5815, GMU-5865, GMU-7493, GMU-400, GMU-756, GMU-1814 and EC-739480; High number of primary branches (>21): GMU-5865, GMU-5613, GMU-1756 and EC-739480.
- Three CMS hybrids namely DSH-256 (2001 kg/ha), DSH-252 (1904 kg/ha) and DSH-263 (1904 kg/ha) had higher seed yield over check variety A-1 (1800 kg/ha) and check hybrid NARI-H-23 (1596 kg/ha) in IHT
- DSH-388 showed higher seed yield (2856 kg/ha) over the check hybrid NARI-H-15 (2122 kg/ha) and check variety A-1 (1816 kg/ha) in multi-location preliminary hybrid trials at IIOR, Hyderabad, Indore, Parbhani and Phaltan.
- Non-spiny variety in AVT: SPP-70 recorded 30.6% more seed yield (1419 kg/ha) than check variety NARI-6 (1087 kg/ha) in IVT was promoted to AVT-I.
- High oleic varieties in IVT – Three high oleic varieties namely ISF-1 (78.3%), ISF-2 (78.8%) and ISF-3 (76.3%) were entered into IVT.
- DNA based marker assay (KASP) has been developed (based on a functional mutation in fatty acid desaturase -2, *fad2-1* gene) for selection of high oleic plants in safflower. The marker assay is highly robust, cost effective (~Rs. 10/sample) and permits large scale application of marker-assisted selection (MAS) in safflower breeding. Consequently, marker-assisted backcrossing (MABC) programme has been established to transfer high oleic trait in the background of popular cultivars rapidly in a cost effective manner.
- A set of 520 safflower genotypes comprising of core subset, trait specific germplasm, released varieties and high oil lines imported from Mexico and USDA has been assembled for allele mining of oil content.

Crop Production

- Increasing N to 40 kg/ha from 25 kg/ha and retaining P at 25 kg P_2O_5/ha help in realizing higher seed yield in Vidharbha zone of Maharashtra.
- Fertilizer application with STCR based equations recorded the highest seed yield (1500 kg/ha) in presence of FYM which was statistically on par with that of STCR based fertilizer application in absence of FYM application (1375 kg/ha).

Crop Protection

- Two genotypes, DSI-104 and GMU-3263 were moderately resistant to Fusarium wilt**. G**enotypes DSI-103 & GMU-3263 were resistant to Phytophthora leaf blight and DSI-104 & EC-523368-2 were moderately resistant with less than 20% disease severity.

- Seed treatment with *T. harzianum* Th4d SC @ 2ml/kg and cymoxanil 8% + mancozeb 64% @ 0.2% able to reduce incidence of Fusarium wilt (17.6 & 18.2% respectively) compared to control (36.3%).
- Foliar spray of clothianidin 50WDG @ 50g/ha or [chlorpyriphos 50 % + cypermethrin 5 %] 55 EC @ 1000 ml/ha effectively suppresses aphid population with higher IBC ratio.
- Soil application of phorate 10G @10 kg/ha at the time of sowing followed by foliar spray of chlorpyriphos 20EC @ 2.5ml/l to maintaining plant stand and reduced plant damage by Gujia weevil resulting in higher seed yield with IBC ratio in Vidharbha region of Maharashtra.

Social Sciences

- Chitradurga district of Karnataka has been identified as a hot spot area for safflower considering the length of growing period, type of soil, yields of the competing crops, proximity of value chain suppliers (VCS) *viz.*, Karnataka Oilseeds Federation, Chitradurga, ZAHRS (UAHS), Hiriyur and the expertise available at IIOR as value chain enabler (VCE).

SESAME

Crop Improvement

- Assembled 1050 germplasm accessions and characterized for agro-morphological traits. A total of 31 wild accessions (*S. malabaricum*-29 and *S. radiatum*-2) were collected through germplasm exploration in north western region of Gujarat.
- Interspecific hybridization involving *S. malabaricum* is in progress towards development of cytoplasmic male sterility. The backcross programme is currently at BC_2 stage.

Crop Protection

- The sesame phyllody ranging from 5-70% in different varieties *viz*: Swetha-5-10%, P(L)-5-10%, GT-10%, RT-127 40-50%, RT-351 50-60%, GT-2 50-60%, Hima-50-70% was recorded at IIOR, Hyderabad.
- *T. harzianum* Th4d WP seed treatment was effective in control of Macrophomina root rot incidence.

Social Sciences

- Two hundred and thirty five demonstrations on best management practices of sesame were conducted in Kadapa and Prakasam districts of districts of Andhra Pradesh, Khammam district of Telangana and Bankura and West Medinapur districts of West Bengal. Improved varieties of sesame *viz*., TKG-306, Savitri, Swetha Til, Hima and YLM-66 were used for demonstrations.

BREEDER SEED PRODUCTION

- A total of 11 q of sunflower (DRSF-113, CMS-234A, 234B, CMS-17A, 17B, CMS-335A, 335B and RHA-95-C-1) was produced against 1.16 q of DAC indent.

- A total of 12 q of soybean variety JS 95-60 and JS 93-05 (12 q) was produced as per the allocation by IISR, Indore.
- A total of 5.2 q of sesame variety TRC Til 1-8-1-1 was produced and supplied to State Department of Tripura.

HYBRID SEED PRODUCTION

- About 120 q of castor hybrid DCH-177, 60 q of castor hybrid DCH-519 and 5 q of sunflower hybrid DRSH-1 were produced and distributed.

FRONTLINE DEMONSTRATIONS

- Four thousand seven hundred and eighty seven frontline demonstrations (FLDs) were conducted across nine oilseed crops and oilseed based farming systems and 56 trainings were conducted for input dealers, agricultural officers and extension workers under National Mission on Oilseeds and Oil Palm (NMOOP).

IIOR

वार्षिक प्रतिवेदन

Annual Report
2015-16

The Institute

- Mandate
- Staff Position
- Financial Statement


ICAR - IIOR

THE INSTITUTE

The establishment of All India Coordinated Research Project on Oilseeds (AICORPO) in April, 1967 based on the recommendations of a sub-committee appointed by the Government of India was the most significant event in the history of oilseeds research in India. The project had its beginning with one Project Coordinator to coordinate and monitor the research programmes of groundnut, rapeseed-mustard, sesame, linseed and castor operating at 32 research centres. Later during 1972, safflower, sunflower and niger were brought under the umbrella of AICORPO and the number of research centres increased to 40. Realizing the need for one national institute for oilseeds, the AICORPO was elevated to the status of Directorate of Oilseeds Research on August 1, 1977 with a Project Director as its administrative head and seven Project Coordinators for these oilseed crops. Subsequently, groundnut and rapeseed-mustard were delinked from the Directorate with the establishment of National Research Centre for each of these crops during 1979 and 1993, respectively. In April, 2000, the AICRP on Sesame & Niger and Linseed have been separated from the administrative control of DOR. DOR has been entrusted with the responsibility to plan, coordinate and execute the research programmes to augment the production and productivity of sunflower, safflower and castor crops in the country through All India Coordinated Research Project on Oilseeds (AICRP) operating at 29 locations spanning over 14 states. The Directorate of Oilseeds Research is upgraded to Indian Institute of Oilseeds Research (IIOR) w.e.f. February 3, 2015 as per the approval of XII Plan EFC. The IIOR is a premier national institute under the aegis of the Crop Science Division of Indian Council of Agricultural Research, New Delhi.

Mandate

- Basic and strategic research to augment the productivity of castor, sunflower, safflower, sesame, niger and linseed.
- Networking of all Oilseed Directorates on the Research and Technology Dissemination to develop national strategy to enhance oilseeds productivity.
- Planning, Coordinating and Monitoring of applied research on the issues related to national as well as regional importance through All India Coordinated Research Project on Oilseeds.

Staff position as on March 31, 2016

Category	Sanctioned	Filled	Vacant
Scientific	43*	43*	0
Technical	51	42	9
Administrative	29	25	4
Skilled supporting	33**	20	13
Total	**156**	**130**	**26**

* including one RMP

** including additional 8 posts sanctioned by the Council for which administrative approval awaited.

Financial Statement

Allocation and Expenditure

Head of Account	Allocation (` in lakhs)				Expenditure (` in lakhs)			
	IIOR Plan	AICRP (OS + S&N + LIN)*	IIOR-Non-Plan	Total	IIOR Plan	AICRP (OS + S&N + LIN)*	IIOR Non-Plan	Total
A. Grant-in-Aid (Capital)								
Works	99.43	0.00	0.00	99.43	99.43	0.00	0.00	99.43
Equipment	148.50	5.00	10.54	164.04	148.49	5.00	10.54	164.03
Library	2.07	0.00	8.72	10.79	2.07	0.00	8.72	10.79
Furniture	0.00	0.00	7.74	7.74	0.00	0.00	7.74	7.74
B. Grant-in-Aid (Salaries)								
Establishment Charges	0.00	1868.48	1325.26	3193.74	0.00	1868.48	1298.35	3166.83
Overtime Allowance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pension	0.00	0.00	100.00	100.00	0.00	0.00	92.87	92.87
Wages	0.00	0.00	296.74	296.74	0.00	0.00	296.74	296.74
C. Grant-in-Aid (General)								
TA	15.00	66.03	12.00	93.03	15.00	66.03	12.00	93.03
Res. & Operational Expenses	234.94	204.47	70.00	509.41	234.93	204.47	70.00	509.40
Administrative Expenses	49.48	0.00	173.00	222.48	49.46	0.00	172.97	222.43
Miscellaneous Expenses	6.58	0.00	11.75	18.33	6.58	0.00	11.75	18.33
Need Based Research	0.00	16.05	0.00	16.05	0.00	16.05	0.00	16.05
Tribal Sub-Plan	14.00	84.00	0.00	98.00	14.00	84.00	0.00	98.00
Total	**570.00**	**2244.03**	**2015.75**	**4829.78**	**569.96**	**2244.03**	**1981.68**	**4795.67**

* include sunflower, castor, safflower, sesame & niger and linseed

AICRP on Sunflower, Safflower, Castor, Sesame & Niger and Linseed

Head of Account	AICRP (Sunflower, Safflower & Castor)		AICRP (Sesame & Niger)		AICRP (Linseed)	
	Allocation (` in lakhs)	Expenditure (` in lakhs)	Allocation (` in lakhs)	Expenditure (` in lakhs)	Allocation (` in lakhs)	Expenditure (` in lakhs)
Grants for Capital	0	0	0	0	5.00	5.00
Grants for Salaries	825.00	813.95	477.00	485.80	565.74	568.74
Grants for General	107.06	118.11	82.00	73.20	98.26	95.26
TSP	28.00	28.00	28.00	28.00	28.00	28.00
Total	**960.06**	**960.06**	**587.00**	**587.00**	**697.00**	**697.00**

Resource Generation

Particulars	Amount (` in lakhs)
Sale of Farm Produce	5.43
Sale of Old Vehicles & Machine Tools	0.00
Sale of IIOR Publications & Tender forms	0.02
Rent	7.88
License Fee	1.68
Interest earned on Loans & Advances	6.80
Leave Salary & Pension Contribution	0.00
Analytical testing charges	1.66
Interest earned on STDR	25.89
Receipts from service rendered/Sale of Tech.	0.00
Unspent balance of grants	0.00
Training	1.15
Miscellaneous receipts	4.50
Total	**55.01**

Funds Received for Externally Funded Projects

Particulars	Amount (` in lakhs)
DBT Projects	0.00
DST Projects	48.50
Deposit Schemes	209.00
Total	**257.50**

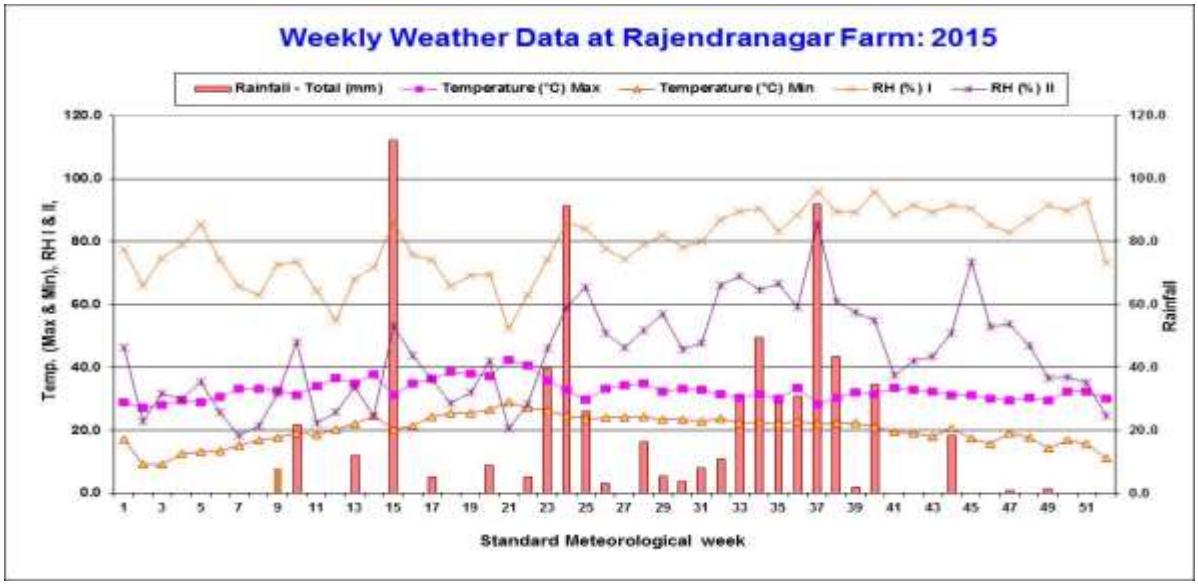
IIOR

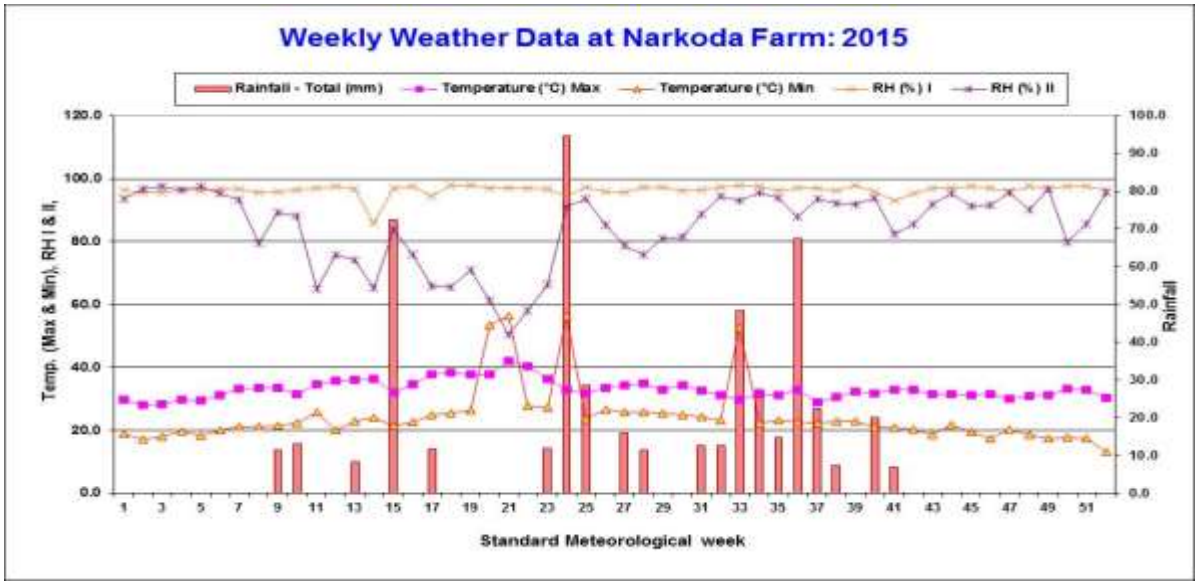
वार्षिक प्रतिवेदन

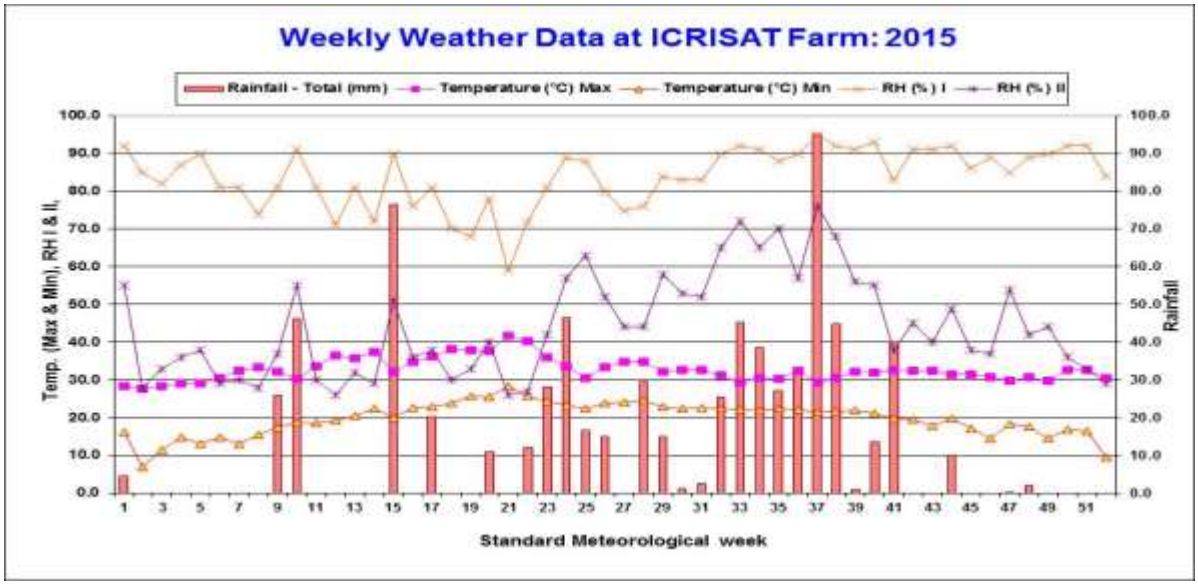
Annual Report
2015-16

Research Achievements

- Castor
- Sunflower
- Safflower
- Sesame
- Other Scientific Activities
- AICRP


Weekly Weather Data at Rajendranagar Farm: 2015
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at Narkoda Farm: 2015
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at ICRISAT Farm: 2015
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week

CASTOR

CROP IMPROVEMENT

DEVELOPMENT OF TRAIT-SPECIFIC INBRED LINES FROM CASTOR PRIMARY GENEPOOL

Fusarium wilt: Twenty four S_4 families of multiple resistant accession, RG-2787 exhibited high resistance (0% WI) to wilt and 42 S_5 families of RG-2787 had 4-19% wilt incidence (WI) in wilt sick plot. Nine high wilt resistant (0%) and 17 resistant (<20%) inbred lines in F_8 generation of crosses *viz.*, RG-2368 x RG-2758, RG-2822 x RG-2836, RG-2008 x RG-2787, RG-2529 x RG-109 and RG-2876 x RG-2822 were developed. Of these, three inbred lines recorded 36 to 70% higher seed yield (581-726 g/net plot; CV%: 16; CD: 124) than the best check variety, GC-3 (427 g/net plot).

Botrytis gray mold tolerant and wilt resistance: Two inbred lines p-130 and p-50 of the cross in F_8 generation RG-2008 x RG-2787 exhibited tolerance (24-28% disease severity) to Botrytis grey mold. These two inbred lines showed resistance to Fusarium wilt (16%, 0% WI) as well in wilt sick plot.

Macrophomina root rot and Fusarium wilt resistance: Three inbred lines *viz.*, p-52, p-72 and p-23 of the cross RG-2822 x RG-2836 in F_8 generation exhibited 13.9%, 8.3% and 9.2% root rot incidence, respectively in root rot sick plot at Junagadh, while two inbred lines, p-40 and p-29 derived from the same cross showed 20% and 22.6% root rot incidence. These five inbreds were also found to be resistant to Fusarium wilt (0%, 16.6%, 0%, 0% wilt incidence, respectively) in wilt sick plot. Seed yield of these multiple resistant accessions ranged from 356-487 g/net plot while the best check, GC-3 recorded 427 g/net plot in a replicated yield trial having three replications with the plot size of 27 sq.m/entry/replication.

Leafhopper-wilt and leaf miner resistant inbreds: Sixty one S_5 families derived from RG-2661, RG-43, and RG-3060 exhibited high resistance to leafhopper (0 burn on 0-4 scale with 5-27 leafhoppers/3 leaves/plant) while the susceptible check, DPC-9 had hopper burn score 4. All the S_5 families of RG-43 were early maturing (<100 days) type with short plant height (100-120 cm). In addition to leafhopper resistance, these inbreds were found to be resistant to Fusarium wilt. Thirty five S_8 families of RG-1771 exhibited resistant reaction against leaf miner (<5 mines/leaf); all were non-spiny and papaya leaf type phenotypes.

Extra-early maturity: Selected 34 S_5 families of RG-22 and RG-26 that flowered in 28-32 days and matured in 89 days while the checks, 48-1, DCS-107, DCH-519, GCH-7, Sowbhagya and GC-3 took 58-69 days to reach 50% flowering and 130-140 days for maturity. The node number in these S_5 families was 6-9. The S_4 families of RG-15, RG-1591 and RG-1481 exhibited low node number (7-9) on main stem and flowered in 32- 35 days and matured in 89-91 days.

Early maturity: Seven S_5 families of RG-17 and RG-187 which flowered in 38-41 days and reached to maturity in 105 to 110 days were advanced further. These selections recorded 42-61 g/plant yield at 120 days after sowing which was at par with the normal duration check, DCS-107 (51 g/plant). These were advanced further for stabilizing early maturity trait together with high seed yield.

High ricinoleic acid: One hundred and forty S_5 families of RG-66, RG-226 and RG-3477 having 91-92.5% ricinoleic acid content were selected. The *per se* performance of these selections ranged from 42-93 g/plant; two among them had very low node number (7, 8) and extra-early maturity (<100 days).

High seed yield and yield contributing traits: Twelve accessions were identified for high seed yield based on multilocation testing including IIOR, Hyderabad for developing for high yielding inbred parental lines. Of these accessions, two wilt resistant accessions, RG-3445 and RG-3100, which have undergone five generations of inbreeding, recoded 4% higher mean seed yield (2267 g/net plot) and at par seed yield (2104 g/net plot), respectively with check hybrid, GCH-7 (2174 g/plant) in a multilocation evaluation trial under irrigated and rainfed conditions respectively. In addition, 10 new accessions collected from S.K. Nagar and Junagadh centres and Chindwara region of MP namely, RG-3974, RG-3977, RG-3994, RG-3999, RG-4001, RG-4003, RG-4018–JI342, RG-4020–JI347, RG-4024–JI394, RG-4025–MCI-18 recorded 421-666 g/net plot yield at IIOR, Hyderabad under severe drought condition whereas the check, GCH-7 recorded 195 g/net plot yield. RG-3798 (FC-094), a farmer's collection from Tamil Nadu after four cycles of selfing was identified for developing trait-specific inbred lines for long effective length of primary spike (EPS) and high no. of capsules/ primary spike. The mean EPS was 53 cm and number of capsules/ primary spike was 60 that were at par with the hybrid check, GCH-7 (53.5 cm; 60 capsules/ primary spike) at multilocation evaluation both under irrigated and rainfed conditions.

Drought, high temperature and salinity tolerance: Two accessions, RG-2059 and RG-3063 were found to be tolerant to high temperature under TIR technique; four accessions *viz.*, RG-89, RG-272, RG-415 and RG-2048 were found to be tolerant to drought under PEG method while two accessions, RG-72 and RG-289 showed salinity (NaCl) tolerance; of which RG-289 was tolerant to drought as well. A preliminary investigation conducted to make out optimum concentration of potassium iodide needed for spraying to control terminal drought stress in castor indicated that spray of 1% potassium iodide was found to be an optimum concentration to screen castor genotypes for terminal drought stress tolerance.

Nine germplasm accessions with known drought tolerance in previous experiments along with checks (48-1, DCH-519) were grown in second year of experimentation as rainfed crop during *kharif*, 2015 with three replications in RBD. Total rainfall received during the crop growth period was 298.8 mm. Yield performance and harvest index indicated that the accessions RG-1494 (101 g/plant) followed by RG-1826 (95.5g/plant) had higher *per se* performance than the best check, DCH-519 under natural drought condition.

Seed yield and harvest index of drought tolerant accessions

Accession	Total seed yield (g/plant)			HI (%)		
	2014-15	2015-16	Mean	2014-15	2015-16	Mean
RG-111	63.5	80.6	72.0	32.3	29.3	30.8
RG-298	115.8	66.2	91.0	45.1	27.1	36.1
RG-1437	68.4	110.8	89.6	22.9	38.7	30.8
RG-1494	76.3	125.6	100.9	32.7	30.0	31.3
RG-1826	111.6	79.4	95.5	46.1	39.0	42.6
RG-2797	33.7	92.4	63.1	10.9	22.2	16.6
48-1 (check)	95.8	63.9	79.8	31.9	28.2	30.1
DCH-519 (check)	87.6	78.8	83.2	32.6	28.5	30.6
Mean	81.58	78.3	-	31.9	28.1	31.1
SEm(±)	4.45	5.51	-	1.39	1.42	
CD (P=0.05)	13.48	16.3	-	4.23	4.2	
CV (%)	9.44	12.2	-	7.58	8.7	

Confirmation of drought tolerance of germplasm accessions with good root traits: Nine accessions identified for good root traits were tested for drought tolerance under field conditions during *rabi* season by taking up sowing in November and imposing drought stress from 30-90 days after sowing and providing irrigation for the irrigation control plot. Total rainfall received during the crop growth period was 298.8 mm. The drought tolerance index (DSI) was relatively low (0.12-0.98) in seven drought tolerant accessions *viz.*, RG-272, RG-289, RG-373, RG-1582, RG-1667, RG-1759, and RG-1963 having good root traits, as compared to that of RG-1520 (1.18%) and the checks, 48-1 (1.58) and DCH-519 (1.34) having poor root traits. These drought tolerant accessions were earlier confirmed the tolerance to drought under field conditions. Seed yield reduction in these accessions was comparatively lower than that in the susceptible genotypes.

Drought susceptibility index in accessions with good and poor root traits

Accession	Total seed yield (g/plant)		Reduction in seed yield (%)	DSI
	Control	Drought stress		
With good root traits				
RG-272	87.8	57.2	34.8	0.78
RG-289	87.3	51.6	40.8	0.92
RG-373	77.7	73.5	5.4	0.12
RG-2058	100	42.6	57.4	1.29
RG-1582	81.2	57.4	29.3	0.66
RG-1667	70.0	44.5	36.4	0.82
RG-1759	92.8	52.2	43.7	0.98
RG-1922	57.6	29.3	49.2	1.10
RG-1963	45.3	31.0	31.6	0.71
With poor root traits				
RG-1520	79.7	37.8	52.7	1.18
48-1 (check)	104.8	31.3	70.2	1.58
DCH 519 (check)	112.5	45.2	59.8	1.34

Resistance to major insect pests: Three accessions *viz.,* RG-2774, RG-2800 and RG-898 were identified for developing capsule borer tolerant inbred lines as these accessions exhibited tolerance reaction (less than 25% damage) against capsule borer in the third consecutive year under artificial infestation. They exhibited similar reaction in multilocation trial conducted for two consecutive years under infester-row method.

Seven accessions, RG-631, RG-1621, RG-2093, RG-2301, RG-2661, RG-3060 and RG-3067 exhibited high resistance to leafhopper (Hopper burn grade:0; Leafhopper population: 0 to 26 leafhoppers/3 leaves/plant), and three accessions *viz.,* RG-2462, RG-2526 and RG-2888 exhibited resistance reaction against leafhopper (Hopper burn grade:1; Leafhopper population:5 to 34 leafhoppers/3 leaves/plant) in multilocation trials conducted for two consecutive years.

Resistance to major diseases: Seven accessions *viz.,* RG-3181, RG-3200, RG-3202, RG-3206, RG-3207, RG-3243 and RG-3257, exhibited low Botrytis severity (10-16%) under detached spike technique in glasshouse. One accession, RG-1060 exhibited 10% Botrytis at Chintapally, the hot spot area for Botrytis and 20% disease incidence at IIOR under detached spike technique in glasshouse and has been included in the programme on development of inbreds for Botrytis resistance. The drought tolerant accession, RG-82 had 33-35% Botrytis infection at both the locations.

Seven accessions *viz.,* RG-3425, RG-3432, RG-3446, RG-155, RG-311, RG-3042 and RG-3070 were identified for development of wilt resistant inbreds. These accessions exhibited wilt resistance (0-20%) in wilt sick plots and root dip inoculation technique carried out at IIOR, SK Nagar and Palem.

Seven accessions *viz.,* RG-392, RG-1834, RG-2035, RG-2719, RG-2722, RG-2746 and RG-2816 were identified for development of diverse Macrophomina root rot resistant inbreds. These accessions exhibited root rot resistance (0-20%) in root rot sick plots and stem-tape inoculation technique at Junagadh.

Development of breeding lines with enhanced resistance to gray mold

Two advanced breeding lines CI-1 (DCS9 × RG1139) and CI-2 (DPC9 × RG1139) were found promising in field and poly-house screening for gray mold resistance with artificial inoculation of pathogen. These lines showed better resistance than the controls in terms of incubation period and amount of sporulation in the *in vitro* detached capsule screening also.

CI-2, a new breeding line showing gray mold resistance in poly-house

Development of Elite Inbred Lines with Wilt Resistance in Castor

A set of 300 recombinant inbred lines derived from the crosses: JC12 × 48-1 and DCS9 × RG3216 was evaluated for agronomic performance at Narkhoda farm (*Kharif*-2015) and for Fusarium wilt resistance in wilt sick plot at Rajendaranagar as well as in pot culture with artificial inoculation of pathogen. Based on the agronomic superiority and disease resistance, a set of 28 inbred lines were selected as potential parental lines for hybrid development with inbuilt resistance to wilt.

DEVELOPMENT OF HIGH OIL YIELDING CASTOR VARIETIES AND HYBRIDS RESISTANT TO *FUSARIUM* WILT, LEAFHOPPER AND DROUGHT

New variety DCS-107: A CVRC released castor variety in 2011 is registered as a new plant variety by PPV & FRA (No.123 of 2015) with an exclusive right to produce, sell, market, distribute, import or export the variety for an initial term of 6 years and renewable for the remaining years from the date of grant i.e., April 27, 2015.

Development of Wilt and Leafhopper Resistant Pistillate Lines with Good Combining Ability

A new pistillate source "Kh-13-154" was used as a donor to create diversity in pistillate trait using DPC-9 and DPC-19 as recipients. Eight parents with desirable plant type and morphological characters were used to generate four F_1s to accumulate favorable alleles for the pistillate trait.

Single crosses developed
DPC 25 (Dwarf, R_3SP) x Rb 13-1854(R_2SP)
CNES-1 (R_0NSP) x NES-6 (R_2NSP)
M-619 (Dwarf, G_3SP) x DPC-9 (G_0SP)
JP-77-1 (G_1SP) x DPC-21 (G_2SP)

Selection and generation advancement for pistillate trait: Single plant selections from 61 crosses involving 12 germplasm lines, farmer's varieties and 5 high yielding lines in different segregating generations (F_3 to F_6) were evaluated for pistillate traits. In addition, single plant selections from two double cross populations, generated earlier were further advanced morphological characters and sex expression. Twenty nine progenies of three crosses

generated from BC_2F_9 were further selected and advanced. 109 single plant selections from 17 cross combinations in F_9 to F_{11}, 120 selections in F_3 from two double crosses, 75 selections from 10 back cross combinations in F_9-F_{16} were advanced based on their pistillate trait.

Three pistillate lines *viz*., DPC-21, DPC-25 and M-571 evaluated in three coordinated centres confirmed their wilt and leafhopper resistance for two years. Among them, DPC-21 and M-571, confirmed for their combining ability for seed yield, primary spike length and late duration.

Evaluation of advanced lines: Among 50 promising advanced lines evaluated, 12 were resistant to wilt. Two open pollinated lines *viz*., PVT-12-160 (45%) and PVT-12-104 (42%) were high yielding compared to the best check, DCS-107 (669 g/plot) and were resistant to wilt (<20%) in sick plot.

Evaluation of prebred monoecious lines (PMC) lines: Twenty advanced lines which were stable at F_7 generation were selected and were grouped as PMC. These lines were evaluated for yield and yield attributing characters and wilt resistance. Among the 20 lines, only one was non spiny with double bloom green stem while the other were spiny types. Plant height ranged from 86 to 136 cm, with an average of 114 cm. Effective spike length ranged from 31 to 56 cm with an average of 39.5 cm. The average yield per plot was 1.3 kg/plot ranging from 0.7 to 1.75 kg/plot under rainfed conditions. These lines were also tested in wilt sick plot and 12 lines were found resistant for wilt.

These lines were utilized to develop hybrids using known pistillate lines, M-574, DPC-9, M-619, SKP-84 and DPC-9 in line x tester mating design to study the combining ability. Twenty prebred monoecious lines developed at IIOR were crossed with known pistillate lines in a line x tester mating design.

Lines	Ttester
M-619, SKP-84, JP-77-1, DPC-21, DPC-25	PMC-4, PMC-7, PMC-9, PMC-11, PMC-13, PMC-14, PMC-18, PMC-19, PMC-27, PMC-31, PMC-32, PMC-35, PMC-39, PMC-55, PMC-57, PMC-58, PMC-60, PMC-61, PMC-66, PMC-67

Apart from the hybrids developed in line x tester design, a set of 150 hybrids were also developed using 36 prebred monoecious lines and 11 pistillate lines.

In addition, 81 PMC lines and 3 checks (DCS-9, DCS-107 and 48-1) were evaluated in an ARBD design. There was variation in initial vigour, bloom, canopy type, branching pattern, days to 50% flowering, susceptibility to pests and diseases, etc. Statistical analysis revealed that there was significant variation for node number to primary spike, primary spike length, plant height, seed yield/plant at 120 days and seed test weight (100 seeds). The PMC lines which yielded > 101 g/plant were PMC-50, PMC-19, PMC-53, PMC-17, PMC-21, PMC-24, PMC-28, PMC-20, PMC-54, PMC-58, PMC-18, PMC-31and PMC-52.

Identification of physiologically efficient genotypes for early vigor and high total dry matter (TDM): A total of 17 genotypes which included male lines, pistillate lines and preliminary hybrids along with 48-1, DCH-519 as checks were sown during *kharif*, 2015 to select genotypes with early vigor, high TDM, seed yield and harvest index (HI). Seedling dry weight at 15 DAS was positively correlated with 100 seed weight (seed size) before sowing (0.46) and with TDM at 35 DAS. TDM at 35 DAS showed strong correlation with TDM at harvest (0.543), seed yield (0.536). Genotypes with bold seed size, early vigor, TDM at 35

DAS, TDM at harvest, total seed yield, HI were identified. Among them, pistillate lines like DPC-9, DPC-21 and male lines *viz.,* DCS-105, DCS-107, DCS-119 with bold seed size (30.3-37.8 g/100 seeds), early vigor (0.45-0.58 g/pl) will be further tested for their combining ability for specific traits. In addition, based on high seed yield (100-153 g/plant) and high HI (30-39.6%), pistillate lines like DPC-21, M-571 and male lines like DCS-107, DCS-9, 48-1, DCS-78, DCS-119 were identified as promising lines for generation of hybrids.

Physiologically efficient genotypes for different characters (2015-16)

Character	Range	Pistillate line	Male line	Hybrid
Bold seed size (g/100 seeds)	30.3-37.8	DPC-9, DPC-21	DCS-105, DCS-107, DCS-119	-
Early vigor (g/plant)	0.45-0.58	DPC-9, DPC-21	DCS-9, DCS-105, 48-1, DCS-107, DCS-119	PHT-14-44
High TDM at 35 DAS (g/plant)	12.5-15.7	DPC-21, M-571,	DCS-78, DCS-107, DCS-119, 48-1	PHT-14-44, DCH-519
High TDM at harvest (g/plant)	300-470	DPC-9, DPC-19 DPC-21, M-571,	DCS-78, DCS-105, DCS-107, DCS-119, 48-1	DCH-519, DCH-1715, DCH-1720
High seed yield (g/plant)	100-153	DPC-9, DPC-21 M-571	DCS-107, DCS-119 48-1	DCH-177, DCH-1715, DCH-1720, PHT-14-44
High harvest index (%)	30.0-39.6	DPC-9, M-571, M-574,	DCS-9,DCS-78,48-1	DCH-177, DCH-1715, DCH-1720, PHT-14-44

Genotypes with good seed size showed early vigor while only few genotypes maintained high TDM at 35 DAS. Among them, DPC-9, DCS-107, DCS-119 and 48-1 recorded high TDM at harvest and high seed yield. But, only DPC-9 (32.3%) and 48-1 (39.6%) recorded high HI also which shows the need for increasing the partitioning efficiency of DCS-107 and DCS-119. Based on the last 4 years data, 66 genotypes were statistically analyzed and ranked for 6 characters every year *viz.,* seed size, early vigour, TDM at 35 DAS, TDM at harvest, seed yield/pl and HI and the best genotypes identified were DCS-78, DCS-105, DCS-107, DCS-108, DCS-119, DPC-21, M-574, M-571, DCH-1715, 48-1 and DCH-519.

Selection of castor parents with high HI: Twenty breeding lines were evaluated to select lines with high HI during *rabi* 2015 with limited protective irrigations. Genotypes with 42-46.7% HI include DCS-9, DCS-78, DCS-84, DCS-97, DCS-112, DCS-119, DPC-9, PVT 12-2, Kh-12-98-3. The breeding line Kh-12-98-3 recorded highest HI of 46.7%. It possessed early vigor (0.81 g/pl.), high TDM (230 g/pl.) and good seed yield (98.4g/pl.). Among 66 genotypes evaluated for three years, 23 genotypes for early vigour and high HI (for at least two years) were identified. Among the selected lines, genotypes with high seed yield (100-177 g/pl) and high HI (35-51.2%), included DCS-84, DCS-89, DPC-17, Kh-12-86-2, Kh-12-91-2, Kh-12-98-3 and PVT-12-2.

Common evaluation of hybrids: One hundred and forty two hybrids were grown in two rows in an ARBD along with two checks replicated after every 10 entries with a spacing of 90 x 60 cm at IIOR, Hyderabad under rainfed conditions and 120 x 60 cm spacing at Anand under irrigated conditions.

- At IIOR Hyderabad, trial was sown in late *kharif* due to delayed monsoon and were exposed to prolonged dry spell during the crop growth period. Thirteen hybrids were numerically superior to the best check, GCH-7 (82 g/plant).
- At Anand, 24 hybrids out yielded DCH-519 (3274 kg/ha) and 6 hybrids out yielded GCH-7 (3452 kg/ha). Among them, CEH-297 and CEH-273 with 35% and 33% higher yield to GCH-7 will be further evaluated.

- Five hybrids *viz*., CEH-346, CEH-271, CEH-352, CEH-302 and CEH-287 were high yielding under both rainfed and irrigated conditions.

Promising preliminary hybrids at IIOR, Hyderabad (rainfed conditions)

Hybrid	Pedigree	Seed yield (g/pl)
CEH-366	M-574 x AP-37	153.5
CEH-365	M-574 x AP-20	131.6
CEH-235	DPC-9 x GP-783	129.0
CEH-231	DPC-9 x GP-672	125.2
CEH-230	DPC-9 x GP-538	124.4
CEH-250	DPC-18 x GP-401	123.4
CEH-263	DPC-19 x 48-1	121.9
CEH-329	DPC-25 x JI-384	120.3
CEH-232	DPC-9 x GP-674	120.2
CEH-346	DPC-9 x PMC-55	111.1
CEH-234	DPC-9 x GP-752	103.6
CEH-355	SKP-84 x PMC-11	102.9
CEH-363	Rb-1682 x PMC-55	100.7
DCH-177 (C)		65.7
DCH-519 (C)		72.3
GCH-7 (C)		82.0

Promising preliminary hybrids at Anand (irrigated conditions)

Hybrid	**Pedigree**	**Seed yield (kg/ha)**	**% increase over GCH-7**
CEH-297	DPC-23 x GP-537	4643	34.5
CEH-273	DPC-21 x GP-783	4605	33.4
CEH-287	DPC-21 x DCS-89	4432	28.4
CEH-268	DPC-20 x GP-672	4347	25.9
CEH-279	DPC-21 x JI-226	4338	25.7
GCH-7 (C)		3452	
DCH-519 (C)		3274	

Preliminary evaluation of hybrids: Twenty four castor hybrids were evaluated along with parents *i.e.* 2 female lines (DPC-23 and M-571) and 12 male lines at Bhawanipatna along with three check hybrids, DCH-177, DCH-519 and PCH-111 under rainfed conditions. Among the 24 hybrids tested, PHT-14-47 (1181 kg/ha) recorded 27.5% and 18.7% higher yield than the check hybrids, DCH-177 (926 kg/ha) and PCH-111(995 kg/ha), respectively.

Fast track evaluation of hybrids: Three hybrids were evaluated in large scale (500 plants per entry) at three centres - IIOR, Hyderabad (rainfed) and Anand and SK Nagar (irrigated). PHT-12-3, a short duration hybrid, recorded highest seed yield at IIOR, Hyderabad. It gave 39% higher seed yield than the short duration hybrid, DCH-177. Under irrigated conditions at Anand, ICH-68 and PHT-12-3 performed better than the three check hybrids. PHT-12-3 (2332 kg/ha) out yielded GCH-7 by 7%, both under rainfed and irrigated conditions at IIOR, Hyderabad and Anand, besides being the earliest to 50% flowering (47 DAS) and maturity (88 DAS) at IIOR, Hyderabad.

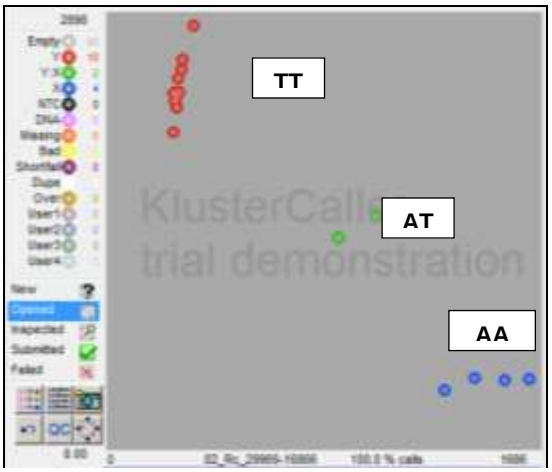
Multilocation evaluation of hybrids: In AHT-I, hybrid DCH-1720 (DPC-21 x DCS-107) recorded 8%, 12% and 15% yield increase over the checks, GCH-7, DCH-519 and DCH-177, respectively under irrigated conditions. It is resistant to wilt in sick plots at IIOR and SK Nagar, free from root rot in sick plot of Junagadh and resistant to leafhopper with a hopper burn grade (0-1) as compared to 3-4 in susceptible checks at Yethapur and Palem.

Development of Cost-Effective SNP Genotyping Technology

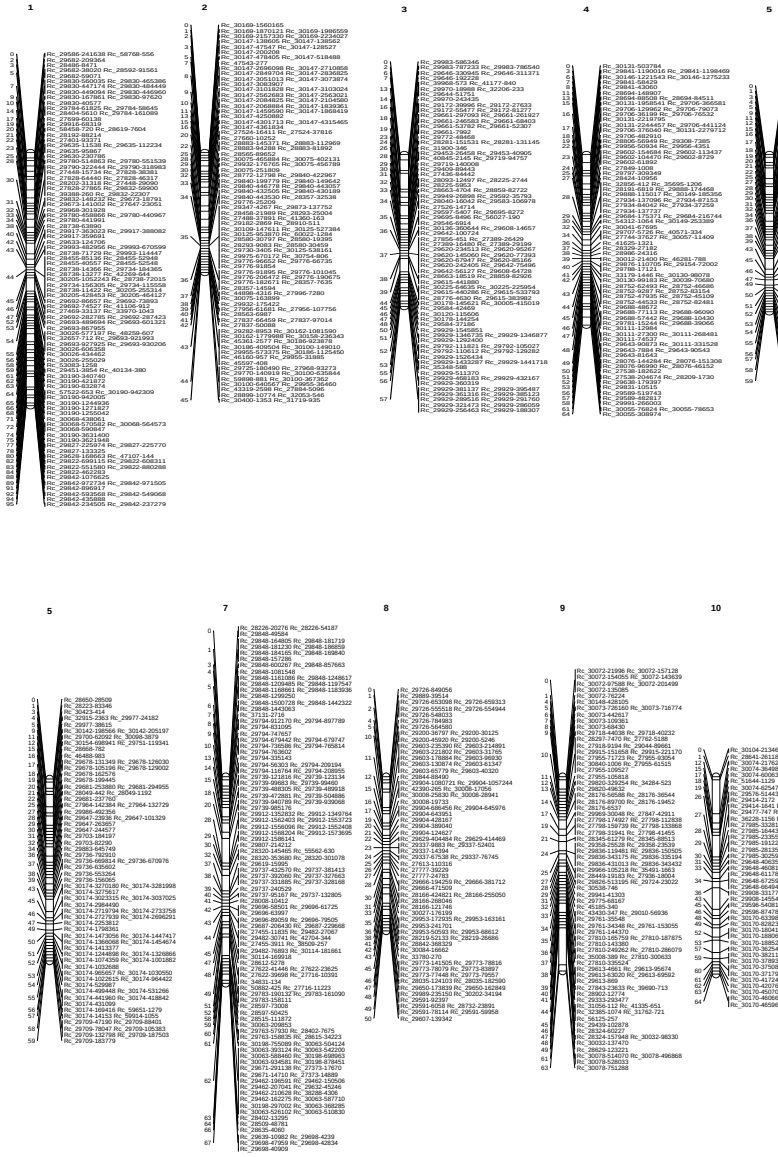
A cost-effective SNP genotyping assay based on 'Kompetitive Allele Specific PCR genotyping system (KASP)', a fluorescent endpoint genotyping technology of LGC Genomics was developed for 300 SNP loci in castor. The assays were validated in a panel of 13 inbred lines consisting of parents of mapping population and breeding lines with gray mold resistance. The genotyping data quality was high with 100 per cent reproducibility among the replicates. The alternate alleles of the SNP locus and heterozygotes could be clearly discriminated. This genotyping system is highly robust, rapid, cost effective (~Rs.10 / data point) and will facilitate routine in-house genotyping applications not only in castor but in other crops as well.

Development of A High-Density Reference Linkage Map in Castor

A preliminary linkage map with 1,099 SNP loci was constructed using a set of 240 recombinant inbred lines (RILs) derived from the cross, JC12 × 48-1. Total length of map was 622 cM across 10 linkage groups. The number of markers per linkage group ranged from 67 to 211 with an average inter-marker distance of 0.57 cM. This is the first ever high density linkage map of castor. The map is a useful resource for trait mapping, gene identification and genomics applications in castor.



Genotyping profile of SNP locus: Rc_29969-16866



Linkage map of castor with 1,099 SNP loci

Prediction of miRNAs genes and homology search

De novo prediction of castor miRNAs resulted in 1248 non redundant true putative castor pre miRNAs. These pre miRNAs were used to predict mature miRNAs using Naive Bayes classifier based on sequence and secondary structure information of the miRNA precursor. The distance between these distributions was estimated using the symmetric Kullback-Leibler metric. A total of 15 classifiers were used with regard to sequence composition and secondary structure for predicting mature miRNAs. Plant specific Pre-miRNAs and mature miRNAs sequences were downloaded from PMRD and MIRBASE websites. A local BLASTX search has been done for pre miRNAs with formatted local blast database. Finally, 970 non-redundant mature miRNAs were obtained.

DeNovo assembly and mining of plant resistant genes of Castor DCS-9

Illimina sequence reads quality was assessed and the paired end reads data was found to be of good quality with Phred score >30 and did not require trimming. DSC-9 had 150,124,684 reads. These paired end reads were subjected to DeNovo assembly with word length of size 25 and bubble size 50 and minimum contig size 200. The assembly resulted in 56,022 contigs with contig measurements: N75 length: 8123 and N50: 20357 sequences. Gene prediction was done by Augustus prediction tool which resulted in 32480 genes. Protein sequences extracted were subjected to functional analysis with interproscan and based on the functional domains, R-genes were identified. Among the different classes of R-genes, Leucine Rich Repeats (LRR) were found to be dominant compared to other R-gene classes.

DEVELOPMENT OF STRATEGIES FOR OBTAINING BOTRYTIS TOLERANT TRANSGENIC CASTOR PLANTS

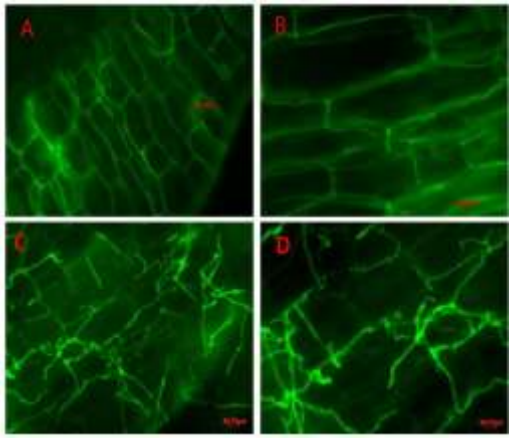
As reported earlier, gene constructs developed under the project for conferring resistance to *Botrytis* were validated using tobacco as a model system. Disease bioassays carried out with trangenic tobacco plants harbouring different transgene(s) revealed that all the three transgenes tested *viz., BIK1, EBP1* and *ERF1* imparted better tolerance against necrotrophic fungus *Alternaria alternata* as well as the hemibiotroph *Phytophthora parasitica* var *nicotianae*. Among the three genes *EBP1* was superior to *ERF1* and *BIK1*. Therefore, more emphasis was given for developing castor transgenic castor plants with *EBP1* gene.

***In planta* transformation of castor**

As reported last year, T_1 seeds from 500 T_0 plants with different gene constructs were obtained. Hygromycin selection was used to screen the T_1 plants. About 22500 T_1 seeds from 300 T_0 plants (with different constructs) yielded 1000 plants that survived antibiotic selection. Out of these, 33 plants were PCR positive for *hpt*II gene and of these, 30 plants were positive for EBP1 gene and two plants were positive for all the three genes, *EBP1, ERF1* and *BIK1*.

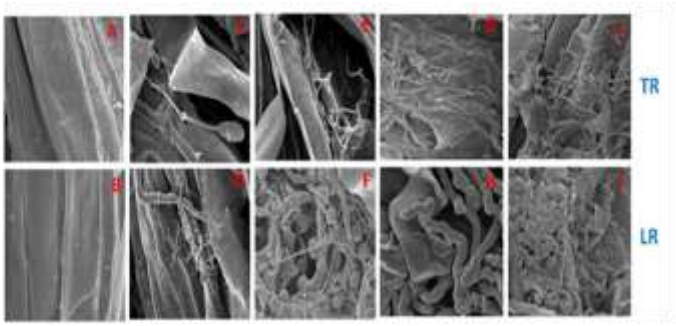
DECIPHERING MOLECULAR MECHANISM OF INDUCTION OF BIOTIC STRESS TOLERANCE BY *TRICHODERMA* SPP. IN CASTOR (*RICINUS COMMUNIS* L.)

As reported earlier, *Trichoderma* strain Th4d was identified as the most promising in terms of colonizing castor roots (genotype DCS-107) based on microscopic and plating techniques. More directed efforts were made towards identifying the presence of *Trichoderma* in castor roots *in situ* through specific staining of fungal chitin with wheat germ agglutinin – Fluorescent iosthiocyanate conjugate (WGA-FITC) and visualization of the fungus using fluorescence microscopy. Colonization of roots was seen in 35 day old seedlings that were seed treated with Th4d strain of *T. harzianum.*

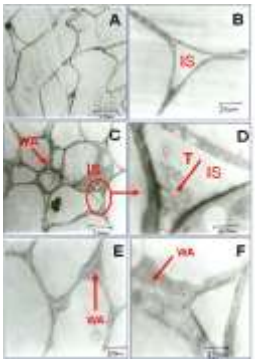


WGA–FITC staining demonstrated penetration and colonization of castor roots by *Trichoderma*
A and B: Untreated castor roots(35-days-old);C & D: Th4d treated castor roots (35-days-old)

To study the colonization and multiplication of Th4D in castor roots at different time points, scanning electron microscopic (SEM) analysis of roots colonized with Th4D at 6, 12, 24 and 48 hpi was done. It was observed that the multiplication of the fungus increased with time and the penetration of the fungal hyphae through the interstitial spaces of the root epidermal cells was observed very clearly. It further established that the lateral roots had more colonization compared to the tap root. These results were reconfirmed using Transmission Electron Microscopy (TEM).



Scanning electron micrographs (3000X) of Th4d-treated and untreated castor roots showing the entry points and colonization by *Trichoderma* into the roots
TR- Tap root LR- Lateral root
A and B: Epidermal cells of untreated roots C to J: Epidermal cells of Th4d treated roots
C and D: 6 hpi E and F: 12 hpi G and H: 24 hpi I and J: 48 hpi



TEM analysis showing *Trichoderma* in the interstitial spaces of root epidermal cells
A. Untreated castor root B. Enlarged image of intercellular space of untreated root C. Th4d treated root D. Enlarged image of intercellular space of treated root showing *Trichoderma* colonization E. Cell wall thickening of Th4d treated root; Enlarged image showing wall appositions; IS: Inercellular space T: *Trichoderma* WA: Wall appositions;
Bars: A. 4 µm B. 2.9 µm C. 5 µm D. 667 nm E. 2.9 µm F. 833 nm

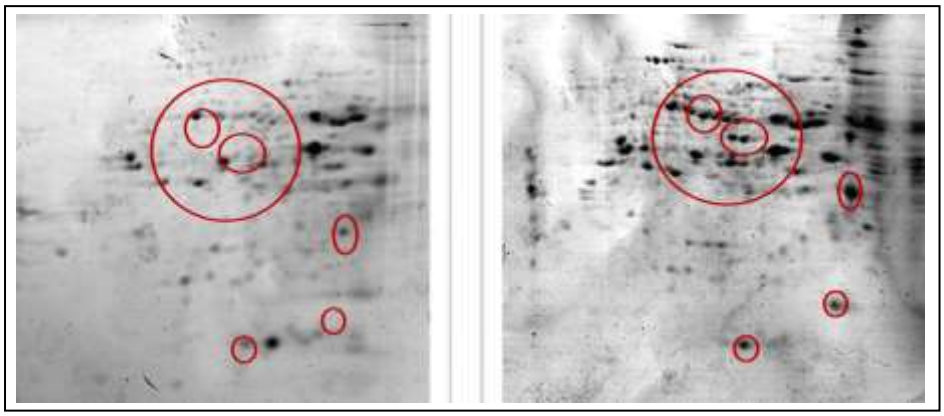
Characterization of the induced systemic resistance (ISR) by *Trichoderma* spp. in castor

Once it was established that colonization of castor roots by *Trichoderma* strain Th4d, induced systemic resistance as evidenced by the significant reduction of the seedling blight caused by Phytophthora as well as wilt caused by Fusarium, the ISR was characterized using different molecular approaches.

Generation of genome-wide transcriptome for castor: Prior to the characterization of ISR at RNA level, it was necessary to establish a good genome-wide transcriptome for castor as only a draft genome sequence of castor bean was available. Utility of draft genome sequence of castor bean is constrained by the limited availability of structural and functional annotation of genes. To ameliorate this deficit, attempt was made towards constructing a near exhaustive genome-wide reference transcriptome of castor. To this end, *de novo* transcriptome assembly was constructed by RNA-seq from twelve different tissues of castor bean, namely, mature leaf, flower buds (male and female), opened flower (male and female), seedling (two stages), rachis and capsule (four stages). The *do novo* transcriptome generated has furthered the transcriptome content from the reported 31,221 gene models to 66,601.

Transcriptome studies of ISR Prime and ISR Boost: The transcriptome studies using the samples of ISR-prime (castor seedlings treated with *Trichoderma* alone) and ISR-boost (castor seedlings treated with *Trichoderma* and challenge inoculated with seedling blight pathogen, *Phytophthora parasitica* var. *nicotianae*) has revealed a significant set of differentially expressing genes across both the conditions i.e. ISR-prime and -boost. Interestingly, only a few sets of genes were identified as commonly regulated between ISR prime and ISR boost and similar results have been reported in other systems as well. However, further data analysis to identify the pathways differentially regulated in the two conditions has been limited by the large number of unannotated genes among the differentially expressed genes in both ISR prime and ISR boost. This is being addressed by using different software tools that identify PUFs (proteins of unidentified functions).

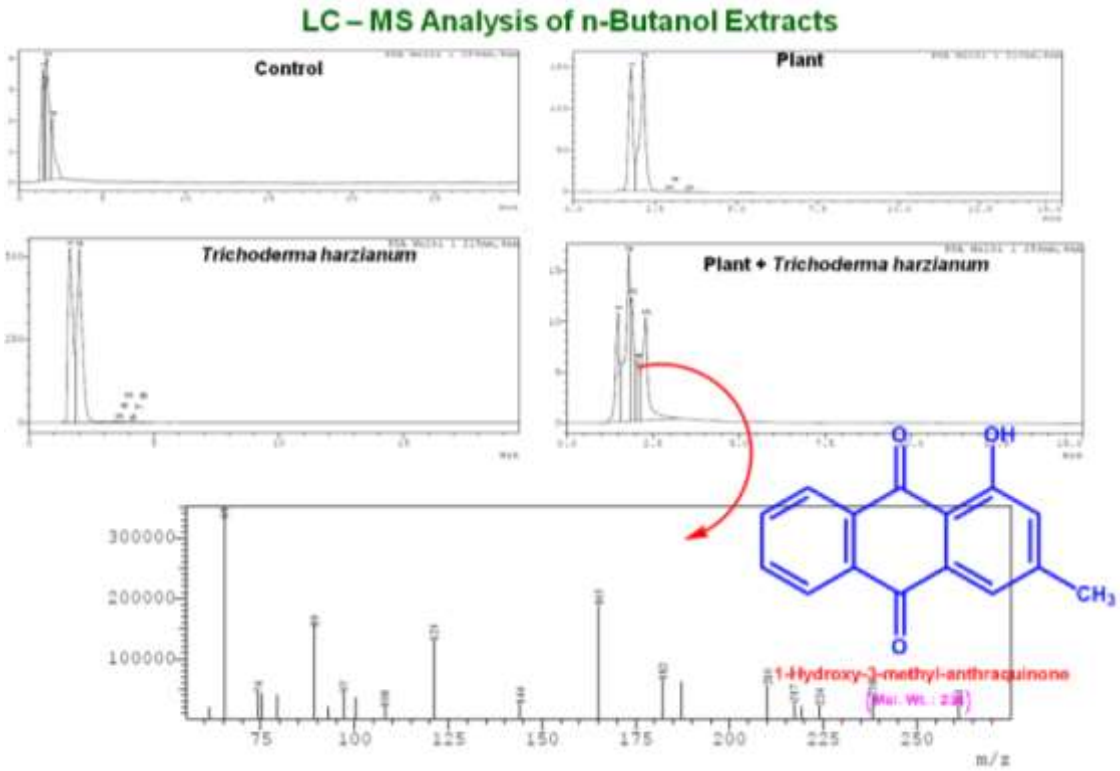
Proteome analysis: To study the effect of *Trichoderma*-treatment on leaf proteome, 2-Dimensional Gel Electrophoresis (2D) study was undertaken using leaf from untreated castor bean as control. Preliminary studies indicated differences between the leaf proteome composition of *Trichoderma*-treated and -untreated castor bean.



2D-gel electrophoresis of proteins isolated from leaves of *Trichoderma* treated and untreated seedlings

Metabolome analysis: To identify the candidate elicitors involved in ISR, analysis of secretome, plant metabolome and *Trichoderma* secondary metabolites using TLC, HPLC, C-MS was done. Initial metabolome analyses have shown subtle differences between treated and untreated castor plants.

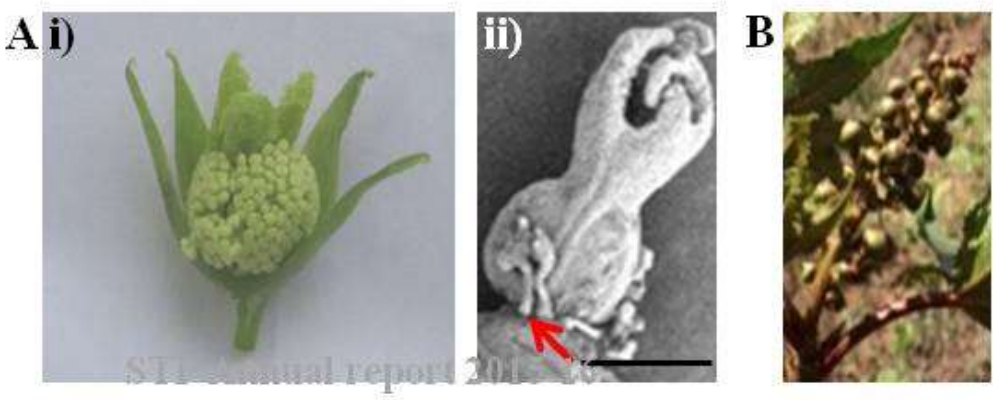
Analysis of culture medium (Secretome characterization): The secretome was characterized through analysis of the culture medium. The samples included the aqueous medium from three treatments *viz.*, plant (*Ricinus communis*) alone, *Trichoderma* alone and *Trichoderma*+plant. Plant support medium alone acted as absolute control. Aqueous media (each 50 ml) were extracted successively with n-hexane, ethyl acetate and n-butanol. TLC finger printing was performed on all the extracts. As the n-butanol extract is more polar and expected to accumulate considerable metabolites, it was subjected to LC-MS studies. Analysis of the data revealed that the plant sample contained harzianic acid, whereas only *Trichoderma*-grown medium showed the presence of phthalide. *Trichoderma*-treated plant samples contained harzianopyridone, ellagic acid and hydroxyl methyl anthraquinone. HPLC and GC analysis of the secretome samples have also identified different amino acids, organic acids and fatty acid derivatives in the three samples which need to be further confirmed.



LC-MS chromatograph indicating the various biomolecules present in *Trichoderma*-treated castor culture medium

MOLECULAR MECHANISMS GOVERNING SEX EXPRESSION IN CASTOR

Molecular mechanisms governing the phenomenon of sex expression in castor needs to be understood to address the sex variations and reversals in castor. Identification of developmental stages in male and female flowers is imperative, prior to delineating causes of sex reversion to monoecism in pistillate lines of castor. The stages involved in male and female flower developmental pathway were elucidated using SEM. Male and female flowers had common developmental stages till stage IV, after which the bifurcation to specific male and female flower development occurred. Bisexuality of flowers was also probed where the pistillate and male lines exhibited gradation in bisexuality such as, fully developed male and female organs or with rudimentary stigma or stamens. At high temperatures, the pistillate inflorescence completely reverted to male inflorescence in higher orders above quarternary.



Bisexual flowers in castor parental lines A.(i) Bisexual flower showing fully developed ovary and stamens in crossed progeny of stable pistillate line. (ii) Bisexual flower showing rudimentary stamens. B. Reversion of pistillate inflorescence (with 1-2 bisexual flowers) to completely male inflorescence at high day temperatures of 39-42 °C.

Gene expression profiling was done for 12 candidate genes in castor based on their role in sex expression in other crops, at the amplification conditions verified using gradient PCR. Differential gene expression was observed for 3 candidate genes possibly involved in male and female flower development, in a monoecious line, using RT-PCR with RNA isolated from 3 different tissues/ stages viz., shoot apical meristem before floral initiation, male and female flower buds.

Sex expression in the progeny of epimutagen treated plants (280) were verified but there was no significant difference in sex expression. Floral differentiation was delayed when compared to the control in a monoecious variety and did not occur in majority of plants.

CROP PRODUCTION

Enhancing Resource Use Efficiency in Castor based cropping systems

Moisture x nutrient interaction in castor – sorghum cropping system in Alfisols under rainfed condition

Drought situation prevailed during 2nd FN of June and July. Total rainfall received for sorghum was 364mm and for castor it was 391mm. Under drought situation receiving 65% normal total rainfall, both sorghum and castor crops were affected in initial period up to flowering. Applying FYM for 25%N along with 75%NPK recorded significantly highest seed yield of sorghum (4338kg/ha) and castor (2266kg/ha) compared to either N alone or NP or NPK without FYM. The dry weight of sorghum stover was highest with 100% NPK+5t FYM/ha. Days for 50% flowering in sorghum and castor were significantly delayed with no manure or fertilizer application. The soil moisture content in the treatment receiving FYM was higher at all stages of crop growth both at 0-15cm and 15-30cm depths.

Performance of *kharif* castor under rainfed conditions in sorghum-castor system

Evaluation of sowing schedules and genotypes suitable for *rabi* castor

Reduction (43-59%) in dry matter accumulation with progressive delay in sowing and the lowest accumulation was noticed in the crop sown on 1st November. Among different sowing schedules, sowing on October 1, registered the highest seed yield (2671 kg/ha). With delay in sowing from October 1 to October 15 (15 days), November 1 (30 days) yield of castor declined by 27.6% and 37.6% respectively. The Growing Degree Days (3573°C), Helio Thermal Units (29153 degree days-hours), Photo-Thermal Units (41136 degree days hours) and Heat Use Efficiency (0748 kg/ha degree days) accumulated was highest in the crop sown on October 1. Ten genotypes of castor (7 hybrids + 3 varieties) presently in the seed chain were evaluated for their suitability in *rabi* season in large plots. Among different sowing schedules, sowing during 1st Oct registered the highest seed yield (2671 kg/ha). Significantly the highest seed yield was recorded in DCH-519 (2921 kg/ha) and closely followed by GCH-7 (2617 kg/ha) and DCH-177 (2456 kg/ha). Among varieties DCS-107 performed superior (2386 kg/ha) over 48-1 and GC-3.The hybrids *viz.,* PCH-111, YRCH-1 were found to be susceptible to wilt.

Evaluation of suitable genotypes of *rabi* castor under different sowing schedules

Performance of *rabi* castor to drip irrigation/fertigation

Drip-fertigation of *rabi* castor at 0.8 Epan along with supply of full amount of water soluble N and K through fertigation resulted in significantly higher castor seed yield (3786 kg/ha) and oil yield (1712 kg/ha) compared to surface irrigation control. This was on par with scheduling irrigation through drip at 0.6 Epan through fertigation. Drip irrigation resulted in high water-use efficiency (3.32 to 6.45 kg/ha-mm) and highest water productivity ranging from (0.3324 to 0.6445 kg/m^3) in comparison to conventional surface irrigation treatment (0.2910 kg/m^3).

Performance of *rabi* castor (DCH-519) under drip-fertigation

IIFSR-IIOR collaborative Farming Systems Research

A Memorandum of Understanding was signed for strengthening Inter institutional linkage between Indian Institute of Farming Systems Research (IIFSR), Modipuram, AICRP (IFS) and IIOR, Hyderabad represented by AICRP (oilseeds). As a part of this linkage, field experiments were continued for second year in S.K. Nagar (*kharif/ rabi*) to assess the performance of castor as component crop in integrated farming systems. During 2014-15, the on-station/on-farm trials were conducted in coordination with IFS (S.K.Nagar)-AICRP Castor (S.K.Nagar) centres.

Performance of castor as component crop in farming systems of Gujarat

SK. Nagar

In Gujarat, castor cultivation is predominant in 6 districts of North Gujarat, *viz.*, Mehsana, Banaskantha, Sabarkantha, Gandhinagar, Patan and Kutch with high livestock population. Since the castor crop and its residues do not produce quality fodder, on-farm assessment of castor in association with fodder crops/cotton was evaluated. In total 12 demonstrations comprising of intercropping of castor with Lucerne (5 demonstrations), green manuring of castor with sunhemp (2 demonstrations), relay cropping of groundnut and Bt cotton with Hybrid castor (5 demonstrations) were conducted in Mehsana district during 2014-15. The salient findings indicated that castor + lucerne (harvested as dual purpose-green fodder followed by seed production) resulted in 50.3% higher net returns than only sole castor crop; Sunnhemp as green manure in castor gave 20.6% higher net monetary return over sole castor; Groundnut + castor as relay crop gave higher net returns (Rs 64776/ha) over sole groundnut and relay cropping of castor in Bt cotton resulted in higher net monetary return (44.1%) than only Bt cotton.

On-farm assessment of castor in farming systems of Mehsana district (Gujarat)

Intervention	On-farm assessment (number)	Method	Cropping pattern	Yield (kg/ha)	Gross returns (`/ha)	Cost of cultivation (`/ha)	Net returns (`/ha)	Per cent increase over net return
Lucerne as intercrop in castor (GCH-7)	5	F. M.	Castor (K+R)	2652	101468	40004	61464	50.5
		I. M.	Castor Lucerne)	3150	142124	49920	92404	
Sun hemp green manuring in castor	2	F. M.	Castor hybrid (GCH-7) only	2470	93860	33685	60175	20.6
		I. M.	Sunhemp green manuring after castor	2915	110770	38510	72260	
Castor as relay crop in groundnut	3	F. M.	Groundnut F	2623	115086	50310	64776	168
		I. M.	Grondnut+ Castor (2:1)	2147	3925	231548	57616	
Castor as relay crop in Bt cotton	2	F. M.	Bt cotton	3160	152350	42600	90120	44.6
		I. M.	Bt cotton+. Castor (2:1)	2415	2475	101430	94050	

F.M. =Farmer Method, I.M. =Improved Method

CROP PROTECTION

Wilt

Comparison of screening methods

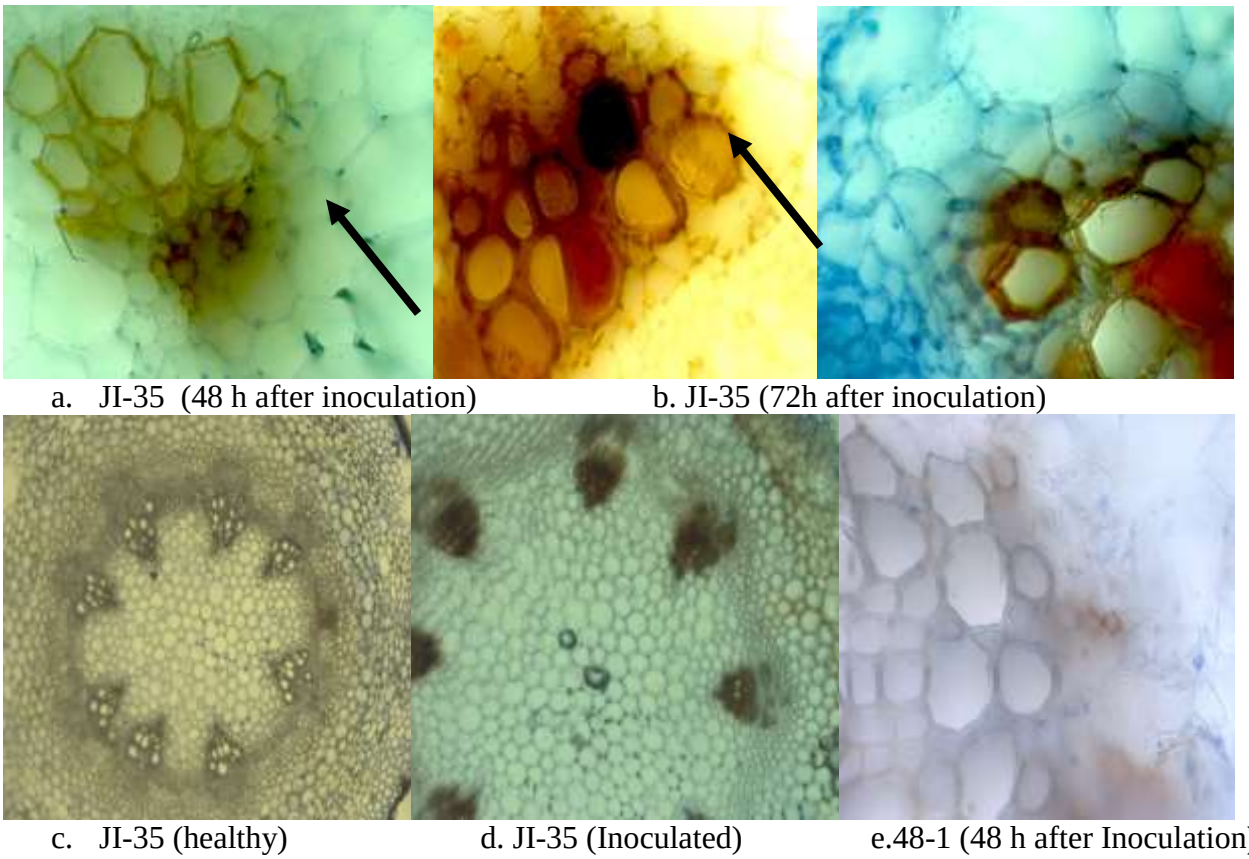
In comparison of screening methods of artificial inoculation to screen against wilt, all the genotypes exhibited comparatively higher wilt incidence in soil infestation method as compared to root dip inoculation methods. In soil infestation method, time taken for wilt incidence was less as compared to root dip inoculation method. Hence, soil infestation m

a.Soil infestation method b. Root dip inoculation method

Comparison of artificial screening methods of wilt disease

Host-pathogen interaction

Fusarium oxysporum f. sp. *ricini* infected susceptible castor cultivar JI-35 showed browning and clogging of vascular bundles while browning or clogging of vessels was not observed in resistant cultivar 48-1 though fungal mycelium observed in vascular region.



a. JI-35 (48 h after inoculation) b. JI-35 (72h after inoculation)

c. JI-35 (healthy) d. JI-35 (Inoculated) e.48-1 (48 h after Inoculation)

Cross sections of JI-35 (susceptible) and 48-1 (resistant) castor genotypes after inoculation

Host Plant Resistance

The castor genotypes *viz*., RG-851, JI-35, GCH-4, VP-1, SKP-84, SKI-215, Kranti, Haritha, RG-3075, AP-134, Ap-240, Ap-241, Ap-130 showed susceptible reaction to all three isolates of Palem, S. K. Nagar, Hyderabad. RG-1916, RG-155, RG-1647, AP-163, Ap-33, Ap-156, Ap-56, Ap-42, Ap-200, Ap-180, Ap-171 showed resistance to all three isolates up to the end of season and these eight lines could be used for further introgression (Fig.2). 11 genotypes showed variability in wilt reaction to the three isolates that needs further confirmation so that they may be used as differentials.

RG -1963-IIOR.isolate - (S). RG-1963- Palem isolate (R) RG-1963- S. K. Nagar isolate (R) JI-35- Palem isolate (S)

AP-33-IIOR isolate(R) AP-33- Palem isolate (R) AP-33- S. K .Nagar isolate(R) JI-35- S. K. Nagar isolate (S)

Wilt reaction of castor genotypes with *Fusarium oxysporum* f.sp. *ricini* isolates from sick plots of IIOR, Hyderabad; Palem and S.K. Nagar

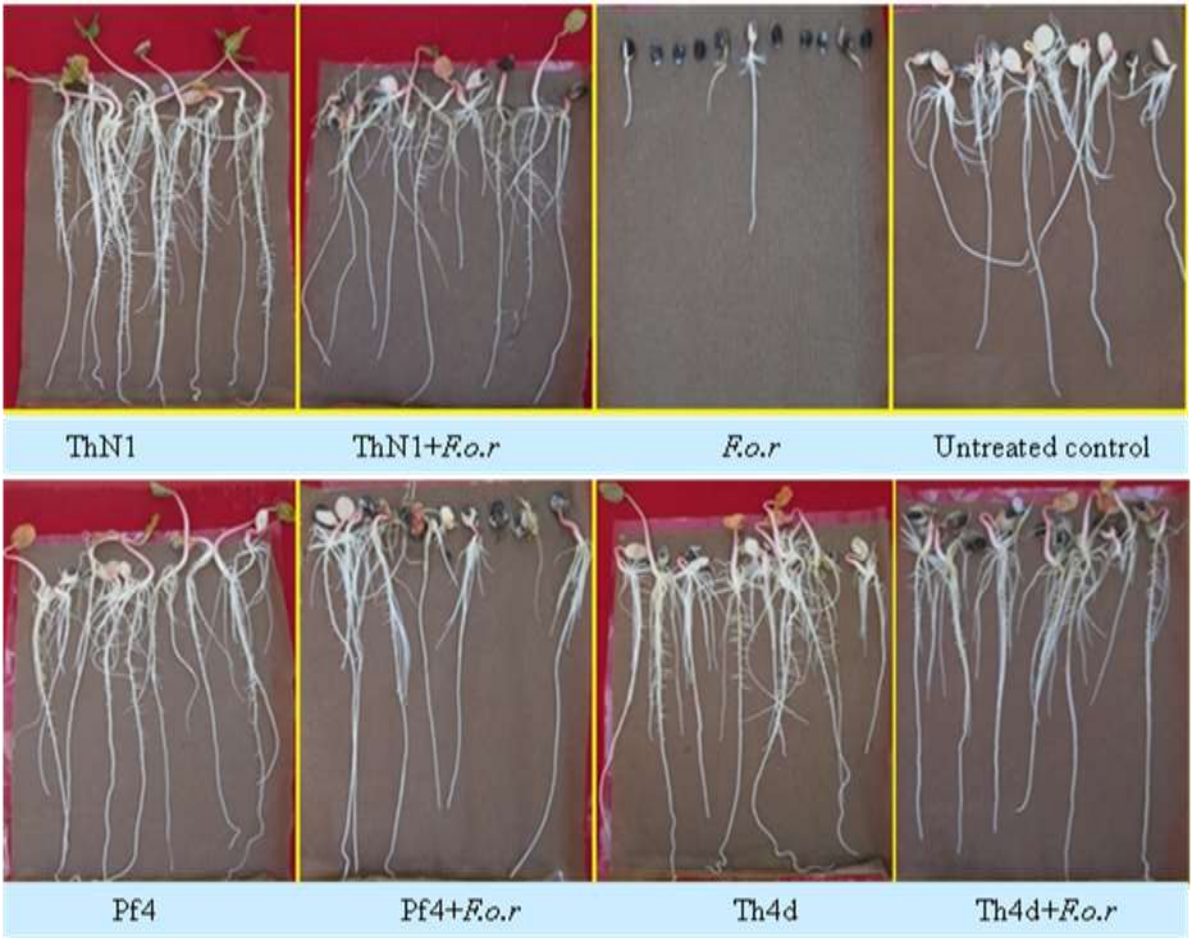
Parental lines & advanced breeding material were evaluated against wilt in sick plot at IIOR, Hyderabad and six entries viz., PVT-11-3, PVT-11-19, DPC-21, DPC-29, PMC-65, PMC -77 recorded highly resistant reaction (0%) and 43 entries viz., PVT-1-14-189, PVT-1-12-2, PVT-1-12-3, PVT-1-12-4, PVT-1-12-6, PVT-1-12-7, PVT-1-12-8, PVT-1-12-9, PVT-1-12-72, PVT-1-12-88, PVT-1-12-90, PVT-1-12-98, PVT-1-12-103, PVT-1-12-104, PVT-1-12-160, PVT-1-12-161, PVT-1-12-167, PVT-11-2, PVT-11-11, PVT-11-17, PVT-11-18, PVT-11-21, PVT-11-26, PVT-11-59, PVT-11-61, DPC-17, DPC-18, DPC-19, DPC-20, DPC-23, DPC-24, DPC-25, DPC-28, PMC-67, PMC-78, PMC-10, PMC-13, PMC-22, PMC-32, PMC-43, PMC-47, PMC-66, PMC-74 recorded resistant reaction with <20% wilt incidence. Entries DPC-21, DCS-118, DCS 123, M-571 were confirmed as resistant to wilt for the second year under sick plot conditions.

Disease Management

Screening of bioagents against *Fusarium oxysporum* f.sp *ricini* in castor

Germination towel tests

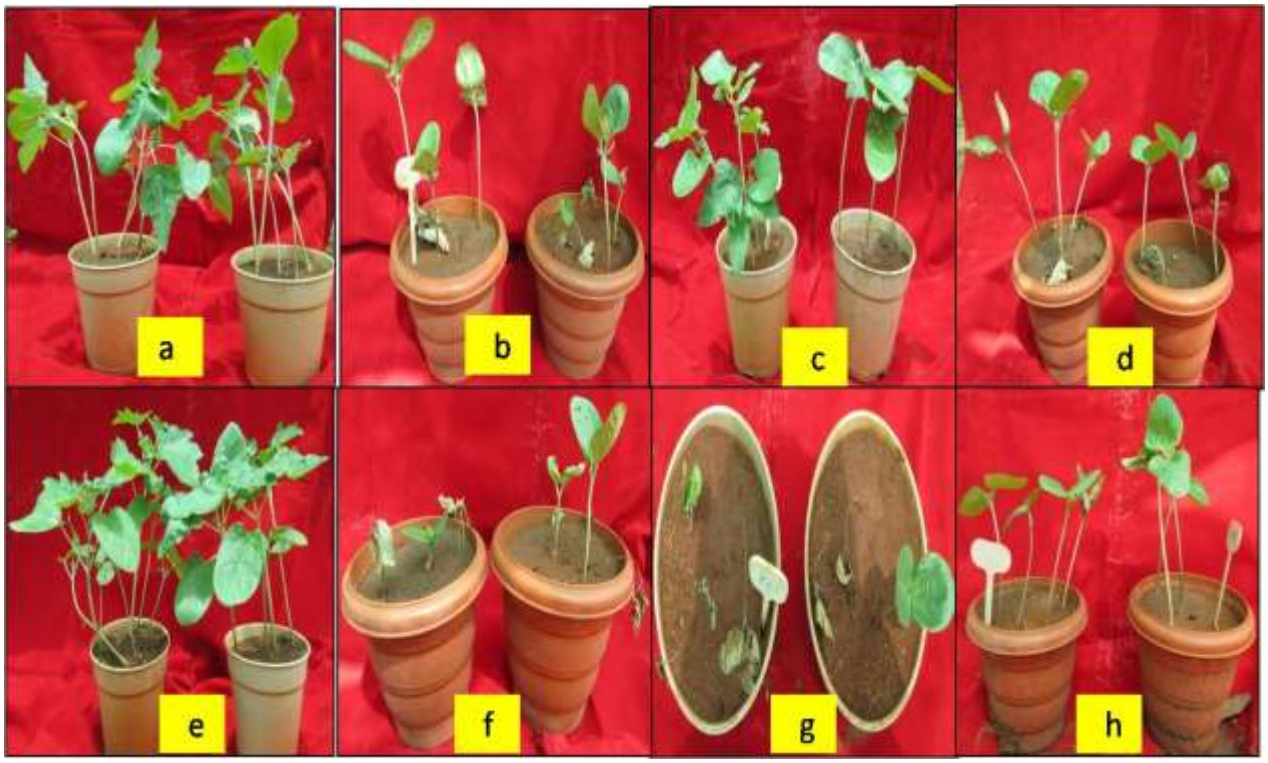
Seed treatment with bioagents (3 *T. harzianum* and 3 *P. fluorescens* strains) showed increased seed germination and vigour index. *T. harzianum* Th4d treatment gave highest vigor index compared to all other bioagents. Among all the treatments, *T. harzianum* N2, *T. harzianum* Th4d and *P. fluorescens* Pf 3 (20%) showed least wilt incidence and high reduction in wilt incidence (67.8%) followed by *T. harzianum* Th N1 and *P. fluorescens* Pf 2 (30%) when compared with pathogen check (90%).



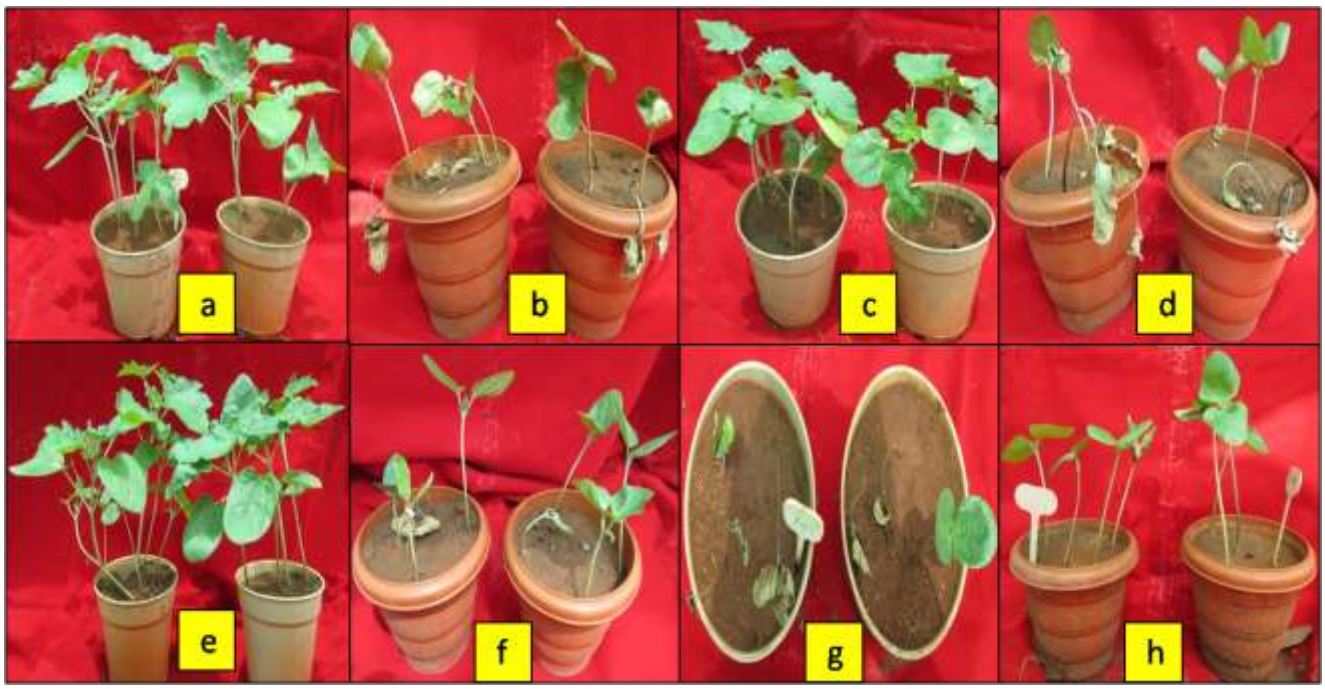
Effect of seed treatment with bioagents against *F. ricini* in castor in germination towel tests. ThN1- *T. harzianum*; Th4d - *T. harzianum*; Pf4 -*P. fluorescens* and *F. o. r* - *F. ricni*

Greenhouse tests

In greenhouse trials with castor cultivar GCH 4, seed germination was found to be significantly high in bioagent treatments when compared to the pathogen check. Among all the bioagents low wilt incidence was recorded with *P. fluorescens* Pf2 (30%) followed by *T. harzianum* Th N2 (45%) and *T. harzianum* Th4d (55%).



Effect of seed treatment with *P. fluorescens* against *F. ricini* in castor; (a) *P. fluorescens* Pf-3 WP (b) *P. fluorescens* Pf-B culture suspension (c) *P. fluorescens* Pf2 WP (d) *P. fluorescens* Pf2 culture suspension (e) *P. fluorescens* Pf4 WP (f) *P. fluorescens* Pf4 culture suspension (g) pathogen check (h) untreated control



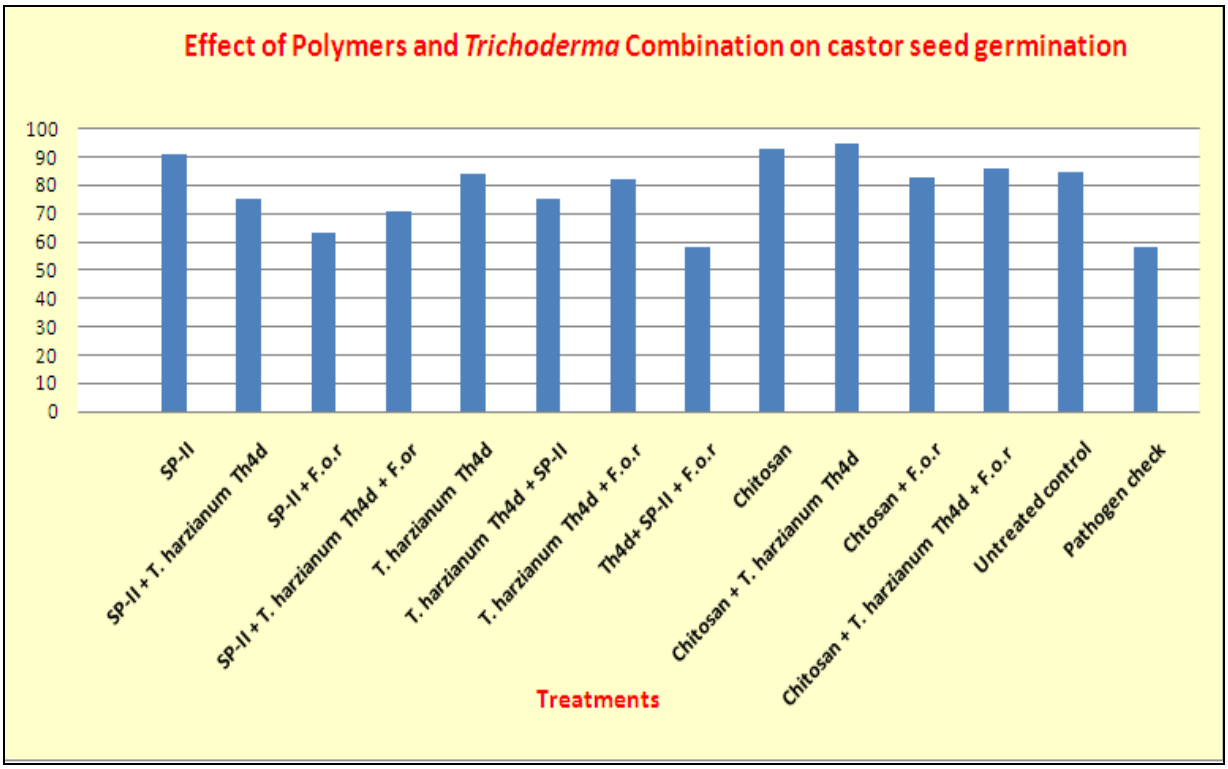
***In vivo* screening of fungal bioagents against *F.ricini* in castor; (a) *T.harzianum* ThN1 treated pots; (b) soil sick pot with *F. ricini* and seed treatment with *T. harzianum* ThN1; (c) *T. harzianum* Th4d treated pots;(d) soil sick pot with *F.ricini* and seed treatment with *T. harzianum* Th4d; (e) *T. harzianum* ThN2 treated pots; (f) soil sick pot with *F. ricini* and seed treatment with *T. harzianum* ThN2; (g) pathogen check (h) untreated control**

Field Evaluation of Chemicals and Biocontrol Agents against Wilt

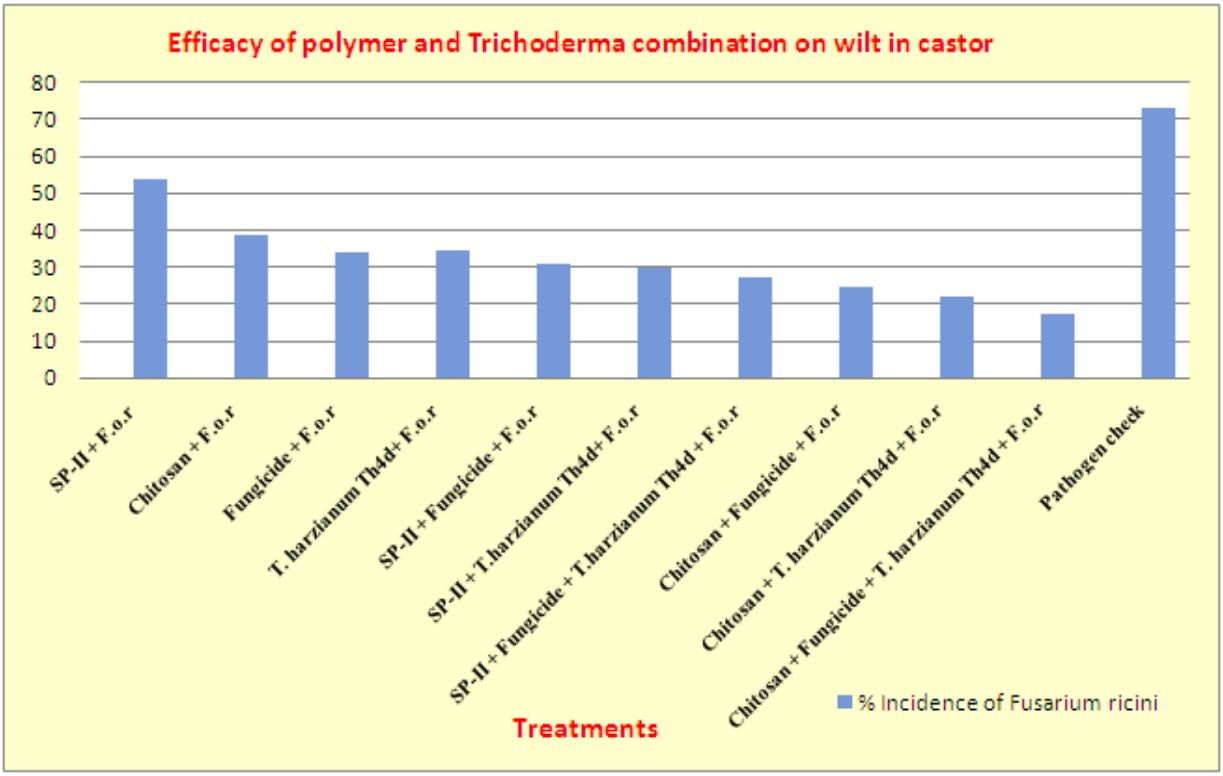
Seed treatment with carbendazim recorded significantly low wilt incidence (24.4 %) with high seed yield of 1123 kg/ha in GCH-4. Seed treatment and soil application of *T. harzianum* Th4d WP also recorded low wilt incidence (26%) and seed yield of 1016 kg/ha whereas in pathogen control the wilt incidence was 60.6% with seed yield of 905 kg/h.

Compatibility studies of seed coat biopolymer with biocontrol agent *Trichoderma harzianum* Th4d in castor

In the compatibility studies of seed coat polymers with biocontrol agent *Trichoderma harzianum*, the combination of chitosan with biocontrol agent gave the highest germination percentage (95%) and vigour index in GCH-4 than the polymers and biocontrol agent used alone. *Fusarium oxysporum* f.sp. *ricini* incited seed and seedling root rot was significantly low in combination of chitosan with biocontrol agent (20%) compared to pathogen check (70%).



Effect of Polymers and *Trichoderma* combination on germination of DCS-107 seeds

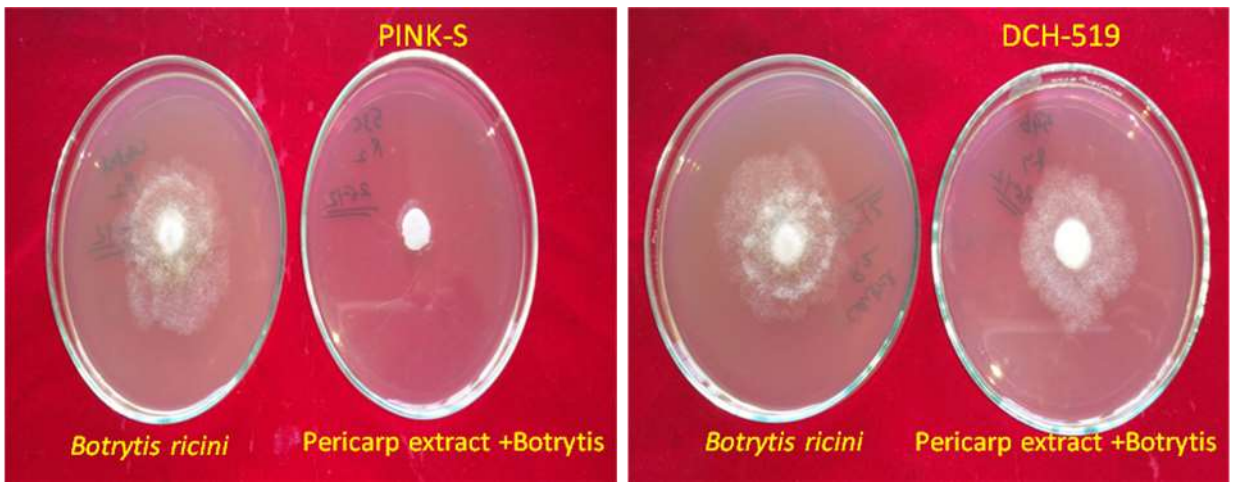


Efficacy of polymer and *Trichoderma* combination on wilt in castor

Botryotinia graymold

Antimicrobial activity of pericarp extracts from different castor genotypes

Pericarp extracts of different castor genotypes namely 48-1, CI-1, Pink-NS, Pink-S, GCH 7, GCH 4 and DCH 519 in different organic solvents were assessed for antimicrobial activity by filter disc diffusion method. Extracts from Pink-NS, Pink-S and 48-1 genotypes showed more than 70% inhibition of *Botryotinia ricini* while extract from DCH-519 showed no inhibition. TLC and LCMS analysis has shown abundance of an antimicrobial compound which need to be identified further.



Antimicrobial activity of pericarp extracts from different castor genotypes castor germplasm against Botryotinia gray mold

Resistance sources

The accessions *viz.,* RG 3206 RG 3344, RG 1062, RG-3179, RG-3181, RG-3186, RG-3187, RG-3200, RG-3202, RG-3207, RG-3210, RG-3243, RG-3251, RG-3257, RG-2008 x 2787-P30 were found to be moderately resistant to gray mold under artificial epiphytotic conditions.

a) RG-3206 **b) DCH-519 (SC)**

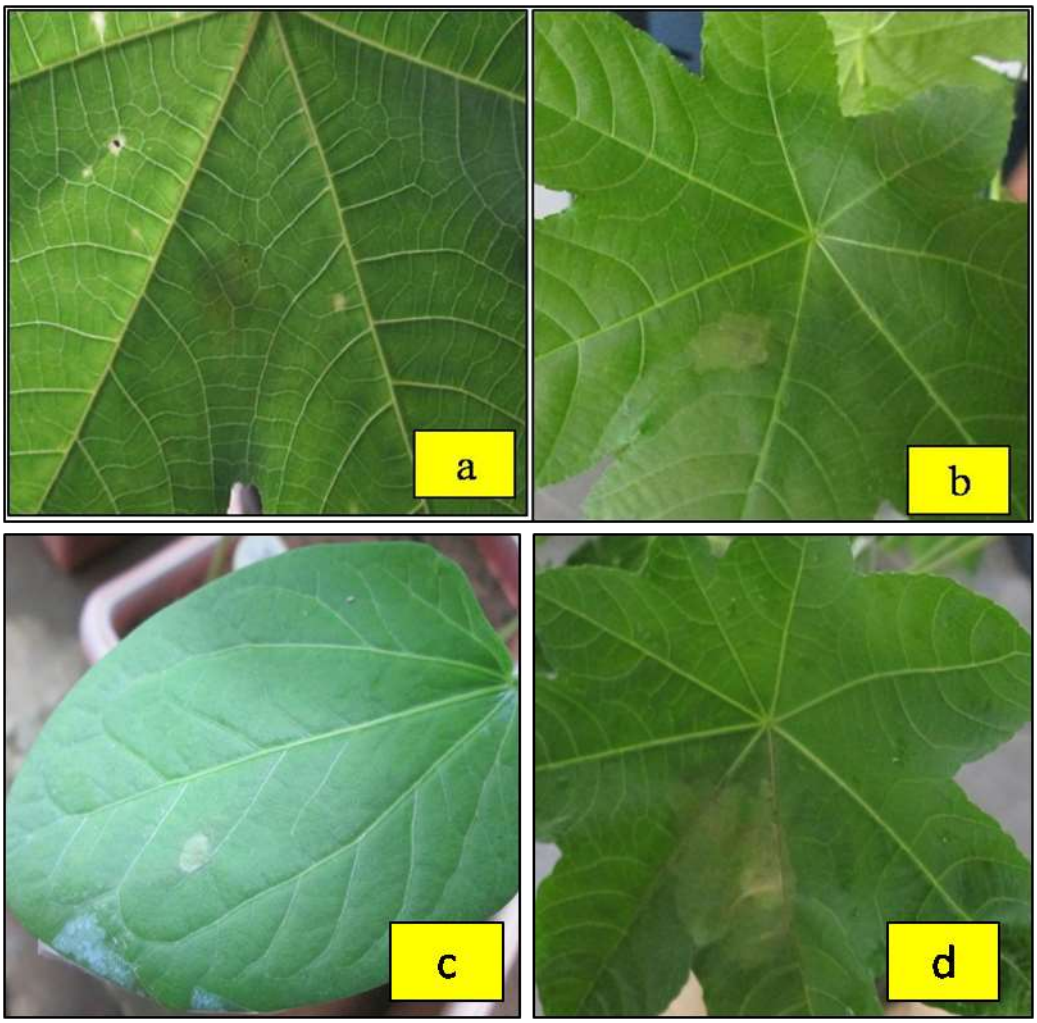
Disease severity on (a) Gray mold resistant castor accession and (b), susceptible check

Phytophthora

Screening of bioagents against *Phytophthora nicotianae* in castor

Greenhouse tests

Seed germination (cv. GCH 4) was found to be significantly high in bioagent treatments when compared to the pathogen check. *T. harzianum* Th4d and *T. harzianum* ThN2 were able to induce systemic resistance against Phytophthora leaf blight recording low disease severity (15.0%) followed by *P. fluorescens*, Pf-B with 20.0% disease severity whereas pathogen check recorded 60.0% disease severity.



***In vivo* screening of bioagents against *P. nicotianae* in castor; (a) *P. fluorescens* PfB WP soil and seed treatment (b) *P. fluorescens* Pf2 WP seed treatment (c) *T. harzianum* Th4d WP seed and soil treatment (d) *P. nicotianae* control (leaf inoculation)**

Management of *Spodoptera litura* through Bt-127

Particle size reduction of Bt-127 technical through Ball Milling for increasing efficacy: Bt-127 technical powder (105µ) was milled with 3mm zirconia balls at 300 rpm in a planetary ball mill. Dynamic light scattering analysis of samples drawn at 30, 60, 90, 120, 150, 180, 210, 240 min revealed particle sizes lower than 5µ *viz*., 1171, 559, 252, 210, 157, 112, 36, 35 nm respectively. Particle size with 559 nm was identified as optimum particle size of Bt-127 against *S. litura*, *H. armigera*, *A. janata*. Bt particles of size 559 nm with polydispersity index 0.338, CFU 3.3 x 10^{17}/g and protein 178 µg/g resulted in higher mortality of 7 days old *Spodoptera litura* larvae 72 h post treatment @ 1.0 mg/ml *i.e*., 83.3% in comparison to 56.7% mortality caused by unmilled Bt powder. These particles can be used for development of formulations with good stability.

Powders of Bt-127 drawn after different milling durations

Development of SC formulations with milled particles of Bt-127 singly and in combination with entomopathogenic fungi, evaluation through laboratory bioassays and field trials

Bt-127 particles of 559 nm and Bt 105µ were formulated as suspension concentrates singly and in combination with *Nomuraea rileyi* and *Beauveria bassiana* and evaluated against *Spodoptera litura* and *Helicoverpa armigera* in lab and LC_{50} values were generated. LC_{50} values of SC formulations against *S. litura* and *H. armigera* were 351 and 90.48 µl/100 ml for Bt-127 SC formulation, 355 and 89.5 µl/100 ml for Bt-127+*N. rileyi* SC formulation, 415 and 88.2 µl/ 100 ml for Bt-127+*B. bassiana* SC formulation respectively.

Field testing against *Spodoptera litura*

Field testing of the SC formulations **of** Bt-127 singly and in combination with *N. rileyi and B. bassiana* was undertaken during *kharif* 2015 in 5.4 x 3.6 m plots against *S. litura* at RARS-Palem, TCRS-Yethapur and IIOR-Hyderabad. Treatments included Bt-127 SC formulation @ 3ml/l, Combination SC formulation of Bt-127 + *N. rileyi* @ 3ml/l, Combination SC formulation of Bt-127 + *Beauveria bassiana* @ 3ml/l, Bt-127 @ 1g/l, *N. rileyi* @ $1x10^{10}$ spores/l, *B. bassiana* @ $1x10^{10}$ spores/l, Profenofos @ 1ml/l and untreated control. Treatments were imposed on observing larval masses of 4-5 days old larvae. Two SC formulations Bt-127 and Bt + *N. rileyi* were found highly effective against *S. litura* on castor RARS-Palem, TCRS-Yethapur and IIOR-Hyderabad (83-99% decrease in larval population) at the test locations by 5 days after spray. At IIOR, seed yield/plot was highest in the treatment Bt-127 SC formulation (3797 g) followed by Combination SC formulation of Bt-127 + *N. rileyi* (2885 g) followed by Profenofos (2302 g)

Field testing of Bt-127 SC formulation against *S. litura* on castor

Screening of self-generation population of leafhopper resistant accessions: Among self-generation populations of RG-2661, RG-43 and RG-3060 screened against leafhopper, none of the plants exhibited hopper burn (Grade 0 on 0-4 scale) with leafhopper population ranging 0 to 15, 13 to 27 and 5 to 18 leafhoppers/3 leaves/plant, respectively.

Self-generation population of leafhopper resistant accession, RG-2661

Self-generation population of leafhopper resistant accession, RG-43

Leafhopper resistant accession, RG-3060

Screening of new castor parental lines against leafhopper: Among six new parental lines screened against leafhopper, two parental lines (DPC-27 and DCS-123) were found resistant to leafhopper (hopper burn grade 0 to 1 on 0 to 4 scale). Two lines *viz*., DPC-28 and DCS-121 were moderately resistant to leafhopper (grade 2), while the lines DPC-29 and DCS-122 were susceptible to leafhopper (grade 3 to 4).

Evaluation of selected advanced breeding material against leafhopper: Out of 30 advanced breeding materials screened against leafhopper, 8 advanced breeding materials (PVT-11-5, PVT-11-11; PHT-11-47, 49, 51, 52, 53, 57) were resistant to leafhopper (hopper burn grade 0 to 1).

Screening of PHT-11-3-F_2 materials against leafhopper: Among 240 plants of PHT-11-3-F_2 screened against leafhopper, 22 plants showed resistant reaction (hopper burn grade 1), 187 plants showed moderate reaction (hopper burn grade 2) and 31 plants showed susceptible reaction (hopper burn grade 3).

Evaluation of synthetic attractants against major lepidopteran pests: Electroantennographic (EAG) response of one-day old female moths of castor semilooper *Achaea janata*, tobacco caterpillar *Spodoptera litura* and capsule borer *Conogethes punctiferalis* to six synthetic kairomonal attractants was studied with two concentrations (0.1 and 1µl). In both concentrations, female moths of semilooper, tobacco caterpillar and capsule borer showed significant hyper sensitive reaction to benzaldehyde (-2.573 to -3.336 mV), phenyl acetaldehyde (-1.518 to -2.221 mV) and 2-phenylethanol (-2.563 to -3.152 mV), respectively. Field evaluation of synthetic attractants singly and in combinations using water trap revealed that phenyl acetaldehyde + 2-phenyl ethanol (1:1 ratio) was effective in attracting

S. litura and *C. punctiferalis* moths with maximum catches of 30.4 and 12.2 moths/week, respectively.

Moth catches in water trap containing phenyl acetaldehyde + 2-phenyl ethanol (1:1 ratio)

Efficacy of poison baits against *Spodoptera litura:* Field evaluation of poison baits against late instar larvae of *S. litura* in castor during *kharif* 2015-16 revealed that wheat bran + sugarcane jaggery + chlorpyriphos 20EC bait was equally effective as the standard bait containing rice bran + sugarcane jaggery + monocrotophos 36SC, resulting in 43.3-56.7% per cent larval mortality. The study showed that wheat bran can replace rice bran in poison baits since rice bran availability is a constraint as it is used for extraction of oil.

Seasonal activity of *Spodoptera litura* monitored using pheromone trap: Seasonal activity of *S. litura* monitored in two locations using pheromone trap during castor cropping seasons (July 2015 to February 2016) revealed two peak trap catches, the first during 36th to 37th MW (3-16th September) and second during 41st to 42nd MW (8-21st October). The highest peak catches of *S. litura* in two locations ranged from 80.3 to 124 moths/trap/week. Significant positive relation was observed between egg-masses in castor and current (r=0.91 to 0.93) and previous week (r=0.57 to 0.82) trap catches. The response of *S. litura* to light trap (up to 28 moths/week) was lower than sex pheromone trap. Moth catches showed significant positive correlation for minimum temperature (r=0.38 to 0.399). Peak oviposition of 14.8 and 10.2 egg-masses/5 plants in castor was recorded during 41st and 42nd MW at Narkhoda and Rajendranagar, respectively.

Evaluation of mating disruption technique against *S. litura*: Mating disruption technique with synthetic sex pheromone of *Spodoptera litura* [(Z,E)-9,11-14Ac and (Z,E)-9,12-14Ac in 10:1] @ 50gm a.i./ha was evaluated in castor (cv. DCH-519) during *kharif* 2015-16. *S. litura* moth catches in pheromone traps as well as the egg masses were low in mating disruption plot (7 to 24 moths/trap/week and 1.2 egg masses/5 plants) compared to control plot (41 to 98 moths/trap/week and 9.4 egg masses/5 plants). However, no significant difference in larval population was observed in mating disruption plot (24.2 larvae/5plants) and control plot (28.8 larvae/5plants) due to migratory behaviour of *S. litura*.

Off-season biology of castor shoot and capsule borer (*Conogethes punctiferalis*): Survey on alternate hosts was made to study the off-season survival of shoot and capsule borer, *C. punctiferalis* during March - July, 2015. Off-season multiplication of capsule borer recorded 0.02 -0.47 larva/fruit/tree in guava fruits, 0.03 - 0.35 larva/inflorescence/tree in mango inflorescence and shoot and 0.5 - 3.0 larvae/plant in capsules of perennial and self sown crop of castor.

Fig.7. Off-season alternate hosts of *C. punctiferalis*

SOCIAL SCIENCES

ICT mediated dissemination of knowledge on castor and sunflower crops in Andhra Pradesh and Telangana

Crop information modules on castor and sunflower were updated and deployed into the information kiosk. A web-based application on prices and arrivals at major APMCs for castor (45 from Andhra Pradesh, 50 from Gujarat and 37 from Rajasthan), sunflower (45 from Andhra Pradesh, 75 from Karnataka and 80 from Maharashtra) from 2001 to till date were compiled and a database was designed for retrieval of the required information. The database has the information on minimum price, maximum price, modal price, quantity of produce for the particular APMC on a specific date. A query based module was designed to retrieve the information based on a particular date, market or over a period of time. This information is updated on a regular basis. The package of practices (POP) on castor, sunflower, safflower, sesame and niger were uploaded to the Institute website. Frequently asked questions for the Institute mandate crops were uploaded to the website. The photos related to castor and sunflower were digitized and a database was designed. Advisories on sunflower and castor (26976) were developed and disseminated using Reliance information services. A course on "Best Management Practices" in sunflower was developed in English. The course is of one hour duration. The course is indented for KVKs, Agricultural Extension Officers, Progressive Farmers and persons interested in sunflower cultivation.

Castor

ICAR-IIOR conducted 80 FLDs during *kharif* (60) and *rabi* (20) seasons. Thirty FLDs each were conducted in Anantpur and Mahabubnagar districts of Andhra Pradesh and Telangana respectively. Due to long dry spells during crop growth in *kharif*, 23 FLDs were vitiated in Anantapur.

In Anantapuram during *kharif*, 20% increase in yield was observed in IT (1156kg) as compared to farmers practice (963kg/ha) with annual net returns (ANR) of ` 7569/ha and BCR of 2.50. In Mahabubnagar district, IT recorded 850 kg as compared to 595 kg/ha in FP with ANR of ` 7581/ha. The BCR was 2.98 in IT and 2.34 in FP, respectively. The demonstrations under irrigated conditions in Gononipalle in Dindi of Nalgonda district, recorded seed yield of 2160 kg/ha in IT as compared to 1810 kg/ha in FP with ANR of ` 6253/ha. The BC ratio 2.24 in IT and 2.09 in FP, respectively.

Productivity potential and economics of FLDs conducted during *kharif* & *rabi* 2015-16

District/ State	Situation	No. of demos	Yield (kg/ha)		% increase	CoC (`/ha)		GMR (`/ha)		ANR (`/ha)	BCR	
			IT	FP		IT	FP	IT	FP		IT	FP
Anant-puram	RF	10	1156	963	20	16700	15850	36992	30800	5342	2.25	1.94
Maha-bubnagar	RF	19	850	595	44	9724	8631	28912	20238	7581	2.98	2.34
Maha-bubnagar	Protective Irrigation	9	1786	1401	28	16555	14194	60727	47641	10715	3.68	3.39
Nalgonda	*Rabi*-irrigated	19	2160	1810	19	30789	27737	69137	57937	6253	2.24	2.09
	Mean	**57**	**1488**	**1192**	**25**	**19048**	**17145**	**47616**	**38144**	**7569**	**2.50**	**2.22**

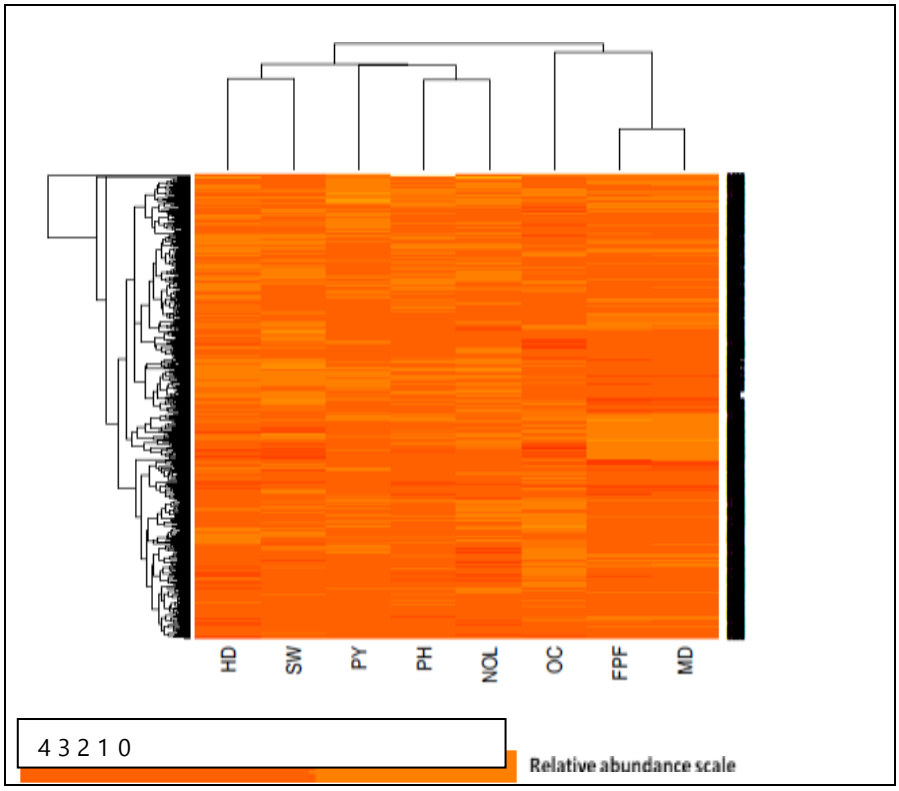
IT-Improved practice, FP-Farmers practice, CoC= cost of cultivation, GMR= Gross monetary returns; ANR = Additional net returns; BCR= Benefit cost ratio

SUNFLOWER

CROP IMPROVEMENT

Diversity analysis using Quantitative traits

During the year, multiplied 1850 accessions, rejuvenated 300 accessions, supplied 361 accessions including genetic stocks to different researchers as per their demand. Diversity analysis of 2140 accessions; 352 GP accessions and 299 EC accessions was carried out based on heat map and D^2 (Euclidean distance) approach. Eight quantitative characters were taken into consideration for diversity study. *viz*., Oil content (OC), Plant height (PH), 100-Seed weight (SW), Head Diameter (HD), Yield/plant (YP), Number of leaves (NOL), 50% flowering (FPF) and days to maturity days (MD). Based on heat map approach using these eight traits the accessions were clustered into 3 major groups. The relative abundance scale showed good variability within the genotypes and the traits under study. Days to maturity and days to 50 % flowering are relatively similar for almost all genotypes.



Diversity analysis of 2140 accessions by heat map approach

Segregation pattern of trishul crosses

During *kharif* 2014 the F_1s between GMU 170x ARM 243 B; GMU 170x 6D1; 6D1x CMS243B; GMU170x6D1 were evaluated and dominance was observed for monohead type. The F_2 generation was studied for segregation pattern and genetics of the trait. The first cross segregated for 130 Monohead; 59 overall branching and 45 trishul (trident) type from 2nd cross for 170 Monohead and 40 Trishul type; 3rd cross for 171 Monohead and 39 overall branching and 4th Cross for 110 Mono head and 62 Trishul type plants.

Evaluation of early and dwarf germplasm

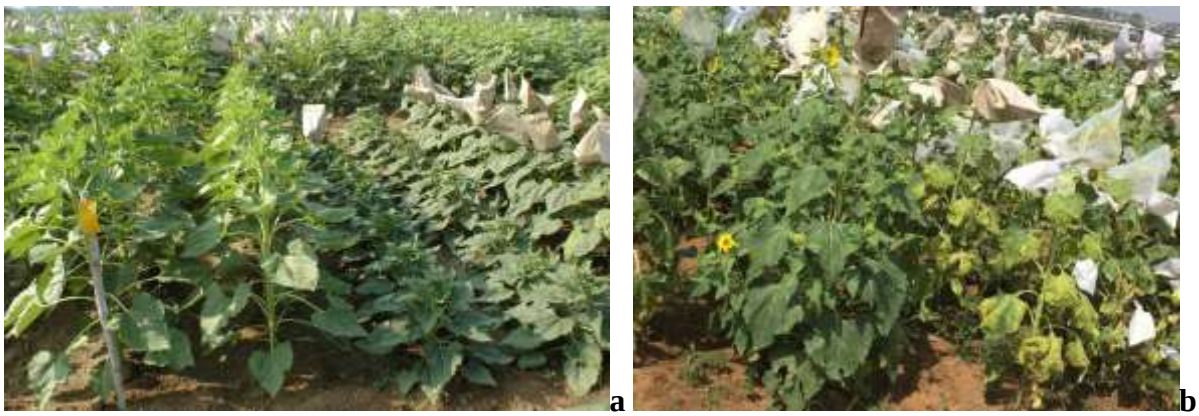
Out of 250 accessions evaluated at ICRISAT during *rabi* 2015, six inbreds and 3 germplasm accessions were confirmed as dwarf and early type. In accessions GMU130, 935 and 119, 50% flowering was lesser than 45 days.

GMU130 **GMU935 GMU119**

Development of trait specific inbreds and parental lines in sunflower (*Helianthus annuus* L.)

Augmentation, multiplication and evaluation of trait specific inbreds

Established and evaluated 282 accessions which included 31 new CMS lines, 90 exclusive B lines, 97 restorer lines and 38 inbreds from Foundation seed stocks, USA for desirable traits like dwarfness, early maturity, high oil lines, maintainer/restorer behavior of the R lines, reaction to SND, powdery mildew and leafhoppers. More than 98% of the lines were uniform and stable in expression and hence, 15 CMS and 50 R lines were multiplied and spared to AICRP centres for production of experimental hybrids with the promising CMS and R lines of the respective centres. Identified four lines TSG 207-EC838712 (36 cm), TSG 108-EC762054 (40 cm), TSG 402- EC838667 (44 cm), TSG 295-EC838665 (49 cm) with less than 50 cm plant height. Identified nine accessions with less than 45 days for flowering of which TSG 355 (EC838692) with 37 days during *kharif* and 40 days during *rabi* for flowering was found to be the most promising. Five accessions (TSG 239-EC838926, TSG 260-EC838756, TSG 291-EC838646, TSG 331-EC838930 and TSG 349-EC838814) were confirmed with more than 40% oil content and TSG 331 possessed 43.4% oil content (39.4% in DRSH-1). The maintainer/restoration ability of the new R lines and few inbreds was tested and the R lines RHA 436, RHA 418 and RHA 280 and the early maturing inbred TSG 355 showed maintainer reaction. Six R lines (RHA 462-EC838900, RHA 374-EC838708, RHA 450-EC838838, RHA 454-EC838852, RHA 276-EC838755, RHA 418-EC838798) combined for high yield/oil content. Under natural high infection of SND during *kharif* 2015, TSG 112-EC762058 and TSG 231-EC838832 showed less than 10% SND infection. Ten accessions failed to show leafhopper infection even till maturity stage of which TSG 295-EC838665 is a dwarf R line which can be exploited directly in the breeding programmes.



a **b**

R lines showing variability for plant height and flowering (a) and reaction to leafhopper (b)

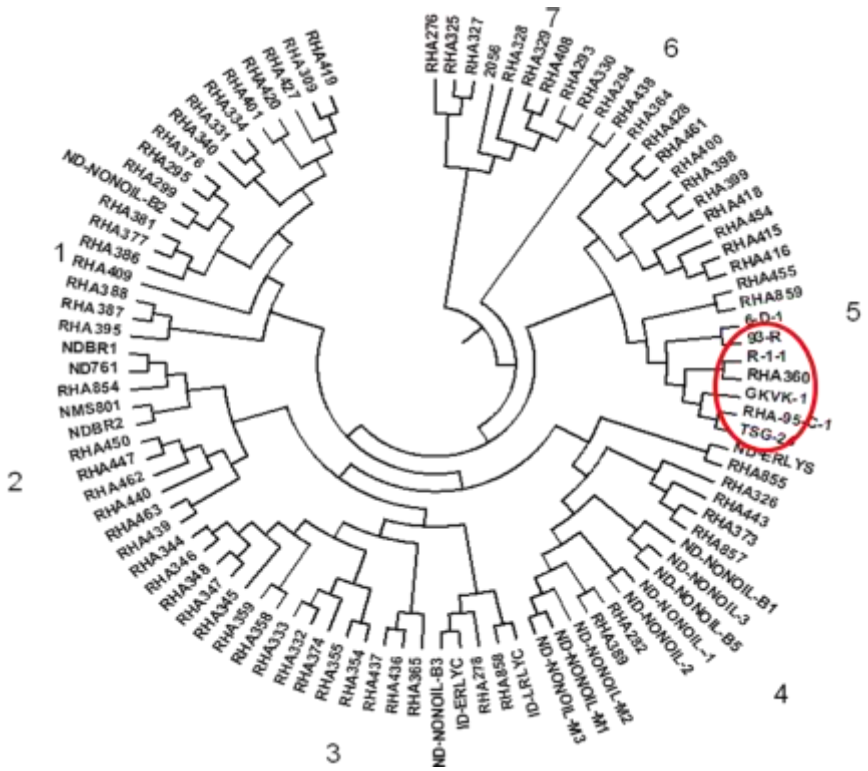
Identification of sources of resistance / tolerance against leafhopper

Among 30 promising sunflower germplasm and advanced lines, selections were made for 6 generations and stable lines were identified as resistant (GMU- 1, 243, 504) with injury grade 1 and moderately resistant (GMU-4, 25,112,116, 255, 327,339, 343, 405, 556, 595, 669, 696, 703, 713, 776, 782, 795, 914, 922, 937, 1029,1093, GP6-570, GP6-1282, GP9-472-4-13 and AKSFI-46-2) with injury grade 2 compared to injury grade 5 in susceptible check, Morden against leafhopper.


Morden (Susceptible) GMU-1 (Resistant line) GMU-504 (Resistant) GMU-522 (Susceptible)

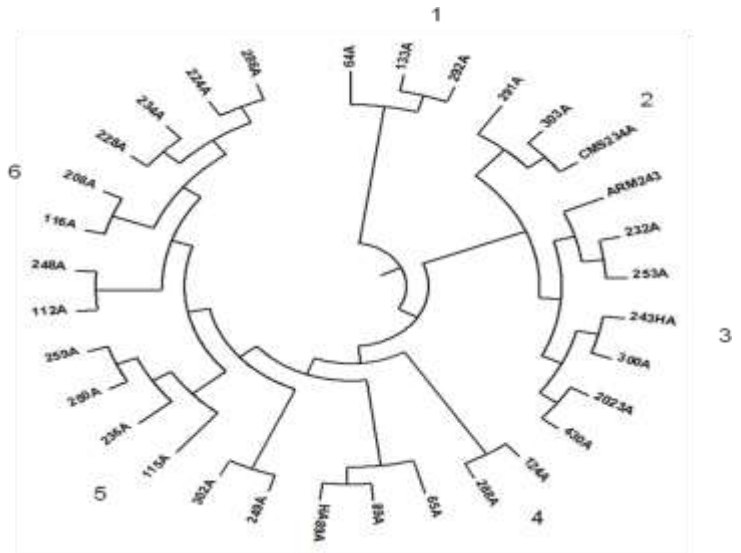
Diversity analysis of CMS and R lines

A set of 96 sunflower lines were subjected to morphological and molecular characterization. Morphological and phenological data along with yield attributing traits such as plant height, branching, head diameter, seeds per head were recorded for two seasons. Among 96 lines, 72 lines were R lines and 17 were inbred lines for high oil content procured newly from USDA, 5 Indian R lines of popular public sector hybrids and 2 trait specific inbreds. Among 72 R lines, RHA 436, RHA 376 and RHA 428 were single headed while the rest were multi headed lines. The flowering duration of two USDA R lines, *viz.*, RHA 454 and RHA 419 was 15 days, which is an important factor for pollen supply. Oil content ranged from 26.6 to 43.3 per cent, RHA 857 had highest oil content. RHA 349 was the shortest plant type (32.5 cm) and RHA 247 was the tallest plant type (124.5 cm). The duration of maturity ranged from 76 to 105 days, among USDA lines, 16 genotypes matured at less than 80 days. Molecular characterization was done with 30 SSR primers covering 17 chromosomes. Seven clusters were formed for 96 genotypes, two genotypes, RHA 294 and RHA 438 formed a distinct cluster. Indian R lines which are being used as parents of public sector hybrids were grouped into one cluster along with one USDA R line. The average genetic distance among Indian R lines was 0.3 and between the USDA R lines and 5 Indian R lines was 0.5.



Dendrogram of 96 genotypes comprising 72 R lines & 17 inbred lines from USDA along with 7 Indian R lines

A set of 26 new CMS lines procured from USDA and 6 CMS lines of public sector hybrids were constituted to study the genetic diversity using 30 SSR primers. Six clusters were formed from 32 CMS lines. Average polymorphic information content (PIC) was 0.33 ranging from 0.11 to 0.55. Indian CMS lines which are being used as parents of public sector hybrids grouped in cluster 3. However, Indian CMS line CMS 234 which is being used as parent for 8 hybrids including KBSH-1, and USDA 234A formed different clusters with the genetic distance between these two lines being 0.48.

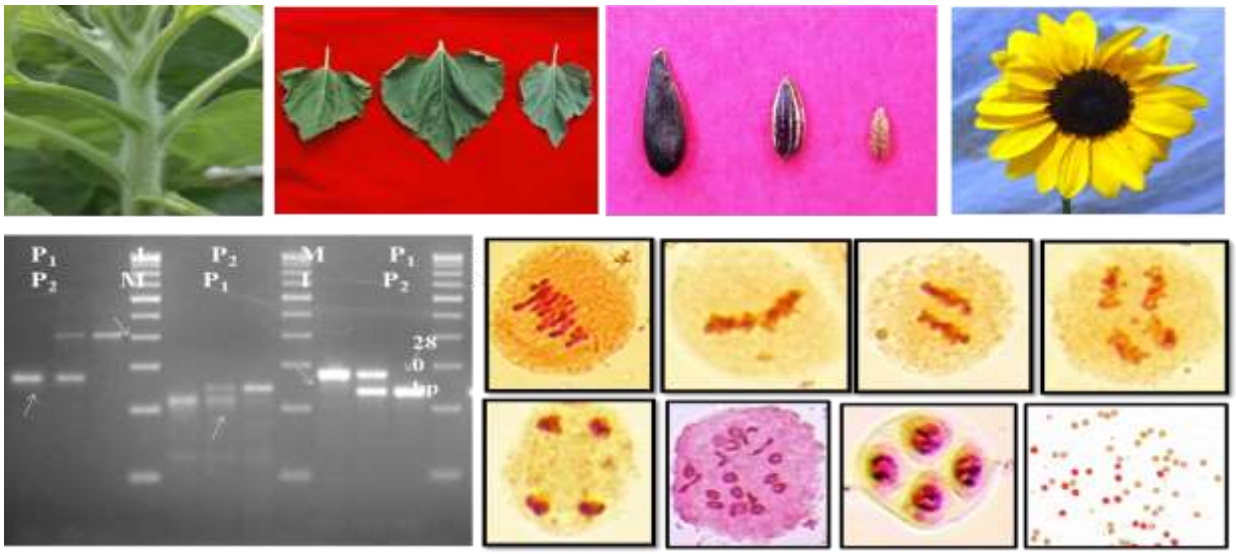


Dendrogram of 32 CMS lines, 26 from USDA and 6 from India

Pre-breeding

Establishment and seed multiplication of diploid wild accessions: A total of 27 accessions of wild *Helianthus annuus* and 6 accessions of *H. argophyllus* and seed multiplication has been done. Characterization of all the accessions for 34 DUS descriptors was also done.

Evaluation of interspecific hybrids: A total of 30 interspecific hybrids (including reciprocal crosses) were evaluated during *kharif*-2015. Out of 30 interspecific hybrid combinations,7 [cultivated x wild (2 with *H. praecox*; 2 with *H. debilis*; 1 with *H. petiolaris*; 1 with *H. argophyllus* and 1 with wild *H. annuus*)]were true hybrids based on cytomorphological characterization and through sunflower specific SSR markers. In another set, 11 interspecific hybrids [wild x cultivated] (1 with *H. debilis*; 4 with *H. praecox*; 3 with *H. argophyllus*; 3 with wild *H. annuus*) were true hybrids based on cytomorphological characterization and hybridity confirmation done through sunflower specific SSR markers.



Cytomorphological and molecular characterization of F_1 interspecific hybrids

New CMS sources from wild species: Male sterile plants were observed in crosses with wild *H. annuus* (ANN-2101) in F_1 generation and ANN-1270 in F_2 generation. The male sterile plants identified in F_2 generation were backcrossed.

Male sterile plants observed in interspecific hybrids with *H. annuus* wild

Generation advancement of pre-bred material: Ten interspecific hybrids [6 with wild *H. annuus* and 4 with wild *H. argophyllus*] were advanced from BC_1F_1 to BC_2F_1 as well as BC_1F_2 during *kharif*-2015 though backcrossing and selfing. Large diversity was observed for different morphological traits. Apart from this, selfed seeds were advanced from F_1 to F_2 generation and morphological characterization was done.

Field view of F_1, F_2 and BC_1F_1 generation of interspecific crosses

Generation of new interspecific hybrids: During *kharif*-2015, a total of 23 interspecific hybrids were developed using 21 accessions of wild *H. annuus* and 2 accessions of *H. praecox* as male parent with CMS-17A.

DEVELOPMENT OF SUNFLOWER HYBRIDS SUITED TO DIFFERENT AGRO-CLIMATIC CONDITIONS

Identification of new maintainers/restorers for different CMS sources

Fifty inbreds (DRSI and EC lines) received from GMU unit were evaluated for restorer or maintainer behavior with 6 diverse CMS (CMS-17A, CMS-7-1A, CMS-852A, CMS-234A, CMS-2A and IMS-852A) lines. A total of 20 inbreds, behaved as common restorers and 16 inbreds as maintainers for most of the CMS lines.

List of common restorers and maintainers for diverse CMS sources	
Restorers	**Maintainers**
DRSI-10, DRSI-16, DRSI-17, DRSI-22, DRSI-44, DRSI-58, DRSI-120, DRSI-159, DRSI-185, DRSI-195, DRSI-283, EC-601850, EC-601660, CSFI-5075, CSFI-5090, CSFI-5133, CSFI-5185, CSFI-5210, CSFI-5261, CSFI-5055	DRSI-33, DRSI-53, DRSI-104, DRSI-133, DRSI-197-1, DRSI-245, DRSI-283-1, DRSI-336, DRSI-86, DRSI-297-1, EC-601730-1, EC-601796, EC-602018, EC-602019, EC-602024, EC-602009

Diversification of CMS & R base

B x B and R x R gene pools: A total of 57 individual plants were selected from B x B gene pool from random mating of 3rd and S_1 raised in *kharif* and individual plant selection (132 plants) from B x B gene pool was made based on yield and yield components. Through random mating, improved oil content (5-6%) compared to parental lines, reduced duration and changed the plant type also. At the same time the undesirable linkage between pollen color and seed color was broken. Yellow pollen progenies with black and brown seeds and white pollen with black and brown seeds with high oil content and earliness were developed.

From R x R gene pool, 80 individual plants were selected from random mating of 3rd and S_1 raised in *kharif* and individual plant selections (150 plants) was done based on earliness, branching pattern, disease free under field conditions coupled with yield and yield components. Individual plant progenies (S_2 generation) were raised in *summer*-2016 and evaluation was done for specific traits. From 150 progenies, 39 progenies were found promising for drought tolerance under natural field condition.

a)CMS-17A type but yellow pollen b)White pollen black seed c)White pollen along with dwarf plant type early & black seed

Evaluation of experimental hybrids: A total of 300 new experimental hybrids were evaluated for yield and yield contributing traits during *summer*-2016, of which 19 hybrids were found promising for seed yield coupled with high oil content, plant height and earliness. All the hybrids were compared with KBSH-44 and DRSH-1 in augmented design and comparison were done for seed yield superiority, per cent over best check, KBH-44 and oil yield superiority over DRSH-1 in each set.

Shortlisted promising hybrids based on seed yield, oil content and duration

Hybrids	Days to 50% flowering	Plant height (cm)	100-seed weight (g)	Single plant yield (g)	Oil content (%)	Seed yield superiority % over best check (KBSH-44)	Oil yield superiority over best check (DRSH-1)
IOSH-177	55.0	125.8	4.9	47.4	32.51	45.39	15.40 (5.21)
IOSH-178	48.0	108.0	4.6	40.2	31.14	23.31	12.51 (2.32)
IOSH-194	58.0	146.8	6.5	48.8	30.77	51.08	15.01 (-0.12)
IOSH-202	56.0	157.4	7.0	54.1	35.02	67.49	18.94 (3.81)
IOSH-206	56.0	139.8	6.6	50.2	34.27	55.41	17.20 (2.07)
IOSH-235	52.0	155.0	5.0	51.4	38.66	4.25	19.87 (8.83)
IOSH-258	62.0	163.4	4.7	58.7	38.18	82.86	22.41 (7.45)
IOSH-261	56.0	156.2	6.0	53.5	39.94	66.66	21.36 (6.40)
IOSH-279	54.0	154.4	6.3	60.0	36.15	29.03	21.69 (3.34)
IOSH-284	55.0	130.8	5.7	61.2	33.42	31.61	20.45 (2.09)
IOSH-318	51.0	144.4	6.0	46.1	31.69	11.35	14.60 (0.1)
IOSH-325	52.0	130.8	5.0	45.4	35.84	9.66	16.27 (1.77)
IOSH-346	63.0	150.0	5.0	50.1	35.54	4.37	17.80 (6.24)
IOSH-349	51.0	123.0	5.6	46.0	34.55	10.51	15.89 (4.33)
IOSH-354	56.0	174.4	5.0	41.3	33.00	4.29	13.62 (-0.35)
IOSH-367	59.0	186.2	5.5	42.7	39.87	7.82	17.02 (3.05)
IOSH-368	54.0	135.8	5.7	49.6	38.55	17.25	19.12 (6.54)
IOSH-369	62.0	166.0	4.5	48.4	40.90	14.42	19.79 (7.21)
IOSH-380	50.0	147.2	5.4	52.3	39.04	23.64	20.41 (7.83)

Identified drought or moisture stress tolerant progenies

A total of 39 R x R gene pool progenies were found promising for drought/moisture stress under field conditions during *summer*-2016. None of the progenies showed any moisture stress symptoms. Twenty two progenies were identified as drought tolerant.

Identified promising progenies and hybrids for physiological parameters

Six B x B gene pool progenies (> 160 mg/plant at 22 DAS) and four R x R gene pool progenies (> 4.0 g/plant at 37 DAS) recorded high seedling vigour. Among the newly developed hybrids, CMS 852 A with EC 601623, EC -601664, EC-601691 and IMS 852A x GMU 157 recorded higher seedling vigour (> 500 mg/plant 25 DAS) than the checks while CMS 852 A x EC 601683, CMS 17A x EC 601932 and IMS 852A x GMU 157 recorded higher leaf area index (≥4.0) at 50% flowering than checks.

Identified promising gene pool (B x B & R x R) progenies for physiological parameters

S. No.	B x B gene pool progenies	Seedling vigour (> 160 mg/plant at 22 DAS)	R x R gene pool progenies	Seedling vigour (> 4.0 g/plant at 37 DAS)
1	B x B-4 P1	199	R x R-50	5.5
2	B x B-13 P1	161	R x R-52	6.7
3	B x B-48 P4	187	R x R-53	4.4
4	B x B-48 P5	163	R x R-60	4.3
5	B x B-51 P1	170		
6	B x B-57 P1	168		

Confirmation of preliminary sunflower hybrids: A total of 15 hybrids were evaluated in 3 replications along with 5 public (DRSH-1, KBSH-44, PSH-1962, LSFH-171 and RSFH-130) and 2 private (Kaveri champ and SB-207) checks. Out of 15 hybrids, 4 hybrids *viz.*, IOSH-15-1; IOSH-15-12; IOSH-15-14; IOSH-15-10 were promising for seed yield and yield components compared to checks.

Mean performance of promising hybrids over two seasons

Hybrids	Days to 50% flowering	Plant height (cm)	Head diameter (cm)	100 seed weight (g)	Seed yield/ plant(g)	Oil content (%)
IOSH-15-1	62.0	134.5	13.0	4.0	29.1	30.6
IOSH-15-3	59.6	142.3	14.9	4.6	23.5	32.7
IOSH-15-5	58.0	136.8	13.8	4.8	24.1	34.6
IOSH-15-9	62.3	162.4	11.4	4.5	22.8	33.7
IOSH-15-10	59.6	160.1	13.2	4.5	24.4	31.1
IOSH-15-12	69.6	173.5	10.9	4.6	28.1	32.7
IOSH-15-13	67.6	167.3	13.7	4.1	20.8	29.6
IOSH-15-14	62.0	148.8	13.5	4.1	26.9	31.5
IOSH-15-15	64.6	168.0	13.4	3.6	22.5	30.7
KBSH-44 (C)	70.3	148.6	11.4	3.5	14.9	26.7
DRSH-1 (C)	63.6	156.8	12.4	4.6	19.9	34.3
LSFH-171 (C)	63.6	149.3	12.8	4.6	24.4	28.2
RSFH-130 (C)	64.3	160.3	12.4	4.0	25.8	35.5
PSH-1962 (C)	63.6	140.3	13.1	5.3	23.4	34.0
Kaveri Champ (C)	64.6	130.9	12.3	3.6	15.0	

Molecular tagging and mapping of powdery mildew resistance in sunflower (*Helianthus annuus* L.)

The emphasis during the year was on crosses involving PS 2023 B (susceptible) and *H. praecox* (Accns 1823 and 1157). The F_1 hybrids showed no infection of powdery mildew but the major challenge of generation advancement was the low pollen fertility which ranged from 7.0 to a maximum of 18.7% in 22 confirmed hybrids. Hence, backcrosses were effected and 2 populations of 42 and 28 plants were evaluated for the reaction to powdery mildew. More interspecific crosses are being attempted.

Generation advancement, multiplication and evaluation of RILs for reaction to SND, *Alternaria helianthi* and powdery mildew: Three sets of RILs (Morden x EC537925; 2023 x TX16R; ID-25 X TX16R) were screened for reaction to SND which was unusually high during *kharif* 2015. Scoring for SND was done at 30 and 50 days and among the 3 sets of RILs, 100% infection was observed in RILs derived from 2023A x TX16R; TX16R X ID-25. However, EC537925 was completely free of SND infection and the RILs derived from Morden x EC537925 showed low incidence in 49 out of 193 RILs. EC537925 is being multiplied for confirmation through artificial sap inoculation. Of the RILs derived from Morden x EC537925, RIL Nos 152 and 203 were free of powdery mildew infection in the F_6 generation.

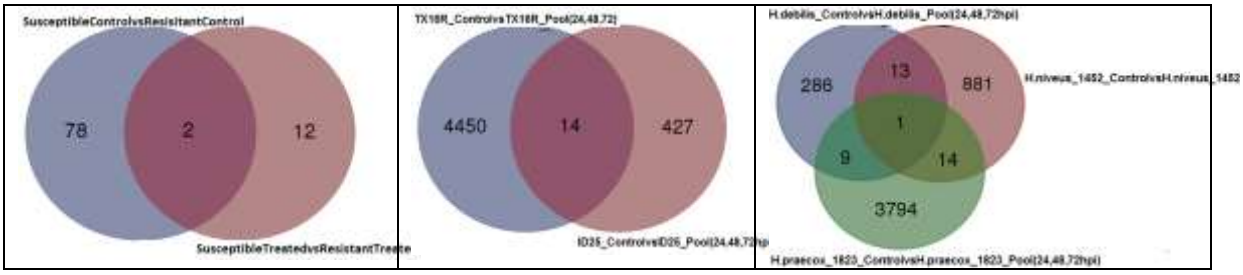
Transcriptome analysis: Following the preliminary light microscopic and biochemical analysis, the host-pathogen interactions were subjected to transcriptome profiling. Leaves of the resistant species- *H. debilis*, *H. praecox*, *H. niveus*, tolerant genotypes- TX16R, USDA-25 and the susceptible genotype - PS 2023B were dusted with the powdery mildew conidia from infected leaves of the susceptible accession (PS 2023B). Infected leaves were fixed at 0 (no infection), 24, 48 and 72 hours post infection and subjected to transcriptome profiling. Libraries were prepared using TruSeq RNA library prep kit (Illumina) and were sequenced (PE-2x100) on HiSeq to obtain 80 million reads per sample. Following filtration of organelle genome and non coding RNA sequences, the cleaned reads were aligned to the reference genome of *H. annuus* cv. Ha-412-HO with a gene model downloaded from Genomics of Sunflower database using Tophat2 tool. Results showed that in each of the donors, the mechanism of resistance varied as evident for the upregulated and down regulated genes following infection. Maximum number of genes in response to the pathogen infection was observed in TX16R and *H. praecox.*

Total up and down regulated genes in transcript level [P value <= 0.01 and FPKM >= 1] found using Cuffdiff analysis

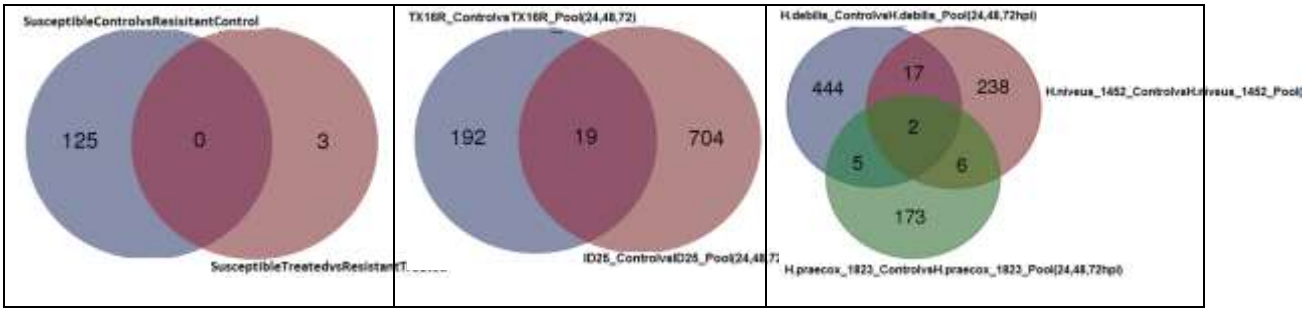
Samples	Up Regulated	Down Regulated
2023_B_Control vs 2023_B_Pool (24,48,72 hpi)	779	335
TX16R_Control vs TX16R_Pool (24,48,72 hpi)	4,464	211
ID25_Control vs ID25_Pool (24,48,72 hpi)	441	723
*H. niveus*_1452_Control vs *H. niveus*_1452_Pool (24,48,72 hpi)	909	263
*H. praecox*_1823_Control vs *H. praecox*_1823_Pool (24,48,72 hpi)	3,818	186
*H. debilis*_Control vs *H. debilis*_Pool (24,48,72 hpi)	308	468
2023_B_Control vs TX16R_Pool (24,48,72 hpi)	677	803
2023_B_Control vs ID25_Pool (24,48,72 hpi)	892	435
2023_B_Control vs *H. niveus*_1452_Pool (24,48,72 hpi)	1,252	797
2023_B_Control vs *H. praecox*_1823_Pool (24,48,72 hpi)	3,824	204
2023_B_Control vs *H. debilis*_Pool (24,48,72 hpi)	677	803

Analysis was done to check the genes which are commonly upregulated and downregulated in the susceptible vs resistant donors, among the resistant lines, and the tolerant lines. Only 2 genes were commonly upregulated in the susceptible and resistant genotypes while no genes were commonly downregulated between the two groups. The tolerant genotypes (TX16R and ID-25) had 14 and 19 genes in common that were upregulated and downregulated, respectively. Venn diagrams showed more common genes between *H. praecox* and *H. niveus* than those between *H. debilis* and *H. niveus.*

- **Venn diagram showing commonly upregulated genes in different groups**



- **Venn diagram showing commonly down regulated genes in different groups**



Pathway enrichment was performed using Reactome database. Pathway analysis indicated that the MAPK/MAPK6/MAPK signaling cascades are involved in *H. praecox;* Vesicle-mediated transport and membrane trafficking, regulation of HSF1-mediated heat shock response in *H. debilis,* mRNA splicing in TX16R, purine catabolism and detoxification of ROS in the susceptible genotype (PS 2023B). The transcriptome database was fetched out for WRKY, Kinases and MAPK in the up and down regulated genes across all the pair-wise combinations. In summary, there were 412 genes relating to kinases, 3 MAPK genes and 19 WRKY related genes; from both up and down regulation. Till date, about 2100 sunflower specific SSR markers are available in public domain (Tang et al., 2002). The transcriptome database generated for the 6 genotypes has been mined for SSRs and SNPs and the additional markers would be used for mapping of the targeted trait. Deposited 18 nucleotide sequences in NCBI pertaining to powdery mildew isolates with accession nos KP834315 to KP834332.

CROP PRODUCTION

Long-term Fertilizer Studies for Sustainable Sunflower Production in Alfisols

A fixed plot field experiment was initiated during *kharif* 1999 to assess the need and response of major, secondary and micronutrients on a long-term basis for sustainable sunflower production in sorghum (*kharif*) – sunflower (*rabi*) cropping system in Alfisols. Sorghum yield showed significant variation from the second cropping cycle onwards and application of 150% RDF had recorded the highest yield. Response to K was negative for sorghum seed yield up to 2007-08 and from 2009-10 onwards, K application resulted in increased yield over NP. The response to boron (B) was significant in sunflower from 4th crop cycle onwards, over 100% NPK. Supplementation of 5t FYM/ha along with RDF to *kharif* sorghum followed by growing sunflower with its recommended NPK gave higher sunflower seed yield compared to 150% NPK to both the crops in the system. Un-manured control or nutrient imbalance with application of N or NP alone or reducing the fertilizer dose by 50% resulted in lowest growth

and seed yield of sorghum and sunflower, delayed flowering, lowest test weight and lower sustainable yield index. Soil fertility in general declined over the years except for increase noticed for organic carbon in treatment receiving FYM or crop residue along with NPK. P build up was significant over the years in all treatments receiving regular P applications compared to only N or no manure applications. Sorghum yield showed declining trend due to application of Zn along with NPK to preceding sunflower possibly perhaps due to antagonistic effect of P and Zn under the conditions of very high P build up in P applied treatments. Profile soil depth was 1.15m and the fertility declined with depth from 30cm downward.

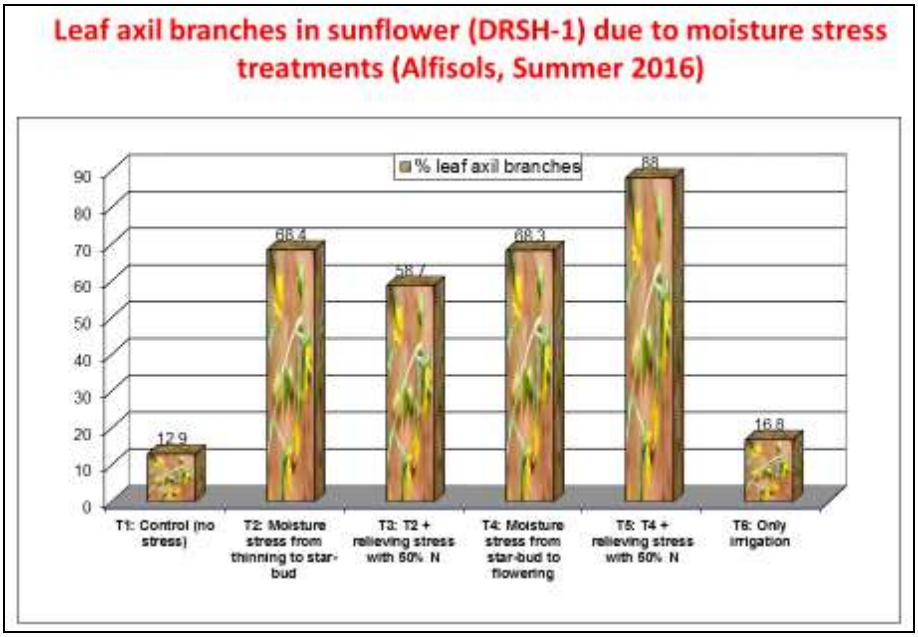
Performance of sorghum: The general growth of sorghum (Hybrid CSH-16) in *Kharif* 2015 was affected due to the severe drought conditions. Significant differences were observed due to treatments. Significantly the highest seed yield (4454kg/ha) of *kharif* sorghum was recorded with 150% RDF to both the crops that was at par with all treatments with 100% NP or NPK combination. 50% NPK significantly recorded lower yield while no manure or N alone recorded significantly lowest yield. Soil P, K, S and Zn varied significantly.

Performance of sunflower: Growth and yield of sunflower (DRSH-1) succeeding sorghum in *rabi* 2015 differed significantly due to nutrient management treatments. Significantly lowest growth parameters viz., plant height, stem girth, head diameter, filling, was recorded in N alone or no manure treatments. Seed yield was significantly highest (1244kg/ha) with supplementation of S, B, Zn along with NPK. The yield parameters were significantly highest with balanced nutrition of S, Zn and B along with NPK.

Soil fertility after the sorghum – sunflower cropping system in 2014 indicated a significant buildup of soil P recorded in all treatments receiving P (75 to 134kg/ha) compared to the available P level of 9-10kg/ha in treatments not receiving any P. Available S was highest in treatments receiving S.

Understanding causes for leaf axil branching in sunflower

Leaf axil branch formation in cultivated sunflower is considered to negatively affect the seed yield from main head and is known to be influenced both by genetic and environmental factors. Among several environmental factors studied, soil moisture stress during vegetative stage is known to cause leaf axil formation occurring at flowering stage. The confirmatory field trial conducted in Alfisols in summer of 2016 clearly established consistently that moisture stress from thinning to star bud stage with or without N top dressing after relieving moisture stress, is critical to trigger leaf axil branch formation in sunflower at field level (hybrid DRSH-1). The magnitude of leaf axil branches due to stress varied from 58 to 88% compared to 12 to 17% under no-stress situation. Variation in seed yield reduction due to retaining leaf axil branches was not significant compared to removal of all leaf axil baranches.



Performance of sunflower and castor under integrated crop management

Integrated Crop Management in Alfisols during *kharif* 2015, resulted in realizing the highest sunflower seed yield of 2t/ha with a B:C ratio of 2.34; in castor, a seed yield of 1.74t/ha with a B:C ratio of 2.83 in large plot demonstration under irrigated condition. The ICM included the dynamic adoption of BMPs of crop rotation, summer ploughing, soil test based balanced nutrition, IPM package, harvesting at physiological maturity, etc. (Normal yield with only RDF was about 12q/ha for sunflower and 15q/ha for castor). The large plot demonstration of ICM package in Vertisols during *rabi* 2015 at ICRISAT farm resulted in the estimated crop yield of 2.5t/ha.

Rapid screening of sunflower genotypes to identify root traits for P acquisition under differential P levels

Based on the previous screening trials, four P efficient sunflower genotypes *viz*., HOHAL-17, CSFI-5075, HOHAL-22, CSFH-8712 and a check (DRSH-1) were further evaluated during *kharif* 2015 in order to validate P acquisition trait of genotypes in soils collected from the long term fertilizer studies experiment treatments (No manure no fertilizer treatment plot for Low P and the soil from 150% RDF treatment for high P situations, respectively). The results showed that the highest P acquisition was noticed in genotype HOHAL-17 (7.2mgP /g dry matter) under P stress situation and was followed by CSFI-5075 (5mgP/g DM). Further, the results pertaining to root parameters under low P situation, genotype HOHAL-17 showed the highest root volume (16cc/pl) followed by CSFI-5075 (9 cc/pl). Similarly, highest root length was observed in CSFI-5075 (33cm/pl) and followed by HOHAL-17 (27cm/pl). Genotypes with such root traits could be responsible for high P acquisition in marginal P soils and further has to be evaluated in different soil types.

LHS: Performance of genotype HoHAL-17 in LTFE soils: P starved situation i.e. No manure no fertilizer (8.4 kg/hal) and P sufficient situation i.e. 150% RDF (58 kg/ha)
Fig1. RHS: Root growth of HOHAL-17 in P starved soil at 30 days

IIFSR-IIOR collaborative Farming Systems Research

A Memorandum of Understanding was signed for strengthening Inter institutional linkage between Indian Institute of Farming Systems Research (IIFSR), Modipuram and AICRP (IFS) and IIOR, Hyderabad represented by AICRP (oilseeds). As a part of this linkage field experiments were continued during second year in Coimbatore and Kakdwip (W.B) to assess the performance of sunflower as component crop in integrated farming systems. During 2015-16, the on-station/on-farm trials were conducted in coordination with IFS (Coimbatore/Kakdwip)-AICRP Sunflower (Coimbatore/Nimpith) centres.

Performance of sunflower as component crop in Integrated farming system in Tamil Nadu

The Integrated Farming System experiment was continued in AICRP-IFS Main centre, Coimbatore including four cropping systems in an area of 1.02 ha. In which, the sunflower was taken up in two cropping systems viz., Bhendi – Maize + Cowpea (F) – Sunflower (CS2) and Cowpea (Veg.) – Cotton - Sunflower (CS4) raised during summer season. The improved hybrid CO 2 was used as test hybrid.

Performance of sunflower (TNAUSFHCO2) as component crop in farming systems of Tamil Nadu

Cropping systems	**Summer-2015**							
	Crop &variety	**Area (ha)**	**Date of sowing**	**Date of harvest**	**Yield (kg)**	**Cost of Cultivation (`)**	**Gross Return (`)**	**BCR**
CS2: Bhendi– Maize+ Cowpea (fodder) - **Sunflower**	Sunflower -TNAU SF Hyb.CO 2	0.20	15.04.2015	24.07.2015	352	8032	13590	1.69
CS4: Cowpea (Veg.)- Cotton- **Sunflower**	Sunflower -TNAU SF Hyb.CO 2	0.25	26.07.2015	23.10.2015	296	7039	11718	1.67

Sunflower thalamus as cattle feed

The sunflower thalamus was fed to the dairy animals. The thalamus harvested by hand, when the upper leaves had dried and petals faded and the moisture content of the harvested product was > 15% were sun dried. The seed removed thalamus was chopped into pieces and fed to the dairy animals in the IFS unit. An average of 75-85 % of chopped head was taken by the dairy animals.

The left out stalks and post-harvest residues of sunflower were shade dried and fed to earthworms. A 250 kg and 301kg of vermicompost were produced by using the left out residues in CS2 and CS4, respectively.

Sunflower residue yield and nutrient concentration

Cattle	Yield (kg)	Nutrient Concentration (%)		
		N	P	K
CS2: Bhendi– Maize+ Cowpea (fodder**) - Sunflower**	2540	1.02	0.12	1.85
CS4: Cowpea (Veg.)- Cotton- **Sunflower**	2716	0.98.	0.13	1.95

Sunflower demonstration at Kakdwip (West Bengal)

At Kakadwip in West Bengal, paddy-sunflower cropping system trials were conducted. Sunflower (KBSH-53) was sown after the harvest of paddy during *rabi* in about 45 farmer's fields. On an average, KBSH-53 and application of balanced fertilizers recorded 9% increase in sunflower yield and net returns by 25%.

Performance of sunflower after paddy in farmers fields at Kakdwip (W. Bengal), 2014-15

Intervention	Number of demonstration	Method	Cropping pattern	Yield (kg/ha)	Gross return (`)	Cost of cultivation (`)	Net return (`)	Per cent increase over net return
Sunflower with improved package & practices	45	F. M.	Local variety	1540	61297	40537	20760	50.53
		I. M.	KBSH-53 plus balanced fertilizers	1675	66674	40693	49920	

FM = Farmers' method; IM = Improved method

CROP PROTECTION

Augmentation of germplasm tolerant to *Alternaria helianthi* and re-confirmation

The genotypes reported earlier as promising viz., PS 2040. PS 2040-1, PS 2040-2. PS 2037. PS 4034. P 75 Wp, 10-9 , 10-25 ,10-30 , EC 537925, SCG 28, SCG 99, GMU 520,440.GP-679, GP6-564 were tested in field for their tolerance levels. The results re- confirmed their low disease intensity levels with normal yields.

Alternariaster leaf blight

Twelve isolates of *Alternariaster helianthi;* incitant of leaf blight of sunflower collected from different sunflower growing areas of India submitted to microbial repository at

National Agriculturally Important Microbial Culture collection (NAIMCC), ICAR-NBAIM, Mau, Uttar Pradesh. The accession numbers from NAIMCC **F-03173** to **NAIMCC F-03184** were allotted to these *A. helianthi* fungal cultures. In these, isolates *Ah* 18- TS; *Ah* 38 - KA; *Ah* 125- MH were highly virulent causing >50% disease severity; *Ah* 157 - BR; *Ah* 142- KA; *Ah* 12- TS moderately virulent causing 35 -50% disease severity while *Ah* 92 (Marchilapuram, KA), *Ah* 160 (Pusa, BR), *Ah* 158 (Sankra, BR) were less virulent showing <35% leaf blight severity in tested sunflower genotypes.

Survey and disease severity of SND & SuLCY diseases in experimental plots and farmers' fields

During the year under report the SND incidence was higher in all the sunflower grown areas of AP, TS, Karnataka. In experimental plots of R. Nagar, Narkhoda farms (breeding, germplasm, NCP and RIL population) the incidence of SND was in the range of 40-70 % and SuLCV was 2-5% and in 4 private farms visited. In five farmer fields the SND incidence was between 30 and 45%.

Field experiment on development of IDM module for the management of major diseases

In the IDM of important diseases of sunflower experiment the treatment: Seed priming with (carbendazim @ 2g/kg + thiamethoxam @ 4 g/kg) + 2 foliar sprays of propiconazole @ 0.1%+ thiamethoxam @ 0.04% as soon as disease appeared and 15 days later or seed priming +2 foliar sprays of propiconazole @ 0.1% + azadiractin @ 0.15% as soon as disease appeared and 15 days later reduced the Alternaria incidence up to 40% and 24% of SND.

Field testing against *Helicoverpa armigera*

Field testing of the SC formulations **of** Bt-127 singly and in combination with *N. rileyi and B. bassiana* was undertaken during *kharif* 2015 against *H. armigera* at RARS-Nandyal, ORS-Latur and IIOR-Hyderabad. Treatments included Bt-127 SC formulation @ 2ml/l, Combination SC formulation of Bt-127 + *N. rileyi* @ 2ml/l, Combination SC formulation of Bt-127 + *B. bassiana* @ 2ml/l, Bt-127 @ 1g/l, *N. rileyi* @ 1 x 10^{10} spores/l, *B. bassiana* @ 1x10^{10} spores/l, Profenofos @ 1 ml/l and untreated control. Treatments were imposed during the star bud stage of the crop when first and second instar larvae were observed. All three SC formulations *viz*., Bt-127, Bt + *N. rileyi* and Bt + *B. bassiana* were effective against *H. armigera* on sunflower at Nandyal, ORS-Lathur and IIOR-Hyderabad (90-100% decrease in larval population) at the test locations by 5 days after spray. Seed yield per 5 plants at RARS-Nandyal was highest in Bt-127 SC formulation (79.3 g) followed by Bt-127 + *B. bassiana* SC formulation (70.0 g) and significantly higher than the seed yield in Profenofos (32.3 g).

Shelf life determination

Shelf life studies were carried out with the samples stored in HDPE bottles at room temperature. At zero month, Bt-127 SC formulations and Bt-127 + *N. rileyi* contained heat viable Bt spores of 3.3 x 10^{17}/ 3ml and 1.7 x 10^{17}/3ml respectively (3ml contains 1g of Bt). Similarly shelf life studies at 3, 6, 9 and 12 revealed that there is no decrease in the CFU as well as efficacy against *S. litura* and *H. armigera*.

Determination of potencies of local isolate of *Bacillus thuringiensis* var. *kurstaki* DOR Bt-127

DOR Bt-127 isolate of *Bacillus thuringiensis* var. *kurstaki* multiplied in Luria broth was found to have potencies of 34,833 and 50,200 IU/mg against *H. armigera* and *Achaea janata* (Linnaeus) respectively. The isolate was also highly effective against *S. exigua* (Hübner) and *S. litura* with potencies of 46,205 and 71,722 SU/mg respectively. Hence this isolate could be a candidate for development into a reference standard since the International Btk reference standard HD-1-S-1980 is exhausted and no longer available.

Development of Water Dispersible Granules (WDG) formulation (60-80% a.i.) with Bt-127

WDG formulations (37 - 53% a.i.) were developed using Bt-127 wet pellet along with starch, guar gum and tween-80 at different concentrations. 37 % WDG was effective against 5 day old *S. litura* larvae @ 1.5 g/l (containing 550 mg Bt) resulting in 90% mortality by 5 days after treatment (DAT) while 53% WDG formulations (containing 530 mg Bt/g respectively) was effective @ 1.0 g/l resulting in mortality above 90% by 3 DAT. Complete dispersion and dissolution of the granules in water took place slowly requiring 30 minutes. Bt-technical was effective @ 1.5 g/l. Bioassays revealed that formulating as WDG lowered the Bt requirement by more than 50%.

Identification of sources of resistance / tolerance against leafhopper

Of 20 promising sunflower advanced breeding lines evaluated under high pest pressure against leafhopper, two lines AKSFI-51-6-1 and AKSFI-52-2 were found promising with injury grade 2 and 3, respectively compared to 5 injury grade in susceptible check Morden .

The sunflower germplasm lines, GMU-339, 595 and 669 were identified as sources of tolerance to leafhopper based on seed yield in the protected and unprotected conditions.

Among 30 promising sunflower germplasm and advanced lines, selections were made for 6 generations and stable lines were identified as resistant (GMU-1, 243, 504) with injury grade 1 and moderately resistant (GMU-4, 25,112,116, 255, 327,339, 343, 405, 556, 595, 669, 696, 703, 713, 776, 782, 795, 914, 922, 937, 1029,1093, GP6-570, GP6-1282, GP9-472-4-13 and AKSFI-46-2) with injury grade 2 compared to injury grade 5 in susceptible check Morden against leafhopper.

Morden (Susceptible) GMU-1 (Resistant line)

GMU-243 (Resistant line)

GMU-504 (Resistant line) **GMU-522 (Susceptible line)**

GMU-714 **GMU-714** **GMU-713**

(Moderately Susceptible) (Highly Susceptible) (Moderately resistant)

SOCIAL SCIENCES

ICAR-IIOR conducted FLDs (200 acres) in Haveri and Bagalkot districts of Karnataka (125 acres) and Prakasam district of Andhra Pradesh (75 acres) during *rabi* 2015-16. Out of which, 50 FLDs were vitiated due to severe drought in Haveri and Prakasam. The seed yield ranged from 750 kg/ha to 2200 kg/ha indicating wide variation depending the location.

Field day at Manglur, Bagalkot, Karnataka

A sunflower field day was organized in Manglur villages of the district for the benefit of farmers. The Scientists of ICAR-IIOR, ICAR-NBSSLUP, ZAC-ADL, UAS, Dharwad, KVK, Bagalkot, Officers of Directorate of Oilseeds Development, Staff of State Department of Agriculture, Karnataka, farmers of Gonal, Manglur, Hosakote and Belakoppe villages participated in the field day and shared their success stories on BMPs of sunflower. Speaking on the occasion, Dr. B.B. Singh, Assistant Director General (Oilseeds and Pulses) stressed on the need for crop diversification and intensification based on rainfall. He emphasised the scope for sunflower crop residue management. He also distributed soil health cards to the farmers. Dr.V.I. Benagi, Director Extension, UAS, Dharwad highlighted the importance of crop rotation with green manuring crops for improving soil fertility and health. Dr. Rajendra Hedge, NBSS&LUP, Bengaluru Centre emphasized on the need for soil test based nutrient management in sunflower as it is an exhaustive crop. He enlightened the farmers on the importance of B application in sunflower. Naratti, ADA, Badami taluka narrated about the schemes of the Agricultural Department such as Soil health cards, Pradhan Mantri Sinchai Yojana and Solar pumps for the benefit of farmers.

Srinivas Rao, Zonal Head, Zuari Agro-chemicals offered the services of Agricultural Development Labs of Zuari for analysing soil samples of farmers.

Around 120 farmers participated and actively interacted with the Scientists. The Principal Investigators Dr. G.D. Satish Kumar, Dr. Rama Murthy and Dr. Aziz Qureshi coordinated and conducted the programme.

Dr. B.B. Singh, ADG (Oilseeds and Pulses) addressing the farmers

Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer funded by NMOOP, DAC&FW

Gap analysis was done to understand the farmers' current practices in sunflower and sesame cultivation in six districts of three states Andhra Pradesh (Kadapa and Prakasam districts), Karnataka (Bagalkot and Koppala), Telangana (Khammam) and West Bengal (Bankura and West Medinapur). Soil samples were collected and analysed with the collaboration of Zuarai Agro Chemicals, Agricultural Development Labs. Based on the soil test values and STCR equations for the districts, target yields were fixed and required nutrients were provided to the farmers.

Demonstrations on best management practices (BMPs) of sunflower and sesame were conducted in the seven districts. Eight trainings and two workshops on best management practices for increasing production of sunflower and sesame were conducted involving farmers, extension personnel and agricultural department personnel. Distributed 279 soil health cards to farmers in collaboration with state agricultural departments of Karnataka and West Bengal.

Village-wise details of farmers selected for conducting demonstrations on BMPs of sunflower & sesame

State	District	Mandal	Villages	No. of farmers
Andhra Pradesh	Kadapa	B.matam	Chowdharivari palli	13
			Lingaladinna palli	11
	Prakasam	Giddalur	Diguvametta thanda	11
		Racharla	Kotthapalli	4
		Komarrole	Yerrapalle	7
			Rajupalem	5
Karnataka	Bagalkot	Badami	Gonal	42

			Mangalore	24
	Koppala	Koppala	Bettageri	58
Telangana	Khammam	Vemsoor	Kandukuru	40
West Bengal	West Medinapur	Binpur	Kankoo	32
			Jyothsna	43
		Chakonavan	Khirpai	71
	Bankura	Chatna	Brindavanpur	30
			Barshi	50
		Sonamukhi	Parbatiya	20
			Bhairabdanga	20
			Dubrajhati	22
			Kalyanpor	15
			Total	518

Training the farmers on collection of soil samples in collaboration with NBSS & LUP

Farmers adopting optimum seed rate and spacing in sunflower at Gonal village Karnataka

DRSH-1 at Betagiri village, Karnataka

DRSH-1 at Manglur village, Karnataka

SAFFLOWER

CROP IMPROVEMENT

Genetic Resources

Collection of fresh accessions: Thirteen landraces were collected during exploration tour to Balangir and Kalahandi districts of Odisha during February, 2016 in collaboration with NBPGR- Base centre at Cuttack.

Evaluation and characterisation

Of the 1800 accessions evaluated for seed yield and oil content, 21 accessions recording seed yield > 40 g/plant with oil content >30% were identified. Nine accessions *viz.* GMU-253, GMU-777, GMU-849, GMU-850, GMU-1693, GMU-1830, GMU-1840, GMU-1881, GMU-1940 were identified for oil content >34%.

Variability was recorded for number of capitula (18-134), number of branches (10-29), seed yield (3.4-36.7 g/plant) and 100-seed weight (2.2-5.6 g) among 50 trait specific accessions. Promising accessions were identified for yield/yield related traits.

Trait	Accessions
Seed yield (>30 g/plant)	GMU 5338, GMU 5865
Number of effective capitula (>60)	GMU-5229, GMU-5613, GMU-5774, GMU-5804, GMU-5815, GMU-5865, GMU-7493, EC-739480, GMU-400, GMU-1756, GMU-1814
Number of primary branches (>21)	GMU 5865, EC 739480, GMU 5613, GMU 1756

Multiplication, Conservation and Supply

Multiplication of 525 safflower germplasm accessions was undertaken during *rabi* 2015-16. Seeds of 1800 accessions were conserved under medium term storage and 65 accessions were submitted to National Gene Bank, NBPGR, New Delhi for Long term storage. A total of 631 samples of 435 germplasm accessions were supplied for multilocation evaluation and screening at different AICRP (Safflower) centres and 246 accessions for utilization in breeding programmes.

Consortium Research Platform on Agrobiodiversity Component-I Safflower

As part of the Consortium Research Plotform on Agrobiodiversity, trait specific accessions for high oil content [>35%] (8), appressed plant type (3), high number of effective capitula [>75] (13), high seed yield [>50 g/plant] (71) and bold capitula (12) were identified from among the 1600 accessions characterized during 2014-15.

A total of 1400 accessions received from National Gene Bank, NBPGR, New Delhi were raised in *rabi*, 2015-16 for multiplication, characterization and evaluation for 30 descriptors in Augmented block design with 2 checks. Seed multiplication of 404 accessions of 2014-15 with less seed quantity was undertaken. Seeds for 1450 accessions were submitted to NBPGR, New Delhi.

Improving seed and oil yields and wilt resistance through hybrid development

Development of CMS-based hybrids

Initial Hybrid Trial of CMS hybrids: Three hybrids *viz.*, DSH-256, DSH-252 and DSH-263 gave 25% (2001 kg/ha), 21% (1939 kg/ha) and 19% (1904 kg/ha) higher seed yields, respectively over hybrid check, NARI-H-23 (1596 kg/ha) and 11%, 8% and 6% higher seed yield, respectively over variety check, A1 (1800 kg/ha) and 13-17% (536-556 kg/ha) higher oil yield over A1 (472 kg/ha) and 6-10% higher oil yield over NARI-H-23 (505 kg/ha) at national level were promoted to Advanced Hybrid Trial.

Multilocation Preliminary Hybrid Trial: In multilocation PHT conducted at IIOR, Hyderabad, Indore, Parbhani and Phaltan, the hybrid, DSH-388 yielded 35% higher mean seed yield (2856 kg/ha) over the best check hybrid, NARI-H-15 (2122 kg/ha) and 57% higher than A-1 (1816 kg/ha). It also gave 44% higher oil yield than NARI-H-15 (594 kg/ha) and 89% higher oil yield than A-1 (454 kg/ha) with 30% mean oil content. Three other hybrids, DSH-368, DSH-364 and DSH-319 gave 4-8% higher seed yield (2206-2298 kg/ha) and 4-12% higher oil yield (618-667 kg/ha) over NARI-H-15 and 21-26% higher seed yield and 36-47% higher oil yield over A-1.

Mean seed and oil yield performance of CMS hybrids in PHT at multilocations

Hybrid	Mean seed yield (kg/ha)	Increase over NARI-H-15 (%)	Increase over A1 (%)	Oil content (%)	Mean oil yield (kg/ha)	Increase over NARI-H-15 (%)	Increase over A1 (%)
DSH-388	2856	35	57	30	857	46	89
DSH-319	2298	8	26	29	667	12	47
DSH-364	2254	6	24	28	631	6	39
DSH-368	2206	4	21	28	618	4	36
NARI-H-15 (hybrid check)	2122	-	16	28	594	-	30

NARI-H-23 (hybrid check)	1946	-	7	30	584	-	28
A-1(variety check)	1816	-	-	25	454	-	-

Preliminary Hybrid Trial: At IIOR, Hyderabad, 31 new CMS hybrids along with the varietal check, A-1 were tested in two trials in RBD with 3 replications in 9 sq. m plot size for each entry. DSH-344, DSH-345, DSH-367, and DSH-385 were the promising hybrids in terms of seed and oil yield.

Multilocation testing of CMS line for male sterility and fertility percent: The CMS line, A-133 was tested at Parbhani, Indore and IIOR, Hyderabad for male sterility stability. Male sterility percent in A-133 was between 96 and 98% over the locations indicating stability of A-133 for male sterility.

Male sterility percent in A-133 over multilocations

Centre	Male sterility in A-133 (%)	Temp. during bud initiation (^{0}C)		Temp. during flowering (^{0}C)		RH during bud initiation (%)		RH during flowering (%)	
		Max	Min	Max	Min	Max	Min	Max	Min
Parbhani	96	25.2-26.8	9.6-17.8	29-33	11.6-16	84-88	25-61	74-80	17-28
Indore	97	-	-	-	-	-	-	-	-
IIOR,Hyd.	98	26.4-29.8	6.7-10.2	26-29	12-19.8	84-95	29-40	88-98	49-68

Development of parental lines and varieties

Short duration parental lines: Three short duration BC_1F_6 families yielded 11-17% higher seed yield (500-530 g/net plot of 6.75 sq.m) over normal duration check, A-1 (450 g/net plot) and 96-107% higher seed yield than short duration check variety, JSI-99 (255 g/net plot) in a replicated yield trial with three replications under rainfed conditions in black soil. These lines flowered 23-24 days earlier (DF: 67-68 days) than A-1 (DF: 80 days) and matured 25-26 days earlier (DM: 110-113 days) than A-1 (DM: 136 days) while JSI-99 was 15-16 days earlier in flowering and 19-20 days earlier in maturity than the short duration lines. Among the three short duration lines entered in multilocation PVT, ISF-862 recoded 7.48 kg/plot seed yield against 3.08 kg/plot yield of the short duration check variety, JSI-99 and 6.12 kg/plot yield of normal duration variety, PBNS-12 (6.12 kg/ha) at IIOR, Hyderabad in a replicated yield trial with three replications and 112.5 sq.m plot size/entry/replication.

High seed yield: One non-spiny variety, SPP-70 has been advanced to AVT-I based on its high yield performance in IVT at multilocations. It recorded 22% (1045 kg/ha) higher seed yield than NARI-6 (857 kg/ha) under rainfed conditions, 36.3% (1794 kg/ha) higher than NARI-6 (1316 kg/ha) under irrigated conditions, and 30.6% (1419 kg/ha) higher than NARI-6 (1087 kg/ha) at national level in IVT.

In a replicated preliminary yield trial conducted at IIOR in RBD with 2 replications and plot size of 56.25 sq.m/entry/replication, the spiny variety, ISF-764 recorded 58% higher seed yield (1600 kg/ha) than A-1 (935 kg/ha), the high oil variety, ISF-9943-1 with oil content 36% gave 20% higher oil yield (281 kg/ha) than A-1 (233 kg/ha) and the non-spiny variety, ISF-763 gave 37% higher seed yield (631 kg/ha) than the non-spiny check, NARI-6 (458 kg/ha) (Seed yield: CV: 15%; CD: 111). These three varieties have been entered in IVT of 2015-16.

Among the 99 parental lines evaluated in ABD with 4.5 sq. m net plot size/entry, five parental lines were selected for high seed yield; among them, A1-134-7-105-p1 recorded

101% higher seed yield (1.66 kg/net plot) than A-1 (0.825 kg/net plot) followed by S-05-184 with 86% higher seed yield (1.535 kg/net plot), 2997-p11-p1 with 40% higher seed yield (1.16 kg/net plot), and ISF-3313 (1.03 kg/net plot), ISF-158 (1.1 kg/net plot) with 24 and 33% higher seed yield than A-1, respectively.

High yielding Fusarium wilt resistant varieties: One wilt resistant variety, W-521-3 recorded 66% higher seed yield (1558 kg/ha) than A-1 (935 kg/ha) in a replicated yield trial in RBD with two replications and the plot size of 56.25 sq.m/ entry/ replication (CV: 14%; CD: 103). In another replicated trial in RBD having two replications and plot size of 11.25 sq.m/entry, the wilt resistant variety, ISF-48 recorded 86% higher seed yield (2524 kg/ha) and the varieties, ISF-44 and ISF-39 gave 16% (1573 kg/ha) and 13% (1533 kg/ha) higher seed yield than A-1 (1351 kg/ha), respectively.

High yielding interspecific inbred lines: Among 17 interspecific inbred lines evaluated along with the check variety, A-1 in a RBD trial having two replications and plot size of 27 sq.m, the inbred lines, ISF-31, ISF-36 and ISF-21 recorded 41% (1866 kg/ha), 32% (1733 kg/ha) and 29% (1704 kg/ha) higher seed yield, respectively than A-1 (1316 kg/ha). These lines were derived from the crosses between cultivated species, *C. tinctorius* and wild species, *C. oxyacantha*, *C. lanatus* and *C. palaestinus*, respectively.

Development of Genotypes with High Oil Content/Oil Yield in Safflower

A set of 12 promising lines (F_4) with high oil yielding potential were selected based on oil content and seed yield per plant from the crosses involving Indian high oil variety NARI-57 with exotic high oil germplasm sources from USDA. These selections had at least 8% higher oil content over the popular Indian varieties: A-1, Bhima, PBNS-12 and SSF-708 and about 4% higher oil content than NARI-57. The selection IIOR-SAF-103 appeared to be more promising due to high oil yield. Furthermore, a set of 130 high oil F_3 progenies (from a total of 3000 F_3 plants) were selected with oil content ranging from 37 to 41% from crosses involving high seed yielding Indian varieties: A-1, Bhima, PBNS-12 and high oil sources from Mexico and USDA. High oil F_3 selections included normal, striped or thin hull types.

Promising high oil selections in safflower

Selection ID	Pedigree	Seed yield/ plant (g)*	Oil con-tent (%)**	Oil yield (g/plant) @ 95% recovery rate
IIOR-SAF-20	NARI-57 x EC-736500-F_4	24	36	8.2
IIOR-SAF-29	NARI-57 x EC-736500-F_4	22	37	7.7
IIOR-SAF-39	NARI-57 x EC-736500-F_4	18	36	6.2
IIOR-SAF-40	NARI-57 x EC-736501-F_4	13	41	5.1
IIOR-SAF-54A	NARI-57 x EC-736501-F_4	25	36	8.6
IIOR-SAF-54B	NARI-57 x EC-736501-F_4	25	36	8.6
IIOR-SAF-56	NARI-57 x EC-736501-F_4	16	40	6.1
IIOR-SAF-57	NARI-57 x EC-736501-F_4	16	37	5.6
IIOR-SAF-60	NARI-57 x EC-736516-F_4	27	37	9.5
IIOR-SAF-91	NARI-57 x EC-736501-F_4	20	40	7.6
IIOR-SAF-103	NARI-57 x EC-736501-F_4	30	38	10.8
IIOR-SAF-121	NARI-57 x EC-736501-F_4	12	39	4.4
A-1 (Check)	-	25±5	26	6.2
Bhima (Check)	-	35±5	28	9.3
PBNS-12 (Check)	-	27±6	28	7.2
SSF-708 (Check)	-	26±7	28	6.9
NARI-57 (Check)	-	25±7	36	8.6

*Average of at least 50 plants; ** data from pooled seed samples

Development of high oleic safflower genotypes for Indian conditions and development of protocols for marker-assisted selection for high oleic trait in safflower

Three high oleic varieties namely, ISF-1 (78.3% oleic acid content), ISF-2 (78.8% oleic acid) and ISF-3 (76.3% oleic acid) have been entered into IVT of AICRP-Safflower. Large quantity seed of these three varieties was produced for evaluation in large plots during *rabi*, 2016. About 115 lines have confirmed high oleic acid content (>70%).

Cloning of *FAD 2* gene and reconfirmation of indel mutation associated with high oleic trait in safflower

The full length candidate gene, fatty acid desaturase 2-1 (*FAD 2-1*) which is responsible for conversion of oleic acid into linoleic acid during fatty acid biosynthesis was cloned from a panel of 20 genotypes The full length 1.2 kb gene (s) was amplified by PCR with the designed primers. The PCR amplified 1.2 kb full length gene was cloned and from 10-15 recombinant clones obtained with each amplicon 4 clones were selected and confirmed for the cloned fragment. Four clones for each amplicon were sequenced and the sequence alignment indicated a point mutation, deletion of 'C' in all the high oleic lines of different sources and reconfirmed the previous reports in safflower.

FAD2-1 gene sequence

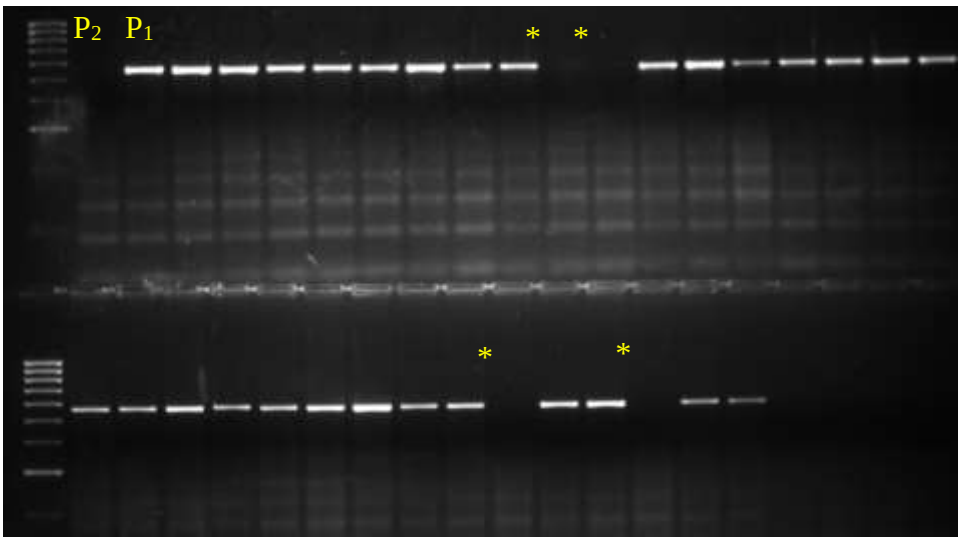
ctFAD2-1	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC
A1	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
Bhima	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
PBNS12	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
NARI57	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
SSF708	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
Centennial (EC-736516)	CGTCTCTGGAAGA**C**CCTACAACCGTTTCGC (LO)
S334 (EC755660)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Quilantan97 (EC755661)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
S518 (EC755662)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
CW-99 (EC755664)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
CC1469 (EC755666)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
CCC-B2 (EC755669)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
CCC-B4 (EC755671)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Humaya65 (EC755673)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Aceitera (EC755675)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Saphuaripa (EC755677)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Oleic leed (EC736514)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Montola2000 (EC736515)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
Lasaff (EC736517)	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)
EC523367-1	CGTCTCTGGAAGA -CCTACAACCGTTTCGC (HO)

LO – Low oleic acid; HO- High oleic acid

Development of Marker-Assisted Backcrossing Procedure for High Oleic Trait in Safflower

A set of 92 BC_1F_1 plants of the cross: Bhima x Montola-2000 was produced and genotyped by sequencing of *FAD2-1* gene. As expected, the BC_1F_1 population consisted of two genotypic groups: homozygous for high linoleic alleles (*OlOl*) (59 plants) and heterozygous (*Olol*) (33 plants). A single BC_1F_1 plant, which carried heterozygous alleles for *FAD2-1* and resembled the recurrent parent (Bhima) for flower colour, was backcrossed to Bhima and BC_2F_1 seeds were produced. A population of 34 BC_2F_1 plants were genotyped by sequencing of *FAD2-1* gene. As expected, the BC_2F_1 population consisted of two genotypic

groups: homozygous for high linoleic alleles (*OlOl*) (14 plants) and heterozygous (*Olol*) (20 plants). A single BC_2F_1 plant, which carried heterozygous alleles for *FAD2-1* and resembled the recurrent parent (Bhima), was backcrossed to Bhima and BC_3F_1 seeds were produced. Simultaneously, a set of 46 high oleic progenies (F_3-23, BC_1F_2-3, BC_2F_2-23) were identified by MAS (Fig.1), which are being stabilized.



P_1-Bhima, P_2-Montola-2000, *indicate high oleic progeny

Gel based assaying of high oleic F_3/BC_1F_2 /BC_2F_2 plants carrying homozygous alleles (*olol*)

DEVELOPMENT OF HIGH THROUGHPUT GENOTYPING ASSAY (KASP) FOR HIGH OLEIC TRAIT IN SAFFLOWER

A cost-effective SNP genotyping assay based on Kompetitive Allele Specific PCR genotyping system (KASP), a fluorescent endpoint genotyping technology was developed for genotyping an in-del in *FAD2*-1 gene and validated in F_2, BC_1F_1 and BC_2F_1 populations produced from the cross Bhima x Montola-2000. The KASP assay unambiguously discriminated homozygous high oleic (*olol*), heterozygous (*Olol*) and homozygous high linoleic (*OlOl*) genotypes in all the populations. The KASP genotyping results corroborated with *FAD2-1* sequencing and oleic content, which were generated earlier. The KASP assay is robust, non-gel based and cost effective, which can be successfully implemented in high throughput MAS for breeding of high oleic varieties in safflower.

KASP genotyping of F_2 population

KASP genotyping of BC_1F_1 population

Population

Sample ID	KASP Assay	*FAD2-1* Sequencing	Oleic acid content (%) in GC*
Bhima (B)	B	B	18.95
Montola-2000 (M)	M	M	81.64
$F_{2:3}$-1	B	B	17.23
$F_{2:3}$-3	B	B	19.49
$F_{2:3}$-4	Heterozygous	Heterozygous	28.61
$F_{2:3}$-5	M	M	75.31
$F_{2:3}$-6	M	M	81.83
$F_{2:3}$-7	Heterozygous	Heterozygous	25.86
$F_{2:3}$-8	M	M	80.26
$F_{2:3}$-9	M	M	80.60
$F_{2:3}$-10	Heterozygous	Heterozygous	46.70
$F_{2:3}$-11	Heterozygous	Heterozygous	31.82
$F_{2:3}$-12	Heterozygous	Heterozygous	37.18
$F_{2:3}$-13	Heterozygous	Heterozygous	41.73
$F_{2:3}$-14	B	B	18.87
$F_{2:3}$-15	Heterozygous	Heterozygous	34.02

*oleic acid content data from F_3 seeds; B-allele type of Bhima; M-allele type of Montola

KASP genotyping compared with actual gene sequence & oleic value in $BC_1F_{1:2}$ population

Sample ID	KASP Assay	*FAD2-1* Sequencing	Oleic acid content (%) in GC*
$BC_1F_{1:2}$-3	B	B	20.72
$BC_1F_{1:2}$-4	B	B	17.24
$BC_1F_{1:2}$-5	B	B	17.87
$BC_1F_{1:2}$-6	B	B	20.43
$BC_1F_{1:2}$-7	Heterozygous	Heterozygous	34.26
$BC_1F_{1:2}$-8	B	B	19.50
$BC_1F_{1:2}$-9	B	B	16.42
$BC_1F_{1:2}$-10	B	B	25.50
$BC_1F_{1:2}$-11	B	B	15.66
$BC_1F_{1:2}$-12	Heterozygous	Heterozygous	33.58
$BC_1F_{1:2}$-13	Heterozygous	Heterozygous	24.11
$BC_1F_{1:2}$-14	B	B	17.57
$BC_1F_{1:2}$-15	B	B	15.70

*oleic acid content data from BC_1F_2 seeds; B-Bhima type allele

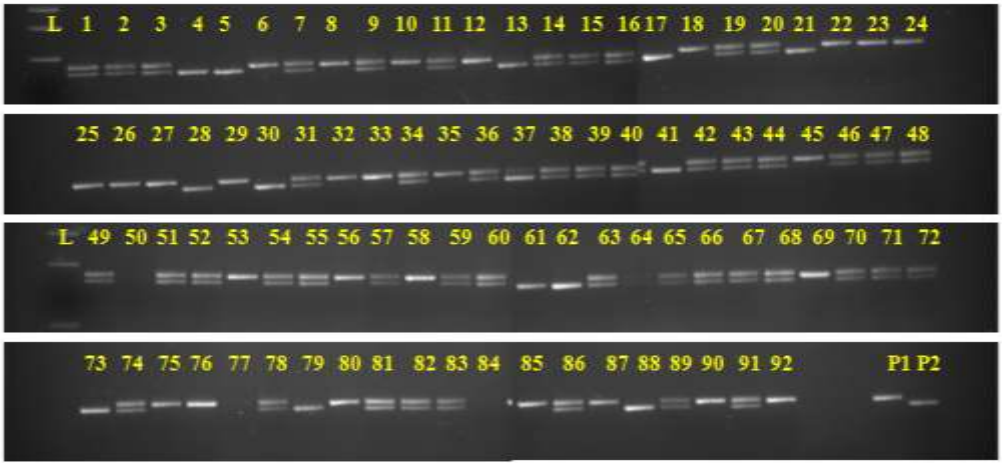
Allele mining of oil content in safflower

Development of germplasm mapping panel for oil content in safflower

To develop a germplasm mapping panel for oil content in safflower, a set of 520 genotypes consisting of safflower core subset (148 accessions), trait specific germplasm, released varieties and high oil lines imported form USDA and Mexico were evaluated and multiplied. The most representative plant from each accession was selected and scored for different morphological and agronomic characters. The selfed seeds from the selected plant were harvested for further stabilization. The genomic DNA of selected plants of all the accessions was isolated for genotyping for analyzing the population structure.

Molecular characterization of mapping population for construction of linkage map in safflower

The parental lines (A-1 X Humaya 65) used to develop mapping population was genotyped using ~1000 SSR markers. Of which only 67 SSR markers were polymorphic. The level of polymorphism between the parental lines was very low. The F_2 mapping population was screened with polymorphic markers in 6% PAGE gels and scored for construction of linkage map in safflower.



Screening of F_2 population of A-1 x Humaya-65 with SSR marker (C + DES 76)

Identification of SSR markers flanked to Fusarium wilt resistance in wild species, *C. lanatus:* True-hybridity of F_1 of the cross Nira x *C. lanatus* was confirmed using SSR markers. BSA was done in F_2 generation of Nira x *C. lanatus* cross. SSR markers flanked to wilt resistance in *C. lanatus* were identified. The SSR markers flanked to wilt resistance were validated in F_2 generation in wilt sick plot.

Marker-assisted selection for wilt resistance: Marker-assisted selection was practiced for wilt resistance using SSR markers flanked to wilt resistance in F_2-F_6 generations of (Nira x *C. oxyacantha*) and (Nira x *C. palaestinus*). Simultaneously, phenotyping for reaction to wilt was done by growing parents and various generations in wilt sick plot. Wilt incidence in various generations ranged from 0-7% indicating successful transfer of wilt resistance from resistant wild species, *C. oxyacantha* and *C. palaestinus* into wilt susceptible cultivated variety 'Nira' belonging to cultivated species (*C. tinctorius*) and stability of wilt resistance over generations.

CROP PRODUCTION

Site specific nutrient management in safflower

Different integrated nutrient management (INM) practices were evaluated with an objective of developing site specific nutrient management for sustainable productivity of safflower. Five treatments of INM (N_1: No fertilizer, N_2: Recommended fertilizer, N_3: STCR equation based fertilizer application, N_4: STCR equation based fertilizer application + Zn + S, N_5: STCR equation crude method (+25% of recommended fertilizer if soil nutrient availability is deficient, recommended fertilizer if soil nutrient availability is medium, -25% of recommended fertilizer if soil nutrient availability is high) in sub plots; FYM (5t/ha) and no FYM in main plot were evaluated in split plot design with four replications. The crop was grown under rainfed conditions and crop suffered from severe moisture stress. Seed yield response to FYM application, INM and its interaction was significant. Fertilizer application with STCR based equations (N_3) recorded the highest seed yield (1500 kg/ha) in presence of FYM which was statistically on par with that of STCR based fertilizer application in absence of FYM application (1375 kg/ha).

Selected Mexican cultivars response to fertilizer input

Five Mexican cultivars along with one check (NARI-57) of high oil entry were evaluated under three levels of fertilizer input *viz*., 100% NPK, 150% NPK and STCR based fertilizer (SSNM) in RBD with three replications under rainfed conditions. Crop suffered from severe moisture stress. Among the cultivars, check entry NARI-57 recorded significantly higher seed yield (1000 kg/ha). None of the Mexican entries yielded economically viable seed yields (250 kg/ha). Fertilizer levels did not statistically differ in influencing the seed yield of all 6 entries. Interaction effect was also non significant.

OTHER SCIENTIFIC ACTIVITIES

Assessment of performance of new crop Chia

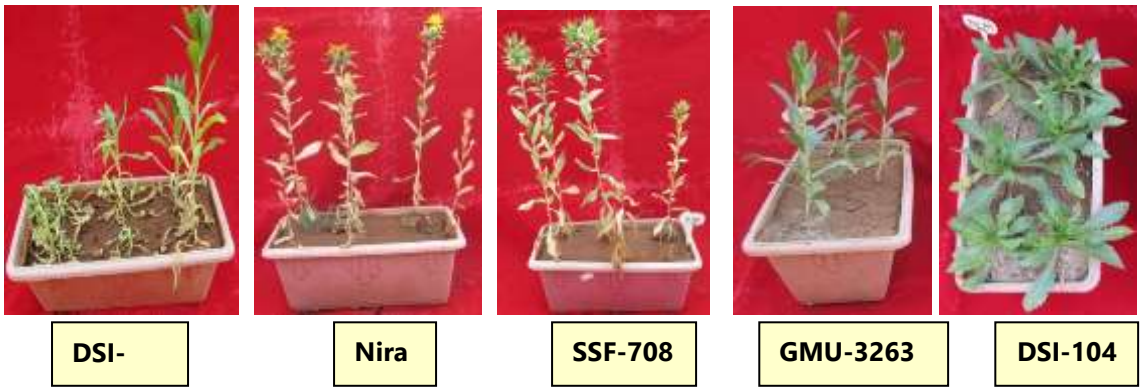
The new crop Chia (*Salvia hispanica*) a Mexican nutraceutical crop could be established with the mixed seed (black and white) obtained from farmers field through Mr Satya Bhoopal Reddy of Giddaluru and studied for its growth and yield during *rabi* season in both Alfisols and Vertisols in a small plot feeler trial. Plants were branched with about 70 to 1 m height. The crop duration was ~120 days. About 1t/ha seed yield was recorded at each site. Seed colour was black (grey) and white. The leaves were of mint aroma. Two flower colour plants (violet and white) were in the population. Good activity of bumble bees was noticed on the crop at flowering stage. About 1 t/ha seed yield was recorded at each site. 1000 seed weight was 1.50g. The crop was amenable for transplanting.

CROP PROTECTION

Wilt

Resistant sources to Fusarium wilt

Two genotypes viz.DSI-104 and GMU-3263 were moderately resistantFig.12). Ten genotypes (DSI-103, GMU-4912, SSF-658, Bhima, GMU-5133, SSF-GMU-6878, EC-523368-2, Manjeera & NARI-38) recorded less than 30% wilt incidence.



Reaction of safflower cultivars to Fusarium wilt

Management of Fusarium wilt

T. harzianum Th4d SC @ 2ml/kg and cymoxanil 8% + mancozeb 64% @ 0.2% treatments were most effective (Fig.13) recording significantly low incidence of Fusarium wilt (17.6 & 18.2% respectively) whereas control plots in a field experiment recorded a wilt incidence of 36.3%.

Trichoderma harzianum Th4d SC@ 2ml/kg

Cymoxanil 8% + Mancozeb 64% @ 0.2%

Captan @0.2%

Control

Plant stand and diseases incidence in fungicides and biological agents on Fusarium wilt in safflower under field conditions

Phytophthora Seedling Blight

Sources of resistance to *Phytophthora nicotianae*

Two genotypes DSI-103 & GMU-3263 were resistant *Phytophthora nicotianae* incited leaf blight. Two genotypes (DSI-104 & EC-523368-2) were moderately resistant with less than 20% disease severity; genotypes *viz*. SSF-GMU-6878, GMU-1205-2, SSF-1302, GMU-1946, GMU-4912, SSF-658 and Manjeera recorded less than 30% severity.

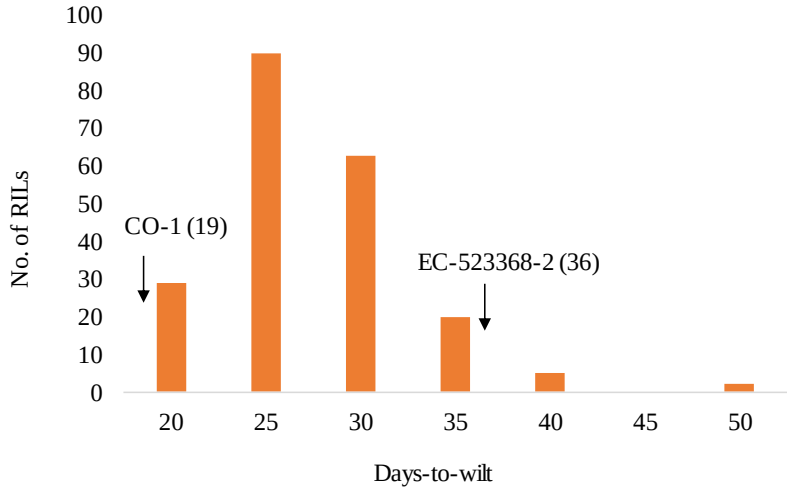
DSI-103 GMU-3263 EC-523368-2 DSI-101 Nira PBNS-12

Reaction of safflower cultivars to *Phytophthora nicotianae*

Development and evaluation of recombinant inbred line (RIL) mapping population for aphid resistance

Two RIL (F_5) populations were developed from the crosses CO-1 x EC-523368-2 (~300 lines) and CO-1 x A-1 (~200 lines) through single seed descent method. A subset of 209 RILs of the cross CO-1 x EC-523368-2 and 152 RILs of the cross: CO-1 x A-1 were evaluated for resistance to aphid based on 'days-to-wilt' of seedlings in the field (Rajendranagar farm) using the newly developed artificial screening method during *rabi* season. The screening trial was replicated two times. Days-to-wilt of CO-1 ranged from 18-24 with the mean of 19, A-1 ranged from 20-35 with the mean of 26 and EC-523368-2 ranged from 30-50 with the mean of 36. The results showed that EC-523368-2 had higher level of resistance to aphid than A-1 at seedling level. Days-to-wilt in the RIL population of CO-1 x EC-523368-2 ranged from 19 to 50 with the mean of 25 indicating quantitative resistance but clearly measurable. Heritability estimate was high (0.76), which is encouraging for genetic mapping studies.

Reaction of RILs to aphid



Frequency distribution of aphid resistance in RILs of the cross: CO-1 x EC-523368-2

Reaction of safflower varieties to aphids

All the 21 varieties of safflower were evaluated for aphid resistance during *rabi* season. Six varieties, MMS-White 2F, NARI-NH-1, C-28-29-5-3A-6, PBNS-12, SSF-658 and NARI-57 were found susceptible or highly susceptible to aphids.

Evaluation of Mexican germplasm to aphids

Mexican safflower accessions (30) were evaluated for aphid resistance during *rabi* season. Among them, 18 accessions, EC755659, EC755667, EC755668, EC755669, EC755670, EC755671, EC755672, EC755673, EC755675, EC755676, EC755677, EC755678, EC755679, EC755680, EC755681, EC755682, EC755683 and EC755684 were found susceptible or highly susceptible to aphids.

SESAME

CROP IMPROVEMENT

Germplasm activities:

Assembled around 1050 PGRs and evaluated 200 during *kharif*, 450 in late *kharif* and 400 during *rabi* along with checks. Identified promising diverse as well as agronomically superior lines for use in crossing.

Trait	Genotypes
Basal bearing	NIS 5174
Appressed plant type	IC 245556, RJ 46, SI 3100
Lanceolate types	KIS375, IS 427, G25, SI 607, NIC 161848
Early	IS 81564, NIC 6059, IS 387-12 , IC 204670, IS 101-2-2, S-003116, GAD 4
High biomass	IS 350, CT 36, IC 14146, IS 101-2, IC 204632
Diverse types	S0449, SI 1516, GT 10, DS 5
Chagatam local; Trilobe leaf	EC 131953
Chagatam local; Fascition type	IS 431
Petiole pigmentation	IS 100-8
Dark green leaf	GRT 8681,SI 1516, GT 10, K 96239, IC 101620
Powdery mildew %	CO 1= 40, EC 182832 = 5, SI 1147=5, NIC 16100= 4, S0368=30, IC 204139=3, KMR 118=5, IC 114146F =40, ES 334974=5, NIC 13590=5, SI 3114=8, SI 1070=8, IC 43777=8, NIC 7835=28;
Very low bimass	RT 127
High branchinig	IS 15-A-B, SI 1390(6-8), KMR 118
Long bold capsule	KIS 304B;
Short duration, light green leaf & more susceptible to diseases.	SVPR1
Very good plant type and relatively more resistant diseases	GT10

Low disease.	IS 562
Phyllody %	NIC 166-4=31,NIC 3181=3, SI 2073=48, ES 62=4, S 479=31, S 449=5, NIC 8352=23, SI 479=38, NIC 166-4=34, IS 101-2 =34, IS 712=42, GRT 5355=38, NIC 161848=2, SI 3097=6, RT 346=11, TKG 21=16, TKG 22=14, SAVITRI =22, GT 2=34, JLT 408=18, GT 10=5, RT 351=28, NIRMALA=18, DS 5=24, RT 127=42, HT-2=6, SWETHA=8, HIMA=28, T78= 36.

Synthesized around 740 new crosses. Based on the phenotype, RT346/S0449; RT127/ GT1; DSS9/Prachi; So479/DS5; RT346/So449; IS289/Savitri; RT127/ICR1411; RT346/ GRT860; RT351/KMR90; Swetha/IS24-1; RT127/GRT8368; JLT408/IS387; NIC 17301/ DS5; TKG22/GT2; RT346/NIC8020; RT346/TC326, cross combinations were identified as promising. Accession of *S. malabarium* were multiplied and supplied to the breeder at Raichur.

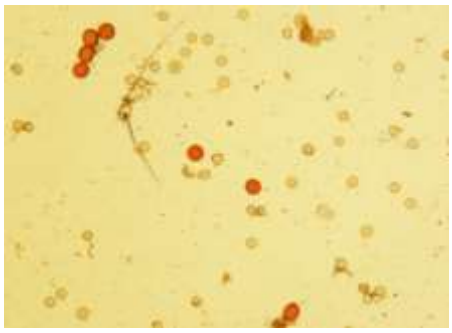
Seed multiplication of 300 lines for use in breeding was undertaken along with seed production of 20 superior varieties.

Interspecific hybridization:

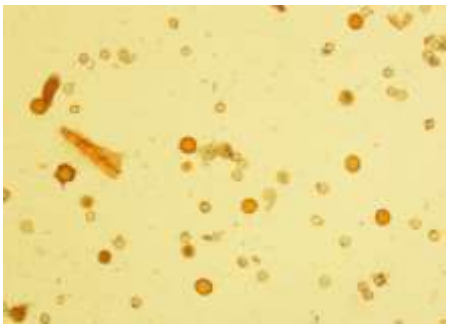
Seeds of sesame wild species, *S. malabarium* (3 accessions) and *S. alatum* (1 accession) were treated with GA_3 germinated and successfully established in the field. Six paired interspecific crosses (*S.malabaricum* x TKG-22, *S.malabaricum* x GT-10, *S. malabaricum* x TKG-22, *S. malabaricum* x GT-10, *S.malabaricum* x TKG-22, *S.malabaricum* x GT-10) were generated. Also, male sterile BC_1F_1 plants obtained from interspecific crosses earlier using *S. malabaricum* and cultivated species, were back crossed with their respective recurrent parents to obtain BC_2.

Polymorphism studies using molecular markers

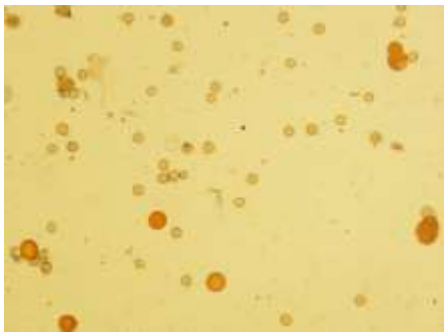
In order to develop a set of DNA markers with genome-wide coverage and robustness, PCR conditions were optimized for 100 publicly available SSR markers. When SSR markers were screened for their polymorphism among 4 wild sesame genotypes M21, CSMB-1, MLB, and M20 and 16 released varieties (G-Til-2, RT-127, TKG-21, VRI (SV)-2, HT-2, G-Til-10, TKG-22, TMV-7, Swetha, DS-5, JLT-408, Savithri, RT-351, Nirmala, Hima and RT-346), of which 15 markers showed polymorphism among wild sesame genotypes.



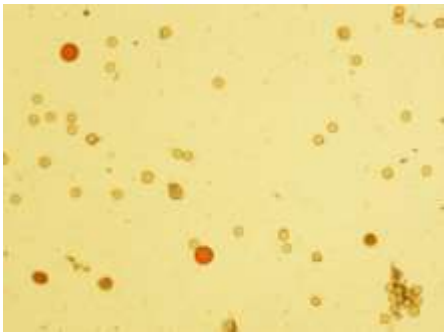
(ISMB-1 x GT-10)-F_1 x GT-10



(ISMB-2 x GT-10)- F_1 x GT-10



(ISMB -3 x GT-10)-F_1 X GT-10



(ISMB-4 x TKG-22)-F_1 x TKG-22

Germplasm exploration was undertaken in N-W Gujarat along with NBPGR, Thrissur and collected a total of 31 different sesame wild accessions (*S.malabaricum*-29 accessions *S.radiatum*-2 accessions).

Collection of *S.malabaricum* from Ambapada, Ahwa Mandal, Dangs District, Gujarat

Collection of *S.Radiatum* from Dandi, Jalapor Mandal, Navsari District, Gujarat

CROP PROTECTION

Survey of sesame diseases under different cropping areas and seasons

The sesame phyllody in *Kharif* : 2015 (R. Nagar) - was observed which ranged from 5-70% in the different varieties *viz*: Swetha-5-10%, P(L)-5-10%, GT-10%, RT-127 40-50%, RT-351 50-60%, GT-2 50-60%, Hima-50-70%. In farmer field the incidence was 15- 40% in 6 out of 10 locations surveyed.

Evaluation of Biocontrol agents for soilborne and foliar diseases

Four biocontrol agents viz: *Trichoderma viride*, *T. harzianum*, *T.asperellum* and *Pseudomonas fluorescens* were tested by seed treatment against Macrophomina root rot disease of Sesame under glasshouse conditions. Among all *T. harzianum* seed treatment reduced the disease incidence up to 35%

SOCIAL SCIENCES

Consortium approach at Adilabad

The hamlets of Sitagandi gram panchayat in Gudihathnoor Mandal of Adilabad district, such as Kothwalguda, Malkapur, Chinnamalkapur, Peddamalkapur where six farmers have grown groundnut with sesame (11:1) under dug out farm pond water. The sowings were taken up between December 2015 and first week of January 2016. Castor was also grown as pure crop by two farmers'. The crop stand of castor was good and primaries have harvested. The sesame yield recorded as 500 kg/ha. The problems expressed with castor are labour, threshing and stray animals.

OTHER SCIENTIFIC ACTIVITIES

Central Sector Scheme for Plant Variety Protection and Farmers Rights Authority

DUS testing trial of Castor

One new hybrid (2nd year) with 2 reference varieties and 2 VCK parental lines with 4 reference varieties were raised in *kharif*, 2015 in three replications. Data for 30 DUS traits was recorded in accordance with the DUS test guidelines.

DUS testing trial of Sunflower

DUS hybrid trial comprising of 16 candidates and 5 reference varieties, R lines trial of 10 candidates and 4 reference varieties, A/B lines trial of 9 candidates and 6 reference varieties were conducted and entries were characterised for 30-32 traits in accordance with the DUS test guidelines.

DUS testing trial of Safflower

One farmer's variety and 4 reference varieties were raised and characterized for 26 DUS traits.

Institute Technology Management Unit (ITMU)

The ITMU of this Directorate has facilitated licensing of Bt-1 technology to one bio-pesticide entrepreneur. The data base of IP assets and commercialisable technologies was updated. The reports on two contract services, one with T. Stanes & Co. Ltd., Coimbatore for the study on feasibility of stabilizing powder formulation of *P. lilacinus* by spray drying technique and other with NIPHM, Hyderabad for bio-efficacy data generation of bio-agent cultures were sent to them. Facilitated for the agreement with NBA for taking the approval for obtaining Indian Patent on 3 applications. Agreement was also signed with NBA for licensing Bt-1 and Th4d formulations to two Indian companies having foreign share in their capital and management. Agreement was signed with Telangana State Biodiversity Board for licensing Bt-1 formulation to three Indian companies. Benefit sharing of the licensing fee received with different stakeholders was initiated. The replies to the different queries of CIB&RC on Bt-1 and *B.bassiana* data were sent to the respective licensee. Assisted in conducting one ITMC meeting and preparing proceedings.

Agriculture Knowledge Management Unit (AKMU)

The AKMU involves in regularly updating the Institutes website with pertinent databases on oilseeds, market prices and arrivals, press gleanings,tender documents, photographs of the various events, AICRP & FLD releases, employment opportunities etc. During the year under report, the unit had developed and uploaded a user friendly database pertaining to the area, production and yield of the nine annual oilseeds for the period 1949-50 to 2013-14. The updating of database on the price information system castor crop traded in the major Agricultural Produce Market Committees (APMC's) with respect to date-wise transactions on arrivals, minimum price, maximum price and modal price for the year 2015 are uploaded to the database. The querry based database developed enables the user to access the market information as per the choice.

Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell has prioritized the researchable areas based on the recommendations of RAC and QRT, thrust areas of research in XII plan and action plan submitted to PMO to increase the oilseed production. The progress of all the existing research projects were reviewed and major areas of research as per the priority were identified.

Accordingly action has been initiated to take up the new projects as per the priority areas. Also, it has been ensured that the projects are addressing the thrust areas identified in XII five year plan and in vision document of the Institute. RPPs of 39 Institute research projects were reviewed as per the IRC recommendations and submitted to Director for approval. The database on publications updated and maintained. More than 10 project proposals were evaluated for submitting to different funding sources.

Six monthly reports on targets and achievements in HYPM have been uploaded. It has coordinated and arranged Institute Research Committee meeting to review the progress of on-going projects and externally funded projects. Agreement signed between IIOR and NIPHM for collaborative study on pesticide residue and bio-pesticide management and IIOR and MANAGE for utilisation of ICT tools for effective dissemination of improved technologies.

Supply chain scenario in oilseeds

During the period under report, an attempt was made to identify the hotspot areas for value chain in safflower through convergence of stakeholders. The hotspot areas on "CLUSTER APPROACH" were identified based on the Length of Growing Period, Agro Ecological Region/Agro Ecological Sub Region, and Soil type besides the economics of competing crop(s), and the socio economic conditions of the safflower farming community. The aim of this novel initiative is to trigger handholding between the farmers and the stakeholders in oilseeds and facilitate creation of Farmer Production Organizations(FPO)/Self Help Groups(SHG)/Entrepreneurs as elements of the value chain process in creating a brand image for the safflower oil.

In this endeavor, Chitradurga district of Karnataka has been identified as a hot spot area considering the Length of growing period, type of soil, yields of the competing crops, proximity of value chain suppliers (VCS) *viz.*, Karnataka Oilseeds Federation, Chitradurga, ZAHRS (UAHS), Hiriyur and the expertise available at IIOR as value chain enabler (VCE).

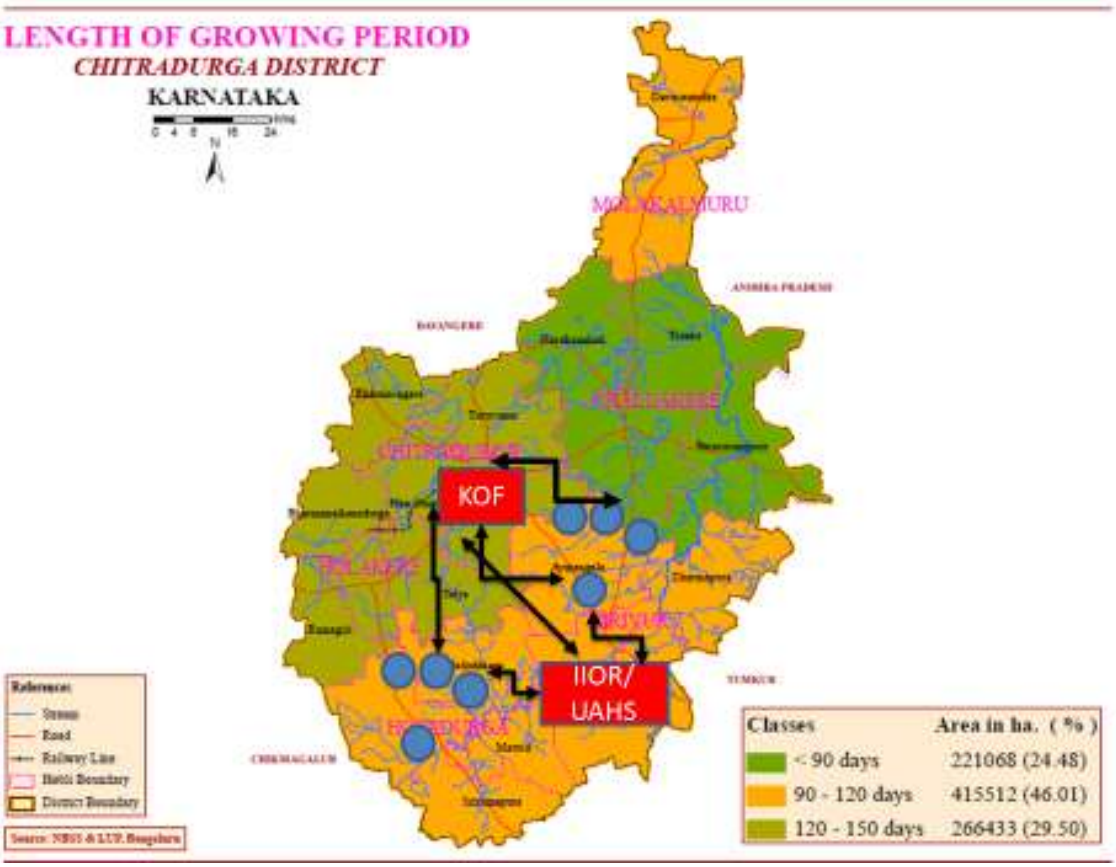


Fig. 1: Clusters for value chain of safflower in Chitradurga district

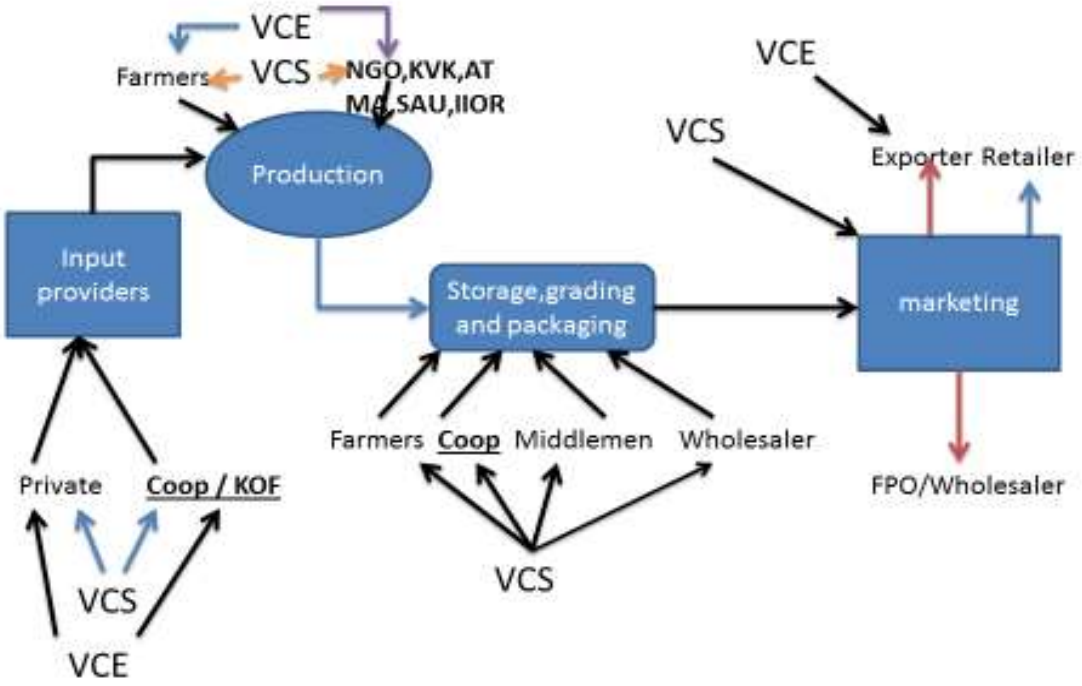
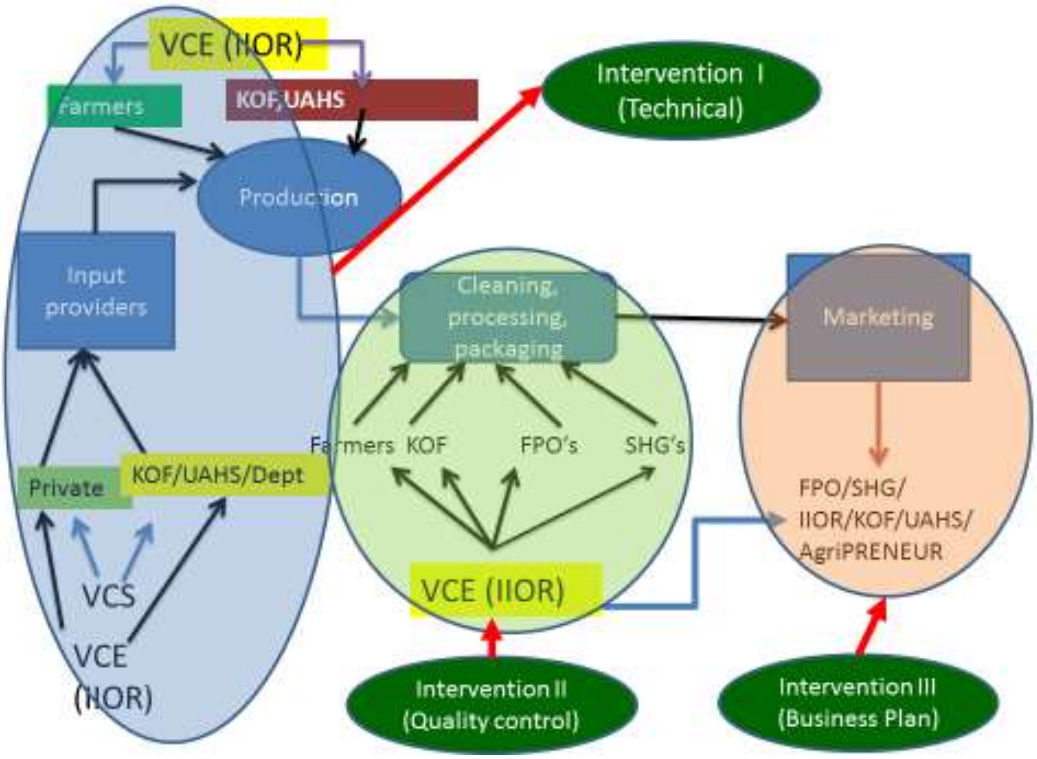


Figure: Structure of Value Chain in safflower



Structure of Value Chain and Value Chain Interventions

The proposed value chain on safflower identified in the above identified district is focused on extracting pure expeller oil in identified clusters (two to three) with the objective of creation of FPO's /SHG's for processing activity(s). The capacity of the processing units would be fabricated in a manner that it would enable absorption of the locally produced safflower seed for the domestic production and also for marketing the oil in the identified cluster. In this new initiative, IIOR would handhold the processing clusters on the technical process Intervention I would enable for greater farm level, technical efficiency involved in the production process while Intervention II could focus on analyzing the chemical composition in the extraction process and Intervention III would primarily focus on the processing and packing aspects, preparation of business plan and developing appropriate business plans and marketing strategies.

Frontline demonstrations (FLDs) and extension activities on oilseeds

The annual action plan (AAP) for conducting frontline demonstrations on oilseed technologies was developed which was approved by the National Mission on Oilseeds and Oil Palm (NMOOP). A total of 2427 frontline demonstrations and 23 trainings were conducted against the allotment of 2618 and 25 trainings, respectively by IIOR, Hyderabad. Additional 300 FLDs were conducted on safflower.

Inputs dealers are the first source of information on agriculture for the farmers. Hence, in order to improve the knowledge of input dealers on oilseed production technologies, 56 trainings were conducted for input dealers, agricultural officers and extension workers.

Frontline Demonstrations and Trainings – Allotted and Conducted

Institute/AICRP	**Physical progress**					
	FLDs				**Trainings**	
	Approved		**Conducted**		**Approved**	**Conducted**
	Kharif	***Rabi***	***Kharif***	***Rabi***		
IIOR, Hyderabad						
Castor	300	100	300	100		
Safflower		568		568	20	18
Sunflower	50	400	50	400		
Project Coordinator (Sesame), Jabalpur	500	0	380	-	0	0
Niger	200	0	129	-	0	0
PC (Linseed), Kanpur	0	500	-	500	5	5
Total	**1050**	**1568**	**859**	**1568**	**25**	**23**
Additional FLDs and Trainings						
Safflower (IIOR)	-	300	-	300	-	-

TMC MM 1.6: e Kapas network and technology documentation

In Telangana State, during *kharif* 2015-16, there was severe drought and the total rainfall of the State was 639.9 during the crop season as against the annual normal rainfall of 905.4. Inspite of severe drought, farmers preferred cotton over other crops and the area marginally increased from 16. 92 lakh ha (2014-15) to 16.97 lakh ha (2015-16).

During 2015-16, 7425 farmers from all the nine districts of Telangana were registered into the advisory system making the total number of registered farmers to 11,237.A total of 169 messages, out of which 130 distinct messages were recorded and disseminated to farmers. Three lakh forty eight thousand one hundred and nineteen voice based advisories on production, protection, harvest and post-harvest technologies apart from weather alerts and market information were disseminated to the registered cotton farmers during *kharif* 2015-16. More than 79% success was observed in delivery of voice advisories.

To evaluate the effect of these advisories, 60 farmers were selected among the registered farmers by random sampling method and data were collected by face-to-face interview of the farmers. The results indicated that the majority of farmers were middle aged (41-57 years), with primary education (35.0%), married with small land holding (65.0%), medium information seeking (60.0%), information management (55.0%) and listening behaviour (46.6%) and with high risk orientation (58.3%).

Farmers had favourable attitude towards mobile advisory services (51.7%) with medium level of knowledge on cotton cultivation (58.3%) and medium extent of adoption of recommended practices (40.0%).

The item-wise knowledge of cotton farmers indicated that 91.6% farmers had knowledge on the name of the chemical to prevent flower drop in cotton, followed by agronomic management during heavy rains and drought (88.3), general agronomic management in cotton (75.0%), sucking pests management (78.3%) refugia belt (66.7%), ill-effects of use of excessive nitrogenous fertilizers (61.7%) and benefits of trap crops (58.3%).

Around 10% of cotton farmers registered into the advisory system were growing oilseed crops during *rabi*2015-16 as compared to 15% during *rabi* 2014-15, due to severe drought. The technologies for cotton-oilseed based cropping systems need to be developed and fine-tuned for the benefit of farmers.

For the benefit of oilseed farmers around 25 messages were disseminated to 1100 farmers through Reliance Information Services.

Seed Production

IIOR is the nodal centre for the production of breeder seed of mandate crops. It also includes monitoring of the breeder seed production with co-operating centres spread all over the country. A total of 11.50 q of breeder seed of castor (SKP-84, SKI-215, DCS-107 and 48-1 (Jwala) was produced by various centres against 2.96 q of DAC indent. Breeder seed of sunflower (DRSF-113, CMS 234A, 234B, CMS-17A, 17B, CMS-335A, 335B and RHA-95-C-1) was produced to the tune of 11.0 q against 1.16 q of DAC indent. The produced breeder seed of varieties and parental lines of castor and sunflower hybrids released through AICRP was distributed to the indenting agencies through Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India. The seed section of IIOR has produced and distributed breeder and truthfully labeled seeds of hybrids and varieties released by IIOR under the ICAR Seed Project" Seed Production in Agricultural Crops".

Breeder/ Foundation seed production at IIOR

Crop	Parent/ Variety	Quantity (q)
Castor	DCS -107	4.50
	48-1 (Jwala)	4.00
	DCS- 78	2.00
	DCS-9	2.00
Sunflower	DRSF-108	0.10
	DRSF-113	0.80
	CMS 243 A	0.60
	CMS 243 B	0.30
	RHA 6 D-1	0.10

IIOR also produced breeder seed of soybean var. JS 95-60 and JS 93-05 during the off-season (*rabi*-summer) and produced about 12.0 q as per the allocation by IISR, Indore. About 5.2 q of sesame breeder seed of TRC Til 1-8-1-1 was also produced by IIOR and

supplied to State Department of Tripura for further multiplication and spread in north-eastern states.

Production of sunflower hybrid, DRSH-1

Seed of sunflower hybrid DRSH-1 was produced both at IIOR-ICRISAT and IIOR-Narkhuda farms in about 3 acres during *rabi*/summer 2015-16. The total seed yield was about 5 q.

Production of castor hybrids

About 120 q of DCH-177 castor hybrid was produced both under TSP-Seed production of ICAR Seed project in 8 acres of tribal farmers of Doddigadda Thanda of Krishnanagar Farooqnagar Mandal and 20 acres of general farmers of Konkala village of Waddepally Mandal, Mahabubnagar district, Telangana State during *rabi* 2015-16. The tribal farmers were supplied with inputs *viz.*, parental seed, fertilizer, pesticides, Taiwan sprayers etc.

Production of DCH-519 was undertaken in about 20 acres with general farmers of Konkala village of Waddepally Mandal, Mahabubnagar district, Telangana State during *rabi* 2015-16 and about 60 q seed was produced.

Trainings organized in Seed Production

Trainings for quality seed production of castor hybrids DCH-177 and DCH 519 were organized under ICAR Seed Project to tribal and general farmers in small groups from time to time. A field day cum seed production training in hybrid castor was organized for 400 farmers on February 10, 2016 at castor seed production fields of Konkala Village, Mahabubnagar Dist., Telangana and at Rural Development Trust, Ananthapur on March 24, 2016 benefiting 200 farmers. A training on 'Post-harvest technology in castor and sunflower seed production' for women workers associated in castor seed production was conducted on March 22, 2016 at Narkhoda farm of IIOR

Maintenance Breeding

Castor

Nucleus seed of the following released varieties and parental lines are produced by bulking selfed seed of individual plants.

- Varieties : DCS-107 (1 kg), 48-1 (0.5 kg)
- Male lines: DCS-9 (0.5 kg), DCS-78 (0.5 kg)
- Female lines: DPC-9 (0.4 kg), M-574 (0.2)

Sunflower

25 A and B, 60 R lines and 52 inbred lines were maintained through sib mating and selfing and evaluated during *kharif*-2015. Promising 85 EC lines were selected during *rabi*-2015 at Narkhoda farm for different yield and yield contributing traits for utilization in breeding.

Safflower

Seed production of CMS hybrids and A- and B-lines: Around 15 kg seed of A-133 and 6 kg seed of its B-line was produced under isolation. Around 3 kg each of AHT-I hybrids, DSH-256, DSH-252 and DSH-263, IHT hybrid, DSH-272 and two new hybrids, DSH-388 and DSH-299 were produced along with their parental lines under net condition.

AICRP ON

CASTOR, SUNFLOWER AND SAFFLOWER

The significant achievements made under AICRP on Oilseeds are furnished here under.

Castor

- Among the high ricinoleic acid type accessions, RG-3477, RG-22 and RG-3789 recorded 13% (1749 g/net plot), higher seed yields, earliest flowering (46 days to reach 50% flowering and 93 days to maturity across locations under rainfed and irrigated conditions) and highest number of capsules on primary raceme (79), respectively.
- SKI-402, SKI-401 at S.K.Nagar and JI-435 (5620 g/plot), JI-430 and JI-426 at Junnagadh were identified as Superior Male combiners.
- Development of stable pistillate lines is continued through development of genepools and recombination breeding involving different pistillate lines to develop wilt resistant pistillate lines of suitable maturity and morphological characters.
- New initiatives were taken up at the coordinating centre to create diversity in pistillate lines using new sources with more than 95% pistillate expression from pre-bred material Kh-13-154 and PMC-36.
- Six hybrids *viz.*, CEH-297 (41%), CEH-293 (30%), SHB-1022 (43%), SHB-1014 (36%), SHB-102 (41%), JHB-1060 (30%) with significant increase above GCH-7 (3124-5025 kg/ha) under irrigated conditions and 3 hybrids *viz.*, YRCH-1523 (35%), PHT-BP-14-3 (14%) above DCH-177 (1308-2125 kg/ha) under rainfed conditions were promising in preliminary hybrid trials.
- Five hybrids of IIOR, Hyderabad *viz.*, CEH-346, CEH-271, CEH-352, CEH-302 and CEH-287 were high yielding both under rainfed and irrigated conditions.
- Among 23 promising genotypes, at Bhavanipatna, DCH-1715 recorded 21 % higher seed yield (1578 kg/ha) than the check hybrid DCH-177 (1308 kg/ha). The hybrid took 51 DAS for 50 % flowering and 101 DAS to maturity. JHB-1003 at Hiriyur and varieties like Haritha, MCI-14, GC-3 at Kanpur centre were significantly higher than the national check, DCS-107 (1850 kg/ha).
- In Coordinated multi location trials, ICH-66, ICH-68, SLCH-158, JHB-1018, SHB-974, PHT-14-44, PHT -12-3 are promoted to AHT-I based on their improvement in seed yield than the checks.
- In AHT-I, DCH-1720, with 8 per cent yield increase over the best check, GCH-7 under irrigated conditions is resistant to wilt in all the three sick plots. In AHT-II, SHB-896 with 6 % and 4 % yield increase over best check, GCH-7 under irrigated conditions and national average is resistant to wilt at SK Nagar only.
- A total of 8.7 q of breeder seed of varieties and parental lines of castor was produced against the DAC indent of 2.96 q.
- Under South Gujarat heavy rainfall zone (AES-III), application of pendimethalin 1 kg/ha as pre-emergence herbicide followed by one hand weeding at 40 DAS resulted in effective weed control, higher seed yield (2061 kg/ha) and economic returns (B:C ratio 2.42) of *rabi* castor (GCH-7) under irrigated conditions (AICRP Castor-Navasari)**.**
- In Saurashtra region of Gujarat at Junagadh, castor (GCH-7) sown at crop geometry of 120 x 60 cm with application of 40 kg K_2O along with recommended N - P_2O_5 (120-60) for realizing higher seed yield (3506 kg/ha) and economic returns (B: C ratio 3.86) (AICRP Castor – Junagadh).

- As a whole, due to prevailing low rainfall conditions during cropping period, incidence and intensity of castor diseases were low during 2015-16.
- Among germplasm accessions evaluated against wilt, RG 3425, RG 3432, RG 3446 showed resistant reaction (<20%) at three sick plots of Hyderabad, Palem, S.K. Nagar. RG 3206 was found to be resistant with 10% gray mold incidence, which needs confirmation and RG-109, RG-116 were found free from root rot disease.
- In confirmation studies of resistance to wilt, three germplasm accessions each at IIOR, Hyderabad and S.K. Nagar, RG-311, RG-3042, RG-3070 showed resistant reaction (<20%) to wilt at Hyderabad, S.K. Nagar, Palem. Against gray mold confirmation, RG-1062, RG-3344, RG-907 recorded low gray mold (<25%) under artificial epiphytotic conditions. Against root rot, RG 392, RG 2816 were free from disease. Accessions RG-1834, RG-2035, RG-2719, RG-2746 recorded low root rot (<20%) under artificial inoculation conditions.
- In management of wilt disease, seed treatment with carbendazim (2g/kg seed) recorded low wilt incidence followed by seed treatment with *T. harzianum* Th 4d (10g/kg) and soil application at IIOR- Hyderabad and Yethapur, while no significant difference in wilt incidence among treatments observed at S.K. Nagar.
- Survey and monitoring of castor insect pests revealed heavy infestation of leafhopper at Palem during October and Yethapur during January. There was no major pest problem at S.K. Nagar and Junagadh. Negligible or very low infestation of capsule borer was recorded during *kharif* 2015-16 in all four locations. Very high larval parasitisation of semilooper b*y Snellenius (Microplitis) maculipennis* (up to 72.5%) was recorded at Palem.
- Under multi-location testing to confirm leafhopper resistance, four entries *viz*., RG-43, RG-631, RG-2661 and RG-3060 were found resistant (Hopper burn grade 0 to 1 on 0-4 scale as compared to grade 3 to 4 in susceptible checks) consistently for the third year at Palem, Yethapur and IIOR, Hyderabad.
- In the trial to confirm leafhopper resistance in eight promising DPC-23 selections (mutant DPC-9), four selections were found consistently resistant (Hopper burn grade 0 to 1 on 0-4 scale) for second year of testing at Palem and Yethapur.
- The newer insecticide, clothianidin 50WDG @ 0.1g/l found effective against leafhopper (93.4 to 99.4% reduction over untreated control) and resulted in higher seed yields of 1286 and 882 kg/ha with cost benefit ratios of 1: 1.82 and 1: 1.36 at Palem and IIOR, Hyderabad, respectively. The seed yields with conventional insecticides ranged from 820 to 1122 kg/ha with cost benefit ratios from 1: 1.31 to 1: 1.70 at Palem and IIOR, Hyderabad.
- IPM module (application of *Btk* against early instar larvae of semilooper, monitoring *Spodoptera litura* using pheromone trap and mechanical control of gregarious stages of lepidopteran defoliators, need based application of flubendiamide against lepidopteran defoliators and profenofos against capsule borer and leafhopper) found superior in reducing the insect pest population over farmers' practice at Palem, Yethapur and IIOR, Hyderabad. Higher seed yields (1120 to 1394 kg/ha) and cost benefit ratios (1: 1.45 to 1: 1.98) were obtained from IPM module over farmers' practice (seed yields of 810 to 1101 kg/ha and cost benefit ratios of 1: 1.08 to 1: 1.58) at different locations.

Recommendations

- A high yielding and wilt resistant hybrid suitable for late *kharif* or *rabi* season GNCH-1 developed by Navasari was released for castor growing region of South and Middle Gujarat.
- In rainfed conditions of Tamil Nadu, seed treatment of castor with biophos @ 600g/kg seed + 60 kg P_2O_5 improved the seed yield (1768 kg/ha) and economic returns (B: C ratio 2.42).
- In clay loam soils under rainfed conditions of Karnataka , foliar application of 0.5% $ZnSO_4$ twice (at 50 and 90 DAS) was effective in realizing higher castor seed yield (12.3 %) with higher profitability (B: C ratio 3.4).
- Under loamy sands, GCH-7 castor hybrid in Rajasthan and DCH-177 in Haryana, adoption of 150 x 90 cm planting geometry with application of 20 kg K_2O/ha resulted in realizing higher seed yield and economic returns.

Sunflower

- Open-Pollinated Populations *viz.*, SS-1407 (1495 kg/ha) and SS-1316 (1776 kg/ha) recorded highest seed yield
- New hybrids *viz.*, PKVSH-959 (1284 kg/ha), PKVSH-960 (1264 kg/ha) at Akola; five test hybrids, SAHT-Kh-15-28, SAHT-Kh-15-07, SAHT-Kh-15-36, SAHT-Kh-15-41 & SAHT-Kh-15-21 at Raichur; six entries *viz.*, HSFH-1594 (2883 kg/ha), HSFH-1558 (2876 kg/ha), HSFH-1202 (2767 kg/ha), HSFH-1616 (2696 kg/ha) and HSFH-1549 (2637 kg/ha) at Hisar; PSH-2091 (2658 kg/ha) followed by PSH-2080 (2636 kg/ha) PSH-1962 (2570 kg/ha) and KSFH-460 (2439 kg/ha) at Ludhiana; NDSH-1012 (1904 kg/ha) and NDSH-1035 (1532 kg/ha) at Nandyal were promising in terms of seed yield.
- Under the national crossing programme, about 300 experimental hybrids were produced at Latur, Coimbatore, Bengaluru and IIOR using the promising CMS lines from the AICRP centres and those obtained from IFVCNS, Serbia. From these, 72 common hybrids were evaluated at all the 4 centres, 162 hybrids at 3 centres, and 252 hybrids at 2 centres. Multilocation evaluation indicated superiority of the hybrids, NCP44 (ARM 243A x R1-1), NCP39 (ARM243A x R-630), NCP69 (HA430A x CSFI-99), NCP70 (HA430A x P-90R) and NCP-132 (CMS 17A x EC-178170) with regard to seed yield (10-15% higher than the checks-based on 160 plants).
- Dual inoculation of *Azospirillum+Azotobacter* as seed treatment could save up to 25% of N requirement of spring sunflower under alluvial soils at Pantnagar. Individually, *Azatobacter* is promising compared to *Azospirillum* for sunflower. Seed yield of sunflower can be further increased beyond 100% N with the dual inoculation *wi*th *Azospirillum+Azotobacter* along with 100% N.
- In sunflower-chickpea cropping system in Vertisols at Nandyal, supplementation of NPK with S and micronutrient Zn and/or B to sunflower and NPK to chickpea in the system recorded higher seed yield of chickpea (1748 kg/ha) and sunflower (897 kg/ha) with high B:C ratio of 2.8. Soil N and K content was highest with 150% NPK for both crops in the system. Soil P was highest with crop residue incorporation.
- Site specific (soil test based) NPK+ S + B together with 5 t FYM/ha + crop residue incorporation with *Trichoderma viride* was found to be best for higher seed yield, profitability under potato - sunflower cropping system at Ludhiana. Significant improvement in soil fertility was recorded for the past 2-3 years with soil test based fertilizer management. Similar results were reported at Latur, Nandyal and Dholi.

- Organic manures at 5 t/ha did not significantly influence sunflower productivity in most of the centres. The present recommended spacing of 60 cm x 30 cm (55555 plants/ha) with 33% higher fertilizer dose gave higher seed yield and profitability at Nanydal, Ludhiana and Dholi.
- The integrated weed management comprising Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10EC @ 37.5 g a.i/ha at 15–20 DAS as directed post-emergence spray on weeds recorded higher seed yield. There was no phytotoxicity to either sunflower crop or succeeding blackgram as residual toxicity.
- It is estimated that sunflower production in the country during *rabi*/spring season can be increased to 6.33 lakh t from 3.09 lakh t by bridging the yield gap II (yield gap between improved technology and state average yield) with the adoption of available improved technologies in the current area under sunflower. During *kharif*, sunflower production can be increased from 1.53 lakh t to 2.34 lakh t with the complete adoption of available improved technologies with the existing area under sunflower.
- Management of charcoal rot with seed treatments with SAAF (mancozeb + carbendazim) @ 2 g/kg seed at Ludhiana
- Seed treatment with *T. viride* (0.4%) +*P. fluorescens* (0.4%) + soil application of *T. viride* @ 2.5 kg/ha for management of collar rot (Ludhiana).
- Management of powdery mildew with two sprays of Difenoconazole @ 0.05% at 45 and 60 DAS at Akola, Bengaluru, Latur, Coimbatore, Nandyal, Raichur.
- Integrated disease management of important diseases of sunflower employing seed priming with Carbendazim @ 2 g/kg + Thiamethoxam @ 4 g/kg) + foliar spray of Propiconazole @ 0.1% + Thiamethoxam @ 0.04%/ Azadirachtin @ 0.15% as soon as disease appears and 15 days later at Akola, Bengaluru, Latur, Coimbatore, Nandyal, Raichur, Ludhiana.
- In the experiment of induced systemic resistance through bioagents and fungicides for management of *Alternaria* leaf blight, (seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed followed by spray of Propiconazole @ 0.1% at 45 and *P. fluorescens* @1.0% at 60 days after sowing was found effective compared to others.
- Among 15 entries under Uniform Pest Nursery (UPN), GMU-243, 504 and 1036 were found promising against leafhopper with injury grade 1 at Hyderabad.

Recommendations

- Under clay loam soils of West Bengal, sunflower crop respond to application of 90:90:40kg $N:P_2O_5:K_2O$/ha with 48% higher yield (1774 v/s 1195kg/ha) and a B:C ratio of 1.95 v/s 1.44.
- Application of Pendimethalin @ 1.0 kg a.i/ha (Pre emergence) + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha at 15 – 20 DAS (Post emergence) effectively controls weeds and help in realizing higher sunflower yields in Vertisols of Latur and Raichur (9 to 36% higher yield with B:C ratio of 2.2 Vs 1.82).
- The IPM and BIPM modules are effective against insect pests and diseases of sunflower over the farmers' practice with a higher seed yield of 519 and 543, 1092 and 1200,1475 and 1550 kg/ha with IBCR of 1.29 and 1.80, 1.07 and 2.00, 1.44 and 2.71 in Akola, Latur and Bengaluru, respectively and can be adopted for the management of major insect pests and diseases of sunflower in Telangana, Vidharba and Marathwada region of Maharashtra and Southern zone of Karnataka.

Safflower

- GMU 4502 (EC-566009) recorded higher seed yield than checks under both rainfed (1924 kg/ha; best check A-1, 1712 kg/ha) and irrigated (1844kg/ha; best check A-1, 1724 kg/ha) situation.
- Five germplasm accessions GMU 2380, 2687, 2757, 2928, 3206 confirmed P use efficiency recording higher values at Solapur (1.35-1.57mg/g dry matter) and Tandur (0.88-0.95mg/g dry matter) than checks [A-1 (0.73-1.21mg/g drymatter) and PBNS-12 (0.71-1.12mg/g dry matter respectively].
- Three early maturing entries *viz.*, NARI-SD-38, NARI-SD-83 and RSS-2011-1-1 with 20-26 days (50% flowering) reported.
- The CMS hybrids, DSH-388 and DSH-385 developed at IIOR, Hyderabad, recorded higher mean seed yield than the checks.
- At Parbhani, four populations yielded 26.9-43.9% higher seed yield (2302-2481 kg/ha) over the check, PBNS-12 (1724 kg/ha). Akola centre has selected 12 moderately aphid resistant selections from 2nd cycle population.
- In Initial Variety Trial (IVT), SSF-1307 yielded 6.4% higher seed yield (1634 kg/ha) than the best check A-1 (1535 kg/ha). It gave 19% higher oil yield (492 kg/ha) over A-1 (414 kg/ha). The non-spiny entry, SPP-70 yielded 21.9% higher seed yield (1045 kg/ha) than the non-spiny high yielding check, NARI-6 (857 kg/ha). It yielded 7% higher oil yield (274 kg/ha) over NARI-6 (256 kg/ha) under rainfed conditions.
- The spiny entries, SSF-1350 and SSF- 1369 and spiny entry, SPP-70 with gave 4 – 36 % higher seed yield and 9 – 20 % higher oil yield than the checks
- NARI-96 in AVT-I gave 10.1% higher oil yield (520 kg/ha) than A-1 (472 kg/ha) at national level. None of the entry in AVT-I & II could yield higher than A-1 at national level.
- In IHT, under rainfed condition, three test hybrids *viz.*, DSH-263, DSH-252, DSH-256 yielded 17.8-38.6% (1436-1721 kg/ha) higher seed yield and 16-32.4% higher oil yield than check hybrid, NARI-H-23 (1242 kg/ha). Two of these hybrids namely, DSH-252 and DSH-256, gave 3.7 and 17.2% higher seed yield (1524 kg/ha and 1721 kg/ha) and 15 and 20.9% higher oil yield (439 kg/ha and 462 kg/ha) than A-1, respectively.
- Under irrigated conditions, four test hybrids *viz.*, DSH-263, DSH-253, DSH-256 and DSH-252 yielded 17.6-23.3% higher seed yield (2175-2280 kg/ha) than check hybrid, NARI-H-23 (1849 kg/ha) and 6.8-11.9% higher seed yield than A-1 (2037 kg/ha). These hybrids gave 14-17% higher oil yield (604-620 kg/ha) than A-1 (528 kg/ha) and 1.3-4% higher oil yield than NARI-H-23 (596 kg/ha).
- A total of 33.17q. of breeder seed of 5 varieties *viz*. AKS-207, PBNS-40, PBNS-12 (Parbhani kusum), S-4 (Bhima), JLSF-414 (Phule kusuma) was produced against the assigned target of 27.65q. breeder seed of 6 varieties.
- In greengram-safflower system (rainfed), application of safflower residues could save 50% NPK of greengram crop; greengram crop residues could save 50% NPK of safflower in Maharashtra (Akola).
- In soybean-safflower (irrigated), application of safflower residues along with 2.5 t FYM/ha could save 50% NPK of soybean; soybean residues along with 2.5 t FYM/ha could save 50% NPK of safflower in Maharashtra (Parbhani and Phaltan).
- Late sowing resulted in decrease of oil content at Indore (1st November to 30th

November); and at Phaltan (24th October to 2 December)

- Pre-emergence application of oxyflurofen @ 250 g a.i/ha followed by one hoeing at 25 DAS was effective in controlling weeds in rice-fallow safflower in Chhattisgarh plains.
- The average yield under whole package technology demonstrations under rainfed situation was 1043 and 915 kg/ha under IT and FP demonstrations respectively with yield enhancement of 14 per cent resulting in additional net returns of Rs.5613 per ha. The B:C ratio computed over returns was 1.28 and 0.73 respectively on IT and FP plots suggesting that for every one rupee spent, the farmer was able to realize Rs.1.28 and 0.73 additional income for the aforesaid plots.
- Germplasm accessions *viz*., GMU-6016, 6024, 6042, 6060, 6112, 6161, 6169, 6305, 6357, GMU-6487 and breeding lines DSF-5, DSF-104 and DSF-2014 recorded tolerant reaction to Alternaria leaf spot disease with less than 25% disease severity. At Solapur, NARI-P-6, GMU-5517 and GMU-5933 were moderately resistant to wilt. At Tandur, entries *viz.*, NARI-P3, NARI-P5, NARI-P6, NARI-P8, DSI-103 and DSI-118 were free from wilt and the entries *viz.*, NARI-P2, NARI-P7, DSI-116, SSF-GMU-4912, SSF-1374, A-134-7-10, GMU 5761 and TSF-1 were moderately resistant.
- Fusaric acid (Solapur, Parbhani), seed soaking method (IIOR) and soil cup method (Tandur) were able to differentiate resistant and susceptible genotypes to wilt.
- For effective and economical management of Phytophthora damping-off and seedling blight of safflower and getting higher seed yield, it is recommended to treat the safflower seed before sowing with cymoxanil 8% + mancozeb 64% @ 2 g/kg or captan 50% WP @ 3 g/kg or *Trichoderma harzianum* Th4d SC @ 1 ml/kg.
- For effective and economical management of the seed/soil borne diseases of safflower like Alternaria leaf spot, Fusarium wilt and Phytophthora damping-off and seedling blight and getting higher seed yield, it is recommended to treat the safflower seed before sowing with cymoxanil 8% + mancozeb 64% @ 2 g/kg or carbendazim 12% + mancozeb 63% @ 2 g/kg or *Trichoderma harzianum* Th4d SC @ 2 ml/kg or captan 50 WP @ 3 g/kg.
- Aphid, *Uroleucon compositae* was the major insect pest in safflower growing areas. Incidence of minor pests like safflower caterpillar and *Helicoverpa armigera* was low. Natural occurrence of predators and parasites was low.
- Under multi-location testing, GMU 2020 (EC-210554), GMU 1628 (EC- 181958), SAF- 1335 and SAF- 1356 were found resistant at all the 3 locations (Akola, Solapur and IIOR, Hyderabad). The entries which were found resistant in previous year (2013-14) have been evaluated for confirmation of resistance at 3 locations. SAF1224, EC-523368-2 and SAF-11-13 were confirmed resistant.
- Insecticides that were found consistently effective in previous years against safflower were validated in farmers field near Solapur. The insecticides clothianidin 50WDG @ 50 g/ha and [chlorpyriphos+cypermethrin]55EC @ 1000ml/ha were found very effective against aphids and resulted in increase of seed yield (1575 and 1500 kg/ha respectively)
- Validation of method,comprising soil application of phorate 10G @ 10 kg/ha and foliar sprays of chlorpyriphos 20EC@ 2.5ml/l was undertaken at farmer's field at Akola. The treatment was found very effective by increasing plant stand and reducing plant damage and resulted in increased seed yield (664kg/ha).

Recommendations

- Release and notification of safflower variety, NARI-57 for the states of Maharashtra, Karnataka, Madhya Pradesh, Rajasthan, UP, Punjab, Jharkhand, West Bengal
- Increasing N to 40 kg/ha from 25 kg/ha and retaining P at 25 kg P_2O_5/ha helps in realizing higher seed yield in Vidarbha zone of Maharashtra
- Foliar spray of clothianidin 50WDG @ 50g/ha or [chlorpyriphos 50 % + cypermethrin 5 %] 55 EC @ 1000 ml/ha effectively suppresses aphid population with higher IBC ratio.
- Soil application of phorate 10G @10 kg/ha at the time of sowing followed by foliar spray of chlorpyriphos 20EC @ 2.5ml/l to maintains plant stand and reduces plant damage by Gujia weevil resulting in higher seed yield with IBC ratio in Vidharbha region of Maharashtra.

IIOR

वार्षिक प्रतिवेदन

Annual Report
2015-16

Institutional Activities

- Extension and other Activities
- Education and Training
- Awards and Recognitions
- On-going Research Projects
- Meetings and Events
- Human Resource Development
- Hindi Activities
- Publications
- Infrastructure Development
- Visitors
- Promotions / Upgradations / Transfers / Superannuations
- Personnel
- Results Framework Document

EXTENSION AND OTHER ACTIVITIES

Tribal Sub-Plan

Tribal sub-plan programme was implemented in 55 villages of 12 districts spanning over 8 states (Andhra Pradesh - 11 villages of Prakasam and Ananthapur; Rajasthan - 2 villages of Serohi; Karnataka - 2 villages of Chitradurga; Tamil Nadu - 2 villages of Salem; Telangana – 3 villages of Ranga Reddy and Nalgonda; West Bengal – 6 villages of Paschim Medinipur and Purulia and Chattisgarh – 7 villages of Rajnandijaon) with the objective of reducing poverty among the schedule tribe population and creation of productive assets for them. Under this programme, 619 Schedule Tribe farmers were benefitted through demonstrations of latest released varieties/hybrids of castor, sunflower and safflower along with improved technologies conducted in association with NGOs such as, Viksit Rythu Sankshema Samstha (VRSS) and Agri-Biotech Foundation (ABF) and AICRP centres such as Nimpith, Yethapur, Hiryur, Mandor, Raipur, Navasari and Tandur. The farmers of these villages were growing crops such as green gram, maize, sorghum, millets, lucerne, tapioca, groundnut, chickpea and vegetables. These farmers were trained about the improved cultural practices to cultivate these crops. The farmers were given all the inputs such as seed, fertilizer and pesticides. Periodically, visited the fields were monitored by the scientists concerned. The farmers were also given different agricultural implements *viz.*, power sprayer, knap sack sprayer, tarpaulin, secateurs, castor shellers, plough planter, weeder and delivery pipe for irrigation. In West Bengal the tribal farmers got the access to use sunflower oil for edible purpose.

Productivity potential and economics of demonstrations conducted under TSP by IIOR

No. of demos	Yield (kg/ha)		% In-crease	Cost of cultiva-tion (Rs/ha)		GMR (Rs./ha)		ANR (Rs/ha)	BCR	
	IT	FP		IT	FP	IT	FP		IT	FP
57*	958	758	28	8439	7705	33542	26526	6540	4.0	3.5
26**	764	605	27	8229	7427	26724	21182	4740	3.3	2.8
83	897	710	26	8373	7618	31406	24852	5799	3.7	3.3

*Prakasam,**Mahabubnagar, IT=Improved technology, FP= farmers practice, CoC = cost of cultivation; GMR = Gross monetary returns; ANR= Additional net returns

Mera Goan Mera Gaurav (MGMG)

Mera Goan Mera Gaurav programme as launched by the Honorable Prime Minister of India was initiated with objective of, to identify a village and strengthen interface with farmers, periodically update farmers about agricultural activities through phone and mobile messages, provide technology handout as per the agro-ecological conditions of the village, provide information to farmers about agricultural inputs, seed, fertilizer, chemical, agricultural machinery, climate, market, etc, educate farmers through newspapers, community radio, etc, create awareness among farmers about the programmes being implemented by various organizations and institutions working at local level e.g. voluntary organizations, farmers' organisation, ATMA, other Govt.

departments, make farmers aware of the sensitive issues of national importance such as: Swachh Bharat Abhiyaan, climate change, water conservation, soil fertility, etc, organise farmer's meet by visiting the selected villages as per need and facilitate the participation of specialists of the concerned institutes, identify technical problems at village level and make use of those in prospective research programmes and generate technical, social and economic data related to a village and to submit quarterly report of work done.

Ten teams were formed and each team selected 5 villages in Ranga Reddy, Mahabubnagar, Medak and Nalgonda districts of Telangana.The following are the activities under this programme

- Collection of Farmers' data base, studied cropping pattern for technical planning to improve production
- Encouraged farmers in adopting improved technologies of the crops grown by them and use of micro-irrigation
- Associated with state Departments such as Agriculture, Horticulture, Animal Husbandry, Forestry, Revenue, ICAR Institutes such as IIMR, IIRR, DPR and PJTSAU etc. for implementing technologies as well as other government programmes
- Explained the farmers to grow oilseed crops like castor, sesame, safflower, sunflower, groundnut, soybean and mustard; horticultural crops
- Organization of field days for bringing awareness among the farmers
- Conduction of field demonstrations for adoption of new technologies
- Dissemination of mobile based crop wise information from time to time to the selected farmers
- Trained the farmers on seed production activities
- Organized time to time interface meeting with the farmers to solve the field problems

Radio Talk

Scientist	**Topic**	**Date of broadcast**
Dr. M. Padmaiah	Drought effect on oilseed crops	July 19, 2015
Dr. Satish Kumar, G.D.	*Kharif prodduthirugudu panta lo adhika digubadi saadhincha taaniki melakuvalu*	July 24, 2015
Dr. I.Y.L.N. Murthy	Importance of zinc in oilseeds	September 7, 2015

Television Programme

Scientist	**Topic**	**Date of broadcast**
Dr. M. Padmaiah	Farmers day a way for outreach of technologies of oilseeds	September 14, 2015

EDUCATION AND TRAINING

Details of students working for Ph.D. (2015-16)

Name of the student	Title of thesis	Discipline	University
	Major advisor: **Dr. M. Sujatha**		
M.Tarakeswari d	Development of transgenic castor for resistance to lepidopteran pests through deployment of *Cry1 AabcF* gene	Genetics	OU, Hyderabad
Vasavi Singa Reddy	Development of tissue culture and transformation protocols in sunflower for SND resistance	Genetics	OU, Hyderabad
K. Prathap Reddy	Mapping gene(s) for male fertility restoration (ARG cytoplasm) and resistance to powdery mildew (*Golovinomyces cichoracearum*) in sunflower (*Helianthus annuus* L.)	Plant Sciences	UoH, Hyderabad
D. Sandeep Kumar	Tissue culture studies and genetic transformation in castor (*Ricinus communis* L.) by deploying *Cry1 Aabc* gene for resistance to lepidopteran pests	Genetics	OU, Hyderabad
	Major advisor: **Dr. V. Dinesh Kumar**		
B. Madhu	Development of transgenic fertility restorer lines in safflower (*Carthamus tinctorius* L.).	Plant Sciences	UoH, Hyderabad
S. Velu Mani	Assessment of viral vectors for expression of gene cassettes for possible applications in castor	Plant Sciences	UoH, Hyderabad
Ch. Anil Kumar	Genetic transformation of safflower (*Carthamus tinctorius* L.) and *Arabidopsis* for increased oil content	Genetics	OU, Hyderabad
G.Lakshmidevi	Strategies to develop transgenic castor (*Ricinus communis* L.) tolerant to necrotropic fungi	Bio-technology	ANGRAU,Hyderabad
	Major Advisor: **Dr. P. S. Vimala Devi**		
V. Vineela	Development, characterization and evaluation of nanocarrier embedded toxin of *Bacillus thuringiensis* var. *kurstaki* for management of insect pest	Micro-biology	OU, Hyderabad
	Major Advisor: **Dr. R.D. Prasad**		
T.Navaneetha	Development of suitable formulations of potential bioagents for management of important diseases in castor,sunflower & safflower	Micro-biology	OU, Hyderabad
P. Sowmya	Study of molecular mechanisms involved in high temperature stress tolerance in *Trichoderma* species	Bio-technology	JNTU, Hyderabad
	Major Advisor: **Dr. M. Santha Lakshmi Prasad**		
K. Sujatha	Study of resistance mechanism and manage-ment of *Alternaria* leaf blight in sunflower	Genetics	OU, Hyderabad
D. Usha	Variation in fungicide sensitivity, toxin production in *Alternaria helianthi* isolates and studies on induced systemic resistance in sunflower against leaf blight	Micro-biology	OU, Hyderabad
N. Naresh	Diversity analysis of *Alternaria* leaf blight in sunflower based on morphological, pathogenic and molecular characters	Bio-technology	JNTU, Hyderabad
E. Bharathi	Variability in pathogen population of castor wilt fungus and its management	Micro-biology	OU, Hyderabad
	Major advisor: **Dr. S. Senthilvel**		
J. Poornima Kumari	Genetic and molecular analysis of nematode resistance in castor (*Ricinus communis* L.)	Genetics	OU, Hyderabad
Ranjan Kumar Shaw	Genetic and molecular analysis of Fusarium wilt resistance in castor (*Ricinus communis* L.)	Genetics	OU, Hyderabad

Training Programmes Organized

- Two training programmes *viz*., (1) Model Training Course on Seed Production in Oilseed Crops from January 21-28, 2015 for 17 participants and (2) Model Training Course on Good Management Practices for Increasing Profitability and Resource Use Efficiency in Oilseed Crops from October 27 to November 3, 2015 for 20 participants.
- Field day-cum-training programmes on Castor hybrid seed production at Shantinagar, Mahbubnagar district of Telangana on February 10, 2016 and on 24/03/2016 at Anantapur for castor farmers.
- Field day-cum training on Seed production on 22/03/2016 at Narkhoda Research farm, IIOR, Hyderabad for farmers of Telangana State.

Germplasm-cum-Breeders Day Organized

- Castor germplasm- cum- breeders day at Narkhoda farm on 15/12/15 to 16/12/15 which was attended by the castor breeders of AICRP Castor centers.
- Sunflower germplasm- cum- breeders day organized on January, 28-29, 2016 at IIOR-ICRISAT Farm. Fourteen breeders of different AICRP centres participated and observed the variability among the trait specific germplasm accessions raised from material conserved at IIOR, Hyderabad and NBPGR, New Delhi, and the breeding lines received during the year from USDA ARS, USA. The breeders have selected 550 accessions for utilization in breeding.
- Safflower germplasm-cum-breeders day organized on February 12, 2016 at IIOR-ICRISAT Farm. 12 safflower breeders of AICRP (Safflower) centres and 4 scientists from NBPGR, New Delhi and NBPGR Regional Station, Hyderabad attended the programme. They observed the variability among the germplasm accessions raised from material conserved at IIOR, Hyderabad as well as 1400 accessions received from National Gene Bank, NBPGR, New Delhi and selected promising trait specific accessions for utilization in breeding. Participants also visited the plots where parental lines, hybrids and other trait specific breeding material are evaluated.

Field and Farmer's Day Organized

- Sesame field day at Vemsoor, Khammam district of Telengana on 28-01-2016.
- Field day and farmer Interaction meeting at ICRISAT research farm on 09th February, 2016 under Mera Gaon Mera Gaurav programme.
- Participated in Farmers' Day at University of Agriculture and Horticulture, Shivamogga, Karnataka on October 3-6, 2015.
- More than 2500 farmers of Telangana, Andhra Pradesh, West Bengal, Karnataka and Maharashtra visited the fields where latest hybrids/varieties of mandate crops and improved technologies were demonstrated on IIOR Farmers' Day at Rajendrangar farm, Hyderabad on 12th September, 2015

AWARDS AND RECOGNITIONS

Best Worker Award

The Best Worker Award in different categories of IIOR staff were awarded to the following staff on the occasion of IIOR Foundation Day held on August 1, 2015.

Name/Designation	Category
Dr.V.Dinesh Kumar	Best Research Paper
Sri D.Mallesha	Technical
Sri G.Chandraiah	Administration
Sri Narsimha	Skilled Supporting Service
Smt. A.Lalitha	Temporary status labour, Narkhoda Farm
Smt. B.Suvarna	Temporary status labour, Narkhoda Farm
Sri M.Kistaiah	Temporary status labour, Rajendranagar Farm

Other Awards

- Dr P. Kadirvel received the Best Oral Presentation award as co-author for the paper entitled "Evaluation of parental lines of castor hybrids for resistance to leafhopper, *Empoasca flavescens*, in the National Seminar on Breeding of field crops for biotic and abiotic stresses in relation to climate change during 28-29th March, 2016 held at College of Agriculture, VNMKV, Parbhani (M.S.), India.
- Dr. P. Kadirvel received the Best Research Paper award for the paper titled "Relationship of seed physical, physiological and biochemical traits with oil content in safflower (*Carthamus tinctorious* L.)" in 8th National Seed Congress organized by Department of Agriculture and Cooperation, Government of India and Telangana at Hyderabad during 27-29 October 2015
- Dr. P. Kadirvel received the Best Research Paper award for the paper titled "Marker-assisted breeding for improvement of high oleic acid content in safflower" in International Symposium on Biodiversity, agriculture, environment and forestry organized by Association for the Advancement of Biodiversity Science at Ooty, Tamil Nadu during 11-12 December 2015.
- Dr. Mangesh Y. Dudhe received the Young Scientist Award by Society for Scientific Development in Agriculture and Technology in the National Conference on Global research initiatives for sustainable agriculture & allied sciences (GRISAAS-2015) during December 12–13, 2015 held at RVSKVV, Gwalior (M.P.)
- Dr. P. Duraimurugan received Achiever Award -2015 by the Society for Advancement of Human and Nature, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh, India.

- Dr. P. Duraimurugan received Best Oral Presentation Award for the research paper entitled "Evaluation of parental lines of castor hybrids for resistance to leafhopper, *Empoasca flavescens* in the National Seminar on 'Breeding of field crops for biotic and abiotic stresses in relation to climate change' organized by the Indian Society of Genetics and Plant Breeding, IARI, New Delhi on 28 to 29 March, 2016 at VNMKV, Parbhani.

- Dr. P. Duraimurugan received Certificate of Excellence in Reviewing for the meticulous contribution in peer reviewing the manuscripts by the Indian Journal of Plant Protection, Plant Protection Association of India, Hyderabad.

Recognitions

- Dr. K. Anjani was invited to present a lead lecture on "Breeding strategies to address negative effects of climate change on production of oilseed crops" during National Seminar on "Breeding of field crops for biotic and abiotic stress in relation to climate change" held at College of Agriculture, VNMKV, Parbhani from 28-29 March 2016.
- Dr. M. Sujatha as a member of the scientific committee constituted for the 19th International Sunflower Conference for reviewing the articles.
- Dr. M. Sujatha as a Board Member of International Sunflower Association for the year 2015.
- Dr. M. Sujatha as an IBSC External Expert for Amar Biotech Limited, Hyderabad from 2015.
- Dr. M. Sujatha as a Member of Accreditation Committee of the National Certification System of Tissue Culture raised plants (NCS-TCP) of DBT/BCIL.
- Dr.H.P.Meena as Editor of the Journal of Plant Science and Research and Journal of Oilseeds Research.
- Dr. G.D. Satish Kumar as a Member of the Jury Panel of the Mahindra Samriddhi Indian Agri Awards 2016 for 3rd stage screening of the farmer nominations from Andhra Pradesh and Telangana.
- Dr. G.D. Satish Kumar as an Editor of Food Agriculture and Environment (JFAE), WFL Publishers, Finland.

ON-GOING RESEARCH PROJECTS

Institute Projects

Project code	Project title	Project leader
101-4	Development of sunflower hybrids suited to different growing situations	Dr. H.P.Meena
101-5	Development of trait specific inbreds and parental lines in sunflower (*helianthus annuus* l.*)*	Dr. M. Sujatha
102-6	Improvement of oil content in safflower	Dr. P. Kadirvel
102-7	Development of trait specific germplasm sets of safflower for enhanced utilization	Dr. N. Mukta
102-8	Improving seed and oil yields and wilt resistance in safflower through hybrid development	Dr. K. Anjani
102-9	Allele mining for oil content in safflower	Mrs. Betha Usha Kiran
103-10	Identification of molecular markers associated with disease resistance in castor	Dr. Senthilvel Senapathy
103-11	Elucidating the molecular mechanisms governing sex expression in castor	Dr. Sujatha, T.P
103-12	Developing trait-specific inbred lines from castor primary genepool	Dr. K. Anjani
103-13	Development of high oil yielding castor hybrids resistant to fusarium wilt, leaf hopper and drought	Dr.C.Lavanya
104-8	Studies on phosphorus acquisition in sunflower genotypes	Dr. Md. A. Aziz Qureshi
104-11	Enhancing resource use efficiency in castor based cropping systems	Dr. G. Suresh
104-12	Agronomic interventions for increasing productivity and resource use efficiency of cropping systems involving sunflower	Dr.S.N.Sudhakara Babu
104-13	Soil moisture resilient technologies for sustainable productivity of safflower	Dr. P. Padmavathi
105-10	Development of semio-chemical based monitoring and management methods against major insect pests of castor	Dr. P. Duraimurugan
105-11	Development of water dispersible granular (wdc) formulation of *bacillus thuringiensis var. Kurstaki* for management of *spodoptera lithura*	Dr. P.S. Vimala Devi
105-12	Studies on host pathogen interaction in castor wilt complex, variability in *f.oxysporum* f.sp.*ricini* and disease management	Dr. M. Santha Lakshmi Prasad
105-13	Genetic, physiological and biochemical analysis of host-plant resistance for the management of aphids in safflower	Dr. Satya Srinivas Pothukuchi
106-1	Biochemical characterization of sunflower, safflower and castor for potential value addition	Dr. Praduman
107-7	Development of pedigree information system for mandate crops	Dr. K. Alivelu
107-14	*In-silico* mining of castor draft genome	Dr. Ch. Sarada
107-16	ICT mediated knowledge dissemination on castor and sunflower in Andhra Pradesh and Telangana	Ms. Paladugu Madhuri
108-1	Development of stable cytoplasmic genetic male sterile system in Sesame through wide hybridization	Dr. Jawahar Lal Jatothu

Externally Funded Projects

Sponsor	**Project title**	**Principal Investigator**	**Budget (2015-16) (` in lakhs)**
ICAR-NPTC	Development of transgenic castor for resistance to lepidopteran pests	Dr. M. Sujatha	10.13
AMAAS	Development of practicable technologies for field level exploitation of consortia of microbial agents as ameliorators of biotic and abiotic stresses in crops	Dr. R.D. Prasad	8.66

AMAAS	Mass Production of *Bacillus Thuringiensis* (Bt) and *Beauveria Bassiana*, Formulation as Oil Based Suspension Concentrates Singly and in Combination and field Evaluation	Dr.P.S.Vimala Devi	9.96
ICAR Network Project	*Phytophthora, Fusarium* and *Ralstonia* diseases of horticulture and agricultural crops	Dr. R.D. Prasad	6.00
ICAR plan	Seed production in agricultural crop	Dr M. Lakshminarayana	
National Fund	Deciphering the molecular mechanism of induction of biotic stress tolerance induced by *Trichoderma* spp. in castor (*Ricinus communis* L.) Collaborating institutes: DOR and UoH, Hyderabad	Dr. V. Dinesh Kumar, DOR Dr. R. Makandar, UoH	29.87
DBT	Discovery of genome-wide SNPs and its use in developing a reference linkage map and association analysis in castor	Dr. Senthilvel Senapathy DOR Dr.Sanjay K. Shahi, Xcelris Genomics Ltd.,	33.00
DST	Crop management options to make safflower cultivation profitable for small farmers through enhanced utilization of petals	Dr.P.Padmavathi	4.68
DST	Molecular tagging and mapping of powdery mildew resistance in sunflower (*Helianthus annuus* L.)	Dr.M.Sujatha	10.00
Central Sector Project	Protection of Plant Varieties and Farmers Rights Authority	Dr. N. Mukta	8.00
NMOOP, DAC	Frontline demonstration on oilseed crops	Dr.G.D.Satish Kumar	150.00
TMC, DAC	EKAPAS Network and technology dissemination	Dr.G.D.Satish Kumar	2.94
NMOOP, DAC	Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer	Dr.G.D.Satish Kumar	18.66
MARICO	Developing high oleic safflower genotypes for Indian conditions development of protocols for market assisted selections for high oleic traits in safflower	Dr.K.Anjani Dr.P.Kadirvel	20.00

MEETINGS AND EVENTS

Annual Group Meeting on Sunflower, Sesame and Niger, 2015

The Annual Group Meeting on Sunflower, Sesame and Niger was held at Odisha University of Agriculture and Technology, Bhubaneshwar during 16-18 April, 2015 to review the results of research conducted during 2014-15 and formulate the strategies to increase the production and productivity of sunflower for the year 2015-16. The introductory session was chaired by Prof. Manoranjan Kar, Hon'ble VC, OUAT, Bhubaneshwar and the other dignitaries who shared the dais were Dr. S.S. Nanda, Dean of Research, OUAT, Bhubaneshwar, Dr. B.B. Singh, ADG (OP), ICAR, New Delhi and Dr. K.S. Varaprasad, Director, IIOR. Dr. Nanda welcomed the gathering and informed the house about the significant contributions of the University and evinced keen interest to support sunflower cultivation in Odisha. Accordingly, three new voluntary centres under OUAT have been identified for undertaking coordinated trials and FLDs in Odisha. Dr. Varaprasad presented the research highlights of AICRP sunflower for the year 2014-15. He presented the new initiatives undertaken during the year with regard to the widening of the genetic base using diploid annual *Helianthus* species and also procurement of 282 accessions including new CMS and R lines from USA, and characterization of germplasm at 2 centres (Bengaluru and Latur) as a prelude for development of an Indian core set, He also informed that West Bengal, Odisha and Bihar are the potential areas under rice fallow situation for expansion of sunflower with minimum resource utilization. Dr. B.B. Singh opined that improved varieties and agro-production technologies capable of increasing the productivity levels in sesame and niger be developed for different agro-ecological situations besides, meeting the standards for export purpose. He had advised the participants to tap the resources from DAC for intensification of the seed production activities and for upscaling the technologies. While high seed yield and oil content remains the priority in sesame, concerted efforts are required for development of photoinsensitive varieties and in heterosis exploitation programmes. Dr. Kar expressed concern over the shrinking natural resources, burgeoning population and climate change. He emphasized the need for development of a strategic plan for development of better ideotypes with all desirable traits, genotypes responsive to inputs, chemicals including organic fertilizers, abiotic stress responsive genotypes, climate resilient agriculture, short duration varieties for effective utilization of available nutrients and speciality (high oleic, high linoleic) cultivars.

Annual Group Meeting on Castor, 2015

The Annual Group Meeting of Castor was held at Davanagere, hosted by UAHS, Shivamogga during 14-16 May, 2015 to review the results of research conducted under AICRP (Castor) during 2014-15 and formulate the strategies to increase the production and productivity of castor for 2015-16. The Introductory session of the group meeting was chaired by Dr. P. Narayana Swamy, Director of Research, UAHS, Shivamogga and Dr. T.H. Gowda, Director of Extension, UAHS was the Chief Guest. Dr. Chandrappa, Associate Director of Research, ZAHRS, Hiriyur welcomed the dignitaries and participants. Dr. K.S. Varaprasad, Director, IIOR presented the overview of research achievements made during 2014-15. He advised the participants to formulate time bound action plans for the activities envisaged and submitted to PMO which are: enhancement of national productivity to 1850 kg/ha; production to 2.20 m.tonnes with an area enhancement upto 4 lakh ha and reduction of duration to 90-100 days with ideal plant type suitable for mechanical harvest. It was followed by release of publications brought out by ZAHRS, Hiriyur. Dr. Gowda in his Chief Guest address informed the castor workers to explore the possibilities of castor area expansion in particular under the jurisdiction of UAHS, Shivamogga. He advised to make the strategic plan to grow castor as intercrop with groundnut, castor under residual moisture after paddy in Malnadu area of Karnataka and after maize in place of redgram. Dr. Narayana Swamy in his Chairman's remarks opined that there is scope for expansion of castor area in Karnataka. He said that there is a need to identify gaps between the cultural practices followed by farmers and the improved technologies emanated from the research programmes.

Institute Research Committee

IRC meeting was held from 5-8 June, 6-7 July and 28-29 September, 2015 under the chairmanship of Dr. K.S. Varaprasad, Director, IIOR. Results of the 39 Institute projects were reviewed and technical programme for 2015-16 were finalized

ICAR- IIOR Foundation Day Celebrations

IIOR Foundation Day was observed on 1st August 2015. The Foundation Day Lecture on "Science in human well-being" was delivered by Dr. S. Chandrasekhar, Director, CSIR-IICT, Hyderabad. Dr. D. Rama Rao, Director, NAARM presided the function and Dr. D. Rama Rao, Director, NAARM, Hyderabad was the Guest of Honour. In this celebrations, the staff of IIOR belonging to different category were awarded based on their contribution to the Institute. This function was attended by staff, students, RAs, SRFs of IIOR and dignitaries from other local organizations. In the afternoon, a lecture on Yoga and meditation by an expert from Kasturiba Nature Cure Hospital, Shivrampally, Hyderabad was delivered.

Annual Group Meeting on Safflower and Linseed, 2015

The Annual Group Meeting of Safflower was held at College of Agriculture, RVSKVV, Indore during August 27-29, 2015 to review the results of research conducted under AICRP (safflower) during 2014-15 and formulate the strategies to increase the its production and productivity in 2015-16. The meeting was attended by the Scientists working under AICRP (Safflower), officials of central and State Department of Agriculture, Public and Private Seed Entrepreneurs and host University. The introductory session was chaired by Dr. A.K. Singh, Hon'ble Vice-Chancellor,. RVSKVV, Gwalior. The other dignitaries included Dr. B.B. Singh, ADG (OP), ICAR, Dr. K.S. Varaprasad, Director, IIOR, Hyderabad.The session commenced with the welcome address by Dr. H.S. Yadav, Director of Research, RVSKVV, Gwalior. This was followed by the presentation of Research Highlights of Castor by Dr. K.S. Varaprasad, Director, IIOR, Hyderabad. The Chaiman, in his presidential address narrated the diversified uses of safflower and linseed. Under changing climate conditions, safflower and linseed are the ideal climate resilient crops. He suggested the researchers to rethink on strategies to improve oilseed production on a sustainable basis. He stressed upon value addition, processing and marketing as an important strategy to be followed. Dr. B.B. Singh, ADG, (OP), ICAR, advised the research workers to formulate the strategy as per PMO direction to improve the oilseed and pulse production in the country. He stressed that expansion of areas and arrangement of quality seed is essential for this purpose.

Institute Management Committee

The 37th to 38th meetings of the Institute Management Committee were held on October 31, 2015 and February 11, 2016, respectively under the Chairmanship of Dr. K.S. Varaprasad, Director, IIOR. The Chairman welcomed the Management Committee Members and presented the research achievement of the Institute in the both the meetings. The Member Secretary apprised the committee about the action taken report on the proceedings of the preceding IMC meeting. The committee appreciated the work being carried out at the Institute. The revenue generated and expenditure incurred in each quarter was also presented to the committee.

Vigilance Awareness Week observed at IIOR during October 26-31, 2015

As per the instructions of the Central Vigilance Officer, ICAR, New Delhi vide letter F.No. 42-1/2014-Vig-I dated 22 Sept 2015, Vigilance Awareness Week for the year 2015 was observed at IIOR, Hyderabad during October 26-31, 2015. Vigilance Pledge in Hindi and English was administered on October 26, 2015. Relevant to the theme, on October 29, 2015, a talk on "Preventive Vigilance as Tool of Good Governance" was delivered by Dr. K.S. Varaprasad, Director, IIOR for the benefit of the staff of IIOR. The Banners made in bi-lingual, was displayed at the main office throughout the week. During the occasion of observance of Vigilance Awareness Week, posters of slogans against corruption were displayed at different places in the campus. Besides, a permanent notice regarding the complaints on vigilance matters was prominently displayed in the Annexe (administrative) building to draw the attention of everyone at IIOR.

A Talk on "Preventive Vigilance as Tool of Good Governance" by Dr K.S. Varaprasad, Director, IIOR

Research Advisory Committee

The 29th RAC meeting was held during October 30- 31, 2015 at IIOR, Hyderabad under the Chairmanship of Padmasri Dr. E.A. Siddiq, Hon. Chair Professor, Biotechnology, ANGRAU & former DDG (CS), ICAR. Dr. V. Muralidharan, Retd. Professor, TNAU, Coimbatore, Tamil Nadu; Dr. D. G.T. Gujar, Former Prof. & Head, Deptt. of Entomology, Pusa, IARI, New Delhi; Dr. H.S. Sen, Former Director, CRIJAF, Kolkatta; Dr. R.B.N. Prasad, Chief Scientist & Head (LST), IICT, Hyderabad; Dr. M.N. Reddy, Former-Director, MANAGE, Hyderabad; Members were present. Dr. K.S. Varaprasad, Director, IIOR welcomed the Chairman and Members of RAC and presented the highlights of IIOR activities for the year, 2015-16. It was followed by the presentation on Action Taken Report on the recommendations of 28th RAC meeting by Dr.G.Suresh, Member Secretary, RAC. The designated scientists of this Institute made presentation on Research highlights pertaining to their discipline. On October 31, the committee visited the experimental farms at Narkhoda and Rajendranagar farms. The two day meeting of the Research Advisory Committee reviewed the status of research progress and strategies in the mandated oilseed crops of the Institute and made recommendations.

HUMAN RESOURCE DEVELOPMENT

National Trainings

Name	Training Programme	Venue	Date
BV Noble Shoukat Ali S Narasimha B Ashok V Sambasiva rao	Competency enhancement programme for technical officers (CEP)	NAARM	May 13-22, 2015; October 6-15, 2015 and March 1-10, 2016
M. Sujatha H.H. Kumaraswamy	Training of Institute biosafety officers	BCIL, New Delhi	May 27-28, 2015; September 28, 2015 and February 18, 2016
Shri A. Prem Kumar, Shri P.R.Varaprasad Rao Shri G. Laxman Murthy	Payroll module of MIS/FMS	IASRI, New Delhi	May 28-30, 2015
Dr.M. Sujatha	Stress management	NAARM, Hyderabad	June 16-19, 2015
Shri A. Prem Kumar Shri E.V.R.K.N. Prasad Shri G. Rakesh	Project budget,stores & assets and annual accounts under MIS/FMS	IASRI, New Delhi	July 13-15, 2015
Shri V. Sambasiva Rao	Capacity building in Agriculture library professionals in NARS	PJTSAU, Hyderabad	July 22-31, 2015
H.H. Kumaraswamy	Analysis of experimental data	NAARM, Hyderabad	August 17-22, 2015
S.V Ramana Rao	Value chain agriculture development and public policy: Qualitative and quantitative approaches	IPFRI, New Delhi	August 24-30, 2015
C Sarada Pushpa HD	Current trends on Bio informatics in agriculture	NAARM, Hyderabad	September 22-24, 2015
HH Kumaraswamy	Genomics and Phenomics Assisted Crop Breeding: Principles and practices	IARI, New Delhi	November 18 to December 8, 2015
P S Srinivas	Regional Plant health ssystems	NIPHM, Hyderabad	November 23 to December 7, 2015
N Mukta C. Lavanya	MDP on Leadership development	NAARM, Hyderabad	November 30 to December 11, 2015
P Padmavati	Managing innovation and technology for competitiveness	ASCI Hyderabad	January 4-15, 2016
Usha kiran	Computational Tools and Techniques for Molecular Data Analysis in Agriculture	IASRI New Delhi	February 11 to March 2, 2016
Dr. Mangesh Y. Dudhe	Recent advance in statistical genetics and genomics	Agricultural Education Division, ICAR, New Delhi	March 04-24, 2016
J Narasimha P Mary Shoukat Ali M Ramulu P Ashok BV Noble Saida Reddy N Vasanth GY Prabhakar Ch Anjaiah	Refresher cum skill enhancement programme for technical staff (RSEP)	IIOR	March 11-29, 2016

Physical targets and achievements (2015-16)

Category	Total No. of Employees	No. of trainings planned	No. of employees undergone training during			% realization of trainings planned during 2015-16
			April-September 2015	Oct. 2015 - March 2016	April 2015 - March 2016	
Scientist	43	13	6	8	14	107.7
Technical*	44	6	4	11	15	250.0
Administrative & Finance	23	10	5	0	5	50
SSS	23	0	0	0	0	0

*In house training of technical staff increased the realisation in case of technical staff

Financial targets and achievements (All employees)

Total HRD allocation as per RE 2014-15	Actual Expenditure 2014-15 for HRD	% Utilization	RE 2015-16 for HRD			Actual Expenditure 2015-16 for HRD
			Plan	Non plan	Total	
(Lakh Rs.)	(Lakh Rs.)	2014-15	(Lakh Rs.)			(Lakh Rs.)
1.57	1.57	100	4.91	0	4.91	4.91

A Session of spraying equipment

A Session on micro irrigation

Valedictory funtion

Group photo

Participation in National Conference/Seminars/Symposium/ Workshops/Meetings

Name	Programme	Venue	Date
Dr. S.V. Ramana Rao Dr.S.N. SudhakaraBabu	ISOR Seminar – 2015	DRMR, Bharatpur	February 19-21, 2015
Dr. M. Sujatha	Workshop on Dossier preparation for Genetically Engineered Plants	DBT and BCIL at NASC, New Delhi.	February 25, 2015
Dr. M. Padmaiah	Brain storming session for assessing the convergence conditions as perceived by the team members of KVK, University and others	NAARM, Hyderabad	April 15, 2015
Dr.K.S. Varaprasad	Symposium on Dynamics of Crop Protection : Challenges in Agril.-Horticultural Ecosystems Facing Climate Change	MPAU&T, Udaipur	April 23-25, 2015
Dr. M. Sujatha	Workshop on Application of RNAi in Crop Improvement	New Delhi	May 5, 2015
Dr. M. Padmaiah	Meeting on working committee interacted on the various technologies for on-farm trials by the KVK	KVK, CRIDA, Hyderabad	May 25, 2015
Dr. V. Ramana Rao	"Governance of Global Food Systems: Lessons from Millennium Development Goals for Achieving Sustainable Development Goals"	Centre for Good Governance Road Jubilee Hills, MCR HRD campus, Hyderabad	May 30, 2015
Dr. V. Dinesh Kumar	MoEF workshop on Biosafety issues and Monitoring of Confined Field Trials of Regulated GE Plants	ICAR-NAARM, Hyderabad	June 3-4, 2015
Dr. P. Duraimurugan	Workshop on Post harvest pests in peanuts	NIPHM, Hyderabad	June 5, 2015
Dr. N. Mukta	Take it to the Farmer- The Farmers' Rights through Awareness'	NASC Complex, New Delhi	July 7, 2015
Dr. Ch. Sarada Dr. G.D. Satish Kumar Dr K. Alivelu Mrs P. Madhuri Dr. V. Ramana Rao	Group discussion on Digital and Sensor Based Agriculture	ICAR-IIOR, Hyderabad	July 31, 2015
Dr. P. S. Vimala Devi	Meeting of the Expert Committee for considering the issues related to moisture, pH, delta endotoxin contents (Bti. & Btk. products) etc. in biopesticides and review the toxicity guidelines & Protocols for registration of biopesticides"	DPPQS, Faridabad	August 3, 2015
Dr. Ch. Sarada	First Workshop of Nodal Officers of ICAR Research Data Repository for Knowledge Management	New Delhi	August 04-05, 2015
Dr.V. Dinesh Kumar Dr.Pushpa, H.D	Symposium on Germplasm to Gene: Harnessing Biotechnology for Food Security and Health	NAS Centre, Pusa, New Delhi	August 9-11, 2015
Dr. V. Dinesh Kumar	SPBB National Symposium on "Germplasm to Genes: Harnessing Biotechnology for Food Security and Health"	NAAS Complex, New Delhi	August 9-11, 2015
Dr. G.D. Satish Kumar	Annual review workshop of Technology Mission on cotton (TMC) Mini Mission-1	Central Institute for Cotton Research, Nagpur	August 11 - 13, 2015
Sri H.H. Kumaraswamy	Training on "Analyses of experimental data"	NAARM, Hyderabad	August 17 - 22 , 2015
Dr. V. Dinesh Kumar	Current Trends on Bioinformatics in Agriculture	ICAR-NAARM, Hyderabad	September 22, 2015
Shri Pradeep Singh,	Workshop on Hindi on RajyaBasha	Goa	October 7-9, 2015
Dr.S. Chander Rao	National Conference VIROCON 2015	NEIGRIHMS,	October 8-

		Shillong	10, 2015
Dr. V. Ramana Rao	Workshop on Mitigating Agrarian Distress in Indian Agriculture	Centre for Good Governance, Gachibowli Campus, Hyderabad	October 15, 2015
Dr. V. Dinesh Kumar Dr P. S. Srinivas	Workshop of Agro-climatic Zone-X of Southern Plateau and Hill Region'	ICAR-IIOR, Hyderabad	October 21, 2015
Dr. P. S. Vimala Devi	Follow-up meeting on 'Epidemic of whitefly in cotton in Punjab, Haryana and Rajasthan' and 'factors responsible for lower production of Soybean in Madhya Pradesh"	NASC, New Delhi	27 October, 2015
Dr. V. Dinesh Kumar	8th National Seed Congress on "*Quality Seed for Farmers' Prosperity*"	HICC, Hyderabad	October 27-29, 2015
Dr. I.Y.L.N. Murthy Dr. A. Aziz Qureshi	FAI Workshop on Need for Reforms in Fertilizer Policy for Sustaining Soil Health through Balanced Fertilization	FAI, Hyderabad	November 13, 2015
Sri H.H. Kumaraswamy	Winter school on "Genomics and phenomics assisted crop breeding: Principles and practices"	Division of Genetics, IARI, New Delhi	November 18 – December 8, 2015
Dr. P. Duraimurugan	Second Meeting of Indian Grain Storage Working Group	NASC complex, New Delhi	November 21, 2015
Dr. N. Mukta	Joint DUS Workshop on Indo-German Bilateral Cooperation in Seed Sector	PPV&FR Authority, Deptt of Agri. Cooperation & Farmers Welfare & ICAR-IARI at NRCPB, Audi-torium, LBS building, IARI Pusa campus, New Delhi	November 23 & 24, 2015
Dr. P. S. Srinivas	Regional Plant Health systems Analysis	NIPHM, Hyderabad	23 November - 7 December, 2015
Dr. P. S. Vimala Devi	TSBB-NAARM Collaborative Workshop on Biodiversity	NAARM, Hyderabad	24 November, 2015
Dr. V. Dinesh Kumar Dr. P. S. Vimala Devi	STEM (Society for Technology Management) Annual Summit	Taj Vivanta, Hyderabad	November 26, 2015
Dr. R.D. Prasad	ISPP National Symposium on Climate Challenges: Status and Management of Plant Diseases from at Hyderabad	NIPHM, Hyderabad	December 1-3, 2015
Mrs. P. Madhuri	Workshop on Unified communications	NAARM, Hyderabad	December 5, 2015
Dr. I.Y.L.N. Murthy	80th Annual Convention of Indian Society of Soil Science	GKVK, Bengaluru	December 5-8, 2015
Dr. G.D. Satish Kumar	Sensitization programme for the KVKs of Zone II	ATARI, Zone II, Kolkata, at BCKC, Kalyani, W.B.	December 8 - 10, 2015
Dr.H.P. Meena	National workshop programme on "*Hindi me taknikisahityakasrijanauruskavistritsancharkrishikevisheshsandarbh me*"	MANAGE, Hyderabad	December 9, 2015.
Dr.Mangesh Y. Dudhe Dr.H.P. Meena Shri Pradeep Singh	Workshop on Hindi Rashtriya KrishiVistaran	MANAGE, Hyderabad	December 9, 2015
Dr. Mangesh Y. Dudhe	Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2015)	RVSKVV, Gwalior (M.P.)	December 12–13, 2015

Dr.S. Chander Rao, Dr.M. Padmaiah Dr.A.Aziz Qureshi Dr.V.Dinesh Kumar Dr.I.Y.L.N. Murthy Dr.P. Padmavathi Dr.A.R.G. Ranganatha Dr.K.S. Varaprasad Dr.S.N.Sudhakara Babu Dr.G. Suresh	Seminar on Integrated Farming System for Sustainable Agrculture and Enhancement of Rural livelihood	NAARM, Hyderabad	December 13-14, 2015
Dr. V. Ramana Rao	National workshop of ABI's	t NASC Complex, New Delhi	December 23, 2015
Dr. K. Anjani	Workshop on Essential Skills for the 21st Century Researchers	NAARM, Hyderabad	January 13, 2016
Dr. Ch. Sarada Dr. G.D. Satish Kumar	4th NKN annual workshop on NKN at the Core of Cyber Space	JNTU, Hyderabad	January 21 – 22, 2016
Dr. V. Dinesh Kumar	Current Trends on Bioinformatics in Agriculture	ICAR-NAARM, Hyderabad	February. 2, 2016
Dr.M. Santhalakshmi Prasad	Priorities in Plant Health Management	S.V.Agril.College, Tirupathi	February 4-5, 2016
Dr. V. Ramana Rao	Meeting on FICCI India Innovation Growth Programme	Green Park, Begumpet, Hyderabad	February 12, 2016
Dr. R.D. Prasad	Workshop on Biodiversity act, Access of Biological Resources and Benefit Sharing	NAARM	February,13 ,2016
Dr. Ch. Sarada	Workshop on Current Trends in Agricultural Bioinformatics	NAARM, Hyderabad	February 15-17, 2016
Dr.M. Padmaiah	Conference to discuss about the role of Public Relations in Govt. & Public Sector	Hotel Ashoka, Hyderabad	February 21, 2016
Dr. V. Ramana Rao	Workshop on Strengthening and Sustainability of E-Granth	NASC complex, New Delhi	February 26- 27, 2016
Dr. N. Mukta	TSBB One day state level capacity building workshop on Economic valuation of Bio-resources for Access and Benefit Sharing	The Haritha Plaza, ,Hyderabad	March 1, 2016
Dr. V. Ramana Rao Dr. G.D. Satish Kumar Dr P.S. Srinivas	Economic valuation of bio resources for Access and Benefit sharing to create awareness and capacity building among the key biodiversity stakeholders/managers	Telangana State Biodiversity Board, (TSTDC), Hyderabad.	March 1 2016
Dr. P. S. Srinivas	State level workshop on Economic valuation of bioresources for ABS"	People's Plaza, Hyderabad	01 March, 2016
Dr. V. Ramana Rao Dr. R.D. Prasad	State level brain storming programme on Biological Diversity Act, Rules & Access and Benefit sharing (ABS) mechanism	Andhra Pradesh State Biodiversity Board, Vijayawada	March 4 , 2016
Dr. V. Ramana Rao	Sensitization Workshop on Agri-Business Incubation	NAARM, Hyderabad	March 21 - 22, 2016
Mrs. P. Madhuri	Attended one day workshop on "ICT enabled information systems and services for agricultural extension"	Extension Edun.Institute, Rajendranagar, Hyderabad	March 26, 2016
Dr.P. Duraimuragan Dr.Ramya, K.T Dr.T. Manjunath Dr.Manjunatha Dr. P. S. Srinivas	Seminar on Breeding of Field Crops for Biotic and Abiotic Stress in relation to Climate Change	VNMKV, Parbhani	March 28-29, 2016

Dr. P. Duraimurugan			

International Conferences

Name	Programme	Venue	Date
Dr. M. Sujatha	5th International Conference on Next Generation Genomics and Integrated Breeding for Crop Improvement	ICRISAT, Hyderabad	February 18 – 20, 2015
Dr. V. Ramana Rao	International Conference "Climate Change Impacts on Agriculture-Adaptation and Mitigation Strategies"	Centre for Good Governance,Gachibowli campus, Hyderabad.	February 23, 2016
Dr.Praduman Yadav	International Conference on recent advances in Bio-energy resource at SardarSarovan Sign National Institute of Renewable Energy	Kapurthala, Punjab	February 25-28, 2015
Dr. P. Duraimurugan	International Rice Symposium - Rice Science for Global Food and Nutritional Security	ICAR-IIRR, Hyderabad.	November 18-20, 2015
Dr. A.R.G. Ranganatha Dr. G. Suresh	25th Asian Pacific Weed Science Society conference on "Weed Science for Sustainable Agriculture, Environment & Biodiversity	PJTSAU, Hyd	October 13-16, 2015
Dr.P. Lakshmamma Dr.LakshmiPrayaga Dr.Praduman Yadav	3rd International Plant Physiology Congress on "Challenges and Strategies in Plant Biology Research	JNU, Delhi	December 11-14, 2015
Dr.P. Padmavathi	International conference on "Climate Change &Food Security Ethical Prospective	PJTSAU Campus, Hyderabad	February 11-13, 2016.
Dr.R.D. Prasad Dr. M. Santhalakshmi Prasad	6th International conference on Plant Pathogen & People	NASC Complex	February 23-26, 2016.

हिन्दी पखवाड़ा समारोह

संस्थान में 01-15 सितंबर, 2015 तक आयोजित हिन्दी पखवाडा का समापन समारोह संस्थान के निदेशक डॉ. के. एस. वरप्रसाद की अध्यक्षता में संपन्न हुआ। समारोह की मुख्य अतिथि डॉ. रेखा शर्मा, प्रधानाचार्य, विवेक वर्धनी कॉलेज ऑफ आर्ट, साईंस एण्ड कामर्स एण्ड पीजी स्टडीज, जामबाग, हैदराबाद थी। समारोह का आरंभ श्री. प्रदीप सिंह, सहा. निदेशक)रा.भा(के स्वागत तथा मुख्य अतिथि परिचय से हुआ। इसके पश्चात डॉ. एन. मुक्ता, प्रधान वैज्ञानिक एवं प्रभारी राजभाषा ने संस्थान में राजभाषा कार्यान्वयन की रिपोर्ट प्रस्तुत की तथा संस्थान में हिन्दी की गतिविधियों पर प्रकाश डाला। इसके बाद हिन्दी पखवाड़े के दौरान आयोजित स्मरण, शब्दानुवाद, सामान्य ज्ञान, एक मिनट, पुस्तक पाठन और श्रुतलेख प्रतियोगिताओं के विजेताओं को प्रथम, द्वितीय एवं तृतीय पुरस्कार तथा कुछ प्रोत्साहन पुरस्कार भी मुख्य अतिथि के कर कमलों से वितरित किए गए।

समारोह की मुख्य अतिथि डॉ. रेखा शर्मा ने अपने संबोधन में विश्व में हिन्दी की स्थिति की विस्तृत जानकारी दी, की यह किन देशों मे हिन्दी पढाई जाती है, बोली समझी जाती है। कैसे हिन्दी आज व्यापार एवं वाणिज्य की भाषा बन गई। स्वतंत्रता संग्राम में हिन्दी ने कैसे महत्वपूर्ण भूमिका

निभाई है। आपने कार्यालय में सरल भाषा के उपयोग पर बल दिया, कलिष्ट भाषा साहित्य के लिए ठीक है परन्तु कार्यालय के लिए नहीं।

अपने अध्यक्षीय भाषण में डॉ. वरप्रसाद जी ने कहा कि हिन्दी में काम करना हम सभी का दायित्व है, यथा संभव सभी हिन्दी में अपना कार्य करें। उन्होंने आगे बताया कि कैसे वे सभी फाइलों पर टिप्पणी हिन्दी में ही लिखते है। किसी शब्द की हिन्दी न आने पर उस शब्द हिन्दी में लिप्यंतरण कर देते है, परन्तु हिन्दी में ही लिखते है। वरप्रसाद जी ने कहा कि हमारे संस्थान को पिछले तीन वर्षों में दो अवार्ड मिले है, इससे संतुष्ट हो कर हमे बैठना नहीं है बल्कि इससे हम पर और बेहतर करने की जिम्मेदारी आ जाती है।

डॉ. प्रद्युम्न यादव, वैज्ञानिक के धन्यवाद ज्ञापन से कार्यक्रम का समापन हुआ।

राजभाषा कार्यशाला

संस्थान में एक दिवसीय कार्यशालाओं का आयोजन 12 जून, 2015, 01 सितंबर, 2015 , 19 दिसंबर, 2015 तथा 24 फरवरी, 2016 को किया गया।

इन कार्यशालाओं में श्रीमती वैष्णवी, अध्यापिका, भारतीय विद्या भवन, एनआरआईडी, हैदराबाद, श्री. कमालुद्दीन, हिन्दी प्राध्यापक, हिन्दी शिक्षण योजना, हैदराबाद, श्री. होमनिधि शर्मा, वरिष्ठ प्रबंधक)रा.भा(, भारत डायनामिक्स लिमिटेड, हैदराबाद तथा श्री. ए.के. सिंहा, ऑडिट अधिकारी, आईपीआईए, हैदराबाद ने अतिथि व्याख्याता के तौर पर भाग लिया।

इन कार्यशालाओं में सरल कार्यालयीन हिन्दी पर प्रकाश डाला गया। इतर हिन्दी भाषियों को हिन्दी लिखने में आने वाली कठिनाईयों तथा इसे दूर करने के उपाय बताए गए। व्याकरण के नियमों को बहुत आसान तरीके से समझाया। शब्द एवं वाक्यांशों की रचना के बारे में जानकारी दी। कैसे हम बोलचाल की हिन्दी का उपयोग कार्यालय के दैनंदिन कार्य में कर सकते है, इसे उदाहरण सहित प्रस्तुत किया गया। इस तरह कार्यशाला के सहभागियों के संदेहों को दूर कर, उन्हें अभ्यास भी करवाया गया। कंप्यूटर पर कार्य करने हेतु युनिकोड पर कक्षाएं आयोजित की गई इनमें अधिकारियों व कर्मचारियों को कंप्यूटर में युनिकोड को सक्रिय करना, उस पर हिन्दी में कार्य करने की जानकारी दी गई। इसके अतिरिक्त कार्यालय की क्रय प्रक्रिया के बारे में प्रशासन एवं वित्त लेखा के कर्मचारियों को हिन्दी में प्रशिक्षण दिया गया।

संस्थान राजभाषा पुरस्कार से सम्मानित

भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने 15 मई, 2015 को राष्ट्रीय कृषि विज्ञान केंद्र परिसर, नई दिल्ली में आयोजित भारतीय कृषि अनुसंधान परिषद के निदेशकों तथा राज्य कृषि विश्वविद्यालयों के कुलपतियों के सम्मेलन में भाकृअनुप संस्थानों में राजभाषा के उत्कृष्ट कार्यान्वयन हेतु पुरस्कार प्रदान किए गए। इन्हें कृषि राज्य मंत्री श्री. मोहनभाई कुंडरिया ने प्रदान किया। भारतीय तिलहन अनुसंधान संस्थान को ग क्षेत्र में राजभाषा के उत्कृष्ट कार्यान्वयन हेतु द्वितीय पुरस्कार से सम्मानित किया गया। इसे संस्थान के निदेशक डॉ. के.एस.वरप्रसाद तथा सहा. निदेशक)रा.भा(श्री. प्रदीप सिंह ने प्राप्त किया।


हिन्दी पखवाड़ा समारोह
01-15 सितंबर, 2015
भाकृअनुप - भारतीय तिलहन अनुसंधान संस्थान
-500 030

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Name of the Scientist(s)	Title / Organizer/ Place / Date(s)
Murthy, I.Y.L.N.	Paper presented in 80th Indian Society of Soil Science National Seminar on Developments in soil Science-2015 at GKVK, Hebbal, Bengaluru from December 6-8, 2015.
Ranganatha, A.R.G.	Delivered invited lecture on Oilseeds at PPVFRA workshop at Bapatla during 2-3 March 2016
Sujatha, M.	Delivered a lecture on Creation of genetic variability with particular reference to oilseed crops during the 1st National Workshop on TILLING at University of Hyderabad, Hyderabad on April 20, 2015.
Dinesh Kumar, V.	Delivered an invited lecture on Introduction to cloning and transgenic technologies for crop improvement to the participants of the DBT sponsored short term training course on Molecular cloning and transgenic technologies for crop improvement at Agri Biotech Foundation on September 4, 2015**.**
Dinesh Kumar, V.	Delivered a lecture on Transcriptomics and its applications in agriculture to the participants of National workshop on Current Trends on Bioinformatics in Agriculture organized by NAARM, Hyderabad during September 22, 2015.
Kumaraswamy, H.H.	Delivered guest lecture on Signal transduction and role of G-proteins to post graduate students of the department of biotechnology of PJTSAU, Hyderabad, at the seminar hall of Institute of Biotechnology, PJTSAU on September 18, 2015.
Kumaraswamy, H.H.	Delivered guest lecture on Plasma membrane receptors and protein kinases to post graduate students of the department of biotechnology of PJTSAU, Hyderabad, at Institute of Biotechnology, PJTSAU on September 25, 2015
Kumaraswamy, H.H.	Delivered guest lecture on DNA, gene, chromosome, cell, tissue, organ, organism and live forms, to post graduate students of the department of biotechnology of PJTSAU, Hyderabad, at the seminar hall of Institute of Biotechnology, PJTSAU on October 05, 2015
Jinu, J., Sujatha, M., Varaprasad, K.S.	Simple sequence repeat analysis of acetohydroxyacid synthase L1 locus reveals resistance to sulfonylurea and imidazolinone in *Helianthus* wild species. Poster presented during the 25th Asian Pacific Weed Science Society Conference at Hyderabad from October 13-16, 2015.
Dinesh Kumar, V.	Delivered a lead lecture on Advances in molecular markers for variety identification and genetic purity testing under the theme Advances in Seed Science for Future Food Security as part of the 8th National Seed Congress on "*Quality Seed for Farmers' Prosperity*" organized by DAC, Telangana and DAC & FW, GoI at Hyderabad. on 27-10-2015
Lavanya, C.	Paper presented on Innovative approaches to break yield barrier in oilseeds and improved strategies in quality seed supply in 8th National Seed Congress at Hyderabad on October 27-29, 2015.

Kadirvel, P., Saisanthosh, K., Keshavalu, K., Mukta, N., Joseph Raju, T., Sultana, R., Yadav, P. and Varaprasad, K.S.	Paper presented on Relationship of seed physical, physiological and biochemical traits with oil content in safflower (*Carthamus tinctorious* L.) in 8th National Seed Congress at Hyderabad on October 27-29, 2015.
Ranganatha, A.R.G.	Delivered lecture on Productivity enhancement and resource use efficiency in sesame and niger with best practices at DOE-GOI training on October 28, 2015.
Kumaraswamy, H.H.	Delivered a lecture on Genetically modified(GM) crops: A potential tool for increasing profitability and resource use efficiency in oilseed crops in model training course on "Good management practices for increasing profitability and resource use efficiency in Oilseed Crops" organized by ICAR-IIOR at Hyderabad on October 27 – November 3, 2015.
Kumaraswamy, H.H.	Delivered guest lectures on Genomics, transcriptomics and proteomics to post-graduate students of the Department of Biotechnology of PJTSAU, Hyderabad on November 2, 2015.
Kadirvel, P., Veerraju, C.H., Usha Kiran, B. and Yadav, P.	Paper presented on Marker-assisted breeding for improvement of high oleic acid content in safflower in International Symposium on Biodiversity, Agriculture, Environment and Forestry organized by Association for the Advancement of Biodiversity Science (India) at _____ on December 11-12, 2015.
M.Y. Dudhe, M. Sujatha, H. P. Meena and K. S. Varaprasad.	Paper presented on Sunflower genetic resources activities in IIOR, Hyderabad in National Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2015) at RVSKVV, Gwalior (M.P.) on December 12–13, 2015.
Sujatha, M.	Delivered a lecture on Pre-breeding and genetic enhancement in oilseed crops in 2nd National Workshop on TILLING at University of Hyderabad, Hyderabad on December 15, 2015.
Ranganatha, A.R.G.	Delivered lecture on Technology for enhancing sesame production in KVK Conference on Cluster Demonstrations on December 21-22, 2015.
Trebbi D., Sujatha, M., Oliver, J., Francis, G. 2016.	Paper presented on Edible Jatropha: SNPs linked to non-toxic trait identified to support molecular breeding in Plant and Animal Genome Conference at San Diego, California, USA on January 9-13, 2016.
Dinesh Kumar, V.	Delivered a lecture on Transcriptomics–An overview in National workshop on Current Trends on Bioinformatics in Agriculture organized by NAARM, Hyderabad on February 15, 2016.
K. T. Ramya, A. Bellundagi, and G.P.Singh.	Paper presented on Gene actions of stomatal conductance in cross GW 322 X KAUZ/AA/KAUZ under heat stress in wheat (*Triticum aectivum*.L) in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
K. Anjani, P. Bhavna, Debadutta Mishra, R.D. Prasad.2016	Oral presentation on Exploitation of wild species, *Carthamus oxyacantha* Bieb. for disease resistance and yield improvement in safflower (*C. tinctorius L.*) in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29,

	2016.
Manjunatha T, Ramya, K.T. and Lavanya, C.	Oral presentation on Effect of high temperature on castor seed production in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
K. Anjani, P. Bhavna, Debadutta Mishra, Praduman Yadav and R. D. Prasad.2016.	Poster presented on Development of a wilt resistant-high oil inbred line in safflower (*Carthamus tinctorius* L.) in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
K. Anjani, R. D. Prasad, Debadutta Mishra and P. Bhavna.2016	Poster presented on Multiple resistance to Fusarium wilt and Phytophthora damping-off and seedling blight in safflower in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
Dinesh Kumar, V.	Delivered lecture to the M.Sc and Ph.D students at IBT on Cloning vectors and their applications; Overview of RNA interference and Applications of RNAi in Agriculture on _____
C. Lavanya, P. Duraimurugan and M. Santhalakshmi Prasad	Paper presented on Development of leafhopper and wilt resistant parental lines in castor through conventional breeding approaches in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
P. Duraimurugan, M. Lakshminarayana and C. Lavanya	Paper presented on Evaluation of parental lines of castor hybrids for resistance to leafhopper, *Empoascaflavescens* in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
T. Manjunatha, K.T. Ramya and C. Lavanya, 2016.	Paper presented on Effect of increased seasonal temperature on hybrid seed production in castor in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
Kadirvel, P. and Srinivas, P.S.	Paper presented on Genetics of resistance to aphid (*Uroleucon compositae* Theobald) in safflower in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
Meena, H.P., Prashant Kumar Soni and M. Sujatha	Oral presentation made on Characterization of F_1 interspecific hybrids between cultivated sunflower and *Helianthus argophyllus* T.&G in National Seminar on Breeding of field crops for biotic and abiotic stress in relation to climate change at VNMKV, Parbhani, Maharashtra on March 28-29, 2016.
Padmaiah, M.	Delivered a lecture on extension methods for out reach of technologies to the trainees of Model training course held at IIOR from October 27 to November 3, 2015.
Ramana Rao, V.	Paper presented on Increasing soybean production and future alternatives in *Krishi Manthan* organized by Department of Agriculture, Madhya Pradesh at Bhopal on October 31, 2015.
Sarada, Ch.	Delivered lecture on Oilseeds at a glance–A mobile application in

	Model training course on Good management practices for increasing profitability and resource use efficiency in oilseed crops at IIOR, Hyderabad during October 27 to November 3, 2015.
Sarada, Ch.	Delivered a lecture on Data processing – Preliminary (Tabulation, means, etc.) and advanced (Tabulation, analysis, trends, comparative assessment, etc.), Software for preliminary data processing in Refresher cum skill up-gradation training for technical staff of IIOR on March 15, 2016.
Satish Kumar, G.D.	Presented a guest lecture on Best management practices for oilseeds for Zone-II at the Sensitization programme for the KVKs of Zone II organized by ATARI, Zone II at BCKC, Kalyani, West Bengal during December 8-10, 2015.
Satish Kumar, G.D.	Delivered a lecture on ICTs for technology transfer and methods of data collection in social sciences in Refresher-cum-skill upgradation training organized for the technical staff of IIOR at IIOR, Hyderabad March 28, 2016.
Satish Kumar, G.D.	Delivered a lecture on Use of mobile phones in outreach of agricultural technologies in Model training course on Good management practices for increasing profitability and resource use efficiency in oilseed crops at IIOR, Hyderabad during October 27 to November 3, 2015.
Satish Kumar, G.D.	Delivered a guest lecture on Best management practices for achieving higher yields in oilseed crops in Training Programme on Capacity building of input dealers and extension officials in the advisory process to the farmers with special emphasis on oilseeds at Palem March 10, 2016.
Mrs. P. Madhuri	Delivered a lecture on IIOR website, E-mail communication, Biometric attendance" in the Refresher-cum-skill upgradation training organized for the technical staff of IIOR at IIOR, Hyderabad on March 28, 2016.
Prasad, R.D.	Delivered a guest lecture on Epidemiology, diagnosis and integrated management of major diseases of safflower and minor oilseed crops in training programme organized by Department of Plant Pathology, VNMKV, Parbhani on September 7, 2015.
Prasad, R. D., Dinesh Kumar, V., Aziz Qureshi, A., Lakshmamma, P., Navneetha, T. and Kulkarni, A.	Paper presented on Amelioration of biotic and abiotic stresses in plants by Trichoderma species in IPS 6th International Conference on Plant, pathogens and people- Challenges in plant pathology to benefit humankind at New Delhi on February 23-27, 2016.
Prasad, R. D., Dinesh Kumar, V and Varaprasad, K. S.	Paper presented on Trichoderma: A wonder fungus for agriculture in ISPP National Symposium on Climate challenges: Status and management of plant diseases at Hyderabad during December 1-3, 2015.
Yamuna, C., Kishore Varma, P. and Prasad, R.D	Paper presented on Evaluation of fungicides against *Botryotinia ricini*, the incitant of gray mold of castor in Conference on National priorities in plant health management at Tirupati on February 4-5, 2016.
Santhalakshmi Prasad, M.	Oral presentation on Parental lines and advanced breeding material of castor resistant to wilt disease in 6th International

	Conference on Plant, pathogens and people - Challenges in plant pathology to benefit humankind at New Delhi during February 23-27, 2016.
Santhalakshmi Prasad, M.	Delivered lecture on Low cost disease management strategies for oilseed crops in Model training course on Good management practices for increasing profitability and resource use efficiency in oilseed crops at New Delhi on October 29, 2015.
Dr. S. Chander Rao	Presented a lead paper on Important viral diseases of sunflower (*Helianthus annuus* L.) in India and its confirmation of non-transmission through seeds in National Conference VIROCON 2015 at NEIGRIHMS, Shillong on October 8, 2015.

INFRASTRUCTURE DEVELOPMENT

Library and Documentation

The Library and Documentation unit continued to collect, store, organize and disseminate information on all aspects of crop improvement, crop production, crop protection and utilization of oilseed crops. An amount of Rs. 10,00,000/- was spent in 2015-16 to acquire 105 books and subscription of 50 periodicals, 4 databases *viz*., Crop Science database and AGRIS on CD, AGRICOLA and Biological and Agricultural Index. A total of 70 publications were received on gratis, besides newsletters and annual reports from different organizations. New records of books were added to the computerized library catalogue database. The KOHA Integrated Library Management Software has been in operation at IIOR. Four issues of ICAR-IIOR Newsletter and 280 electronic article delivery though e-mails have been brought out and circulated to all scientists working in AICRP (Sunflower, Safflower and Castor) centres across different states and IIOR. Literature searches have been carried out in the mandate crops using in-house database, CROP CD, AGRIS on CD and AGRICOLA. The online databases Indiagristat.com (Agriculture) and Plant Science Protocols has been subscribed for the year 2015-16.

Civil Works

The following civil works have been carried out at ICAR-IIOR during the period under report:

- Foundation stone for Central Laboratory Complex laid by the Secretary, DARE & Director General, ICAR.
- Repairs and Maintenance of Main Office-cum-Laboratory Building.
- Renovated main drain at Northern side of Rajendranagar Farm.
- Repairs and maintenance of Farm Building Complex at Rajendranagar Farm.
- Re-constructed part of compound wall at Rajendranagar Farm.
- Repaired old sheds with AC sheet roofing for the use of proper storage of pollination/ bird nets.
- Developed off-season cultivation facility for safflower research at Rajendranagar Farm with iron framed structure and polyurethane sheet roofing.
- Renovated the instruments rooms in the soil science laboratory with granite top RCC tables and wall mounted storage racks etc.
- Repairs and maintenance of Type IV Residential Quarters.
- Installed the drip irrigation systems at Narkhoda Farm.

VISITORS

During the year under report, about 1695 visitors including farmers and students from seven states visited this Institute and interacted with the scientists. This include the farmers from Karnataka, Maharashtra, Chhattisgarh, Tamil Nadu, Telangana, Andhra Pradesh, Kerala and students from Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Maharashtra, Odisha, etc.

Smt. Renuka Chowdhury, Member of Parliament (Rajya Sabha) and former Union Minister of State for Women and Child Development, Govt. of India visited IIOR on 8th June, 2015.

APPOINTMENTS / PROMOTIONS / TRANSFERS / SUPERANNUATIONS

Appointments

Name	Post	Date
Dr. Pushpa, H.D	Scientist (Plant Breeding)	01.04.2015
Ms. B. Gayatri	Scientist (Nematology)	01.04.2015
Ms. K.S.V.P. Chandrika	Scientist (Ag. Chemistry)	01.04.2015
Ms. P. Swapna	LDC	28.08.2015
Smt G. Maheshwari	LDC	28.08.2015

Promotions

Name	Post	Promoted to Post	Date
Shri B.V. Noble	Sr. Technical Assistant	Technical Officer (T-5)	01.07.2008
Shri E. Ravi Kumar	Technical (Driver)	Sr. Technical (Driver)	26.05.2014
Shri S. Saida Reddy	Technician	Sr. Technician (F/F)	18.05.2014
Shri Ch. Anjaiah	Technician(F/F)	Sr. Technician (F/F)	26.05.2014
Shri P. Sunil Kumar	Sr. Technical Assistant	Technical Officer (T-5)	01.01.2015
Shri G. Parathasaradhi	Technical Assistant (Driver)	Sr. Technical Assistant (Driver)	01.01.2015
Smt P. Mary	SSS	Technical (T-1)	25.04.2015
Shri J. Narsimha	SSS	Technical (T-1)	25.04.2015
Smt A. Lalitha	TSL	SSS	01.02.2016
Smt K. Kalavathi	TSL	SSS	01.02.2016

Transfers

Name	Post	Date
Dr. T. Manjunatha	Scientist (Plant Breeding)	Joined IIOR, Hyderabad on 29.04.2015 from SBI, Coimbatore
Dr. A.J. Prabhakaran	Pr. Scientist (Plant Breeding)	Transferred on 27.05.2015(AN). to SBI, Coimbatore
Smt B. Swarna Kumari	Sr. Admn. Officer	Joined IIOR, Hyderabad on 2.09.2015 from CTRI, Rajahmundry

Superannuations

Name	Post	Date
Shri Anil Behari	Sr. Admn. Officer	30.04.2015
Shri G. Keshauloo	Technical Officer	31.08.2015
Smt. M.H. Elizabeth	SSS	30.11.2015
Shri N. Prabhakara Rao	Chief Technical Officer	31.01.2016
Smt P. Narsamma	SSS	31.03.2016

PERSONNEL

(as on March 31, 2016)

Dr. K.S. Varaprasad	Director

Director's Cell

Dr. Durgamadhab Pati	Chief Technical Officer
Mr. G. Chandraiah	Private Secretary
Mr. P. Srinivasa Rao	Personal Assistant

Research Sections

Crop Improvement

Dr. A.R.G. Ranganatha	Pr. Scientist (Pl. Breeding)
Dr. M. Sujatha	Head & Pr. Scientist (Gene. & Cyto.)
Dr. K. Anjani	Pr. Scientist (Pl. Breeding)
Dr. V. Dinesh Kumar	Pr. Scientist (Biotechnology)
Dr. N. Mukta	Pr. Scientist (Eco. Botany)
Dr. C. Lavanya	Pr. Scientist (Pl. Breeding)
Dr. Senthilvel Senapathy	Sr. Scientist (Pl. Breeding)
Dr. Kadirvel Palchamy	Sr. Scientist (Genetics)
Dr. N.V.P.R. Ganga Rao	Sr. Scientist (Pl. Breeding) (deputation with ICRISAT)
Mr. H.H. Kumara Swamy	Scientist (Biotechnology)
Dr. Mangesh.Y. Dudhe	Scientist (Plant Breeding)
Mrs. B. Usha Kiran	Scientist (Biotechnology)
Dr. Sujatha T.P.	Scientist (Biotechnology)
Dr. J. Jawaharlal	Scientist (Plant Breeding)
Dr. Hari Prakash Meena	Scientist (Plant Breeding)
Dr. T. Manjunatha	Scientist (Plant Breeding)
Dr. Ramya, K.T	Scientist (Plant Breeding)
Dr. Pushpa H.D	Scientist (Plant Breeding)
Mr. G. Balakishan	Asst. Chief Technical Officer
Mr. K. Sayendra	Technical Officer
Mr. P. Gopinathan	Technical Officer
Mr. D. Mallesha	Technical Officer
Mr. P. Sunil Kumar	Technical Officer
Mr. G. Srinivasa Rao	Technical Assistant
Mr. S. Jagadishwar	Technical Assistant
Mrs. P. Mary	Technician
Mr. J. Narsimha	Technician

Crop Production

Dr. I.Y.L.N. Murthy	Head & Pr. Scientist (Ag. Chemistry)
Dr. S.N. Sudhakara Babu	Pr. Scientist (Agronomy)
Dr. P. Padmavathi	Sr. Scientist (Agronomy)
Dr. P. Lakshmamma	Pr. Scientist (Pl. Physiology)
Dr. Lakshmi Prayaga	Pr. Scientist (Pl. Physiology)

Dr. G. Suresh	Pr. Scientist (Agronomy)
Dr. Md. A. Aziz Quereshi	Pr. Scientist (Soil Science)
Dr. Praduman Yadav	Scientist (Biochemistry)
Mrs. K.S.V.P. Chandrika	Scientist (Ag. Chemistry)
Mrs. Ch.V. Haripriya	Senior Technical Officer
Mr. P. Ashok	Technical Officer
Mr. L. Krupakar	Technical Officer
Mr. S. Narasimha	Technical Officer

Crop Protection

Dr. P.S. Vimala Devi	Pr. Scientist (Agric. Entomology)
Dr. H. Basappa	Pr. Scientist (Agric. Entomology)
Dr. R. Durga Prasad	Pr. Scientist (Pl. Pathology)
*Dr. M. Lakshminarayana	Pr. Scientist (Agric. Entomology)
Dr. S. Chander Rao	Pr. Scientist (Pl. Pathology)
Dr. M. Santha Lakshmi Prasad	Pr. Scientist (Pl. Pathology)
Dr. P.S. Srinivas	Pr. Scientist (Agric. Entomology)
Dr. P. Duraimurugan	Sr. Scientist (Agric. Entomology
Mrs. B. Gayatri	Scientist (Nematology)
Mr. M. Ramulu	Technical Officer
Mr. Shaik Shoukat Ali	Technical Officer
Mr. J. Balram	Senior Technician
Mr. Ch. Anjaiah	Senior Technician
Mr. S. Saida Reddy	Senior Technician

Social Sciences

Dr. M. Padmaiah	Head & Pr. Scientist (Agric. Extension)
Dr. S.V. Ramana Rao	Pr. Scientist (Agric. Economics)
Dr. Ch. Sarada	Pr. Scientist (Agric. Statistics)
Dr. G.D. Satish Kumar	Sr. Scientist (Agric. Extension)
Dr. K. Alivelu	Sr. Scientist (Agric. Statistics)
Mrs. P. Madhuri	Scientist (SS) (Comp. Applications)
Mr. B. Krishna	Senior Technical Officer
Mr. B. Kistaiah	Technical Officer

Support Services

AKMU Cell

Mr. P. Srinivasa Rao	Technical Officer

Library and Documentation

Mr. G. Raghunath	Senior Technical Officer
Mr. V. Sambasiva Rao	Senior Technical Officer

Art & Photography

Mr. B.V. Rao	Senior Technical Officer
Mr. B.V. Noble	Technical Officer

Technical Coordination Cell

Mrs. R. Raji	Personal Assistant
Mr. G. Srinivas Yadav	Personal Assistant

Farm Section

Mr. M. Bhaskara Reddy	Asst. Chief Technical Officer
Mr. Y. Ramagovinda Reddy	Senior Technical Officer
Mr. M. Panduranga Rao	Technical Officer
Mr. G.Y. Prabhakar	Technical Officer
Mr. C. Prabhudas	DMO (Duplicating Machine Operator)
Mr. Surender Prasad	Senior Technical Assistant (Electrician)
Mr. A. Srinivasa Raju	Technical Assistant (A.C. Mech.- cum Operator)
Mr. N. Vasanth	Technical Assistant (Fitter)
Mr. K. Srinivas	Technical Assistant (Generator Operator)
Mr. M. Indrasena Reddy	Technical Assistant (Tractor Driver)
Mr. Y. Venkateshwara Rao	Technical Assistant (Tractor Driver)
Mr. T. Bichanna	UDC

Seed Section

Mr. T. Veeraiah	Senior Technical Assistant

Administration

Mrs. B. Swarna Kumari	Senior Administrative Officer
Mr. Pradeep Singh	Assistant Director (OL)
Mr. S. Shamdas	Assistant Administrative Officer
Dr. G. Annapurna	Technical Officer
Ms. J. Vijayalakshmi	Assistant
Mrs. S. Swarupa Rani	Assistant
Mrs. C. Lalitha	Personal Assistant
Mr. P.R. Varaprasada Rao	Assistant
Mr. B. Giri	UDC
Ms. P. Swapna	LDC
Mrs. G. Maheshwari	LDC

Stores

Mrs. R.A. Nalini	Assistant
Mr. G.B.N. Prasad	UDC
Mr. Rakesh Geeda	Assistant
Mr. G. Raghava Kiran Kumar	Jr. Steno

Drivers

Mr. V.Y. Swamy	Technical Assistant
Mr. G. Ramulu	Technical Assistant
Mr. G. Parthasaradhi	Senior Technical Assistant
Mr. E. Ravi Kumar	Technical Assistant

Audit & Accounts

Mr. H. Ganesha	Finance & Accounts Officer
Mr. A. Prem Kumar	Junior Accounts Officer
Mr. E.V.R.K. Nagendra Prasad	Assistant
Mr. G. Srinivasa Rao	Assistant
Mrs. P. Gyaneshwari	UDC

Skilled Support Staff

Mr. G. Rajamouli	Skilled Support Staff
Mr. G. Mallesh	Skilled Support Staff
Mr. D. Narsimha	Skilled Support Staff
Mr. K. Ramulu	Skilled Support Staff
Mr. M. Venkatesh	Skilled Support Staff
Mr. A. Rambabu	Skilled Support Staff
Mr. M. Ramulu	Skilled Support Staff
Mr. P. Krishna	Skilled Support Staff
Mr. D. Balaiah	Skilled Support Staff
Mr. B. Narsimha	Skilled Support Staff
Mrs. P. Narsamma	Skilled Support Staff
Mrs. B. Kistamma	Skilled Support Staff
Mr. K. Sanjeeva	Skilled Support Staff
Mr. Ch. Balaiah	Skilled Support Staff
Mr. B. Vishnu	Skilled Support Staff
Mrs. G. Bharathamma	Skilled Support Staff
Mr. Narasimha	Skilled Support Staff
Mr. B. Gyaneshwar	Skilled Support Staff
Mr. P. Srinivas	Skilled Support Staff
Mrs. K. Kalavathi	Skilled Support Staff
Mrs. A. Lalitha	Skilled Support Staff

RFD