ICAR-IIOR

Annual Report

वार्षिक प्रतिवेदन

Annual Report 2016-17

भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान
ICAR-Indian Institute of Oilseeds Research
राजेंद्रनगर, हैदराबाद / Rajendranagar, Hyderabad-500 030

ICAR-IIOR Annual Report

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PREFACE

It gives me immense pleasure to present the ICAR-IIOR Annual Report 2016-17, highlighting the significant research achievements and activities of the Institute.

The salient achievements during the period under report include: release of one hybrid (HCH-6) for Karnataka and one variety (Pragathi) for Telangana in castor and one hybrid (Prabhat) in sunflower for Andhra Pradesh; registration of one extra-early maturing castor accession (RG-19) with PGRC, ICAR-NBPGR; development of three high oleic lines (ISF-1, ISF-2 and ISF-3) in safflower; Under irrigated conditions of South Gujarat, pre-emergence application of pendimethalin 1 kg/ha followed by one hand weeding at 40 DAS was effective in realizing higher castor seed yield in *rabi*; seed treatment with *Pseudomonas fluorescens* (Pf1) @ 10 g/kg seed followed by spray of Hexaconazole / Propiconazole @ 0.1% at 45 days and *P. fluorescens* (Pf1) @ 1.0% at 60 DAS is effective for the management of Alternaria leaf spot in sunflower as it reduced the disease incidence by 25-63% and increased seed yield by over 40% and substitute 100% P of either greengram or safflower with PSB + 5 t FYM/ha for sustaining greengram-safflower system productivity in Vidarbha region of Maharashtra and northern transition zone of Karnataka.

A total of 84.96 q of breeder/foundation seed and 314.50 q of TFL seed were produced; 6832 demonstrations in FLDs across nine oilseed crops were conducted and 43 trainings were also conducted for different stakeholders; a total of 142 voice advisories were disseminated to 11,237 registered farmers in nine districts of Telangana; evaluation of promising hybrids of castor, sunflower and sesame varieties in NEH states for area expansion and distribution of 250 soil health cards to farmers in Koppal district, Karnataka. National Castor Kisan Mela sponsored by the NMOOP, DAC, Government of India was organized at the Institute. Under Mera Goan Mera Gaurav (MGMG), farmers of 50 villages in Telangana state were periodically updated about various agricultural activities to enhance their income.

I place on record my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. J.S. Sandhu, Dy. Director General (CS); ICAR; Dr. S.K. Chaturvedi, Asst. Director General (OP) Acting and Dr. B.B. Singh, Former 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 Smt. R. Raji, PA for secretarial assistance and Shri P. Srinivasa Rao, PA for cover page designing, editorial assistance, proof reading and final page setting is thankfully acknowledged.

IIOR, Hyderabad
July 7, 2017

(A. VISHNUVARDHAN REDDY)
Director

CONTENTS

ICAR-IIOR

वार्षिक प्रतिवेदन

Annual Report
2016-17

Executive Summary

EXECUTIVE SUMMARY

CASTOR

Germplasm

- A set of 54 trait-specific inbred lines possessing extra-early maturity (82-89 days), early maturity (99-112 days), resistance to leafhopper and wilt (0-10% wilt incidence; 0 hopper burn on 0-4 scale), resistance to leafhopper (0-1 leafhopper burn on 0-4 scale) and high ricinoleic acid content (90-92%) was developed from germplasm accessions.
- Registered an extra-early maturing accession, RG-19 (IC0612166; INGR15008) with Plant Germplasm Registration Committee, ICAR-NBPGR.
- Seven root rot resistant accessions namely RG-2757, RG-2819, RG-2818, RG-2746, RG-123, RG-118, RG-2774 were found to be immune in the wilt sick plot.
- Eight accessions (RG-2661, RG-3060, RG-631, RG-2093, RG-2301, RG-2462, RG-2526, RG-3067) confirmed leafhopper resistance (0-1 hopper burn on 0-4 scale) under artificial screening by infester-row method.
- Tolerance to drought in seven accessions (RG-373, RG-1582, RG-1667, RG-1759, RG-1922, RG-1963, RG-2058) possessing good root traits, was confirmed (drought susceptibility index of <1.0) under imposed drought conditions during rabi in the second year of trial.
- Three accessions (RG-82, RG-11, RG-298) exhibited drought tolerance (PEG method), three accessions (RG-89, RG-282, RG- 1667) exhibited temperature tolerance (TIR method) and four accessions (RG-298, RG-539, RG-1463, RG-1582) exhibited salinity tolerance (150 mmhos NaCl solution) in the laboratory.

Plant Breeding

- GCH-8, a new hybrid with 16% yield superiority over check hybrid, GCH-7 was identified for All India release.
- Pistillate lines: IPC-17, IPC-18, IPC-20, IPC-21, IPC-23, IPC-24, IPC-25 and IPC-28, were highly resistant (0-11% incidence) while IPC-19, IPC-27, IPC-29 were moderately resistant (25-28% incidence) under wilt sick plot.
- Among three pistillate lines (DPC-15, DPC-21, M-571) with early vigor and high total dry matter, DPC-21 recorded higher root length (106 cm), volume (178 cm^3), fresh weight (163.6 g), dry weight (31.9 g) and shoot - stem weight (68.6 g), leaf weight (36.4 g), total dry weight (168 g) growth when sampled at 90 DAS in poly bags.
- Two entries namely ICS-129 (PVT-11-4, 45%) and ICS-131 (PVT-11-7, 15%) were higher yielding than the best checks, 48-1 and DCS-107 (2070 kg/ha) while six other early flowering (10-11 nodes to the primary spike) entries were higher yielding (11-55%) than the early maturing check, DCS-9 (1304 kg/ha).
- Three early duration hybrids (90-100 DAS) with 76-134% increase over the best check, DCH-519 (1729 kg/ha) and six medium duration hybrids with 49-64% increase over the best check, DCH-519 (1783-2251 kg/ha) were promising in preliminary hybrid trials.
- Two hybrids namely CEH-329 (DPC-25 x JI-384) and CEH-216 (SKP-84 x PMC-19) were promising in common evaluation of hybrid trial at IIOR (rainfed) and Anand (irrigated) conditions.
- Two farmers' varieties of castor were raised in kharif, 2016 and data was recorded for 30 DUS traits in accordance with the DUS test guidelines.

Biotechnology

- QTL analysis - in a set of 167 recombinant inbred lines (RIL) of JC12 (susceptible) × 48-1 (resistant) using high density SNP linkage map (1,099 SNPs) - revealed four genomic regions linked to wilt resistance with high level of significance (LOD 4.6 - 19.4). These QTLs individually explained 5 to 34% of phenotypic variance.
- In a validation study, three SNP markers namely Rc_29648-63299, Rc_29648-57163 and Rc_29648-75201 showed co-segregation with resistance to wilt in a F_2 population of RG1289 (susceptible) × RG1149 (resistant) which can be used in selecting resistant individuals in segregating populations generated using RG1149 as the source for resistance.
- Four putative QTLs associated with gray mold resistance were detected with LOD score more than 2.5. These QTLs individually explained 8 to 25% of phenotypic variance.
- A set of seven tetraploid castor plants in the genetic background of 48-1 and DCS-107 were confirmed for chromosome doubling based on meiotic behavior and pollen fertility.
- Six analogs of the elicitor molecule, 1H3MAQ (1-hydroxy-3-methyl anthraquinone) were chemically synthesized to study their ability to induce systemic resistance in a fungal free system. These compounds along with the parent compound were tested for their antifungal activity against various plant pathogenic fungi like *Fusarium oxysporum*, *Aspergillus niger, Phytophthora infestans* and *Botryotinia ricini* and results showed a better reduction in the fungal growth with the parent compound in comparison to the synthetic analogs.
- Genome-wide transcriptome analysis indicated that during the initial stages (24 hpi) of ISR prime by Trichoderma spp., there was induction of Microbe Associated Molecular Patterns (MAMP), secondary metabolism, redox pathways, hormone metabolism, signaling and transport. By 48 hpi, genes involved in cell wall formation and secondary metabolite including anthocyanin and flavonoids production were up-regulated indicating surge in cell wall appression formation and scavenging the reaction oxygen species (ROS).
- Differential gene expression was observed for four candidate genes possibly involved in male and female flower development, in monoecious, pistillate and staminate lines. Alcohol dehydrogenase gene was found to be differentially and highly expressed in male flowers in monoecious and staminate lines. Ethylene synthesis genes (1-aminocyclopropane carboxylase synthase) were up-regulated in male flowers and down regulated in female flowers.
- De Novo assembly of 10 castor genotypes *viz.*, 48-1, TMV-5, RG-72, RG-3309, RG-2819, RG-2787, RG-1139, DPC-9, DCS-9, VP-1 analyzed for protein prediction revealed that LRR genes were found to be dominant in all the genotypes and the predicted R-genes can be utilized for development of diagnostic markers.

Crop Production

- Significantly higher castor seed yield was recorded with NPK+FYM (876 kg/ ha) closely followed by 75% RDF+25% N through FYM (767 kg/ha). Integrating organics in supporting higher seed yield from secondaries utilizing late rains and protecting yield from primaries under drought conditions was also observed.
- Significantly higher castor seed (3467 kg/ha) and oil yield (1599 kg/ha) were registered when irrigations were scheduled by drip at 0.8 Epan along with supply of full amount of N & K through fertigation.

Plant Protection

- A water dispersible granular formulation (WDG) with 67% a.i. of a potent local strain DOR Bt-127 belonging to *Bacillus thuringiensis*

var. *kurstaki* (Btk) was developed and found highly effective against larvae of *Spodoptera litura* @ 1.0 g/l

- An action threshold based on pheromone trap catches has been developed for *Spodoptera litura* in castor
- Two morphs of capsule borer (*Conogethes punctiferalis*) with distinct wing pattern have been recorded in castor and barcoded using *COI* gene
- Two parental lines of castor DPC-27 and DCS-123 and one advanced breeding line PVT-11-11 were found resistant to leafhopper
- Breeding lines *viz*., AP-33, AP-56, AP-200 and AP-156 showed resistant reaction to isolates of *F. oxysporum* f. sp. *ricini* collected from Hyderabad, Palem and S.K. Nagar

Soil solarisation combined with seed treatment and soil application of Trichoderma harzianum was found effective in reducing wilt incidence in castor

Germplasm lines RG 1963, RG 3088-1, RG-3344, RG-1062, RG 907 and two hybrids (DPC 9 x CI-2 and M574 x CI-2) and 2 inbred lines CI-1 and CI-2 were found to be resistant to gray mold under epiphytotic conditions.

SUNFLOWER

Germplasm

- A set of 530 accessions was multiplied, 160 accessions were rejuvenated and 213 accessions were supplied to AICRP centres.
- A set of 91 new accessions received from USDA, Ames, USA was established. The accessions included 10 additional diverse CMS sources (ANN14, MUT14, MUT8, MUT9, MUT10, MUT11, MUT12, PET2, GIG1, MAX1), 10 stable interspecific derivatives from crosses involving *Helianthus debilis, H. petiolaris, H. praecox, H. paradoxus* and 8 restorer lines for different cytoplasms (Rf-Rig-Luch, ANN19, ANN783, ANN106, ANN1742, ARG1575, PRA417, GIG2/MAX1631).
- The genotype PSCIM 199 was identified as early maturing genotype with maturity of 74 days.
- CMS line HA 124A/B showed field tolerance to *Alternaria helianthi* and TSG-108, TSG-261, TSG-279, TSG-391, CMS HA430A/B were found to be tolerant to powdery mildew under field conditions.
- Eight accessions (TSG 349, GP2 1227, 104A, HA 124A TSG-391, TSG-401, TSG-403, EC-537925) were identified for resistance to leafhopper with no appearance of injury/ hopperburn symptoms.
- A set of inbreds with high water use efficiency (≥ 5.0; 15 inbreds) and high photosynthetic rate (> 16.0 µmoles $CO_2/m^2/sec$; 14 inbreds), high harvest index (>30%; 19 inbreds) and high seed yield (>40 g/plant; 23 inbreds) was identified.
- Five progenies of R x R gene pool were identified as best genotypes based on survival under drought stress conditions. In addition, five progenies of R x R gene pool were identified as promising for root traits under artificial drought stress condition in poly bags.

Plant Breeding

- Six good combiner inbreds were converted into PETI-CMS lines (CMS-1001A to CMS-1006A).
- Eight hybrids (IOSH-15-08, IOSH-15-10, IOSH-15-11, IOSH-15-12, IOSH-15-14, IOSH-15-20, IOSH-15-23 and IOSH-15-27) were found promising (10-24% increased yield over the checks) in advanced hybrid evaluation trial in *rabi* season.
- A total of 400 new experimental hybrids were synthesized during *rabi*-2016-17 using existing and newly procured CMS and R lines from USDA under a common crossing programme.
- A total of 475 hybrids were evaluated at three locations (Hyderabad, Coimbatore and Bengaluru) under National Crossing Programme and found that four cross combinations (HA 133A x GKVK-2, HA 228A x GKVK-2, HA 250A x R-7, CMS103A x RHA 331) were promising.

- Under pre-breeding programme, 11 interspecific cross combinations (8 with wild *Helianthus annuus* and 3 with *H. argophyllus*) were advanced from BC_2F_1 to BC_2F_2 generation.

- DUS hybrid trial comprising of 8 candidates and 5 reference entries, R lines trial of 5 candidates and 3 reference entries, A/B lines trial of 4 candidates and 4 reference entries were conducted and entries were characterized for 30 traits in accordance with the DUS test guidelines.

Crop Production

- Sunflower seed yield was significantly highest (12.71q/ha) with the new integrated organic treatment with a yield ranging from 353 to 1271kg/ha. Lowest growth parameters *viz*., plant height, stem girth, head diameter, filling, was recorded in N alone or no manure treatments. Soil fertility after the sorghum in 2016 indicate a significant build-up of soil P recorded in all treatments receiving P (38 to 71kg/ha) compared to 9-10kg/ha in treatments not receiving any P. Available S and Zn was highest in treatments receiving S and Zn.

- The highest seed yield of 542g/plot (835kg/ha) was also recorded due to seed priming treatment with TA 5 and the lowest yield was noticed in control with 294 g/plot (452kg/ha).

Plant Protection

- Bt-127 SC formulation was effective against *Helicoverpa armigera* and *Thysanoplusia orichalcea* on sunflower at Latur and superior to the insecticidal check profenophos and a commercial Btk formulation (Delfin®)

SAFFLOWER

Germplasm

- Sixty three safflower germplasm accessions were collected during exploration tour to nine districts of Maharashtra in collaboration with NBPGR Regional Station at Akola.

- Variability was recorded for hull content (42-60%) and oil content (22.3-33%) among 50 trait specific accessions. Among the fatty acids, oleic acid ranged from 9.7 to 25.8% and linoleic acid from 66.2 to 81.7%.

- Nine accessions (GMU-5335 > GMU-4038 > GMU-3281 > GMU-95 > GMU-707 > GMU-3047 > GMU-1409 > GMU-6506 > GMU-2136) and five varieties (S-144 > Bhima > Sagar Muthyalu > PBNS-12 > A-1) showed higher tolerance to salinity in a rapid screening protocol at the laboratory.

- Multiplication of 1700 safflower germplasm accessions was undertaken during rabi 2016-17. Seeds of 33 accessions were submitted for LTS to National Gene Bank, NBPGR, New Delhi. A total of 1017 samples of 240 germplasm accessions were supplied for multilocation evaluation and screening at different AICRP (Safflower) centres and 50 accessions for utilization in breeding programmes.

- Under the Consortium Research Platform on Agro biodiversity Component-I Safflower, a total of 1100 accessions were raised in rabi, 2016-17 for multiplication, characterization and evaluation. Seeds of 889 accessions multiplied during 2015-16 were submitted to NBPGR, New Delhi.

Plant Breeding

- The safflower hybrid, ISH-388 (DSH-388) recorded 35% higher seed yield (2856 kg/ha) than the check hybrid, NARI-H-23 (2122 kg/ha) and 57% higher seed yield than check variety, A-1 (1816 kg/ha) in multilocation PHT.

- Two hybrids, DSH-256 and DSH-263 recording 23 and 21% higher mean seed yield (1574, 1551 kg/ha) than the check hybrid, NARI-H-23 (1415 kg/ha) were promoted to AHT-II.

- The high yielding spiny safflower variety, ISF-764 was promoted to AVT-I, which recorded 26% higher seed yield (1753 kg/ha) than the best check, A1 (1391 kg/ha) and

37% higher oil yield (524 kg/ha) than A-1 (382 kg/ha).

- The non-spiny variety, ISF-763 was promoted to AVT-I, which recorded 22% higher seed yield (1168 kg/ha) and 20% higher oil yield (355 kg/ha) than the non-spiny check, NARI-6 (seed yield: 959 kg/ha; oil yield: 297 kg/ha).
- One non-spiny variety, SPP-70 has been promoted to AVT-II; it recorded 16% higher seed yield (1060 kg/ha) than the non-spiny check, NARI-6 (seed yield: 915 kg/ha).
- Through marker-assisted selection, developed four high yielding wilt resistant (0-2.7% wilt incidence) interspecific inbred lines which recorded 35-69% higher seed yield (1557-1867 kg/ha) than the best check, A-1 (972-1314 kg/ha) in two replicated trials.
- Three wilt resistant safflower inbred lines *viz*., DSI-103, DSI-104 and DSI-101 showed resistance to Phytophthora (Disease severity: 0, 10, 10%) while the susceptible check, PBNS-12 had 86% disease under artificial inoculation (Agar-disc method).
- Developed 132 F_6-F_7 high oil families possessing 35-41% oil content. The high oil entry, ISF-9943-1 exhibited 35% oil content in IVT.
- Three short duration lines *viz*., ISF-863, ISF-864, ISF-865 flowered 16-17 days (67- 68 days) earlier and matured 15 days (120 days) earlier than the normal duration check, A-1 (DF:84 days; DM: 135 days).
- Two high oleic varieties *viz*., ISF-1, ISF-2 possessing 75-76% oleic acid were promoted to AVT-I. These have recoded 9-15% (1515-1597%) higher seed yield and 27% higher oil yield than A-1 (seed yield: 1391 kg/ha; oil yield: 382 kg/ha). Oil content in ISF-1and ISF-2 was 30 and 32%, respectively while it was 24-26% in checks, A1 and PBNS-12.
- Developed 134 high oleic, high yielding F_7 lines that had 70-81% oleic acid, 31-41% oil content and 820-2080 kg/ha seed yield while the best check, A-1 had 14% oleic acid, 24% oil content and 791 kg/ha seed yield.
- A set of 28 selections (F_4/F_5) with oil content ranging from 34% to 38% was identified from the crosses involving Indian and exotic crosses.
- A set of eight backcross progenies (BC F_1, BC F_2 and BC F_3) carrying high oleic alleles (ol^1ol^1 ol^2ol^2) (ol^3ol^3) (selected by marker-assisted selection) from the cross: Bhima x Montola-2000 was shortlisted for field trial.
- One farmer's variety and 2 reference varieties were raised and characterized for 25 DUS traits.

Biotechnology

- A germplasm mapping panel (n=204) was developed for association mapping and allele mining studies for oil content in safflower. The oil content in the panel ranged from 20-45%.
- A skeleton SSR linkage map of safflower was developed with 54 SSR loci using an F_2 mapping population (consisting of 174 individuals derived from A-1 x EC-755673-1 cross). In a preliminary single marker analysis, two SSR loci namely CtDES-81 (R^2=12.2%, P=3.5 x 10-6) and CtDES-91 (R^2=9.4%, P=4.7 x 10-5) showed putative association with oil content (%) in the mapping population.

Crop Production

- Seed yield of safflower in fallow-safflower was the highest with 2 rows/BBF and in greengram-safflower it was with 3 rows/ BBF.

Plant Protection

- Resistance to safflower aphid in EC-523368-2 and A-1 was a dominant trait possibly following quantitative inheritance.
- Seven accessions of safflower GMU- 2594, 2718, 4623, 2987, 5701, 1626, 2432 were found resistant to aphid.

- Safflower advanced generation lines NARI-22, 23, 26, 28, DSI-102, DSI-104, W-2026 and W-521-5 were promising against wilt.

SESAME

- A set of 240 newly synthesized hybrids were evaluated and RT 346 x S0449, Nirmala x JHS 1610 and GRT 83128 x DS5 were identified promising for high seed yield.
- Six F_1s of interspecific crosses (*S. malabaricum*-ISMB-5 x GT-10, ISMB-6 x TKG-22, ISMB-7 x GT-10, ISMB-8 x TKG-22, ISMB -9 x GT-10, ISMB-10 x TKG-22) were evaluated for pollen sterility which ranged between 60.4 and 73.7%.
- A working set of 400 SSR markers were developed and screened for their amplification and polymorphism in 50 Indian genotypes.

SOCIAL SCIENCES

- The crop information modules on castor and sunflower for Andhra Pradesh and Telangana states were developed for dissemination using the ICT's *viz.,* website and mobiles. The voice advisories on sunflower (27) and castor (24) were developed and disseminated to 3245 farmers through Reliance information services. Besides, a static Mobile App was developed for castor, sunflower and safflower which includes the information in modules; viz., crop introduction, details of AICRP-Centres, state-wise contact details of seed availability, market prices of major markets, preferred varieties and hybrids.
- Under the Frontline Demonstrations in oilseeds (FLD) under the National Mission on Oilseeds and Oil Palm (NMOOP), 6832 demonstrations were successfully laid out and monitored.
- To improve the knowledge of input dealers on oilseed production technologies, 43 trainings were conducted for input dealers, agricultural officers and extension workers.
- Under the project on Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer, the adoption of BMPs resulted to doubling the seed yields of sunflower *vis-à-vis* state average yield in Karnataka while in West Bengal seed yield increased by 44% as compared to the state average yield.
- Under the newly initiated farmers FIRST programme in Telangana, activities were undertaken on creating awareness on the importance of soil fertility and imparting skill development in soil sampling; conducting awareness camps on the importance of Integrated Nutrient management; conducting crop production technology oriented capacity building programmes; arranging exposure visits to oilseed demonstration plots besides provision of pertinent literature in local language.

SEED SECTION

- During 2016-17, IIOR SPAC has produced a total of 5q of breeder seed against a target of 2.93 of castor and sunflower. A 41q of certified seed of sesame (GT-10) was produced in farmers field at Chityal village in Nirmal district, Telangana state. Besides, 39.84 q of TFL of castor hybrid DCH-519 and 66.38q of DCH-177 was produced in farmers' field at Konkala village in Andhra Pradesh. A quantity of 12q of safflower seed (PBNS-12) was produced in Adilabad district.
- Five training programmes on seed production, two field days and one Kisan Mela were organized for capacity building and technology dissemination for quality seed production of oilseeds crops. A Skill development training on seed production was organized for diploma graduates in agriculture.

HHH

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The Institute

- Mandate
- Staff Position
- Financial Statement


ICAR - IIHR

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, oil content and quality of castor, sunflower, safflower, sesame, niger and linseed.
- Information management on oilseeds to develop policy framework for research and development strategy.
- Coordination of applied research on national and regional issues to develop location specific varieties and technologies.
- Dissemination of technology and capacity building.

Staff position as on March 31, 2017

Category	Sanctioned	Filled	Vacant
Scientific	43*	43*	0
Technical	51	41	10
Administrative	29	24	5
Skilled supporting	25	19	6
Total	**148**	**127**	**21**

* including one RMP

Financial Statement

Allocation and Expenditure

Head of Account	Allocation (R in lakhs)				Expenditure (R in lakhs)			
	IIOR Plan	AICRPO (OS + S&N + LIN)	Non Plan	TOTAL	IIOR Plan	AICRPO (OS + S&N + LIN)	Non Plan	TOTAL
A. GRANT IN AID - CAPITAL								
1 Works	198.87	0.00	0.00	198.87	198.87	0.00	0.00	198.87
1. Equipment	20.84	0.00	7.00	27.84	18.71	0.00	6.80	25.51
2. Library	8.29	0.00	6.00	14.29	8.28	0.00	5.61	13.89
3. Furniture	0.00	0.00	6.00	6.00	0.00	0.00	5.99	5.99
B. GRANT IN AID - SALARIES								
Establishment Charges	0.00	1897.90	1436.07	3333.97	0.00	1821.85	1436.07	3257.92
Overtime Allowance	0.00	0.00	0.09	0.09	0.00	0.00	0.09	0.09
Pension	0.00	0.00	147.19	147.19	0.00	0.00	147.19	147.19
Wages	0.00	0.00	279.09	279.09	0.00	0.00	279.09	279.09
C. GRANT IN AID - GENERAL								
TA	12.00	44.20	12.00	68.20	12.00	44.20	11.97	68.17
Res. & Operational Expenses	240.84	110.80	75.81	427.45	240.84	186.85	69.33	497.02
Administrative Expenses	23.44	0.00	192.25	215.69	23.43	0.00	189.43	212.86
Miscellaneous Expenses	3.00	0.00	11.50	14.50	3.00	0.00	9.96	12.96
Need Based Research	6.35	0.00	0.00	6.35	5.75	0.00	0.00	5.75
TRIBAL SUB-PLAN	12.50	15.00	0.00	27.50	12.50	15.00	0.00	27.50
TOTAL	**526.13**	**2067.90**	**2173.00**	**4767.03**	**523.38**	**2067.90**	**2161.53**	**4752.81**

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 Salaries	700.00	700.00	615.40	608.00	582.50	513.85
Grants for General	90.00	90.00	40.00	47.40	25.00	93.65
TSP	10.00	10.00	-	-	5.00	5.00
Total	**800.00**	**800.00**	**655.40**	**655.40**	**612.50**	**612.50**

Resource Generation

Particulars	Amount (` in lakhs)
Sale of Farm Produce	0.00
Sale of Old Vehicles & Machine Tools	0.00
Sale of IIOR Publications & Tender forms etc.	0.54
Rent	5.06
License Fee	2.32
Interest earned on Loans & Advances	10.63
Leave Salary & Pension Contribution	0.56
Analytical testing charges	13.12
Interest earned on STDR	36.48
Receipts from service rendered/Sale of Tech.	0.00
Unspent balance of grants	0.00
Training	0.09
Miscellaneous receipts	5.60
Total	**74.40**

Funds Received for Externally Funded Projects

Particulars	FUND	
	Receipt	Expdr
DBT Projects	0.00	0.00
DST Projects	107.90	91.31
Deposit Schemes	195.12	221.01
Total	**303.02**	**312.32**

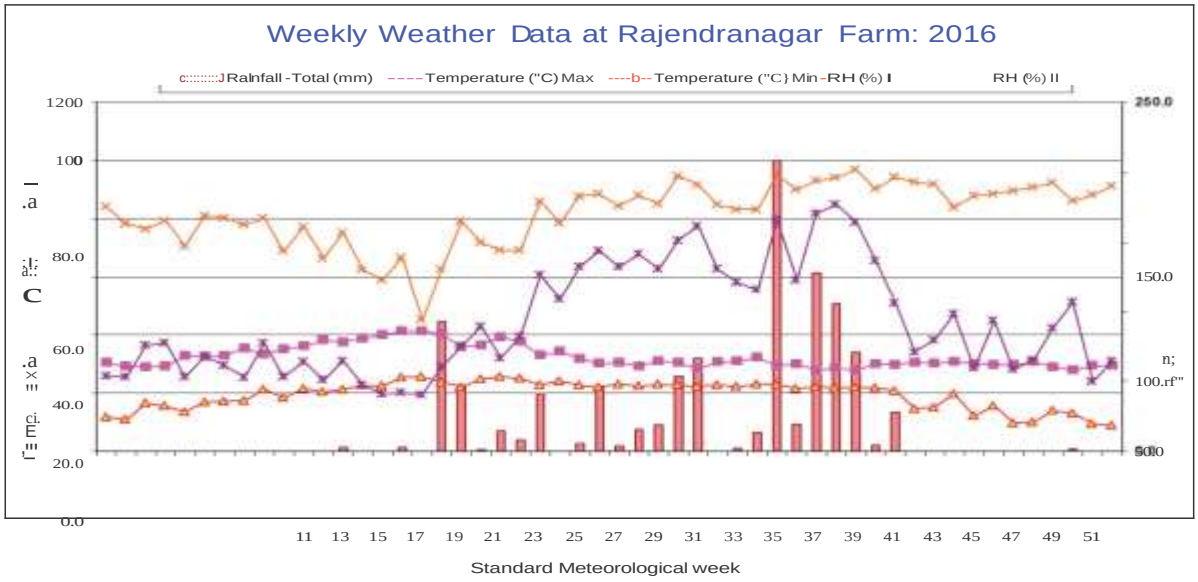
ICAR-IIOR

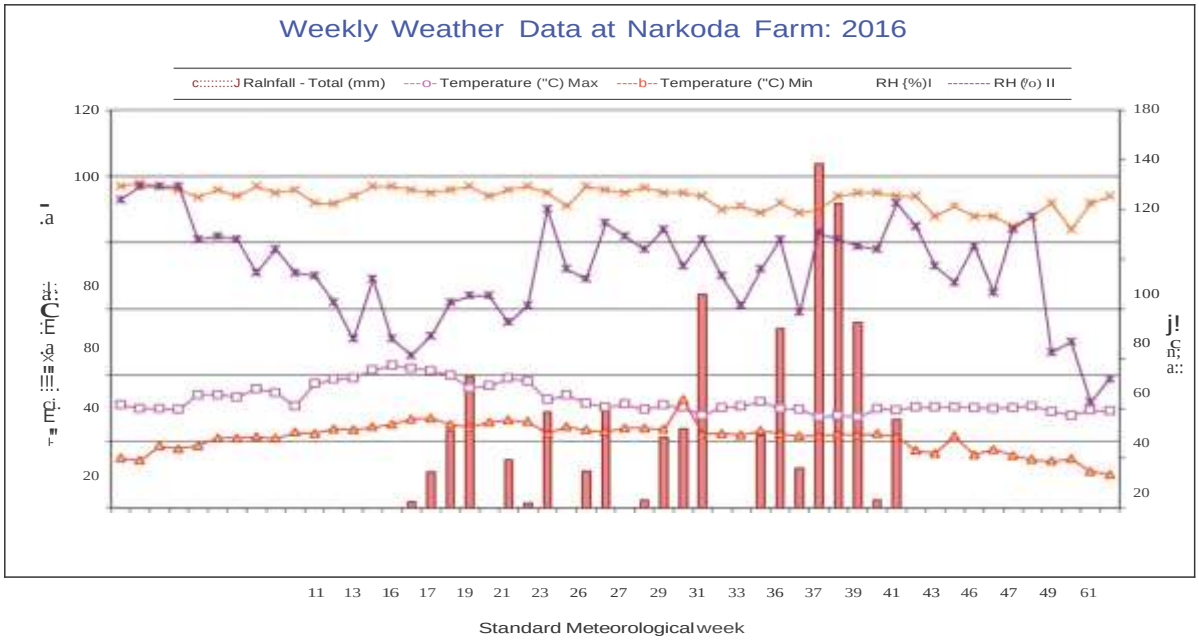
वार्षिक प्रतिवेदन

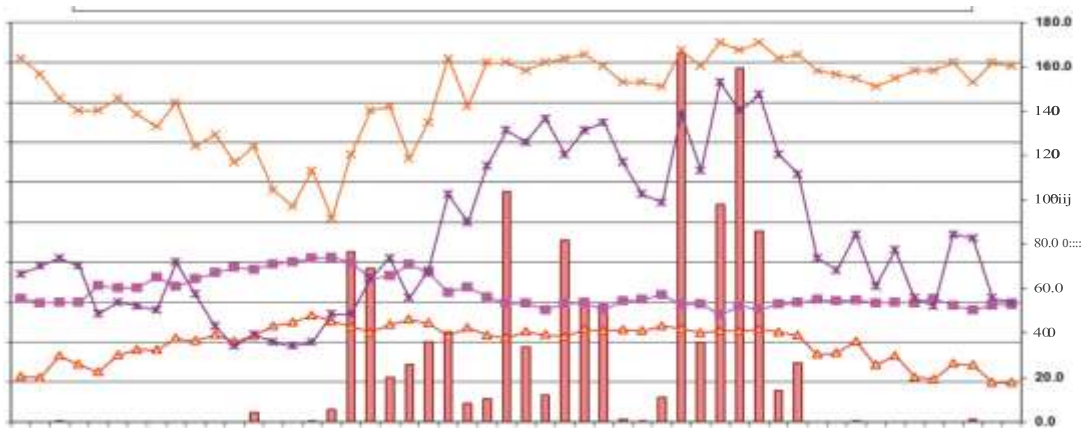
Annual Report
2016-17

Research Achievements

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


Weekly Weather Data at Rajendranagar Farm: 2016
Rainfall -Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Standard Meteorological week


Weekly Weather Data at Narkoda Farm: 2016
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%)I
RH (%) II
Standard Meteorological week



Standard Meteorological week

CASTOR

CROP IMPROVEMENT

Germplasm multiplication, conservation, documentation and supply

During the year, 137 accessions were multiplied and 3289 accessions were conserved under ambient conditions; of which, 3214 were deposited in MTS at IIOR. The information on castor germplasm collections was documented in the germplasm catalogue and Castor-Genetic Resources Information System (C-GRIS).

Exploration trip

An exploration trip was conducted for 10 days (25.11.2016 to 04.12.2016) in Odisha state and 74 accessions of different oilseed crops (sesame-10, niger-21 and castor-43) were collected in collaboration with NBPGR, Hyderabad.

Multilocation evaluation of castor germplasm accessions and inbred lines

Three experiments were taken up under rainfed and irrigated conditions at four locations in RBD with two replications. The rainfed experiments were conducted at ICAR-IIOR and Palem and the irrigated experiments were conducted at S.K. Nagar and Mandor. The net plot size was11.52 m^2 (irrigated) and 8.64 m^2 (rainfed) and the checks were GC-3 and GCH-7.

Evaluation of trait specific castor germplasm accessions: Of the 17 trait-specific accessions evaluated, one accession namely RG-4018 recorded 11% higher seed yield (1966 g/net plot) than the high yielding check variety, GC-3 (1778 g/net plot) under rainfed conditions, and RG-1587 (1614 g/net plot) and RG-1690 (1624 g/net plot) were close to GC-3 with regard to yield performance. The wilt resistant accession, RG-3100 also performed better (1524 g/net plot) under rainfed conditions. Under irrigated conditions, four accessions *viz.*, RG-4018, RG-1587, RG-4025 and RG-3999 recorded 15-26% higher seed yield (3110-3370 g/net plot) than the check variety, GC-3 (2672 g/net plot). The same four accessions also recorded higher mean seed yield (2237-2354 g/net plot) across locations than GC-3 (2200 g/net plot).

Evaluation of high ricinoleic acid castor germplasm accessions: Among 15 high ricinoleic acid (90-92%)

accessions evaluated in the second consecutive year, four accessions namely RG-3761, RG-3728, RG-3454, and RG-2045 recorded higher seed yield (1697-2045 g/net plot) than the check variety, GC-3 (1651 g/net plot) under rainfed conditions while only one accession, RG-3477 could record at par yield (3193 g/net plot) with GC-3 (3182 g/net plot) under irrigated conditions. None of the accessions could yield higher than the check, GC-3 (2416 g/net plot) across locations; however, the accession, RG-3799 yielded (2364 g/net plot) closer to GC-3.

Evaluation of trait-specific inbred lines derived from germplasm: Among the 13 inbred lines derived from five crosses, ICGP-15-11 derived from RG-2008 x RG-2787 cross and ICGP-15-59 derived from RG-2822 x RG-2836 could out yield (1861, 1799 g/net plot) the variety check, GC-3 (1778 g/net plot) under rainfed conditions while under irrigated conditions, two inbred lines namely, ICGP-15-16 derived from RG-2368 x RG-2758 cross and ICGP-15-11 recorded higher seed yield (3249, 3302 g/net plot) than GC-3 (3062 g/net plot). The same inbred lines gave higher mean seed yield (2476, 2582 g/net plot) than GC-3 (2420 g/net plot) across locations, and ICGP-15-59 (2409 g/net plot) was at par with GC-3. ICGP-15-16, ICGP-15-11and ICGP-15-59 exhibited resistance to Fusarium wilt (17, 0, 7.2% wilt incidence) in wilt sick plot.

Identification of best combiners among promising germplasm accessions

When six trait-specific accessions *viz.*, RG-2819 (wilt and root rot resistant), RG-2787 (wilt and root rot resistant and moderately resistant to *Botrytis*), RG-1647 (high yield), RG-2375 (high yield), RG-3242 (high yield), RG-3291 (high yield) were crossed to five pistillate lines each at S.K. Nagar (SKP 84, SKP 121, SKP 122, SKP 123 and JP 96) and Junagadh (JP-65, JP-89, JP-96, JP-104 , JP-106) RG-2819 and RG-3291 were found to be the best combiners at both locations. During 2016, a set of 94 new crosses was made by crossing the five registered germplasm accessions namely, RG-43, RG-47, RG-392, RG-2722, RG-1608, and four trait-specific accessions *viz.*, RG-2746, RG-3105, RG-2462, RG-2661 supplied by GMU (Castor), ICAR-IIOR to four pistillate lines at Junagadh and 3 pistillate lines at S.K. Nagar in L x T fashion.

Germplasm utilization in breeding activities

During 2016-17, a set of 34 germplasm accessions supplied by ICAR-IIOR were utilized by castor breeders at different centres in AICRP (Castor) for development of gene pools, populations, male lines and pistillate lines and for identification of superior male combiners.

Germplasm accessions utilized in various breeding activities at different castor AICRP centres

Centre	Germplasm accession	Specific trait
Junagadh	RG-2787	Resistance to wilt and root rot
Anand	RG-2194	Resistance to root rot
	RG-2822	
Bahvipatna	RG-22	Extra-early maturity
	RG-43	Early maturity and resistance to leafhopper
	RG-47	Resistance to wilt and root rot
	RG-155	Resistance to wilt
	RG-3832	High yield
Junagadh	RG-43	Early maturity and resistance to leafhopper
Navasari	RG-2800, RG-3020	Resistance to wilt
Palem	RG-18	Early maturity and high per day productivity
S.K. Nagar, Palem, Yethapur, Junagadh	RG-27, RG-111, RG-1673	High total dry matter
IIOR, Hyderabad	RG-27, RG-111, RG-298, RG-1494, RG-2139	Drought tolerance
	RG-72	Early maturity, drought tolerance

Prebreeding for developing diverse trait-specific inbred lines

A total of 54 high yielding trait-specific inbred lines was developed from 13 trait-specific germplasm accessions. These inbred lines yielded higher than the source accessions while maintaining the specific-trait.

Disease and insect resistant high yielding selections: A total of 38 trait-specific selections in S_3-S_5 generation was made from germplasm accessions for resistance to diseases and insect pests. All the selections were evaluated for *per se* performance under rainfed conditions. The selections recorded higher seed yield (82-249 g/plant) than the parental accessions (36-78 g/plant). Of these, eight were selected from wilt resistant and capsule borer tolerant (<10% capsule borer damage) accession, RG-2800; nine were selected from capsule borer tolerant (10-20% capsule borer damage) accessions, RG-2774 and RG-898; one was from *Botrytis* tolerant (15-20% disease severity under polyhouse) accession, RG-3243; 10 selections were made from five wilt resistant (confirmed in multilocation wilt sick plots & root-dip technique) accessions *viz.*, RG-3425, RG-3432, RG-155, RG-311 and RG-304, and 10 were selected from six root rot resistant accessions (confirmed by stem-tape method), RG-392, RG-1834, RG-3035, RG-2719, RG-2746 and RG-2816.

Extra-early selections: Six selections from an extra-early genepool were developed through random mating among 21 extra-early accessions for six cycles under isolation. They had 7-9 nodes on main stem, reached to 50% flowering in 33-38 days and matured in 82-87 days. They recorded higher seed yield (109-212 g/net plot) than the parental extra-early accessions (76-100 g/plant) under rainfed conditions.

Evaluation of yield potentiality of drought tolerant accessions: A set of 22 accessions, which was identified for drought tolerance based on laboratory studies and imposed drought condition in the field during *rabi* season over years at ICAR-IIOR, were evaluated for yield performance during *kharif* 2016 to identify the high yielding accessions so as to develop inbred lines. Twenty-one accessions recorded higher seed yield (206-340 g/plant) than the check, GC-3 (187 g/plant). Thirteen accessions and the check, GC-3 matured in 114 days while five accessions matured in 128 days and four matured in 142 days.

Screening of castor inbred lines derived from germpalsm against biotic stresses

Screening of self-generation populations of leafhopper resistant accessions: Among self-generation populations of 11 accessions screened against leafhopper, eight accessions *viz.*, RG-2661, RG-3060, RG-631, RG-2093, RG-2301, RG-2462, RG-2526 and RG-3067 recorded hopperburn grade between 0 to 1 (on 0-4 scale) and confirmed resistant

Trait-specific inbred lines derived from germplasm

Specific trait of inbred line	No. of inbred lines	Source accession(s)	Seed yield (g/plant)	
			Inbred lines	Source accessions
Resistance to leafhopper and wilt (0 hopper burn on 0-4 scale; 0-10% wilt incidence)	10	RG-2661	173-232	110
Resistance to leafhopper (0-1 leafhopper burn on 0-4 scale)	5	RG-631, RG-3060, RG-2526	173-215	82-91
Extra-early maturity (DF: 28-32; DM: 82-89 days), less node (5-9)	29	RG-22, RG-15, RG-26	40-88	22-35
Early maturity (DM: 99-112 days)	4	RG-17, RG-187, RG-190, RG-1591	63-126	48-54
High ricinoleic acid (91-92%)	6	RG-66, RG-226	106-152	79-81

reaction to leafhopper as compared to maximum hopperburn grade of 4 in susceptible check, DPC-9. Self-generation populations of RG-43 recorded hopperburn grade between 1 to 2, while RG-1621 and RG-2888 recorded hopperburn grade between 1 to 3 on 0-4 scale.

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

Screening of trait specific inbred lines of castor against wilt disease: Twenty four inbred lines (S_6 families) derived from multiple resistant accession, RG-2787 were evaluated against wilt disease in wilt sick plot where 12 lines *viz.*, ICI-RG2787-55-6, ICI-RG2787-60-3, ICI-RG2787-83-8, ICI-RG2787-89-30, ICI-RG2787-110-9, ICI-RG2787-152-9, ICI-RG2787-181-12, ICI-RG2787-190-18, ICI-RG2787-192-12, ICI-RG2787-217-6, ICI-RG2787- 248-20 and ICI-RG2787-287-1 were immune (0%) and 11 lines were resistant (<20%) to wilt. The susceptible check, JI-35 showed 100% wilt incidence.

Out of 12 inbred lines (S_6 families) derived from RG-2661, four lines *viz.*, ICI-RG2661-7-5-2, ICI-RG2661-7-9-1, ICI-RG2661-16-2-2 and ICI-RG2661-17-6-1 were immune (0% wilt incidence), 5 lines were resistant (<20%) and 3 were susceptible. The susceptible check, JI-35 showed 97% wilt incidence.

Out of 20 inbred lines developed through recombination breeding, three castor inbred lines IGPS-15-36, IGPS-15-58 and IGPS-15-11 were immune and 8 lines were resistant. Among S_3 families of 26 resistant accessions, seven accessions *viz.*, RG-2757, RG-2819, RG-2818, RG-2746, RG-123, RG-118 and RG-2774 were immune to wilt and resistant to root rot, and nine accessions showed <20% wilt. RG-2800 and RG-898 showed <20% wilt incidence and tolerance to capsule borer.

Seedling tolerance of selected castor germplasm with good root traits to drought, temperature and salinity

Twenty genotypes each were studied for drought as assessed by germination at -4 bars drought stress, salinity as measured by germination at 150 mmhos NaCl solution and temperature tolerance as evaluated by ≥70% survival at induction (35^{0}C) and ≥20% survival at lethal temperature (48^{0}C). Genotypes selected for different stresses are presented below:

Selected germplasm with drought, salinity and temperature tolerance

Trait	Promising accessions
Drought tolerance (with PEG)	RG-82, RG-11, RG-298 (20-37%)
Salinity tolerance (with NaCl)	RG-298, RG-539, RG-1463, RG-1582 (50%)
Temperature tolerance (with TIR technique)	RG-89, RG-282, RG-1667

Identification of diverse sources and development of wilt and leafhopper resistant pistillate lines

Diversification of pistillate base was initiated in a multiple cross programme involving eight diverse pistillate lines. Two double cross combinations involving (DPC-21 x DCS-106) x (JP-77-1 x DPC-21) and (DPC-21 x Rb-13-1854) x CNES-1 x NES-6) were produced. About 190 BC_1F_1 seeds were generated in a backcross programme involving pistillate x farmer's variety (M-619 x FC-8) x M-619.

In backcross involving F_2 of DPC-16 (pistillate) x DPC-16 (bisexual), 1:1 ratio of plants with pistillate : pistillate with top bisexual flowers were observed. In plants with top hermaphrodite flowers, filament (androecium) was abnormal and rudimentary type.

Two stable donor pistillate sources were crossed with four drought tolerant accessions with good

root traits *viz*., RG-72, RG-298, RG-1494 and RG-2139 and two accessions with high total dry matter (RG-27, RG-111) for diversification of pistillate base.

Generation advancement of 29 progenies of three crosses in BC_2F_9, 109 selections from 17 crosses in F_9 to F_{11}, 120 selections in F_3 from two double crosses were done and single plant selections were made based on pistillate trait. Single plant selections of two progenies of three crosses in BC_2F_9, 5 selections from 17 crosses in F_9 to F_{11} homogenous for morphological characters and pistillate expression were identified for further characterization.

Among the 11 pistillate lines screened in wilt sick plot at IIOR, DPC-17, DPC-18, DPC-20, DPC-21, DPC-23, DPC-24, DPC-25 and DPC-28 were highly resistant to wilt (0-11% wilt incidence) while DPC-19, DPC-27, DPC-29 were moderately resistant to wilt (25-28% wilt incidence) compared to susceptible check, JI-35 (100% wilt incidence).

Three pistillate lines with early vigor and high total dry matter *viz*., DPC-15, DPC-21 and M-571 were grown for 90 DAS in poly bags to study comparative crop and root growth in poly bags and root structures. Among these, DPC-21 recorded more root (length, volume, fresh weight, dry weight) and shoot (stem, leaf, total dry weight) growth when sampled at 90 DAS.

Castor germplasm registration

One non-spiny extra-early maturing castor germplasm accession, RG-19 (IC0612166; INGR15008) was registered with Plant Germplasm Registration Committee (PGRC), ICAR-NBPGR.

Diversification and development of wilt resistant monoecious / male lines and hybrids resistant to major pests and diseases

About 1211 progenies of F_4 to F_8 generations were evaluated for desired agro-morphological traits like type of branching (profuse, divergent), spike length (long/medium with 60-70 cm length), number and density of capsules (compact, semi-compact, loose), node number (10-17) and ideal proportion of male flowers on the spike. In addition, 135 single plant selections of three double crosses and 46 selections of a triple cross in F_4 were characterized. About 142 promising progenies, representing diverse parental contributions in their pedigree, were selected for further characterization and screening for major pests and diseases.

Among 68 monoecious lines evaluated for seed yield and yield components, 20 lines had ideal proportion of male flowers and are being used as male lines in development of hybrids. Among them, 8 monoecious lines with good basal branching ability, early to medium (11-15 nodes) duration and non-spiny capsules were selected for testing their combining ability.

Eight promising lines were identified based on maturity. The lines with 9-12 nodes for primary spike were identified as early and with 13-18 nodes as medium maturing. Four lines *viz*., PVT-12-17, PVT-12-230, PVT-12-215 and PVT-12-13 were higher yielding (20-29%) over the medium maturing check, DCS-107 (1888 g/plot).

Fifteen monoecious lines were evaluated for their *per se* performance in an augmented RBD along

Root and shoot growth of pistillate lines in poly bags

Genotype	Root length (cm)	Root volume (cm^3)	Root fresh weight (g)	Stem dry weight (g)	Leaf dry weight (g)	Spike dry weight (g)	Root dry weight (g)	TDM (g)
DPC-15	122.8	88.4	89.9	43.86	18.0	25.6	15.1	102.5
DPC-21	106.2	178.0	163.6	68.6	36.4	30.7	31.9	167.5
M-571	106.6	108.0	99.8	33.4	18.0	20.0	18.5	89.9

Promising monoecious lines in preliminary varietal trials (2016-17)

Entry	Plant height up to primary spike	Number of nodes to the primary spike	Total primary spike length (cm)	Effective primary spike length (cm)	100 seed weight (g)	Seed yield (g/plot)		
						120 DAS	150 DAS	Final
PVT12-184	28.6	7.8	27.4	27.4	19.1	1334	549	1883
PVT-12-87	50.4	8.8	33.8	27.8	32.6	1218	310	1528
PVT-12-86	49.4	9.6	26.6	21.6	33.1	1501	406	1907
PVT-12-21	52	10.6	38.4	34	28.1	1691	275	1965
PVT-12-17	96	15.6	46.6	41	31.1	1929	501	2430
PVT-12-230	74.8	11.6	42.6	42.6	25.7	1611	703	2314
PVT-12-215	140.2	18.2	36	36	18.2	998	1275	2272
PVT-12-13	98.4	13.6	51.8	45.8	30.1	1715	547	2262
DCS-9 ©	42.3	10.7	24.4	23.5	25.6	1085	345	1430
DCS-107 ©	115.9	14.7	29.9	28.8	32.8	1402	487	1888
48-1 ©	107.0	18.0	35.5	35.5	28.9	1995	236	2231

with four checks replicated after every five entries with a plot size of 10.8 sq.m. Two entries *viz.*, PVT-11-4 (45%) and PVT-11-7 (15%) were higher yielding than the best checks, 48-1 and DCS-107 (2070 kg/ha) while six other early flowering (10-11 nodes to the primary spike) entries were higher yielding (11-55%) than the early maturing check, DCS-9 (1304 kg/ha).

In a trial on generation of RILs using wilt susceptible x resistant cross through single seed descent method, 42 RILs were evaluated in an augmented RBD along with 4 male line checks after every 5 entries and found that 30 lines were promising. Selfed seeds of these RILs were generated for large scale yield evaluation. Among them, 1-4-9, 2-1-4, 2-1-18, 3-5-13, 3-5-19, 3-5-35, 3-5-41, 4-3-1 with long spikes (60-70 cm) were identified for male line development.

Studies on combining ability and heterosis

Generation of new hybrids: About 80 hybrids were generated by crossing six pistillate lines *viz.*, DPC-15, DPC-21, DPC-25, M-571, M-574, DPC-16 with 15 wilt and leafhopper resistant, male lines tested earlier for their combining ability *viz.*, DCS-78, DCS-9, 48-1, DCS-89, DCS-86, JI-315, JI-340, MCI-8, JI-226, JI-227, GP-778, JI-322, JI-338, GP-493, GP-788 to identify heterotic combinations and further evaluate in specific ecological niches of Rajasthan, Bawal, Kanpur under irrigated conditions and rainfed conditions of Hiriyur and Palem.

Another set of 24 hybrids using two early flowering pistillate lines DPC-23 and M-571 and 12 male lines *viz.*, DCS-64, DCS-86, DCS-102, DCS-105, DCS- 107, DCS-108, DCS-109, DCS-110, DCS-112, DCS-118, DCS-119 and DCS-123 were generated for evaluating them in Bhawanipatna centre of Odisha under rainfed conditions.

Estimation of heterosis : One hundred and four hybrids were evaluated in preliminary hybrid trials, along with the best checks in two row plots (10.8 sq.m), categorized as early (9-12 nodes) and medium (13-18 nodes) maturing based on their node number to primary spike, in augmented RBD along with two checks after every 5 or 10 entries. Data on yield superiority over the best check (DCH-519) is presented below.

In a trial on common evaluation of hybrids, 192 hybrids were evaluated in an augmented RBD along with 3 checks after every 10 entries at IIOR (under rainfed) and Anand (under irrigated conditions). Ten hybrids with 6-91% standard heterosis were found promising under rainfed conditions. Under irrigated conditions, five hybrids *viz.*, CEH-400

Promising hybrids in preliminary hybrid trials

Hybrid (Parentage)	Seed yield (kg/ha)	Number of nodes to the primary raceme	Significant increase over best check (%)
PHT-I-15-170 (DPC-23 x JI-226)	4054	8	134
PHT-I-15-17 (DPC-9 x GP-788)	3480	10	101
PHT-I-15-179 (DPC-23 x DCS-86)	3050	10	76
DCH-519 ©	1729	15	
PHT-II-75 (DPC-19 x GP-487)	2843	13	59
PHT-II-124 (DPC-21 x SKI-283)	2649	14	49
PHT-II-134 (DPC-21 x JI 338	2613	13	47
DCH-519 ©	1783	14	
PHT-III-230 (DPC-25 x GP-789)	2650	13	64
PHT-III-224 (DPC-25 x GP-753)	2414	13	49
PHT-III-208 (DPC-24 x GP-789)	2406	14	49
DCH-519 ©	2251	14	

(41%), CEH-244 (37%), CEH-496 (28%), CEH-402 (23%) and CEH-429 (22%) were found promising.

Twelve hybrids were evaluated in a RBD with two replications of 21.6 sq.m. plot size, under rainfed and irrigated conditions. Two hybrids *viz.*, CEH-329 (DPC-25 x JI-384) and CEH-216 (SKP-84 x PMC-19) were found promising both under rainfed and irrigated conditions. Five other hybrids *viz.*, CEH-354, CEH-349, CEH-346, CEH-253 and CEH-350 with 10-35% yield increase will be further evaluated in coordinated multi location trials.

Combining ability of parents: Combining ability of male and female parents was studied in two sets under rainfed and irrigated conditions. In set I, 3 female lines (DPC-9, M-574 and RHC- 247) and 10 male lines (PMC-21, PMC-22, PMC-24, PMC- 38, PMC-40, PMC-42, PMC-43, PMC-44, PMC-48, PMC-50) were crossed in line x tester design and evaluated under rainfed conditions in RBD with two replications. The parents were early flowering in nature with node number ranging between 12 and 14.

In set II, 8 female lines (M-619, M 619-1, M 619-2, SKP-84, DPC-21, JP-77-1, Rb-14-168 and DPC-25) and 21 male lines (PMC-4, PMC-7 , PMC-9, PMC-13, PMC-14, PMC-11, PMC-18, PMC-19, PMC-27, PMC-31, PMC-32, PMC-35, PMC-39, PMC-57, PMC-55, PMC-58, PMC-60, PMC-61, PMC-66, PMC-67, PMC-69) were crossed in line x tester design. The parents were of medium duration with node number

Promising hybrids in common evaluation of hybrids in a replicated trial (2016-17)

Rainfed conditions			Irrigated conditions		
Hybrid	Seed yield (g/plant)	% increase over check	Hybrid	Seed yield (kg/ha)	% increase over check
CEH 354	247	31	CEH 253	4657	35
CEH 329	246	31	CEH 216	4021	16
CEH 349	246	31	CEH 350	4006	16
CEH 346	243	29	CEH 329	3823	10
CEH 216	225	20	CEH 316	3589	4
DCH 177 ©	152		DCH 177 ©	2700	
DCH-519 ©	188		GCH 7 ©	3461	
GCH -7 ©	188		DCH 519 ©	3352	
Mean	219		Mean	3418	
CV (%)	11		CV (%)	10.9	
CD	5		CD (P=0.05)	801.3	

ranging from 15 to18. The F_1s were evaluated along with the parents at Hyderabad and Anand centres. Among the new pistillate lines, DPC-25 and DPC-21 and 6 new male lines *viz*., PMC-22, PMC-21, PMC-38, PMC-43, PMC-4, PMC-9 were good general combiners for seed yield.

Mapping of genomic regions associated with wilt resistance in cultivar 48-1 (Jwala)

A set of 167 recombinant inbred lines of (RIL) of JC12 × 48-1 was evaluated for resistance to wilt disease caused by *Fusarium oxysporum* f.sp. *ricini* in pot with artificial inoculation. The disease scoring was done on the basis of 'days to wilt'. The RILs were scored on 1 (susceptible) to 4 (highly resistant). Genotyping of RILs was performed following the standard procedures for Illumina Infinium genotyping assay using 5,238 SNPs. Out of 5,238 SNPs in the array, genotype calls were obtained for 4,988 SNPs of which 1,300 SNP loci segregated in the population. The average call rate of SNPs was 97 per cent. The loci having missing data points of >10% and high level of segregation distortion were removed. Finally, the genotypic data for 1,099 SNP markers was used for constructing the linkage map. The markers were assigned to linkage groups using Join map 3.0 software at the logarithm of the odds (LOD) threshold of >8. Default parameters of the maximum likelihood algorithm were used for ordering of markers in linkage groups. Map distances were calculated using the Haldane mapping function. QTL analysis was performed using QTL Cartographer V2.5. The QTL analysis revealed four genomic regions linked to wilt resistance with high level of significance (LOD 4.6 - 19.4). These QTLs explained 5 to 34% of total phenotypic variance.

QTLs associated with wilt resistance in 48-1

Linkage group	Marker	Position (cM)	LOD score	R^2
3	Rc_29642-56127	37	4.62	0.046
4	Rc_30146-1221543	5.6	9.89	0.177
4	Rc_28694-148907	11.2	19.43	0.339
4	Rc_29706-482910	18.3	11.60	0.203

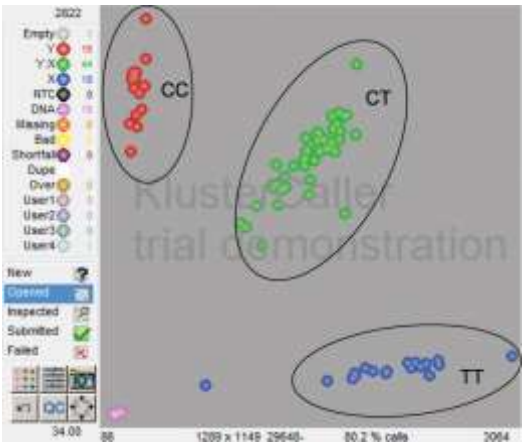
Validation of SNPs associated with wilt resistance

An attempt was made to validate the SNPs showing statistically significant association with wilt resistance in association analysis. The co-segregation of SNP genotypes with wilt resistance was assessed in the F_2 population of RG1289 (susceptible) × RG1149 (resistant). A total of 76 F_2 individuals were screened for reaction to wilt in

GCA and SCA effects of parents in set I and set II

Set I	Pistillate line	GCA effect	Male line	GCA effect	Parentage	SCA effect
	DPC-9	35.73	PMC-22	36.91	DPC-9 x PMC-43	64.84
	M-574	-35.32	PMC-21	29.96	M-574 x PMC-24	37.17
			PMC-38	30.45	RHC-247 x PMC-24	-54.58
			PMC-43	31.91	DPC-9 x PMC-42	-45.65
					M-574 x PMC-44	-29.85
					M-574 x PMC-42	27.85
Set II						
	M-619	-37.0	PMC-4	14.76	DPC-25 x PMC-13	72.35
	DPC-25	22.90	PMC-9	14.15	DPC-25 x PMC-9	58.40
	DPC-21	15.50	PMC-13	-9.80	SL x PMC-13	58.15
	SKP 84	-12.90	PMC-19	-18.30	JP-77-1x PMC-18	55.79
					SKP-84 x PMC-32	55.70
					DPC-25 x PMC-11	54.15
					JP-77-1 x PMC-13	54.14

pot with artificial inoculation. Of the 76 F_2 plants, 32 plants were resistant while 44 plants showed susceptible reaction. A subset of 20 SNP markers from the list of SNPs putatively associated with wilt resistance were used to genotype the parents of the validating population. The polymorphic markers (12) were then used to genotype the F_2 plants. Out of 12 polymorphic markers, three markers namely Rc_29648-63299, Rc_29648-57163 and Rc_29648-75201 showed co-segregation with the observed phenotype. For instance, at the marker locus, Rc_29648-63 299, 17 individuals were homozygotes for the allele 'C', 16 were homozygotes for the allele 'T' and 43 were heterozygotes.



Genotype clusters of F_2 individuals (RG1289 × RG1149) for the SNP locus Rc_29648-63299

As the wilt resistance is controlled by recessive genes with complementary interaction in this cross, it is expected that all the F_2 individuals carrying the resistant allele in homozygous condition (CC) would be resistant. The F_2 individuals carrying the susceptible allele in homozygous condition (TT) and the heterozygote individuals (CT) could be either susceptible (3 parts) or resistant (1 part) depending on the allelic composition of the second locus. When the genotypic data was compared with the phenotype of the corresponding F_2 individuals, 13 out of 17 plants carrying the allele 'C' in homozygous condition were resistant. A total of 16 plants carried the susceptible allele 'C' in homozygous condition out of which four were resistant and 13 were susceptible (1:3). Similarly, out of 43 heterozygotes, 15 were resistant and 28 were susceptible (1:3). The proportion of resistant and susceptible individuals in the F_2 generation was as per the theoretical expectation when the trait is controlled by two recessive genes in complementary interaction. The other markers Rc-29648-57163 and Rc-29648-75201 also showed similar genotype-phenotype pattern. All these markers are physically placed in close proximity (within 18,000 bases) in the genome. These markers can be used in selecting resistant individuals in segregating populations generated using RG1149 as source for resistance.

Expected and observed genotypes and phenotypes of F_2 population of RG1289 × RG1149

Expected		Observed	
Genotype	**Phenotype**	**Genotype**	**Phenotype**
$r_1r_1R_2R_2$ (1 part) $r_1r_1R_2r_2$ (2 parts) $r_1r_1r_2r_2$ (1 part)	Resistant - 19	CC - 17	Resistant - 13
$R_1R_1r_2r_2$ (1 part)	Resistant – 4.8	TT - 16	Resistant - 3
$R_1R_1R_2R_2$ (1 part) $R_1R_1R_2r_2$ (2 parts)	Susceptible – 14.2		Susceptible - 13
$R_1r_1r_2r_2$ (2 parts)	Resistant – 9.5	CT - 43	Resistant - 15
$R_1r_1R_2R_2$ (2 parts) $R_1r_1R_2r_2$ (4 parts)	Susceptible – 28.5		Susceptible - 28
Total	Resistant – 33.3 Susceptible – 42.7		Resistant – 31 Susceptible – 45

Putative QTL associated with gray mold resistance in castor

To identify the genomic regions associated with gray mold resistance, a set of 107 RILs of JC12 × 48-1 was evaluated for resistance to gray mold. The population along with parents and susceptible check (DCH-519) were raised in the experimental farm of Regional Agricultural Research Station, Chinthapalli, ANGRAU during *kharif* 2016. Under epiphytotic condition , the RILs were scored for gray mold resistance on a 1-4 scale (low to high disease severity).

Reaction of RILs of JC12 × 48-1 for gray mold at Regional Agricultural Research Station, Chinthapalli

The disease severity scores were used to identify QTL linked to gray mold resistance using QTL Cartographer V2.5. A total of four QTLs (Table), two on linkage group (LG) 3 and one each on LG-5 and LG-9 were identified at LOD score more than 2.5.

QTLs associated with gray mold resistance in castor

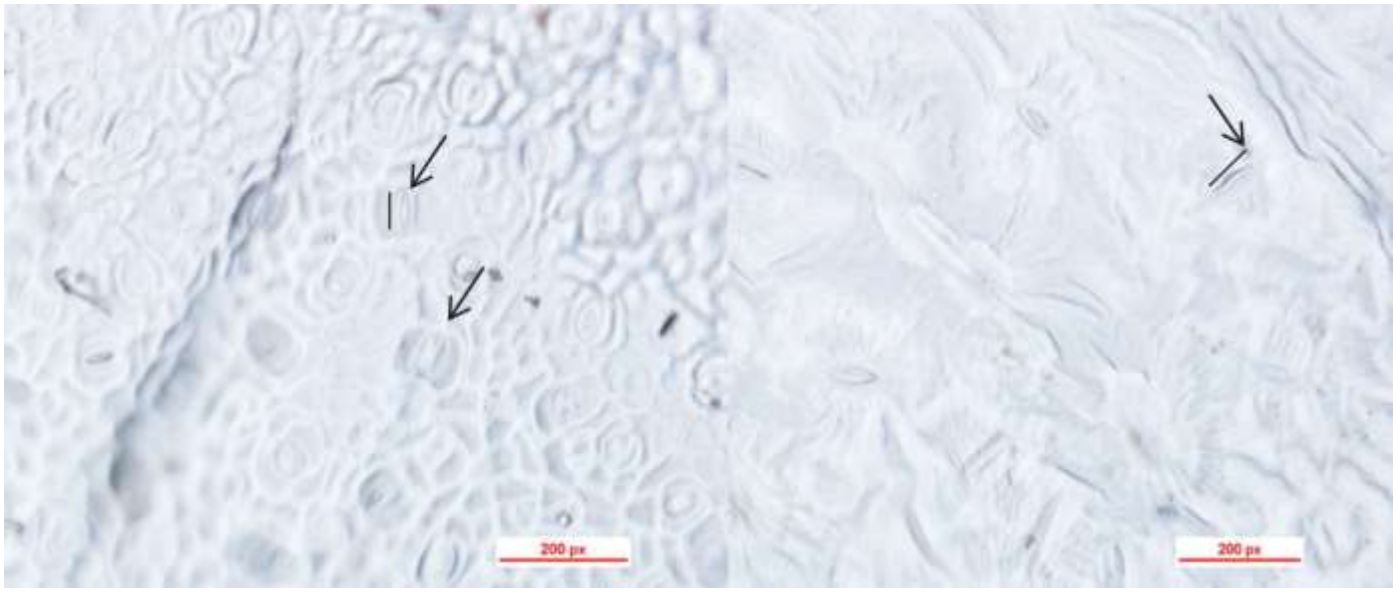
Linkage group	Marker	Position (cM)	LOD score	R^2
3	Rc_29929-1526434	34.8	4.02	0.17
3	Rc_28093-12497	83.1	3.83	0.13
5	Rc_29736-670976	92.9	2.65	0.08
9	Rc_29358-25528	48.1	7.77	0.25

Development and characterization of tetraploid castor

An attempt was made to induce polyploidy in castor using colchicine. Seeds of three castor genotypes *viz*., 48-1, DCS107 and AP41 were treated with colchicine at four different concentrations (1%, 0.5%, 0.3% & 0.1%). The seeds were soaked for three different durations (48h, 24h & 12h). A total of 600 treated plants from each genotype was sown in the field along with untreated control. Colchicine treatment at high concentration coupled with long duration impacted the germination. Germination was only 0 to 10 per cent in the treatment of 48h at 1% concentration. Germination percentage increased with reduced concentration and duration. The LD50 value for colchicine treatment based on Probit analysis was found to be 0.25% (2.44 mg/l), 0.32% (3.21 mg/l), and 0.33% (3.28 mg/l) for 48h, 24h and 12h of treatment, respectively.

Initial screening of plants for polyploidy was done based on the evaluation of stomatal traits *viz*., increase in the stomatal size and decrease in stomatal density in comparison with control. Three plants (two plants of 48-1 and one plant of AP41) with less number of stomata per unit area and increased stomatal size was found out of 1,800 treated plants evaluated (Figure). These plants were suspected to possess increased number of chromosomes.

Out of three plants, one plant (48-1) died subsequently. The pollen fertility of remaining two plants (one each from 48-1 and AP41) were severely affected. The pollen fertility was 0 to 25 per cent in the mutant of 48-1 and 15-35 per cent in mutant of AP41. Both the plants were subsequently selfed. Reduced seed setting with one or two cocci in a capsule containing aborted ovules was observed. About 15 seeds from each plant were harvested and sown in the field. A total of 12 progenies of



Control plant **Treated plant**

Number and size of stomata in control and treated plants

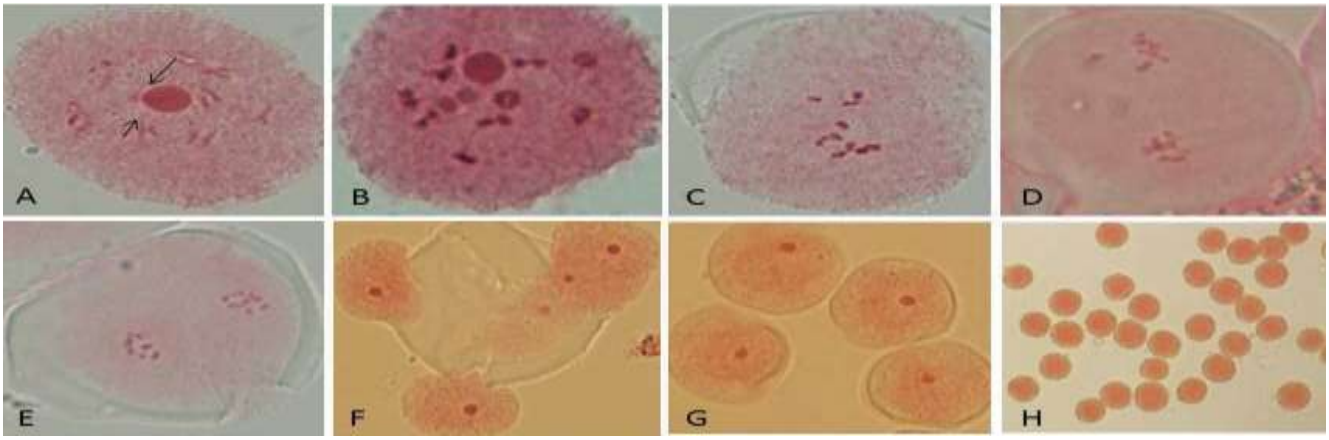
mutant 48-1 and 10 progenies of mutant AP41 were maintained. These plants were analyzed for pollen fertility and ploidy status through standard cytological procedures. The mean pollen fertility of progenies varied from 4 to 55% across plants in mutant 48-1 and 33 to 62% in mutant AP41.

Out of 22 plants, seven highly sterile plants (4 of 48-1 and 3 of AP41) were subjected to meiotic analysis with 1% propionic carmine to count the chromosomes and study the pairing pattern. Male buds fixed from 7 AM to 9 AM were found to undergo sporogenesis. The male flowers possessed anthers of different development stages; therefore, all the stages were observed in a single male flower. The outer anthers matured earlier when compared to the inner ones.

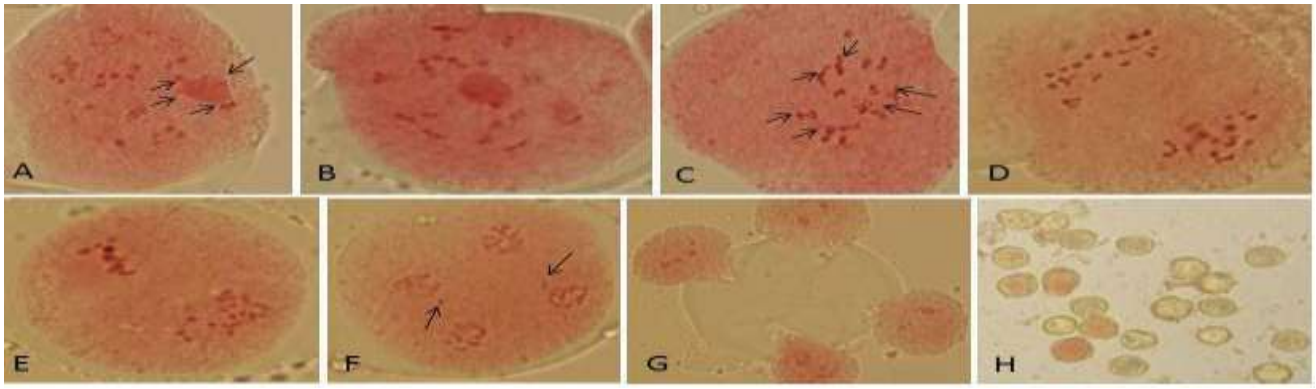
The PMCs with good spread, which were in different stages such as diakinesis, metaphase, anaphase and tetrad, were studied for chromosome association and movements. The chromosome associations were counted at diakinesis and chromosome behavior was studied at anaphase-I and in tetrad. At least 100 well spread cells were counted and the mean was calculated. The control (diploid) plants showed ten bivalents in diakinesis and the immature pollen grains were observed to have one nuclei. The nucleolus organizer region (NOR) was found in two chromosomes. Pollen fertility of control plants was 99% and the pollen grains were of uniform size. The chromosome number in all selected progenies of colchicine treated plants were found to be doubled (2n=4x=40). The chromosome association in Diakinesis and Metaphase-I indicated tetraploid behavior with univalents, bivalents, quadrivalents and other associations. The pairing was abnormal with higher chromosome configurations but the division was normal. Quadrivalent association was more frequently observed. The pollen fertility increases with increased in number of bivalent formation during Metaphase-I. Normal tetrad formation was observed. The immature pollen cells contained more than one nuclei.

Meiotic chromosome associations at Diakinesis/ Metaphase-I, Sporad formation at the end of meiosis II and pollen fertility in different plants

Plant	Chromosome association at diakinesis / metaphase-I							Most frequent association	Number of nuclei	Pollen fertility (%)
	I	II	III	IV	V	VI	VIII			
48-1-P1	0-1	1-12	0-4	1-8	0-3	0-3	-	8II+6IV	1-5	19.4
48-1-P5	-	2-10	0-3	3-7	0-2	0-1	0-1	5II+6IV+1VI	1-3	20.4
48-1-P6	-	2-9	-	4-8	-	0-1	0-1	9II+4IV+1VI	2-4	3.9
48-1-P10	0-1	2-11	0-2	0-9	-	0-1	-	4II+8IV	1-2	15.2
AP41-P1	-	6-16	0	2-7	-	-	-	12II+4IV	1-3	32.5
AP41-P2	0-1	5-14	0-1	4-6	-	0-1	-	14II+3IV	1-2	49.8
AP41-P10	-	6-16	-	2-7	-	-	-	16II+2IV	1-2	62.3



Cytological behavior of normal diploid castor [A: Diplotene with two NOR (arrows indicating NOR), B: Diakinesis with 10 II, C: Metaphase (10 II), D: Anaphase I, E: Metaphase II, F & G: Microspores with single nucleus, H: Stained pollen grains showing 100% pollen fertility]



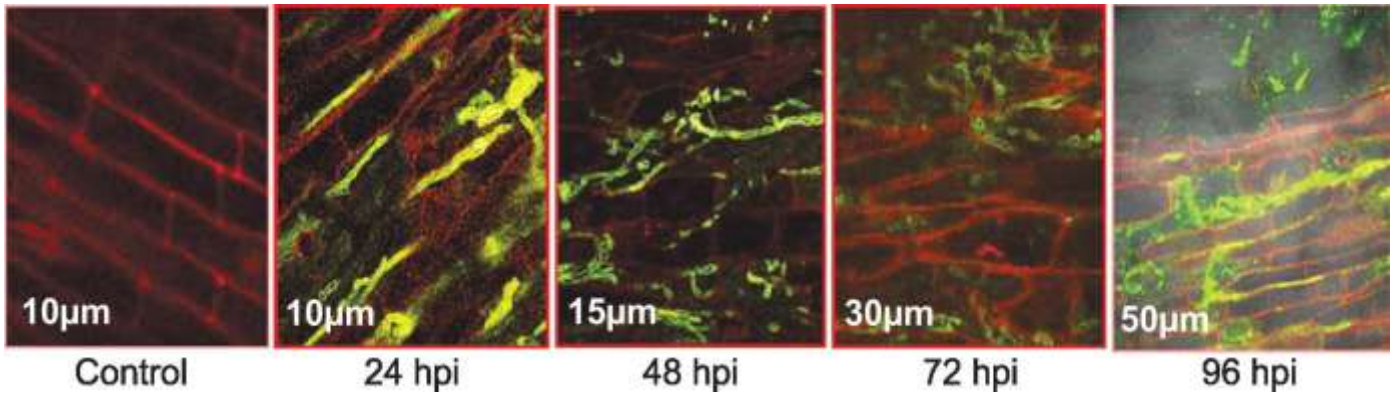
Cytological behavior of treated plant 48-1-P1 [A: 4 NOR association (arrows indicates NOR), B: Diakinesis with 1 I+12 II+3 III+1 IV+1 V, C: Metaphase with 8 II + 6 IV (arrows indicate quadrivalents), D: Anaphase 1, E: Metaphase II (Equatorial and Polar view), F: Anaphase II with laggards, G: Microspore with more than two nuclei, H: Stained pollen grains showing pollen sterility]

Deciphering molecular mechanism of induction of biotic stress tolerance by *Trichoderma* spp. in castor

The *Trichoderma* strain Th4d was identified to be the best in terms of colonizing castor roots (genotype DCS-107). To assess the extent of colonization *vis-à-vis* the time after inoculation, hence, confocal laser microscopy studies were taken up with Tricho-treated castor roots stained with fungal chitin specific wheat germ agglutinin – Fluorescent iosthiocyanate (WGA-FITC) conjugate. Hydroponic seedlings of castor treated with 10^5 spores/ml of Th4d for 24, 48, 72 and 96 hours were used. The clear penetration of the fungal mycelium and colonization was observed through the interstitial spaces of the cortical cells (Figure). By 96 hpi, *Trichoderma* colonized roots up to a depth of 50 µm and it was also observed that the penetration and colonization of *Trichoderma* was restricted only to the cortex region.

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

Characterization of the identified elicitor: In the earlier experiments, it had been demonstrated that 1-hydroxy-3-methyl anthraquinone (IH3MAQ) was present only in the secretome of P+T (Plant+Trichoderma) treatment but not in either P or T alone treatments. Thus it was identified as a candidate elicitor triggering ISR in castor and was established through repeated experiments. To study the ability of 1H3MAQ and its analogs to induce systemic resistance in a fungal free system, 1H3MAQ was synthesized and then six analogs of IH3MAQ were chemically made by substituting the 1 hydroxyl group.

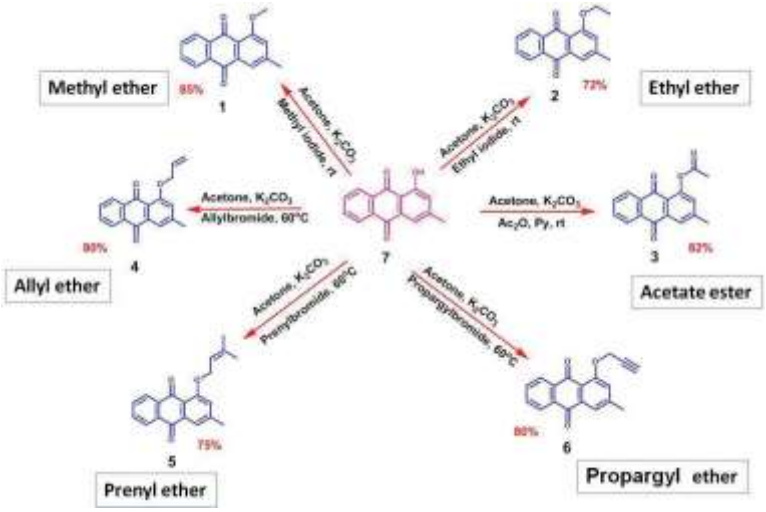


Confocal laser scanning microscopy of the WGA-FITC stained untreated and Th4d treated (24, 48, 72, 96 hpi) castor roots. (Numbers in the figure indicate the depth of laser slicing).

These seven compounds (1H3MAQ and six derivatives) were tested for their antifungal activity against various fungi like *Fusarium oxysporum, Aspergillus niger, Phytophthora infestans* and *Botrytis ricini* and results showed a better reduction in the fungal growth with the parent compound (IH3MAQ) in compared to the synthetic analogs.

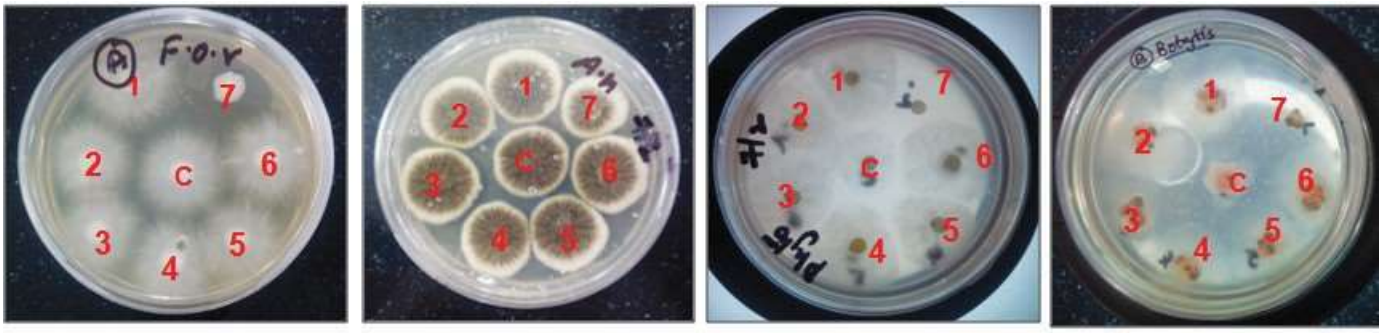
To study the ability to induce systemic resistance, 1H3MAQ and its analogs were used in hydroponic experiments. Assessment of ISR as indicated by the reduction of *Phytophthora* infection on the leaves demonstrated that the compounds did not show ISR comparable to that shown by *Trichoderma* germlings. However, the parent compound (1H3MAQ) showed significant effect in reducing the spread of the fungi. Experiments are underway to check the ability of these compounds at different concentrations and combinations to induce systemic resistance in the hydroponic seedlings.

Transcriptome analysis: Genome-wide transcriptome of castor was subjected to



Six analogs synthesized from I Hydroxyl 3 Methyl Anthraquinone

Burrows-Wheeler Aligner (BWA) analysis and gene ontology studies. Pathway analysis of the differentially expressed genes indicated that during the initial stages (24 hpi) of ISR prime, there was induction of Microbe Associated Molecular Patterns (MAMP), secondary metabolism, redox pathways, hormone metabolism, signaling and transport. By 48 hpi, genes involved in cell wall formation and secondary metabolite including anthocyanin and flavonoids production were up-regulated indicating surge in cell wall appression formation and scavenging the reactive oxygen species (ROS). During ISR boost, the most striking aspect was the cell wall reinforcement along with secondary metabolites and hormone metabolism that pointed to a mounted reaction against the pathogen and trying to restrict the spread of the pathogen as well as activating the transport machinery and signaling.



Antifungal analysis of the elicitor compound (7) and their six analogs (1-6) with Fusarium oxysporum, Aspergillus niger, Phytophthora infestans and Botrytis ricini and untreated control (C).

Proteome and metabolome analysis: Xylem sap collected from one set of Tricho-treated and untreated castor seedlings was subjected to

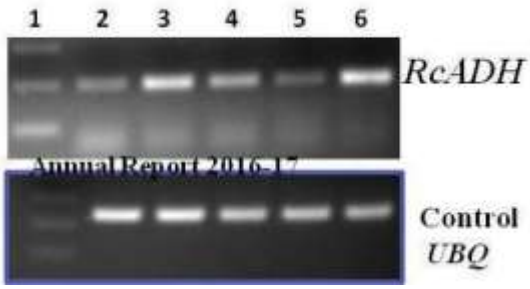
Induced systemic resistance against *Phytophthora infestans* by 1H3MAQ (7) and its six analogs (1-6) as compared to untreated and Th4D treated @10^5 germlings/ml castor seedlings

LC-MS/MS which indicated clear differences induced by *Trichoderma* colonization and for confirmation of results, the same is being repeated with two more sets. Differentially expressed proteins have been identified using 2D electrophoresis.

Molecular mechanisms governing sex expression

The standard sex phenotype in castor is monoecious but castor exhibits wide variations in sex expression. The sex lability/alterations and reversions in castor was found to be due to alterations in the male and female developmental pathways since there was an intermediate bisexual state in both male and female fl Reversion to bisexuality occurs in female fl and bisexual to male fl occurs at higher orders of branching.

Gene expression profi was carried out by RT-PCR for 8 candidate genes, using RNA isolated from monoecious line from 3-5 different tissues/ stages and also for 6 genes in 3 parental lines (monoecious, pistillate and predominantly staminate) to confi differential gene expression of 4 candidate genes, possibly involved in male and female fl development. Gene involved in biosynthesis of ethylene (1- aminocyclopropane carboxylase synthase) was up-regulated in male fl while down-regulated in female fl Alcohol dehydrogenase gene was found to be differentially and highly expressed in male fl in monoecious and staminate lines.



Differential gene expression of alcohol dehydrogenase gene (Rc *ADH)* showing high expression in male fl of monoecious DCS 107.1: 100 bp ladder, 2: Undifferentiated shoot apical meristem, 3: Differentiated shoot apical meristem, 4: Leaf, 5: Female fl and 6: Male fl Lower panel shows gene expression in control gene *Ubiquitin*.

Sex expression in the progeny of epimutagen treated plants were verifi From each of 2 parent plants treated (seed treated and injected) with a single concentration of epimutagen, 10 seeds were sown in fi to raise progeny plants. Progeny plants of both the parents subjected to 4 different concentration (1X, 5X, 10X and 20X) were raised. Nearly 100 plants were monitored for variation in sex expression but no signifi difference was observed in progeny of DCS 107. ISF were observed in DCS 107 in a few plants, while in RG 156 the proportion of male fl decreased (20-30%) instead of 70-80% in one progeny line of 1X concentration. Seed setting was poor in epimutagen-injected parent plants of pistillate line.

Sex expression in progeny of epimutagen treated plants of monoecious lines RG 156. A, Inflorescence of untreated control plants (B, C) Inflorescences of epimutagen (2-deoxy-5-azacytidine) treated plants at 1X concentration with reduced number of floral whorls.

Castor genotypes M574 (male and female) and DCS-107 (monoecious) were chosen for transcriptome analysis. Total RNA from 12 different tissues which included male buds, female buds, male inflorescence, female inflorescence, hermaphrodite flowers and leaves was isolated and subjected to transcriptome sequencing at JAU, Junagadh. The mRNA library was sequenced in Next Generation Sequencer and 1.5 to 12.4 Gbp data was generated in different tissues and the data is being analyzed for identification of candidate genes that are differentially expressed during sex differentiation at IASRI, New Delhi.

De Novo assembly of NGS reads and mining for resistance genes

Illumina reads of fourteen castor genotypes sequenced were subjected to QC analysis which revealed good read quality with phred score >40 suggesting the utilization in deNovo assembly without any requirement for trimming. De novo assembly of 10 castor genotypes viz., 48-1, TMV-5, RG-72, RG-3309, RG-2819, RG-2787, RG-1139, DPC-9, DCS-9, and VP-1 was done and the assembled coatings of each genotype were analyzed for protein prediction using Augustus. Protein functional analysis was done using pfam and plant resistant genes were mined. Among all the classes of R-genes, LRR genes were found to be dominant in all the genotypes. The predicted R-genes can be utilized for development of diagnostic markers.

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

The total annual rainfall at Narkhoda farm for 2016 was higher than normal (859 mm as against the normal rainfall of 730 mm) despite the severe drought during the active *kharif* cropping period (June to August = 207 mm) and excess rain during end of August to September (452 mm) affecting the crop both during growth and at harvest stages.

RDF with or without FYM recorded higher seed yield of sorghum (2343 to 2266 kg/ha). No manure or N alone application recorded lowest seed yield.

For castor, significantly highest seed yield was recorded with NPK+FYM (876 kg/ha) closely followed by 75% RDF+25% N through FYM (767 kg/ha). However, the late rains had helped castor crop for its rejuvenation to

yield high from secondaries. The treatment 75% PK+25% N through FYM recorded highest seed yield from primaries (528 kg/ha) indicating its contribution in imparting better drought tolerance. Under the specific rainfall distribution pattern of 2016, the treatment with NPK+FYM also recorded significantly higher yield from secondaries (552 kg/ha = 63% of total yield) to utilize the available opportunity of moisture (rain) while 75% NPK+25% N through FYM and only NPK recorded majority of yield (69 and 60%) coming from primaries. Other inorganic nutrient management could realize higher yield from primaries only even under the scope for higher moisture availability due to late rains. This indicates the value of integrating organics in supporting higher yield from secondaries utilizing late rains and protecting yield from primaries under drought. 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.

Spike-wise seed yield of castor as influenced by fixed plot INM treatments in sorghum – castor cropping system in Alfisols under rainfed conditions

Treatment		Seed yield (kg/ha)		
Castor	**Sorghum**	**Primaries**	**Secondaries**	**Total**
N (60kg/ha)	N (60kg/ha)	157	35	292
NP (60:40:0)	NP (60:30:0)	384	300	684
NPK (60:40:30)	NPK (60:30:30)	392	256	648
50% NPK (30:20:15)	50% NPK (30:15:15)	187	384	571
75% NPK + 25% N (FYM) (45:30:22) (15N)	75% NPK + 25% N (FYM) (45:22:22) (15N)	528	239	767
NPK (P through SSP)	NPK (P through SSP)	298	248	546
NPK (60:40:30)	NPK (60:30:30) + 10kg Zn/ha (ZnO)	301	220	521
NPK + 5t FYM/ha	NPK + + 5t FYM/ha	324	552	876
No manure/fertilizer	No manure/fertilizer	176	84	260

Performance of *rabi* castor under drip irrigation/fertigation

Significantly higher castor seed yield (3467 kg/ha) and oil yield (1599 kg/ha) were registered when irrigations were scheduled by drip at 0.8 Epan along with supply of full amount of N& K through fertigation. It was on par with scheduling irrigation through drip at 0.6 Epan through fertigation. Drip irrigation resulted in high water-use efficiency (3.93 to 6.28kg/ha-mm) and highest water productivity ranging from (0.3324 to 0.6445 kg/m^3) compared to conventional surface irrigation treatment (0.2232 kg/m^3). Under the scenario of scarcity of water and depleting water table the research output would help in economizing water and nutrients leading to higher productivity and profitability to castor growers.

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

Thermal requirement of *rabi* castor as influenced by planting time and genotypes

The Growing Degree Days (3090 ^{0}c), Helio Thermal Units (24537 degree-days-hours), Photo-Thermal Units (35158 degree days hours) and Heat Use Efficiency (0.741 kg ha^{-1} degree days) accumulated was highest in the crop planted on on 3rd week of Sept. and registered highest seed yield (2281 kg/ha). With delay in planting during Oct 15, Nov 1 (30 days) yield of castor was declined by 18.1% and 63%, respectively. The oil content (47.96%) was highest when castor crop was sown during 3rd week of October and lowest when sown during Ist November (45.28%). Among genotypes, the highest oil content (48.35%) was noticed in DCH-177.

Evaluation of suitable genotypes of *rabi* castor under different planting time

Nine public sector released genotypes of castor in seed chain; six hybrids *viz.*, GCH-4, GCH-7, PCH-111, YRCH-1, DCH-177, DCH-519 and three varieties 48-1, DCS-107 and GC-3 were evaluated in bigger plots during *rabi* season. Among castor hybrids significantly highest seed yield was recorded in DCH-519 (3217 kg/ha) closely followed by GCH-7 (2817kg/ha). The wilt incidence in different genotypes varied from (1.43%) in 48-1 to 93% in YRCH-1.

CROP PROTECTION

ENTOMOLOGY

Development of WDG formulation (60-90%) of *Bacillus thuringiensis* var. *kurstaki* strain Bt-127 using wet pellet with starch and different wetting agents and dispersants

WDG formulation of Bt-127 containing 67% a.i. was developed with starch, guar gum and tween-80. Laboratory bioassays with the formulation resulted in 93.3% mortality of 7 days old *S. litura* larvae by 5 days after treatment in comparison to Bt-127 (technical) @ 1.5 g/l. The effective dose was thus reduced by 55.4%. Heat viable spore count of the formulation was 2.54 x 10^{17}/g. Neither bacterial and fungal contaminants nor human pathogens were present in the formulation media revealed absence of human pathogens - *E. coli*, Salmonella, Shigella and Vibrio. Potency of the formulation against 7 days old *S. litura* larvae at 72 h after treatment was 66,948.61 SU/g using Delfin (55,000 SU/g) as the reference standard.

Determination of physico-chemical properties of the DOR Bt-127 67%WDG formulation

Physico-chemical properties of DOR Bt-127 67%WDG formulation were determined using CIPAC methods. The size of granules in the formulation ranged between 0.43 and 0.85 mm as determined by sieve test. Acidity and alkalinity test revealed that pH of the formulation was neutral. Moisture content was 3.5% while complete wetting of the formulation in standard hard water took 17

minutes. The dispersion and stability/suspensibility were 87.9% and 83.3%, respectively. The flow ability and cohesiveness as determined by Carr index and Hausner ratio of the formulation was in the range of free-flowing class.

Evaluation of Bt-127 SC formulation against *Spodoptera litura*

Field testing of Bt127 SC formulation against *Spodoptera litura* was undertaken during *rabi* 2016 on castor cultivar DCH-519. The testing was undertaken along with an untreated control in half acre each with one protective irrigation. Bt-127 SC formulation sprayed plot recorded lower incidence of *S. litura* larvae/plant (11.2) coupled with low foliar damage (7.8%) at 5 days after spray in comparison to 79.6 larvae/plant and 16.7% foliar damage in control. Yield in Bt sprayed plot was higher at 166 kg in comparison to 112 kg in unsprayed control plot.

Bt-127 SC formulation sprayed Unsprayed control

Developing pheromone trap catches based action threshold for *Spodoptera litura*

Seasonal activity of *S. litura* in castor has been monitored using pheromone traps during *kharif*, 2012-2016 at two locations (Rajendranagar and Narkhoda). Moth catches in pheromone trap and percent defoliation due to *S. litura* on castor were recorded at weekly intervals. Regression analysis of the data revealed that moth catches in pheromone trap was a linear function of percent defoliation in field (3 weeks after catches) indicating possibility of assessing level of damage from pheromone trap catches. Prediction model developed using linear log model revealed moth numbers in pheromone trap corresponding to 25% defoliation estimated as 81 moths/trap/week. Suitable control measures should be initiated within two weeks when moth catches exceeds 81/trap/week.

Prediction of *S. litura* moth emergence in relation to weather factors

Studies have been conducted on influence of abiotic factors on emergence of *S. litura* moths in castor using pheromone trap during *kharif* 2012-16. Analysis of four year data on the influence of abiotic factors in relation to weekly pheromone trap catches revealed that minimum temperature and rainfall have greatly influenced moth emergence in castor, while wind speed adversely affected the emergence. *S. litura* moth emergence based on these weather parameters was computed following the stepwise regression equation as Y = -35.24+3.3* Minimum Temperature -1.02*Wind speed+0.169* Rainfall. The model equation can be used to forecast moth emergence and per cent defoliation in castor.

DNA barcoding of castor capsule borer populations

Two morphs of capsule borer (*Conogethes punctiferalis*) with distinct wing pattern have been recorded in castor. Intra-specific variation in the populations of capsule borer was studied using mitochondrial cytochrome oxidase subunit I (COI) gene. Polymerase chain reactions performed using specific primers amplified ~650 bp of the COI gene. Consensus and related species sequence analysis revealed that the populations have no intra-specific variation. The nucleotide sequences of COI regions of capsule borer populations submitted to the GenBank, NCBI with registration No. KY682726 and KY682727.

Studies on behavioural response of capsule borer to plant kairomones

Behavioural response of adults and larvae of capsule borer to the highly susceptible (DCS-9) and less susceptible lines (RG-2774, RG-2800, 48-1) was studied using free-choice tests. Results revealed that the moths highly preferred for oviposition in DCS-9 (16 to 28 eggs/spike) as compared to less susceptible lines (9-12 eggs/spike). Larval preference studies revealed that the percent attraction of larvae was high (38%) with DCS-9 as compared to less susceptible lines (18 to 25%). Plant kairomones of immature castor capsule coat assayed in GC-MS revealed the presence of alpha-pinene in highly susceptible line, DCS-9.

Confirmation of leafhopper resistance in new castor parental lines

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

Evaluation of selected advanced breeding material against leafhopper

Among 24 advanced breeding materials screened against leafhopper, only one entry *viz*., PVT-11-11 found highly resistant to leafhopper (hopper burn grade 0 on 0-4 scale). Seven lines (PVT-11-5, PVT-11-61, PHT-11-38, PHT-11-47, PHT-11-51, PHT-11-52 and PHT-11-53) found moderately resistant to leafhopper (grade 2), while 16 lines found susceptible to leafhopper (grade 3 to 4).

Screening of PHT-11-3-F3 materials against leafhopper

Among 200 plants of PHT-11-3-F_3 screened against leafhopper, 48 plants showed resistant reaction (hopper burn grade 1), 130 plants showed moderate reaction (hopper burn grade 2) and 22 plants showed susceptible reaction (hopper burn grade 3).

PATHOLOGY

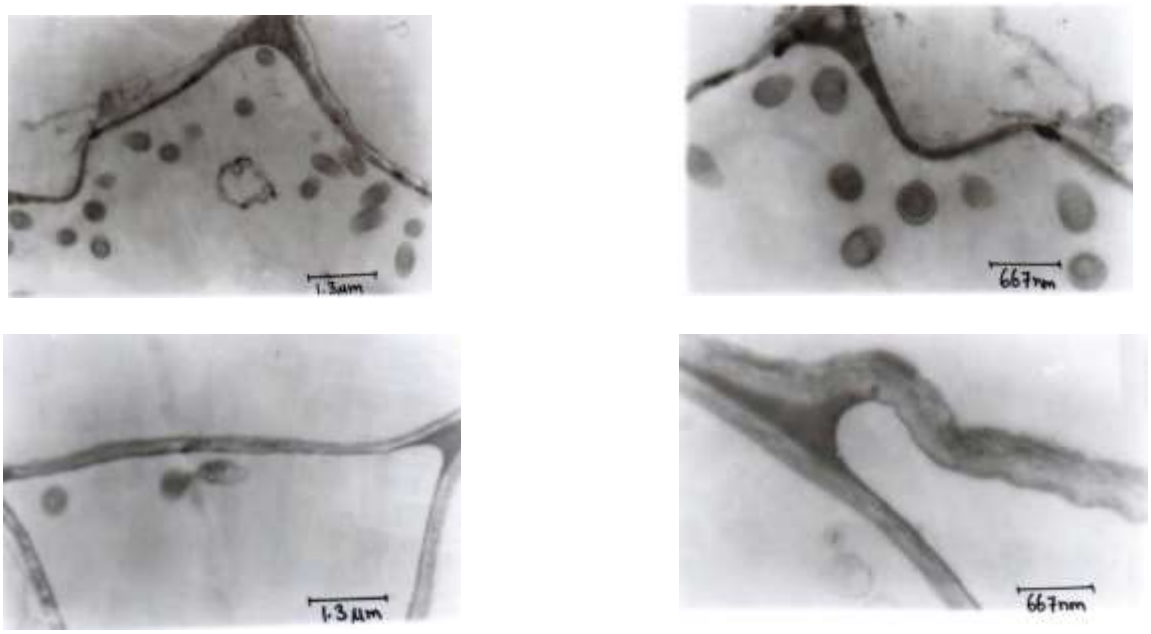
Host - pathogen interaction during wilt disease

The cross sections of castor cultivars JI-35 (susceptible) and 48-1 (resistant) were subjected to transmission electron microscopy (TEM) 48h after inoculation with *Fusarium oxysporum* f. sp. *ricini*. Many small microspores of fungus were observed in cells of inoculated JI-35 and 2-3 spores observed in cells of inoculated 48-1. In sections of healthy JI-35 and 48-1, cells were healthy, hyaline and sterile. The cell membrane was thick in 48-1 than JI-35. Colony count was less in resistant (48-1) than susceptible (JI-35) cultivar. In JI-35, population in the root tissue was moderate at 30 days after sowing (DAS), increased to maximum by 90-120 DAS.

Host plant resistance

Nine germplasm accessions *viz*., RG-2462, RG-2529, RG-737, RG-2746, RG-3018, RG-3233, RG-3477, RG-3746, RG-3795 and RG-2008 x 2787 P30 showed <20% wilt incidence in sick plot screening, confirmation of resistance to wilt in sick pots, accessions RG 155, RG-386, RG-1624, RG-2781, RG-3042, RG-3432 recorded <20% wilt incidence.

The advanced breeding lines *viz*., DPC-25, PVT-11-3, PVT-11-18 were highly resistant to wilt in sick plot and lines PMC-9, PMC-11, PMC-14, PMC-15, PMC-16, PMC-17, PMC-24, PMC-38, PMC-55, PMC-60, PMC-65, PMC-66, PMC-67, PMC-78, PMC-79, PMC-81, DPC-17, DPC-18, DPC-20, DPC-21, DPC-23, DPC-24, DPC-25, DPC-28, PVT-11-3, PVT-11-5,PVT-11-17,PVT-11-18, PVT-11-19, PVT-11-21, PVT-11-26, PVT-11-70 showed <20% wilt incidence. In confirmatory screening, breeding material *viz*.,



Reaction of susceptible and resistant castor cultivars to Fusarium oxysporum f. sp. ricini. A.B. Cross sections of JI-35-48 hrs after inoculation under transmission electron microscopy. C.48-1-48 hrs after inoculation; D.48-1-Healthy.

PVT-11-3,PVT-11-17, PVT-11-18, PVT-11-19, PVT-11-21, PVT-11-26, DPC-17, DPC-18, DPC-20, DPC-21, DPC-23, DPC-24, DPC-25, DPC-28, PMC-65, PMC-66, PMC-67, PMC-78 showed <20% wilt.

In wilt sick pot screening, advanced lines viz., CEH-327, PHT-I-15-181, PHT-I-15-184, PHT-II-15-238, K-14-118-1, K-14-119-1, K-14-123-2, K-14-613-1, K-14-777-1, K-14-847-1 were highly resistant and lines PHT-I-15-179, PHT-I-15-175, PHT-I-15-187, PHT-II-15-135, PHT-II-15-136, PHT-II-15-239, K-14-542-1, K-14-646-1, K-14-648-1, K-14-769-1, K-14-771-1 showed <20% wilt. Apart from this, six new inbred lines were found highly resistant (0% wilt). These six lines will be used for hybrid development.

Inheritance of wilt resistance

The segregation pattern of wilt resistance in four resistance sources was studied. Four F_2 populations were generated by crossing the resistance sources with different susceptible lines. The F_1, F_2 individuals and parents were screened in wilt sick plot. The F_1s of the crosses involving 48-1, CI-1 and AP-48 were susceptible indicating that nature of resistance in these sources could be recessive. The F_1 of AP-134 × AP-42 cross was resistant indicating the resistance to wilt in AP-42 could be dominant. The F_2 segregation pattern indicated that the resistance is inherited as single recessive in JI-35 × 48-1, digenic recessive with complementary interaction in AP-306 × CI-1 and AP-52 × AP-48 and digenic dominant with complementary interaction in AP-134 × AP-42.

Defense related proteins in resistant and susceptible castor cultivars

The initial level of peroxidase activity in roots was observed to be significantly higher in 48-1 (resistant) than in JI-35 (susceptible) after inoculating with *F. oxysporum* f. sp. *ricini*. Significant and progressive decrease in peroxidase activity with increase in infection period was more evident in JI-35 compared to 48-1. The initial level of catalase activity in roots was significantly higher in JI-35 than in 48-1. Significant and progressive increase with

increase in infection period was observed upto 4th day in both the genotypes, while it decreased thereafter in both the genotypes, however, the magnitude of decrease was more in JI- 35 than 48-1.

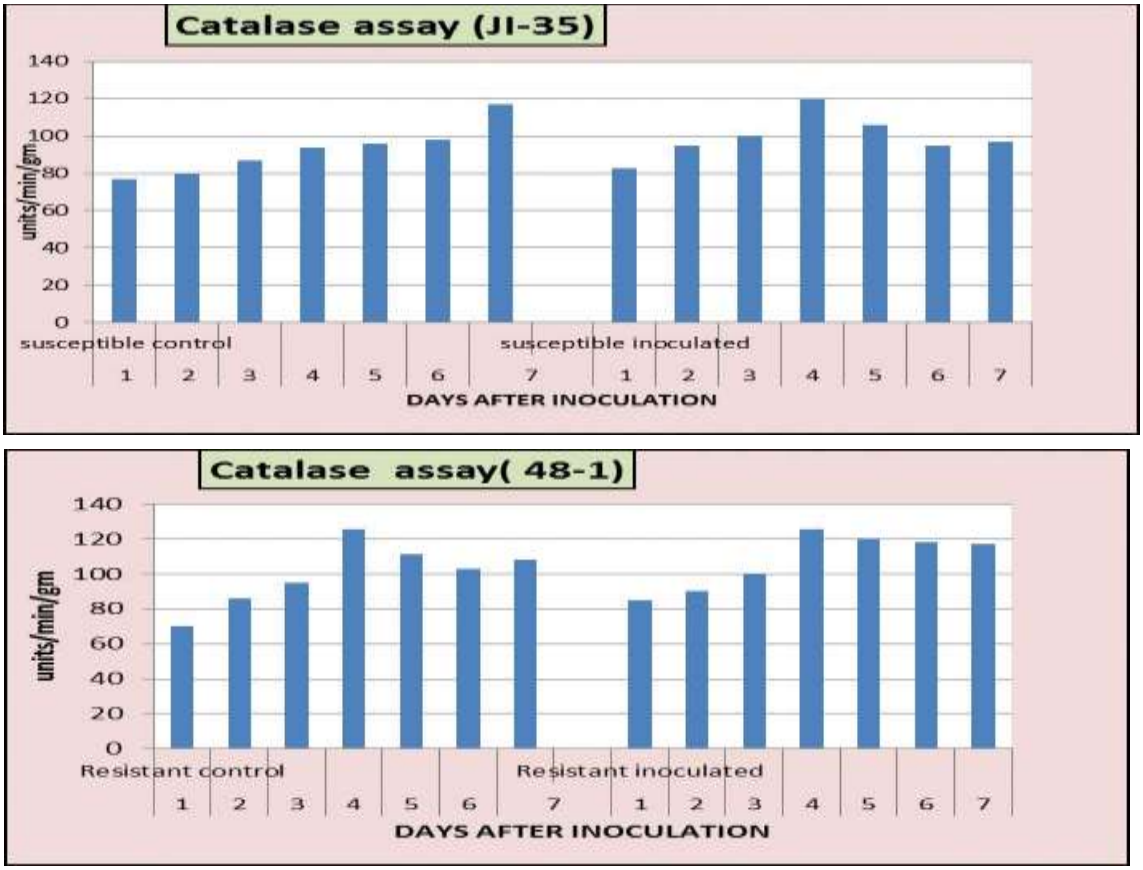
2The basal level of super oxide dismutase (SOD) activity in roots was observed to be significantly higher in JI-35 than in 48-1. In 48-1, SOD activity increased continuously throughout the infection period in control and infected plants. In contrast, in JI-35 the activity increased up to 4th day post infection, thereafter, it decreased sharply.

Studies on variability in isolates of *F. oxysporum* f. sp. *ricini*

Twenty one (21) castor lines including germplasm and advanced breeding material were inoculated with three isolates of *F. oxysporum* f. sp. *ricini* collected from Hyderabad, Palem and S.K. Nagar. RG-2388, RG-2344, RG-1834, AP-241, AP-240, JI-35, Haritha, Kranthi showed susceptible reaction (>20%) to three isolates while breeding lines AP-33, AP-56, AP-200 and AP-156 showed resistant reaction (<20%) to all the three isolates. Lines RG-256, RG-3322, RG-1963, AP-163, DCS-107 showed differential reaction to the isolates.

Management of wilt disease complex

Field trial was carried out with soil solarization, application of metham sodium to soil and application of neem cake. Soil solarization combined with seed treatment and soil application of *Trichoderma harzianum* found effective in reducing wilt incidence followed



Catalase activity in JI-35 (susceptible cultivar) upto 7 days after inoculation in both control and inoculated samples. B. catalase activity in 48-1 (resistant cultivar) upto 7 days after inoculation in both control and inoculated samples

by soil solarization with soil application of carbofuran. Treatment with application of neem cake also recorded low wilt incidence compared to other treatments. The organic carbon in soil samples increased in solarized plots. Plants in control plots were completely knocked down with wilt disease.

Resistant sources to gray mold

Germplasm lines *viz.*, RG-1963, RG-3088-1, RG-3344, RG-1062 and RG-907 were resistant to gray mold. Two hybrids (DPC 9 x CI-2 and M574 x CI-2) and 2 inbred lines CI-1 and CI-2 were found to be resistant to gray mold under epiphytotic conditions. These inbreds can be utilized in breeding for developing gray mold tolerant cultivars of castor.

Influence of weather variables on gray mold development in growth chamber and field - Effect of temperature on gray mold pathogen *Botryotinia ricini* growth (mm) and sporulation:

Mycelial growth of *Botryotinia ricini* started at 10°C and observed up to 30°C on culture medium. Maximum growth (84.7mm) and sporulation (8.9 x10^6) was observed at 22°C and 95% RH on 7th day.

A.Soil solarization during summer. B. Soil solarisation combined with seed treatment and soil application of T. harzianum. C. Application of neem cake. D. Wilt in control plots.

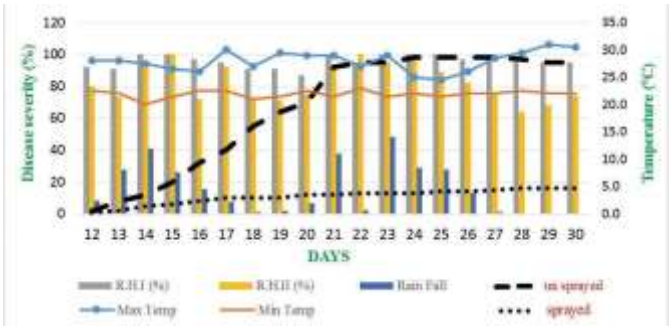
Gray mold disease incidence at different temperature, humidity on leaves of castor cultivar DCH-519 (detached leaf technique): Among the tested temperatures (19 to 24^{0}C) and corresponding RH (72-95%) through detached leaf technique, gray mold disease severity was significantly high (98.0%) on DCH-519 at 21°C temperature and 90 % RH.

Growth in mm on culture medium and Percent Disease Severity (PDS) on natural medium i. e leaf (cultivar DCH-519) under different temperatures ranging from 10^{0}C to 30^{0}C were fitted to hyperbolic function and temperature about 19.9^{0}C for growth on medium and 20.7^{o}C on leaf were found to be optimum.

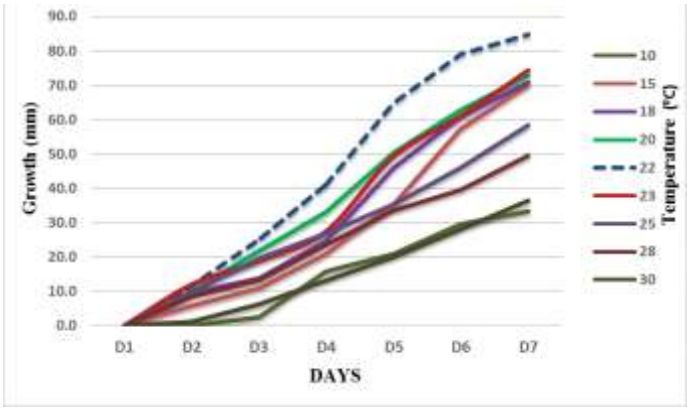
Resistant germplasm line RG 1963

Susceptible hybrid DCH 519

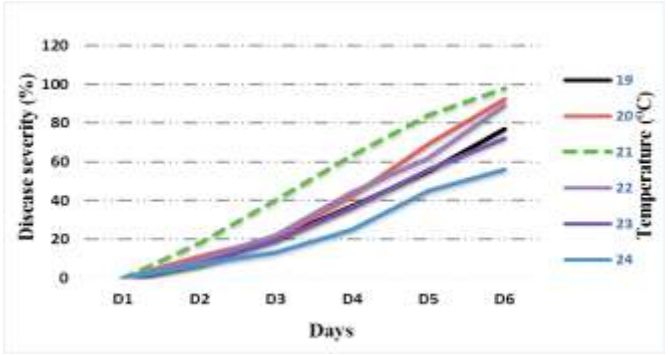
Influence of weather parameters on Botryotinia gray mold development under field conditions: In fungicide (propiconazole) sprayed DCH-519 plants, gray mold disease was observed and disease severity (%) was recorded. Disease progress was observed from 12th to 30th of September on both unsprayed and sprayed plants. High increase in disease severity (2% to 95%) was observed in unsprayed (control) plants due to highly favorable conditions (temperature-21-22^{0}C; RH-90-100%) coupled with continuous rainfall, whereas less spread/ increase in disease severity (1% to 16%) was recorded in propiconazole sprayed plants.



Disease severity on DCH-519 during September 2016



Botryotinia ricini growth (mm) at different temperatures on agar plate



Disease severity on DCH-519

Parameter estimates of the non-linear hyperbolic function shows that under field conditions, favorable temperature was 24.7^{0}C for maximum disease occurrence with a lower confidence interval of 20.6^{0}C and upper confidence interval of 28.8^{0}C.

Parameter estimates of the hyperbolic function with asymptotic confidence intervals-effect of temperature on per cent disease severity under field conditions

Cultivar	a	r	g
DCH-519	92.6 ± 6.3 (79.8 to 105.5)	0.13 ± 0.02 (0.08 to 0.18)	24.7 ± 2 (20.6 to 28.8)

On farm management of gray mold disease

In farmers' fields, a prophylactic spray with propiconazole @ 1 ml/l was given during September month based on weather forecast. Later, the same fungicide was sprayed when the disease started appearing in the fields. Disease severity of 3-4% has been recorded in sprayed fields whereas disease severity ranging between 15-18% was recorded in unsprayed fields. The demonstration clearly showed efficacy of fungicide in management of gray mold disease.

SOCIAL SCIENCES

Crop information modules on castor and sunflower were developed for dissemination using the ICT's viz., website and mobiles. The daily prices and arrivals of major APMCs for castor, sunflower and safflower were updated in the market database. The POP's on castor, sunflower, safflower, sesame and niger were uploaded to the Institute website. FAQs for the Institute mandate crops were uploaded to the website Voice advisories on sunflower (27) and castor (24) were developed and disseminated to 3245 farmers through Reliance information services.

During the period under report, a static Mobile App was developed for Castor, sunflower and safflower which includes the information in modules; *viz.*, crop introduction, details of AICRP-Centres, state-wise contact details of seed availability, market prices of major markets, preferred varieties and hybrids.

Castor – Mobile App

SUNFLOWE

CROP IMPROVEMENT

Maintenance of germplasm accessions

During the year 530 accessions (350 DRSI and 180 GMU) were multiplied, 160 accessions were rejuvenated and 213 accessions including genetic stocks were supplied to different researchers as per their demand. These accessions included 3 high oil content (40-42%) accessions developed from RHA-6D-1 supplied to all the AICRP centres and 6 early maturing accessions supplied to the spring centres. In addition, the breeding lines and inbreds received from USDA, USA were shared with all the breeders and other researchers for utilization in the respective programmes. These included 65 lines supplied to Bengaluru, 110 lines to Latur, 90 lines to Ludhiana, 46 to Coimbatore, 24 to Raichur, 4 to Hisar, 59 to Nandyal and 253 A/B/R lines and inbreds for physiology, breeding and entomology experiments at IIOR, Hyderabad. A total of 1019 accessions were regenerated and deposited in LTS at NBPGR

Evaluation of high yielding inbreds

A trial comprising of 35 inbreds with early maturity and high seed yield was constituted to identify genotypes for high yield and medium maturity. Among these genotypes, GP_2 1227 recorded 86 days to maturity and 31 g of yield per plant whereas, the check DRSF-113 recorded 92 days of maturity and 26.5 g of yield per plant. The genotype PSCIM 199 was identified as early maturing genotype with maturity of 74 days.

Evaluation of high yielding sunflower accessions

S. No.	Genotype	Days to 50% flowering	Maturity (days)	Plant ht. (cm)	Head diameter (cm)	100 seed weight (g)	Seed yield/ (g/plant)
1	PSMO 53	48	81	120	11.1	4.3	24.0
2	Selection 2	51	83	132	15.3	5.6	24.5
3	GP_2 1227	51	86	147	13.2	7.3	31.0
4	GMU 806	49	81	142	14.8	5.5	23.2
5	GP_4 745	53	85	138	10.5	5.9	27.0
6	PSCIM 181	45	78	157	11.6	4.7	21.5
7	PSCIM 199	45	74	143	12.2	7.2	21.0
8	GMU 635	45	81	178	15.1	5.9	24.0
9	HOHAL 30	48	77	118	12.9	3.6	24.0
10	GMU 130	47	85	113	11.6	5.7	17.0
11	HOHAL 70	50	81	163	11.6	4.6	22.0
12	GMU 1119	51	82	140	9.5	5.6	26.0
13	GMU 477	57	86	145	9.5	4.3	23.5
14	DRSF 113 (C)	53	92	145	14.6	5.3	26.5

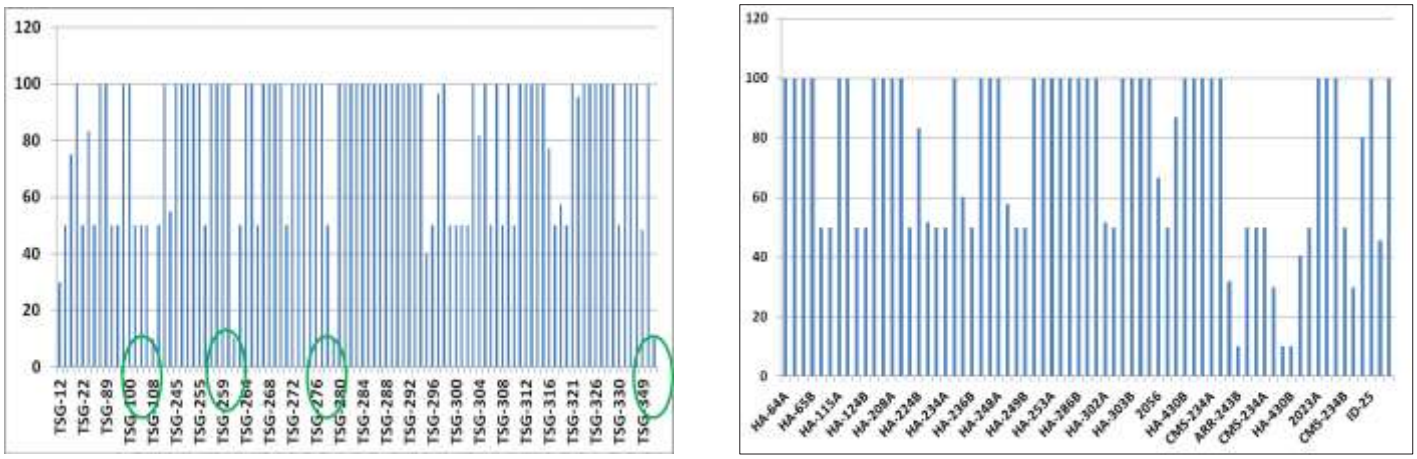
Augmentation and evaluation of new inbreds

Established and evaluated 91 out of 104 accessions received from USDA, Ames, USA which included 10 additional diverse CMS sources (ANN14, MUT14, MUT8, MUT9, MUT10, MUT11, MUT12, PET2, GIG1, MAX1), 10 stable interspecific derivatives from crosses involving *H. debilis, H. petiolaris, H. praecox, H. paradoxus* and 8 restorer lines for different cytoplasms (Rf-Rig-Luch, ANN19, ANN783, ANN106, ANN1742, ARG1575, PRA417, GIG2/ MAX 1631). The dwarf fertility restorer lines with the reduced vigour gene (*Rv*) failed to produce seed. The new alloplasmic lines were maintained by crossing with HA 89B.

All the 400 trait specific inbreds including CMS lines (A/B), R lines and inbreds were raised during *kharif* season for seed increase and data on quantitative traits and reaction to *Alternaria helianthi,* which was unusually high during the season, was scored. Among these, the CMS line HA 124A/B showed very high level of field tolerance to the pathogen at all crop growth stages followed by HA 236A/B, HA 302A/B and TSG 18 which will be confirmed through artificial assays. For powdery mildew, TSG-108, TSG-261, TSG-279, TSG-391, CMS HA430A/B were found to be tolerant. Among the new CMS lines, HA 253 and HA 302 were the earliest to flower; HA 112 was branched, HA 292 had robust growth.

Restorer or maintainer lines with high autogamy are desirable for obtaining high seed set in the hybrids. Data on seed set in R lines and inbreds (200 lines) under self and open pollinated conditions indicated high seed set under selfing in TSG 206, TSG 210, TSG 211, TSG 213, TSG 214, TSG 216, TSG 247, TSG 284, TSG 347, TSG 348, TSG 369 and TSG 376.

Generally, branching is recessive in most of the R lines being exploited in hybrid programmes and the F_1 hybrids are predominantly monoheaded. Some of the new R lines *viz.*, TSG 306, TSG 290, TSG 291, TSG 292, TSG 269 along with the R lines



Reaction of CMS and R lines obtained from USDA, USA to powdery mildew

developed under AICRP *viz.*, R-7, R-630, RHA-6D-1, GKVK-2, RHA-95-C-1 showed dominance of branching and the experimental hybrids were branched and hence, these R lines or the specific crosses were excluded in generation of experimental hybrids. Some of the new R lines including those obtained from AICRP centres showed maintainer reaction with few or all CMS lines tested and include TSG 255, TSG 269, TSG 286, RHA 1-1, RHA 6D-1, RHA 367, RCR 119, TSG 259, TSG 282, RHA 363, TSG 310, TSG 272, TSG 305 and these R lines/cross combinations will be excluded in production of experimental hybrids.

Among the newly procured inbreds, 81 CMS and R lines were evaluated for photosynthetic rate and water use efficiency (WUE). Photosynthetic rate ranged from 10.4 to 17.2 µmoles $CO_2/m^2/$ sec and WUE from 2.8 to 5.8. Promising lines for photosynthetic rate and WUE were identified and are listed below.

High WUE (≥ 5.0)	TSG -135 A, 17A, 103 A, 104 A, 234 A, TSG-266, 272, 281, 294, 301, 307, 308, 312, R-630, CSFI-99
High photosynthetic rate (> 16.0 µmoles $CO_2/m^2/sec$)	HA 49 A, RHA-95 C1, TSG-288, 289, 290, 291, 306, 308, 310, 316, 317, 328, 332

Identification of promising inbreds for seed yield and harvest index

A set of 385 inbreds including A, B, R lines and inbreds with wide range of variation for different traits was evaluated for seed yield and harvest index (HI). Seed yield ranged between 1-104 g/plant and HI from 1-56%. Promising lines for both traits were identified.

High seed yield (> 40 g/plant)			HI (> 30%)	
EC 276161	CPI 3	GMU 522	189/1R	SCG 56
GMU 899	CMS 9B	852 A	TSG 17	Selection 2
PSMO 53A	CSFI 5387	NDSI 15	EC 304687	CSFI 5387
PSMOO-110-1	GP6-79	GMU 804	AKSF-6R	GPN-109
C_1. 56-35-5-1-2	ARM 244A	GMU 308	ID 21	GP6-1746
189/1R	SCG 56		EC 6040331	RCSHS-18-1-2-1-3
EC 131811-1	GMU 1045		EC 502042	RCSHS-13-4-1-3-1
EC 640331	TSG -114		TSG 114	CMS 853 B
RCSHS-18-1-2-1-3			GMU 434	343 A
IC- 502042			EC 131811	

Evaluation for reaction to leafhoppers

Around 540 accessions including the susceptible check, Morden were evaluated for the reaction to leafhoppers. Of these, 8 accessions (TSG 349, GP2 1227, 104A, HA 124A TSG-391, TSG-401, TSG-403, EC-537925) were with injury grade 0, which will be further confirmed.

a-Variations observed in reaction to leafhoppers, b and c showing TSG 403 a genotype with injury grade zero

Reaction of reported sources of resistance to leafhoppers during *rabi* 2016

Accessions	Mean Leaf hoppers/ 6 leaves/plant	% yellowing/ burning	Injury grade
TSG 403 (1)	0.2	0	0
GMU - 1, 25, 339, 343, 669, 696, 1093, TSG-195, 197, 216, 217, 238, 258, 278, 298, 339, 349, 400, 504, 556, 776, 570, 320, 337, 401, 713, 1029, 196, 295, 338, PSCIM-137, PSERM-138, PSMO-52C, ASFI-I-46-2, HA-430B, GP9-472-4-13 (37)	0.1-4.3	5- 10	1
GMU-116, 703, 914, 595; TSG-297, 296, 198, 287, HA 89-B, PSCIM-115, 117, 122, PSECO-70, 81, 90, 53-D, OCRM (17)	3.7	15	2
GMU 112, 255, 327, 922, 405, 782; TSG-302, (7)	2.6	22.5	3
GMU-243, PSMO-53-B-1, PSCIM-186, PSERM-127, PSECO-79, 86, Syngenta 275 (7)	5.2	35	4
Morden	5.12	20	2

Confirmation of drought tolerant R x R gene pool progenies

Twenty four newly developed R x R gene pool progenies that were selected based on desired root traits and wilting symptoms along with two checks, DRSH-1 and KBSH-44 were sown in the field. Crop was subjected to water stress by withholding irrigation from 40- 75 days after sowing. Observations on growth parameters were recorded before imposing stress, before relieving stress and at harvest. Drought significantly affected the different parameters studied. The most affected trait was dry matter production and the least affected was the leaf number. Based on survival under stress condition, the progenies RxR 21-P5; RxR-21-P6; RxR-32-P1; RxR-61-P1 and RxR-61-P2 were identified as best genotypes under stress conditions.

Drought tolerant R x R gene pool progenies under field condition

Generation advancement of B x B gene pool progenies

A total of 60 individual plant progenies of maintainer gene pool was advanced from S_1 to S_2 generation through selfing. Based on days to flowering, plant height, head diameter, seed setting under selfing, seed characters and disease or insect reaction, individual plants were selected for further generation advancement.

Generation advancement, characterization and utilization of R x R gene pool progenies

A total of 150 individual plant progenies were advanced from S_2 to S_3 generation. Uniform progenies were characterized for agronomically important traits like days to 50% flowering, plant height, days to maturity, head diameter, number of leaves/plant, seed yield/plant, 100-seed weight and oil content. The progenies RxR-11-P1-S2 (39.89%), RxR-58-P4-S2 (39.31%), RxR-58-P4-S1-1 (39.18%) were found promising for high oil content, RxR-21-P1 (80 days), RxR-21 P1-S2 (79 days), RxR-21-P3-S1 (78 days) for late maturity and RxR-58-P4-S2 (32.1 g/plant), RxR-85-P1-S1 (31.3 g/plant), RxR-85-P1 (30.1 g/plant) for high seed yield. Range and mean of the uniform progenies for different traits are presented.

Range and mean of the selected RxR progenies for different traits

	Days to 50% flowering	Plant height (cm)	Number of leaves/ plant	Head diameter (cm)	Days to maturity	100-seed weight (g)	Seed yield/ plant(g)	Oil content (%)
Range	61-80	74.8-140.6	15.8-30.0	3.0-14.4	92.0-110.0	2.3-6.7	2.4-32.1	28.5-39.9
Mean	69.5	106.7	23.5	8.3	100.3	3.4	8.4	33.6

From the RxR gene pool progenies, 60 progenies were utilized as male parent and 60 new sunflower experimental hybrids were synthesized using CMS-17A as female parent during *rabi*-2016-17.

Promising sunflower genotypes for root characteristics

Root traits were studied in 36 newly developed restorer lines (R x R gene pool progenies) along with DRSH-1 as check, by growing the plants in poly bags. Crop was grown for 65 days and

plants were harvested. Observations on root length (cm), root volume (cc), root weight (g/plant) and total dry matter (TDM) (g/plant) were recorded at the time of harvest. Significant variation was observed for different characters among the lines studied and five lines were found promising for root traits.

Important root characters in the selected genotypes

Genotype	Root length (cm)	Root volume (cc)	Root dry weight (g/plant)	TDM (g/plant)
R x R 21-P8	62.4	244	35.2	150
R x R 33-P5	96.2	118	13.3	107
R x R 46-P3	86.0	179	19.4	92
R x R 50-P2	86.0	170	24.4	133
R x R 60-P2	89.0	144	18.5	104
DRSH-1 (C)	87.3	139	18.3	106
Mean	**77**	**91**	**11.4**	**88**
Range	**54 - 104**	**26 - 244**	**3.9 - 35.2**	**45 - 150**

Conversion of good combiner maintainer inbreds into different CMS backgrounds

Six good combiner inbreds were converted into new CMS lines with PETI cytoplasm (CMS-1001A to CMS-1006A). The days to flowering varied from 65 to 69 days; plant height from 91 to 143 cm; head diameter 12.2 to 13.5 cm and oil content from 34.3 to 39.6%. Newly developed lines, CMS-1001A, CMS-1003A and CMS-1006A had oil content of more than 37%, while CMS-1006A was short (91.0 cm) compared to other CMS lines. These lines will be utilized in hybrid breeding program to develop promising hybrids.

Evaluation of hybrids in *rabi* season

In advanced hybrid evaluation trial, 19 hybrids along with four public hybrid checks (DRSH-1, KBSH-44, PSH-1962, RSFH-130) and one private hybrid (Kaveri Champ) were evaluated in a randomized block design (RBD) with 2 replications. Of these, 8 hybrids namely IOSH-15-08, IOSH-15-10, IOSH-15-11, IOSH-15-12, IOSH-15-14, IOSH-15-20, IOSH-15-23 and IOSH-15-27 were promising, which recorded increased yield (10-24%) over the checks.

Generation of new experimental hybrids

Under common crossing programme, a total of 400 new experimental hybrids with adequate seed quantity were synthesized during *rabi*-2016 using existing material (CMS and R lines) and newly procured CMS and R lines from USDA for evaluation during *kharif* 2017.

National Crossing Programme

A total of 475 hybrids were evaluated at IIOR during *kharif* 2016 in two replications. There was wide variation for yield and yield contributing traits. The oil content ranged from 22.0 to 40.3%. The R lines TSG 22, TSG 350, TSG 268, TSG 269, TSG 321 resulted in early maturing hybrids (44-48 days as against 56 to 58 days in Checks). Based on evaluation at three locations (Hyderabad, Coimbatore and Bengaluru) seeds of promising crosses (HA 133A x GKVK-2; HA 228A x GKVK -2; HA 250A x R-7; CMS103A x RHA 331) were produced for evaluation on large plots.

Evaluation of NCP-III test crosses for seed yield and yield contributing traits

Hybrid	Pedigree	Plant height (cm)	Days to 50% flo-wering	Head diameter (cm)	Seed yield/ plant (g)	Oil content (%)	100 seed wt. (g)
NCP-357	HA 243A X TSG 274	190	53	17.2	57.8	30.5	5.7
NCP-410	HA 133A X GKVK-2	153	52	15.3	52.0	31.2	3.9
NCP-567	HA 286A X R-7	113	51	14.9	85.9	27.6	7.9
NCP-605	CMS103A X TSG 255	132	55	14.4	42.5	36.5	6.4
NCP-629	HA 250A X R-7	153	55	17.5	53.6	33.7	5.5
NCP-631	HA 250A X GKVK-2	110	57	10.0	68.0	34.8	5.7
NCP-635	TSG 121A X R-7	168	57	20.5	48.1	32.5	4.7
NCP-636	CMS 17A X TSG 274	140	56	18.0	69.0	32.1	8.8
NCP-646	HA 286 A X GKVK-2	155	52	18.5	79.5	32.1	4.3
NCP-659	HA 228 A X RHA-95-C-1	165	53	16.5	46.3	36.8	4.5
NCP-681	CMS 234A X TSG 321	149	50	11.8	45.4	36.4	4.6
DRSH-1	ARM 243A X RHA 6D-1	200	57	20.0	44.6	35.6	5.9
KBSH-44	CMS 17A X RHA-95-C-1	205	59	18.6	36.0	28.7	4.8

Prebreeding

Generation advancement of prebred material involving diploid annuals: Eleven interspecific cross combinations (8 combinations with wild *Helianthus annuus* and 3 combinations with *H. argophyllus*) were advanced from BC_2F_1 to BC_2F_2 generation. Individual plant progenies of each combination were raised during *rabi*-2016. Individual plants of each combination were characterized for plant height, head diameter, seed yield under selfing and oil content. Combination wise, number of progenies, which were raised during *rabi*-2016 are presented.

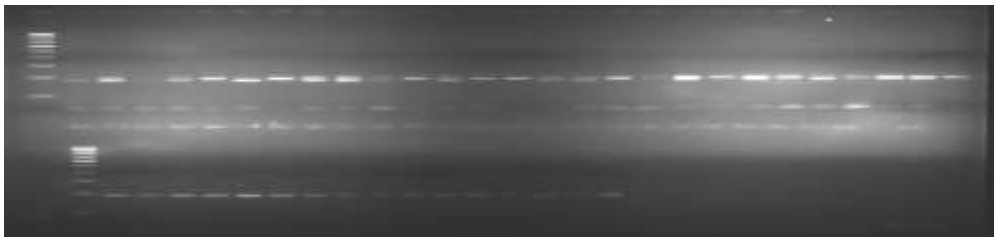
S. No.	Combination	No. of progenies in BC_2F_1	S. No.	Combination	No. of plants in BC_1F_1
Cultivated x wild			**Cultivated x wild**		
1	ARM-243B x ANN-232	86	1	ARM-243B x ANN-2101	42
2	ARM-243B x ANN-243	49	2	ARM-243B x ARG-153	10
3	ARM-243B x ANN-1270	85	3	ARM-243B x PET-1910	30
4	ARM-243B x ANN-1272	4	4	ARM-243B x DEB-691	32
5	ARM-243B x ANN-1483	37	5	ARM-243B x DEB-369	9
6	ARM-243B x ANN-1624	14	6	ARM-243B x PRA-1154	3
7	ARM-243B x ARG-1317	54	**Wild x cultivated**		
8	ARM-243B x ARG-1575	64	7	ANN-2101 x ARM-243B	32
9	ARM-243B x ARG-2126	61	8	ARG-153 x ARM-243B	6
Wild x cultivated			9	PRA-437 x ARM-243B	7
10	ANN-1270 x AKSFI-243B	35	10	PRA-1823 x ARM-243B	19
11	ANN-1490 x ARM-243B	26	11	DEB-1564 x ARM-243B	25

In addition, interspecific hybrids involving *H. praecox*, *H. debilis*, *H. petiolaris*, *H. argophyllus* and *H. annuus* were advanced from BC_1F_1 to BC_2F_1 generation. Number of plants raised from each combination during *rabi*-2016 is indicated in the table. Seed germination of BC_1F_1 material was very poor in *H. praecox* combinations followed by that of *H. debilis*. Highest seed germination was reported in wild *H. annuus* combination followed by *H. petiolaris* and *H. argophyllus*. Seed setting under selfing was very low compared to sibbing and backcrossing with cultivated sunflower which indicated that self-incompatibility was dominant in BC_1F_1 generation as well. Powdery mildew resistant plants were observed in PRA-1823 x ARM-243B cross combination under field condition. All powdery mildew resistant plants were advanced from BC_1F_1 to BC_2F_1 generation through backcrossing. Susceptible and resistant plants are represented in Figure.

Powdery mildew susceptible and resistant plants in PRA-1823 x ARM-243B combination

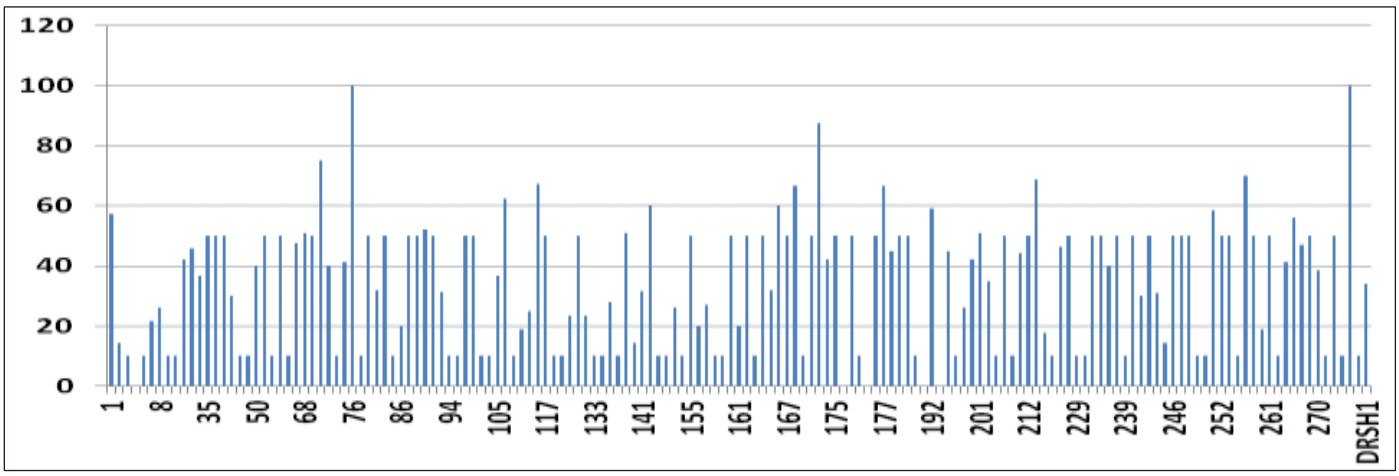
Breeding for powdery mildew resistance and herbicide tolerance

During *rabi*-summer 2016, backcrosses were effected (2023B x PRA1823/2023B) and 2 populations of 42 and 28 plants were evaluated for the reaction to powdery mildew. The accession PRA 1823 of *H. praecox* was found to be resistant to sulfonyl urea based herbicides and characterization of the BC_1F_1 progenies of this cross using SSR primers specific to the *AHAS L*1 locus showed two genotypes in the BC progenies as expected in a Mendelian segregation for single gene and 3 genotypes in the BC_1F_2 progenies. Twelve plants showing powdery mildew tolerance and also the *AHAS* allele specific to *H. praecox* in PCR amplification with gene specific primers were identified during *rabi* 2016, for selection of plants conferring resistance to both powdery mildew and herbicide tolerance in subsequent generations.



Amplification of BC1F2 progenies of the cross 2023B x PRA1823/2023B with SSR primers specific to the AHAS L1 locus

Three sets of RILs (Morden x EC537925; PS2023 x TX16R; ID-25 x TX16R) comprising of 400 lines were screened for reaction to *Alternaria helianthi* which was unusually high during *kharif* 2016. Scoring for *A. helianthi* and powdery mildew was done at pre and post flowering stages and among the 3 sets of RILs, field tolerance to *A. helianthi* was observed in RILs derived from Morden x EC537925 (RIL Nos. 22, 45, 58, 111, 147, 168, 189, 202, 399) and ID-25 x TX16R (RIL Nos 17, 175), which will be reconfirmed through artificial assays. For powdery mildew, 1:1 segregation for low (only infection on lower leaves) and high incidence of disease was recorded and is represented in figure below:



Reaction of RILs of 2023A x TX16R to powdery mildew (n=157)

Bioinformatic analysis of transcriptome data of 1 susceptible (PS2023) and 5 donors (*H. praecox, H. debilis*, ID-25, TX16R, *H. niveus*) was completed and pathways involved in plant pathogenic interactions were delineated through reference based assembly using the sunflower genome database from University of British, Columbia under appropriate MTA. As some novel WRKY factors and key *Pr* genes were detected in the analysis, *de novo* analysis has been undertaken. The transcriptome Shotgun Assembly of *H. niveus* has been deposited at DDBJ/EMBL/GenBank with the NCBI accession number: SRR3597501.

CROP PRODUCTION

Agronomic interventions for increasing productivity and resource use efficiency of cropping systems involving sunflower

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 second cropping cycle onwards and application of 150% RDF had recorded the highest yield. Response to K is negative for sorghum seed yield upto 2007-08 and from 2009-10 onwards, K application is resulting in increase in 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 com-pared 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 is declining 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 is showing declining trend due application of Zn along with NPK to preceding sunflower possibly 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.

During the year 2016, the trial was modified to include two more treatments as only organic sources of nutrition. The treatments were accommodated in the same plot as extension of the existing experiment. This modification with two treatments had the same background of soil and growing conditions except for a compromised randomization of the new treatments. The two treatments were accommodated in one side of the trial with three replications in continuity with the existing treatments in each replication. The two organic treatments were: one with FYM @ 5t/ha per crop and the other at 1/3 N equivalent of FYM, supplied through three organic sources viz., FYM, Goat manure and Poultry manure.

Performance of sorghum: The general growth of sorghum (Hybrid CSH-16) in *kharif* 2016 was good being grown under irrigation despite the drought prevailed during major growth period. The treatment variations were clear and significant for the growth and flowering parameters. But the crop was affected at harvest due to heavy and continuous rains in September just before harvest. Entire crop quality was affected with molds. The yield in terms of weight of grain and straw was also affected due to soaking in rain. Highest sorghum yield of 17.25q/ha was recorded with the new integrated organic treatment. The grain yield ranged from 955 to 1725kg/ha. across 14 treatments. 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* 2016 differed significantly due to nutrient management treatments. Seed yield was significantly highest (12.71q/ha) with the new integrated organic treatment with a yield ranging from 353 to 1271kg/ha. Lowest growth parameters viz., plant height, stem girth, head diameter, filling, was recorded in N alone or no manure treatments.

Soil fertility after the sorghum in 2016 indicate a significant buildup of soil P recorded in all treatments receiving P (38 to 71kg/ha) compared to 9-10kg/ha in treatments not receiving any P. Available S and Zn was highest in treatments receiving S and Zn.

Assessing productivity, profitability and resource use pattern of emerging crop sequences involving sunflower in Alfisols and Vertisols

With an objective to assess the productivity, profitability and resource use of different

and emerging cropping systems including sunflower and other oilseed crops were assessed under limited irrigated situation in Alfisols and Vertisols. In Alfisols, major crops *viz*., cotton, maize, pigeonpea, groundnut, sunflower and greengram-castor crops were grown in *kharif* with different *rabi* crops (chickpea, safflower, sunflower, mustard, sesame, maize and groundnut) under the background of each of the *kharif* crops in fixed plots. The productivity, resource use (inputs, irrigation, labour, time, soil fertility, etc.) were accounted for growing each crop/s and the total productivity and RUE comparisons are being made. The *kharif* crops performance indicate a very high variation in resource use and productivity, profitability and land utilization efficiency. Greengram-castor gave highest B:C ratio followed by pigeonpea, groundnut, cotton, maize and sunflower.

Performance of sunflower and castor under integrated crop management

Integrated crop management in Alfisols during *kharif* 2016, resulted in realizing the highest sunflower seed yield of 1.7t/ha with a B:C ratio of 2.62; in castor, a seed yield of 2.83t/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.

Effect of *Trichoderma* isolates on imparting salinity tolerance to sunflower

A field trial to evaluate the performance of *Trichoderma* isolates along with Chitosan and a synthetic polymer through seed priming on sunflower was taken up in natural saline soils (EC = 8.0dS/m) at ARS Gangavathi, UAS Raichur. The soil type was black cotton belonging to Vertisol soil order with clay texture and poor drainage. Experiment consisted 9 treatments laid with simple RBD design with 3 replications. Size of each treatment plot was 2.4m x 3.6m. The data recorded for various growth and yield contributing parameters are presented in the following table.

Effect of potential *Trichoderma* isolates and polymers on the growth of sunflower in natural saline soil

Treatment	Plant stand/ plot	Head diameter(cm)	Test wt. (g)	Yield/plot (g)	Yield (kg/ha)
T harzianum (Th-4d)	41.00	9.20	4.70	445.23	685.6
T asperellum (N-13)	40.00	9.63	4.23	419.87	646.5
T asperellum (TA 5)	43.67	10.13	4.73	541.80	834.4
Chitosan	41.33	9.00	4.40	503.10	774.8
Chitosan + SP	40.67	10.00	4.13	386.49	595.2
Chitosan + SP + Th 4d	41.67	9.57	4.20	472.40	727.5
Chitosan + SP + N-13	41.33	8.93	4.13	398.45	613.5
Chitosan + SP +TA 5	40.33	10.27	4.10	455.47	701.3
Control	32.33	7.70	3.33	293.84	452.4
CD (0.05)	3.42	1.25	0.40	58.14	--

SP= synthetic polymer

Among all the treatments, it was noticed that seed priming with TA 5 a saline tolerant isolate of *Trichoderma* had significantly improved the sunflower plant stand (44 plants /plot) under salinity of 8.0dS/m against control with 32plants/plot.

Effect of seed priming with TA-5

Control

Seed priming effect of *Trichoderma* isolates, chitosan and synthetic polymer either alone or in combination showed significant improvement in head diameter and test weight and increase in the seed yield of sunflower over control against salinity. The highest seed yield of 542g/plot (835kg/ha) was also recorded due to seed priming treatment with TA 5 and the lowest yield was noticed in control with 294 g/plot (452kg/ha).

Assessment of Pusa hydrogel in sunflower

Evaluation of Pusa hydrogel in sunflower for summer season had been assessed for its irrigation water use and productivity. Application of Pusa hydrogel in sunflower had been established based on the original claims of technology for first season at ICAR-IIOR. In sunflower, indication of higher moisture retention in hydrogel treatment that had caused for delayed irrigation by 8 to 4 days during the early and late summers compared to RDF was noticed. This has also coincided with the crop growth stage. 25% saving of number of irrigation is evident (2 out of eight) due to the reduced frequency when compared with control RDF.

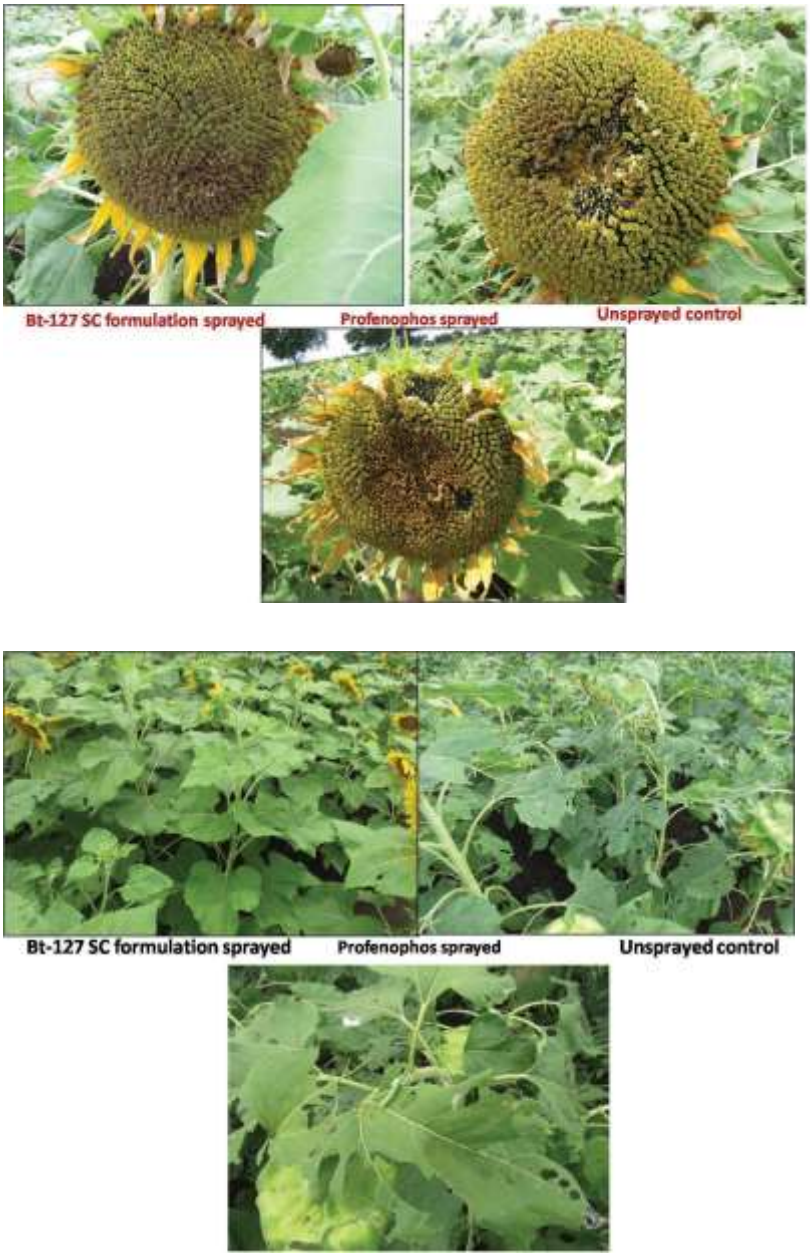
CROP PROTECTION

ENTOMOLOGY

Testing of microbial pesticidal formulations against *Helicoverpa armigera* in sunflower

SC formulations of Bt-127 singly and in combination with *Beauveria bassiana* and *Nomuraea rileyi* were evaluated on sunflower at ORS, Latur during 2016. Bt-127 SC formulation was the best treatment giving 81.8% reduction of *H. armigera* and 100% reduction of *Thysanoplusia orichalcea* over control followed by Bt-127 + *B. bassiana* and Bt-127 + *N. rileyi* SC formulations (78.8% and 100% reduction of *H. armigera* and *T. orichalcea* respectively over control). The treatments were superior to the commercial Bt formulation Delfin (68.7% and 83.3% reduction of *H. armigera* and *T. orichalcea* respectively over control) and insecticidal check Profenophos (56.3% and 66.7% reduction of *H. armigera* and *T. orichalcea* respectively over control). Seed yield/plot was highest in Bt-127 SC formulation with 3.43 kg followed by 3.3 kg and 3.0 kg for Bt-127 +

N. rileyi and Bt-127 + *B. bassiana* SC formulations respectively. Seed yield in Profenophos, Delfin and control plots were 2.88, 2.22 and 2.07 kg, respectively. The SC formulations were not phytotoxic, were safe to natural enemies in field trials and to *Trichogramma chilonis* in lab.



Field testing against *Helicoverpa armigera* on sunflower

Evaluation of reaction of sunflower accessions to leafhoppers

Seventy sunflower accessions were screened for resistance to leafhoppers in field under natural infestation in *rabi* season. One line, TSG- 403 recorded no injury at all and was almost free from leafhoppers while 37 lines recorded injury grade of I on 0-5 scale.

SAFFLOWER

CROP IMPROVEMENT

Genetic Resources

Augmentation: Sixty three safflower germplasm accessions were collected during exploration tour to nine districts of Maharashtra during first fortnight of March, 2017 in collaboration with NBPGR Regional Station at Akola. Farmers varieties/ landraces of safflower were mostly grown as intercrop with sorghum. The crop was also grown solely for vegetable purpose by a few farmers.

District	Number of accessions collected
Parbhani	5
Beed	9
Hingoli	1
Latur	13
Nanded	1
Osmanabad	9
Solapur	6
Satara	12
Sangli	7

Multiplication, conservation and supply

Multiplication of 1700 safflower germplasm accessions was undertaken during *rabi* 2016-17. Seeds of 33 accessions were submitted for LTS to National Gene Bank, NBPGR, New Delhi. A total of 1017 samples of 240 germplasm accessions were supplied for multilocation, evaluation and screening at different AICRP (Safflower) centres and 50 accessions for utilization in breeding programmes.

Evaluation and characterisation: Variability was recorded for hull content (42-60%) and oil content (22.3-33%) among 50 trait specific accessions. Oil yield ranged from 0.76 to 11.26 g/plant compared to 4-7.35 g/plant in checks. Among the fatty acids, oleic acid ranged from 9.7 to 25.8% and linoleic acid from 66.2 to 81.7%. Replicated trial for 28 accessions selected from the above 50 accessions was conducted along with three checks (A-1, PBNS-12, NARI-57) during *rabi* 2016-17 to confirm the performance

of 25 accessions for seed and oil yield and 3 accessions for high seed number per primary capitula.

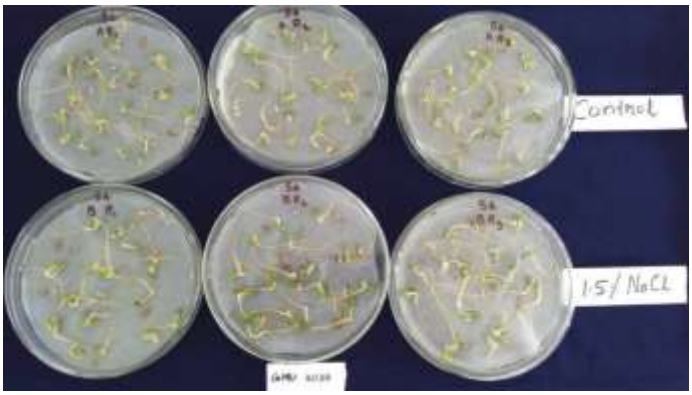
Screening against salinity: A new protocol for rapid screening of safflower against salinity in laboratory conditions was developed to facilitate screening of large number of accessions in short period. The laboratory method standardized for this protocol was based on the use of nutrient solution instead of distilled water for control and using the highest level of salinity (1.5% NaCl) in nutrient solution instead of different salinity levels in distilled water. Scoring was based on the seed germination in Petri dishes for each accession in 2 groups; Group 'A' as control group (CG) and Group 'B' as Salinity group (SG). The ratio of SG/CG was obtained and multiplied with 100. The accessions were then graded into 5 categories based on SG/CG ratio between <50 to >95.

Safflower germplasm core subset consisting of 150 accessions was subjected to rapid screening test in seed germinator. Nine accessions, recording high tolerance towards salinity (SG/CG ratio >95) were identified among the salinity, EC 337375 (GMU-5335) > EC 303232 (GMU-4038) >IC 338338 (GMU-3281) >IC 25317 (GMU-95) >EC 151819 (GMU-707) > IC 406193 (GMU-3047) >EC 337427 (GMU-1409) >GMU-6506 >IC 337741 (GMU-2136). Among the 23 varieties screened, 5 varieties tolerance gradation was noticed *viz.*, S-144, >Bhima, >Sagar Muthyalu, > PBNS-12, and >A-1 recorded high tolerance towards salinity.

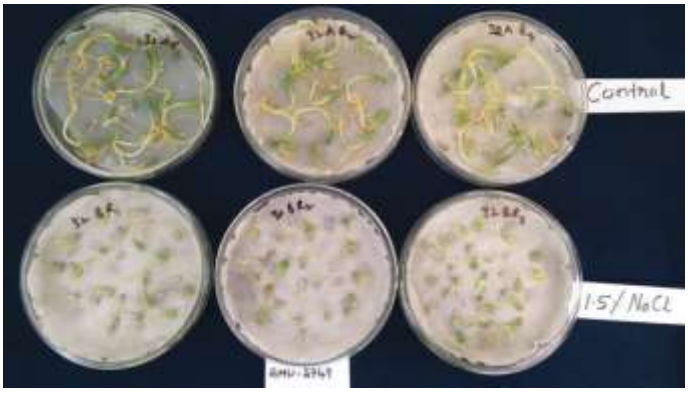
Rapid screening of safflower germplasm core subset and released varieties against salinity

SG/CG Ratio	Grade	State	Germplasm accessions (150)	Varieties (23)
<50	5	Very poor	9	2
51-75	4	Poor	38	6
76-85	3	Moderately tolerant	50	1
86-95	2	Tolerant	44	9
>95	1	Highly Tolerant	9	5

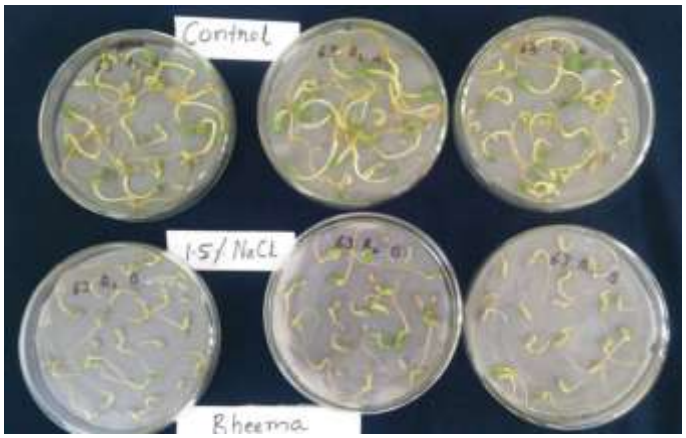
The genotypes identified will be further evaluated in laboratory for confirmation through seedling growth tests up to 15 days and thereafter by evaluation in pot or field in natural saline soils for final confirmation.



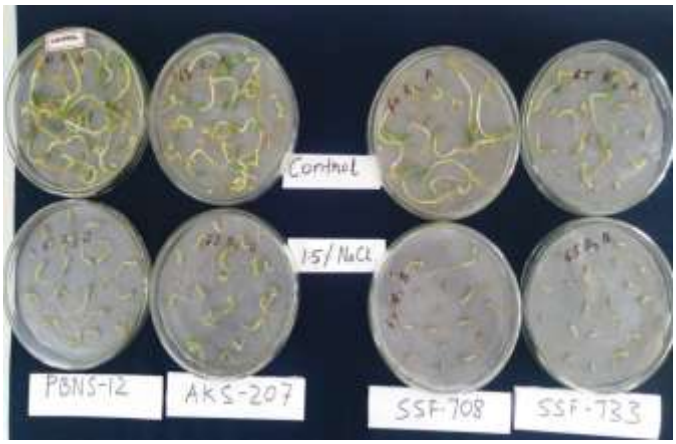
Genotype EC 303232 (GMU-4038) [SG/CG > 95]



Genotype IC 406021 (GMU-2749) [SG/CG <50]



Variety Bhima, highly tolerant to salinity



PBNS-12(SG/CG > 95), AKS-207 (SG/CG <.95), SSF-708 (SG/CG < 50), SSF-733 (SG/CG < 50)

Consortium research platform on Agro biodiversity Component-I-Safflower

Trait specific accessions for high oil content [>35%] (4), high number of effective capitula [>80] (32), high seed number per primary head [>30] (12) and high seed yield [> 30 g/plant] (17) were identified from among the 1179 accessions characterised during 2015-16. A total of 1100 accessions were raised in *rabi*, 2016-17 for multiplication, characterization and evaluation. Seeds of 889 accessions, multiplied during 2015-16, were submitted to NBPGR, New Delhi.

Improving seed and oil yields and wilt resistance in safflower through hybrid development

Development of new CMS-based safflower hybrids

CMS hybrids: New crosses were made between 60 diverse parental lines and a CMS-line, A-133-I A (O) in LxT design and hybrid seed was collected from all 60 crosses. One new hybrid, ISH-388 (DSH-388) which recorded 35% higher seed yield (2856 kg/ha) than the check hybrid, NARI-H-23 (2122 kg/ha) and 57% higher seed yield than check variety, A1 (1816 kg/ha) in multilocation PHT has entered the IHT-2016 trial. In AHT-I, two hybrids, DSH-256 and DSH-263 recorded 23 and 21% higher mean seed yield (1574, 1551 kg/ha), and 8 and 7% higher oil yield (461, 467 kg/ha) than the check hybrid, NARI-H-23 (1415 kg/ha seed yield, 432 kg/ha oil yield) and were promoted to AHT-II. DSH-263 exhibited resistance reaction in wilt sick plot at Tandur (3.6-10.4%) while the susceptible check PBNS-12 had 100% wilt incidence.

Seed production of hybrids: Produced seed of the identified hybrid, DSH-185 and its male parent under isolation at Tandur and Indore. In addition, produced seed of two hybrids in AHT-II *viz.*, DSH-263 and DSH-256 and two new hybrids (A1-133-1A (O) x ISF-764) and (A-133-IIA (w) x ISF-764).

Stabilization and seed production of CMS lines: Seed of CMS lines, A-113-1A (O) and A-133-IIA (w) was produced under isolation. The male sterility percent of these CMS-lines, A-133-1A (O), A-133-IIA (w) was 99%. Male sterility percent in four CMS lines namely, A-512, A-348, A-662 and A-148 ranged from 70-90%. These CMS lines were maintained through paired crossing with their B-lines and the B-lines were maintained through self-pollination.

Multilocation testing of CMS line for male sterility percent: Male sterility percent of the CMS line, A-133-1A (O) was tested in hybrid seed production plots at Tandur, Indore and in

CMS line seed production plot at ICAR-IIOR. Male sterility percent in A-133-1A (O) was more than 99% across the locations indicating stability of male sterility in A-133-1A (O).

Development of male parental lines

High yielding parental lines/varieties: Two varieties, ISF-764 (spiny) and ISF-763 (non-spiny) were promoted to AVT-I-2016 in AICRP (Safflower). ISF-764 recorded 26% higher seed yield (1753 kg/ha) than the best check, A1 (1391 kg/ha) at national level. It gave 37% higher oil yield (524 kg/ha) over A1 (382 kg/ha) at national level. The non-spiny variety, ISF-763 recorded 22% higher seed yield (1168 kg/ha) and 20% higher oil yield (355 kg/ha) than the non-spiny check, NARI-6 (seed yield: 959 kg/ha; oil yield: 297 kg/ha) at the national level. One non-spiny variety, SPP-70 was promoted to AVT-II; it recorded 16% higher seed yield (1060 kg/ha) than the non-spiny check, NARI-6 (seed yield: 915 kg/ha) at the national level.

Wilt resistant parental/inbred lines: The wilt resistant entry, w-521-3 (0% WI) recorded 66% higher seed yield (1558 kg/ha) than the check, A1 (935 kg/ha). The entries, ISF-48-15 (DSI-108) (0-19% wilt incidence) and ISF-44-15 (DSI-101) (0-21% wilt incidence) recorded 86 and 16% higher seed yields (2524, 1573 kg/ha), respectively than A1 (1351 kg/ha).

Three inbred lines *viz.*, w-521-3, w-521-5 and w-521-9 exhibited 0% wilt incidence in wilt sick plot at Tandur while wilt incidence in susceptible check, PBNS-12 was 100%. The entries, DSI-101, DSI-103, DSI-116 and DSI-118 were confirmed for wilt resistance in the 2nd year in wilt sick plots at Tandur, Solapur and Phaltan (0-22.5% wilt incidence) while the susceptible check, Nira showed 78-100% wilt incidence in all wilt sick plots.

Development of Fusarium wilt resistant inbred lines: Developed 22 wilt resistant interspecific inbred lines and selections were done through marker-assisted selection using SSR markers associated with Fusarium wilt resistance. These inbred lines were validated in wilt sick plots for resistance to wilt (0-2.7% wilt incidence) and were evaluated for yield performance along with cultivated variety check, A1 in RBD with three replications for two years in two trials (PVT-I & II). Four wilt resistant (0% wilt incidence in wilt sick pots) inbred lines *viz.*, ISF-22-15, ISF-28-15, ISF-31-15 and ISF-23-15 derived from Nira x *C. oxyacantha* and ISF-19-15 and ISF-21-15 derived from *Nira* x *C. palaestinus* were identified.

In PVT-I, the non-spiny line, ISF-1258 gave 46% higher seed yield (612 kg/ha) and 22% higher oil yield (153 kg/ha) than the non-spiny check, NARI-6 (seed yield: 418 kg/ha; oil yield: 125 kg/ha). The spiny entry, ISF-2039-15 in PVT-I, recorded 69% higher seed yield (1557 kg/ha) and 99% higher oil yield (484 kg/ha) than the best check, A1 (seed yield: 972 kg/ha; oil yield: 243 kg/ha); its oil content was 31%.

In PVT-II, the spiny entries *viz.*, ISF-21-15, ISF-31-15 and ISF-36-15 recorded 30, 42 and 31% higher seed yields (1703, 1867, 1738 kg/ha), respectively, and 35, 76 and 52% higher oil yields (443, 581, 504 kg/ha), respectively than check, A1 (seed yield: 1314 kg/ha; oil yield: 329 kg/ha.

Oil content in interspecific derivatives (30-31%) in PVT-I and II was significantly higher than wild species parents (26-27%) and A1 (26%). The interspecific derivatives were earlier (days to flowering: 80-85 days; days to maturity: 120-125 days) as compared to all the wild species, which were late in flowering (days to 50% flowering: 90-150 days) and maturity (135-185 days)

Four wilt resistant inbred lines, ISF-1258 (non-spiny), ISF-2039-15, ISF-21-15 and ISF-31-

15 have been entered in IVT-2016 of AICRP (Safflower).

Phytophthora resistant inbred lines: Three wilt resistant entries *viz.*, DSI-103, DSI-104 and DSI-101 showed resistance to Phytophthora (Disease severity: 0, 10, 10%) while the disease severity in the susceptible check, PBNS-12 was 86% under artificial inoculation (Agar-disc method). Nine high yielding wilt resistant inbred lines, six wilt resistant interspecific derivatives and one F_6 generation of a cross between high oil and high yielding wilt resistant lines were supplied to Tandur, Annigiri and Raipur.

High oil inbred/parental lines: The high oil entry, ISF-9943-1 exhibited 35.1% mean oil content in rainfed areas of Zone-I, and 36% in Zone-II and 35% at national level in IVT. Seeds of this line were supplied to Tandur for use in breeding programme.

Around 166 high oil F_6-F_7 families were developed through multiple crossing among lines developed at IIOR, Hyderabad. These were tested in ABD along with checks, A1 and PBNS-12 at ICAR-IIOR. Among 166 families, 132 possessed 35-41% oil content (Table) and the remaining 34 families had 31-32% oil content in the second year of testing while the oil content in the checks was 26-27%.

Frequency distribution of oil content among F_6-F_7 families and released varieties

No. of F_6-F_7 families	Oil content (%)	No. of F_6-F_7 families	100-seed weight (g)
45	35.0-36.0	27	5.0-6.2
35	36.0-37.0	26	4.6-4.8
32	37.1-37.9	24	4.2-4.5
12	38.0-38.8	21	4.0-4.1
7	39.0-39.7	34	<4.0
1	41.06		

The 100-seed weight among 132 high oil (35-41%) families ranged from 2.2-6.0 g. In 28 F_6-F_7 families, 100-seed weight and oil content could be simultaneously increased indicating breaking of negative correlation between oil content and seed weight. These families had bold seeds and semi-thin hull, 5-6 g 100-seed weight and 35-39.7% oil content while 100-seed weight in checks, A1 and PBNS-12 was 6.2 and 5.0 g, respectively.

100-seed weight and the corresponding oil content in 28 selected F_6-F_7 high oil families

100-seed weight (g)	Oil content (%)	100-seed weight (g)	Oil content (%)	100-seed weight (g)	Oil content (%)
5.0	35.0	5.0	37.2	5.4	37.6
5.0	35.0	5.0	38.6	5.4	35.0
5.0	35.0	5.2	37.5	5.6	35.6
5.0	35.5	5.2	38.0	5.6	39.7
5.0	35.4	5.2	37.0	5.8	37.7
5.0	38.8	5.2	37.0	5.8	38.6
5.0	35.5	5.2	39.7	6.0	37.3
5.0	37.2	5.2	37.0	6.01	36.4
5.0	39.2	5.2	35.0		
5.0	36.5	5.4	36.5		

Bold seeds of high oil F_6-F_7 families and A1

Short duration parental lines: Three short duration lines *viz.*, ISF-863, ISF-864 and ISF-865 evaluated at ICAR-IIOR flowered 16-17 days (67-68 days) earlier and matured 15 days (120 days) earlier than the normal duration check, A1 (DF:84 days; DM: 135 days) but flowered 13-14 days later and matured 20-25 days later than JSI-99 (DF: 54 days; DM: 92 days). They recorded 11-18% higher seed yield (741-785 kg/ha) than A1 (666 kg/ha) and 270-292% higher seed yield than the short duration check, JSI-99 (200 kg/ha).

Alternaria tolerant interspecific derivatives: Progenies of four Alternaria tolerant interspecific derivatives exhibited 10-40% Alternaria severity under high disease pressure when planted in August. The susceptible checks, A1, PBNS-12 and Nira had 100% Alternaria infection.

Alternaria tolerant interspecific derivatives (green in colour) and susceptible checks, PBNS-12 and A1 (middle rows) which succumbed to Alternaria

Diversity analysis and maintenance of parental lines: Diversity analysis of 164 parental lines was done using K-means statistical analysis. It grouped parental lines into 30 diverse groups and within cluster SS ranged from 0.12-4.89. The grouping pattern by K-means indicated existence of considerable diversity among parental lines placed in different groups. A total of 141 parental lines including 60 promising high combining diverse parental lines were maintained through self-pollination.

Grouping of 164 safflower parental lines by K means analysis

Group (K)	No. of parents in a K	Within K SS	Group (K)	No. of parents in a K	Within K SS	Group (K)	No. of parents in a K	Within K SS
1	8	0.71	11	9	1.39	21	3	0.45
2	5	1.16	12	3	1.46	22	5	1.80
3	3	0.37	13	10	1.61	23	4	3.00
4	8	1.88	14	5	0.86	24	4	0.97
5	7	0.66	15	5	1.08	25	4	4.89
6	4	0.72	16	4	0.79	26	8	1.87
7	4	0.32	17	5	0.87	27	6	1.76

Group (K)	No. of parents in a K	Within K SS	Group (K)	No. of parents in a K	Within K SS	Group (K)	No. of parents in a K	Within K SS
8	6	0.54	18	6	1.92	28	6	0.81
9	8	0.64	19	9	0.95	29	2	0.12
10	6	4.76	20	5	0.77	30	2	0.42

Development of populations

In Recurrent Introgressive Population Enrichment (RIPE) programme, a 3rd cycle population was developed through random mating among 4750 plants in 2nd cycle population. Seed yield of 2460 selections from 2nd cycle population ranged from 30-88 g/plant. Sixty best 2nd cycle selections that gave 65-88 g seed yield per plant were selected to convert into inbred lines whereas the *per se* yield of check, A1 was 24.6 g/plant. 1 kg seed of 3rd cycle population each was supplied to Tandur, Annigeri, Raipur and Indore centres.

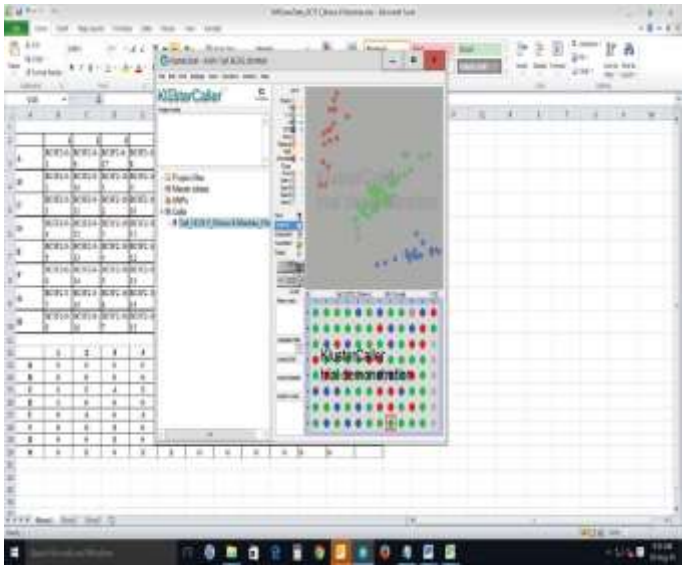
A total of 672 single plants were selected from a 2nd cycle national crossing programme population based on seed yield performance. The *per se* performance of selections ranged from 53-78 g/plant while the yield of A1 and PBNS-12 was 18 and 20 g/plant.

High yielding-high oleic varieties: Three high oleic varieties *viz.*, ISF-1, ISF-2 and ISF-3 were promoted to AVT-I of AICRP (Safflower) and 4 high oleic varieties *viz.*, ISF-4, ISF-5, ISF-7 and ISF-9 have been entred in IVT. At the national level, ISF-1 gave 15% higher seed yield (1597 kg/ha) and 27% higher oil yield (470 kg/ ha) than the best check variety, A1 (1391 kg/ha seed yield; 382 kg/ha oil yield). ISF-2 recorded 9% higher seed yield (1515 kg/ha) and 27% higher oil yield (485 kg/ha) than A1. Oleic acid content in ISF-1and ISF-2 was 75 and 76% respectively while in check varieties A1, PBNS-12 and NARI-6 it was 17, 22 and 14%, respectively. Oil content in ISF-1 and ISF-2 was 30% and 32% whereas it was 24-26% in A1 and PBNS-12. Nucleus seed of seven high oleic varieties in AVT-I and IVT *viz.*, ISF-1, ISF-2 (AVT-I), ISF-3, ISF-4, ISF-5, ISF-7, ISF-9 (IVT) was produced.

Evaluation of selected F_7 families: Among the 134 selected high oleic, high yielding F_7 lines, oleic acid content ranged from 70-81%, oil content was between 31 and 41% and seed yield was between 820 and 2080 kg/ha while oleic acid content, oil content and seed yield in the best check variety, A1 were 14%, 24% and 991 kg/ha, respectively.

Development of High Oleic Lines by Marker-Assisted Backcrossing

Asetof24BC_3F_1 progenies(BhimaxMontola-2000 cross) carrying heterozygous alleles (*Olol*) was identified using KASP based SNP assay. A subset of 10 heterozygous BC_3F_1 progenies was advanced to develop BC_3F_2 families. A total of 155 plants from the selected BC_3F_2 families was genotyped by marker assay and 35 BC_3F_2 plants carrying homozygous recessive alleles (*olol*) (high oleic) were identified. The selected high oleic BC_3F_2 plants were further subjected to background genotyping by SSR markers in order to assess the proportion of recurrent parent (Bhima) genome. The proportion of Bhima genome in high oleic BC_3F_2 plants varied from 51% to 94% (based on 33 polymorphic SSR loci) and three plants carried more than 90% of Bhima alleles. Overall, a set of eight backcross progenies (BC_1F_5, BC_2F_5 and BC_3F_3) carrying high oleic alleles (*olol*) was shortlisted for field testing.



KASP genotyping of BC_3F_2 plants of Bhima x Montola-2000 cross for detection of high oleic allele

Development of Breeding Lines With High Oil Content

A set of 28 selections (F_4/F_5) with oil content ranging from 34% to 38% was identified for further trial. These selections were made from the crosses involving Indian varieties (Bhima, PBNS-12, NARI-57) and the exotic varieties/ germplasm [EC-736501, EC755660 (S-334), EC755675 (Aceitera), EC755664 (CW-99), EC-736501, EC-736487). In order to generate more variability for seed yield traits and oil content, a multi-parent advanced generation intercross population (MAGIC) involving eight parents ([(A-1 x GMU-472-1) x (Bhima x EC-736487)] x (PBNS-12 x EC-755673-1) x (NARI-57 x S-334)] has been developed. A set of 500 MAGIC progenies are being stabilized.

Allele mining for oil content

Development of germplasm mapping panel

Adiversesetof520safflowerаccessionsconsisting of safflower sub-core, trait specific germplasm, high oil lines imported form USDA and Mexico were characterized using agro-morphological and molecular markers to quantify and analyze the structure of genetic variability among the accessions and to construct a germplasm mapping panel for association studies. A total of 50 SSRs was used for molecular studies. The polymorphism information content (PIC) in the safflower accessions selected to compose the core collection ranged from 0.14 to 0.82. All the accessions in the germplasm set splintered into 14 distinct groups in Darwin and four distinct groups in the Structure analysis. After evaluating the genetic structure and genetic variability of germplasm accessions, a sub set of 204 accessions was selected for further studies.

Evaluation of germplasm mapping panel for agro-morphological traits

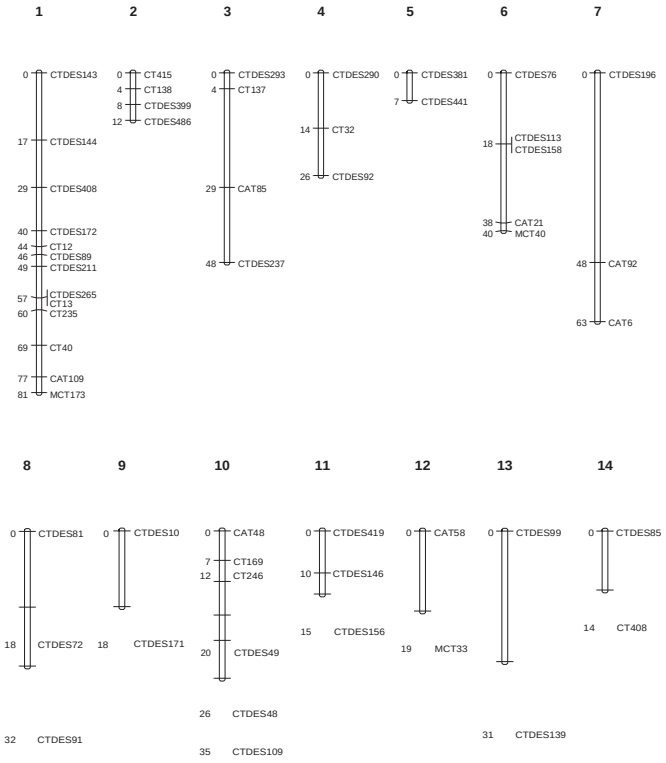
The germplasm mapping panel of 204 safflower genotypes was evaluated in augmented block design (ABD) with four checks A1, PBNS12, NARI57, NARI6 during *rabi* 2016 for agro-morphological characters *viz.*, plant height, flower colour, presence of spines, number of branches/plant, number of capitula/plant, number of seeds/capitula, hull thickness (visual), hull colour, 100 seed weight, seed length, seed breadth, seed thickness, seed yield/ plant and oil content.

Characteristics of germplasm mapping panel

Trait	Range
Plant height (cm)	25 to 115
Flower colour	Yellow, pale yellow/ orange, white
Spininess	Spiny, non-spiny
Number of branches/plant	4 to 38
Days to 50% flowering	63 to 110
Number of capitula/plant	6 to 89
Number of seeds/capitula	8 to 40
Hull thickness (visual)	Thick, thin, intermediate types
100 seed weight (g)	2.7 to 13.8
Seed length (mm)	1.38 to 9.92
Seed breadth (mm)	0.34 to 5.29
Seed thickness (mm)	0.36 to 4.39
L/B ratio	0.95 to 12.89
Oil content (%)	20 to 45

Construction of skeleton SSR linkage map and marker association with oil content trait

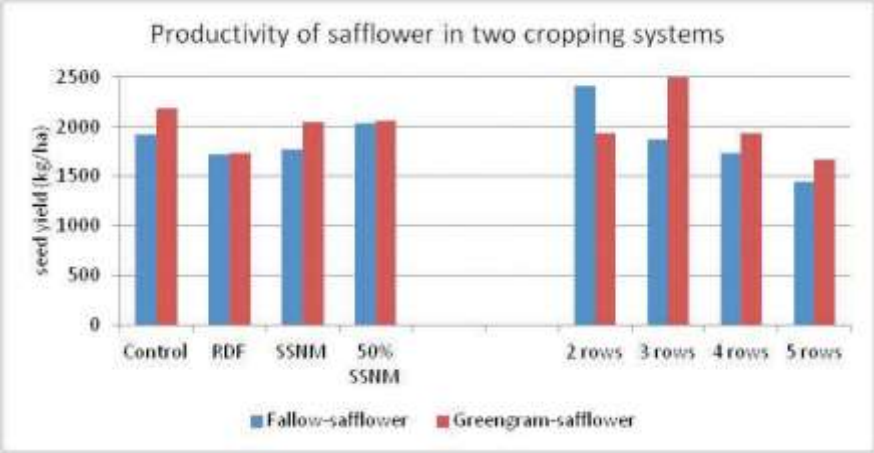
Genotypic data of F_2 population (consisting of 174 individuals derived from A-1 x EC-755673-1 cross) with 54 polymorphic SSR loci (out of 1107 loci tested) were used for linkage analysis to develop linkage groups. The linkage analysis was performed using JoinMap®3 with the key statistical parameters: LOD threshold of >3.0, recombination value of <0.4 and Haldane mapping function. Genetic distance (cM) data of the linked marker loci were obtained. The linkage analysis revealed 14 groups, which were incomplete, fragmented and tentative due to small number of loci mapped. Nevertheless, this map would assist in the development of high resolution SSR linkage map in safflower. In a preliminary single marker analysis, two SSR loci namely CtDES-81 (R^2=12.2%, P=3.5 x 10^{-6}) and CtDES-91 (R^2=9.4%, P=4.7 x 10^{-5}) showed putative association with oil content (%) in the mapping population. Both CtDES-81 and CtDES-91 were also mapped on the same linkage group indicating that these marker loci could be putative landmarks for tracing at least one of the genomic regions associated with oil content in safflower.



CROP PRODUCTION

Soil moisture availability: Agronomic modifications for sustainable productivity of safflower based cropping systems

The field experiment was conducted with three safflower based cropping systems *viz*., fallow-safflower, greengram-safflower and soybean-safflower under rainfed conditions. Safflower was cultivated with zero tillage with 16 treatment combinations *viz* four spacing levels and four fertilizer levels. The four spacing levels are 2 rows, 3 rows, 4 rows, 5 rows on each Broad bed (120 cm) and furrow (30 cm) land configuration. The four fertilizer levels are control (no fertilizer), 100% recommended fertilizer, site specific nutrient management (SSNM) and 50% SSNM. It is unreplicated trial and the data was statistically analyzed as two factor without replication model. The amount of annual rainfall received during cropping season (June to February) was 1032 mm. Greengram and soybean crops were sown on 16 July. Safflower was sown on 20 October with zero tillage after fallow and greengram, but it could not be sown after soybean as it was harvested in first week of November. Greengram crop was failed due to continuous heavy rains in the month of September. The soybean seed yield was 2.2 t/ha. Fertilizer and number of rows/BBF did not have significant effect on productivity of safflower in both the systems. Seed yield of safflower in fallow-safflower was the highest with 2 rows/BBF and in greengram-safflower it was with 3 rows/BBF.



Synthesis and evaluation of polymers for seed health and productivity of oilseed crops

Assessment of Pusa hydrogel in safflower

Evaluation of Pusa hydrogel in safflower for *rabi* season had been assessed for its irrigation water use and productivity. Application of Pusa hydrogel in safflower had been established based on the original claims of technology for first season at ICAR-IIOR. In safflower, there is an indication of increase trend in hydrogel treatments compared with control in crop growth, chlorophyll content, relative water content and membrane stability. Yield increase in spiny cultivar over control is in the range of 20 to 34.1% based on the hydrogel concentration range. In non-spiny the yield increase range is 10.7 to 14.1% over the control based on hydrogel concentration. But in productivity, there is no significant differences had been observed in the hydrogel treatments over control.

Variation in biochemical compounds during the safflower seed growth

Accumulation of oil content, tocopherols and fatty acid profiling was done during various stages of seed development in safflower high and low oleic acid genotypes. Oil content increased up to 36 days after flowering (DAF) and thereafter stabilized in all the genotypes till maturity. Gradual increase in oleic acid and decrease in linoleic acid was observed during maturity in high oleic types (CCC-B1 and Ciano-OL) while no significant difference was observed during maturity in low oleic types (Ciano-Lin and A-1). Maximum α-tocopherol content was reached at 21 DAF that decreased with maturity in all the genotypes. Accumulation pattern of oil, fatty acids and tocopherol content was similar to the previous years

Evaluation of released safflower varieties for quality

Twenty four released varieties of safflower were evaluated for oil content, fatty acid profile, protein content, hull & kernel content and antioxidant capacity. Oil content ranged from 23.65 (SSF-708) to 34.68 (HUS-305). Linoleic acid was the predominant fatty acid in all 24 varieties followed by oleic acid. Manjira recorded maximum oleic acid (37.79%) and minimum linoleic acid (65.27%) while HUS-305 recorded maximum linoleic acid (79.14%) and minimum oleic acid (11.8%) content. Variety PBNS-12 recorded maximum antioxidant capacity (96.6%) and 21.45% protein content.

CROP PROTECTION

ENTOMOLOGY

Evaluation of F_6-RIL Population for Reaction to Aphid

A set of 278 RILs of the cross CO-1 x EC-523368-2 was evaluated for reaction to aphid using artificial screening method under field condition at Rajendranagar farm during *rabi* 2016. The checks, CO-1 (susceptible) and EC-523368-2 (resistant), were repeated in each replication. The F_1s of the crosses CO-1 x EC-523368-2 and CO-1 x A-1 were also tested along with parents in each replication.

Plate 1: Reaction of Parents, F_1s and RILs of the cross: CO-1 x EC-523368-2 to aphid

Sowing of test entries was done during first week of December 2016 and the aphids cultured on CO-1 (in field) were released on the test entries at stem elongation stage during second week of January 2017 (about 35 days after sowing). Uniform infestation of aphids on every test entry was ensured. The trial was regularly monitored for appearance of wilt symptom and was recorded as days-to-wilt after aphid infestation. The average days-to-wilt of the checks, CO-1 and EC-523368-2 were 20.4±0.8 (SD) and 42.1±0.8, respectively. The F_1s of the crosses CO-1 x EC-523368-2 and CO-1 x A-1 were resistant (similar to the respective resistant parents) indicating that resistance to aphid is a dominant trait. The days-to-wilt of RIL population (n=218) ranged from 20 to 43 with the mean of 27.5±4.0, which is a clear indication of quantitative variation for aphid resistance. Overall, the result of F_1s and F_6-RILs confirm that resistance to aphid in EC-523368-2 and A-1 is a dominant trait and possibly follows quantitative inheritance.

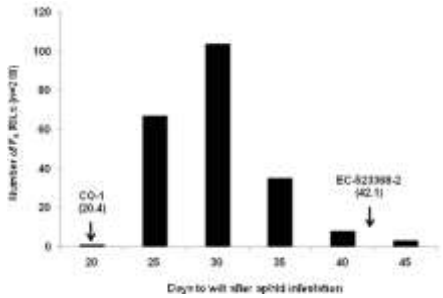


Fig. 1: Frequency distribution of days-to-wilt of F_6-RILs after aphid infestation

Resistant reaction of GMU 665

Resistant reaction of GMU 1626

Identification of sources of resistance for safflower aphids

During *rabi* 2016, a total of 166 safflower accessions from different sources were evaluated for their reaction to aphids. Screening was done through artificial release of aphids in the screening block.

Fifty accessions from sub-core of safflower representing diverse germplasm among safflower were evaluated for their reaction to aphids. Seven accessions (GMU- 2594, 2718, 4623, 2987, 5701, 1626, 2432) were found resistant to aphids with a damage rating of less than 2 on a 0-5 scale. Susceptible check CO-1 recorded a rating of 5 on 5. All CO-1 plants were completely wilted by 19th day after aphid release while the resistant lines remained green and continued to survive beyond 40 days.

Sixty three germplasm accessions that were found resistant earlier were screened using artificial screening method. Fifteen accessions, GMU- 609, 2424, 5142, 5130, 1628, 1301, 5132, 5136, 2067, 5149, 667, 5135, 589, 5133, 665 were found resistant to aphids and did not wilt even after 40 days of artificial release of aphids.

All 30 exotic lines (EC755659-755688) from Mexico were found highly susceptible to aphids. All the lines wilted as that of susceptible check, CO-1, within 19-22 days after release of aphids.

Twenty three released varieties of safflower were evaluated for their susceptibility to aphids during *rabi*, 2016 through artificial release of aphids. Varieties, HUS-305, NARI-6 and NARI-57 were found highly susceptible to aphids and collapsed completely by 19th day after artificial infestation and were at par with susceptible check, CO-1. Whereas, 3 varieties like, A-1, Bhima and Girna were continued to survive without wilting even after 43 days of aphid release.

PATHOLOGY

Resistant sources to Fusarium wilt and Phytophthora seedling blight

Safflower advanced generation lines NARI- 22, 23, 26, 28, DSI-102, DSI-104, W-2026 and W-521-5 were promising with low wilt incidence. The entries SAF-15-21, SAF-22-13 and GMU-3708 were promising with low wilt incidence in confirmatory screening during second year. Germplasm lines GMU 4814, GMU-3263 and breeding line DSI-103 resistant to seedling blight caused by *Phytophthora nicotianae*.

SESAME

CROP IMPROVEMENT

Development of Superior Hybrids/Varieties with Wider Adaptation in Sesame

During *kharif* a total of 240 newly synthesized hybrids were evaluated in two sets in ABD along with suitable checks. In set I, RT 346 x S0449 was superior for seed yield followed by Nirmala x JHS 1610 and GRT 83128 x DS5; however, Savitri x G 25 had highest number of capsules and branches.

Performance of top entries in Set 2

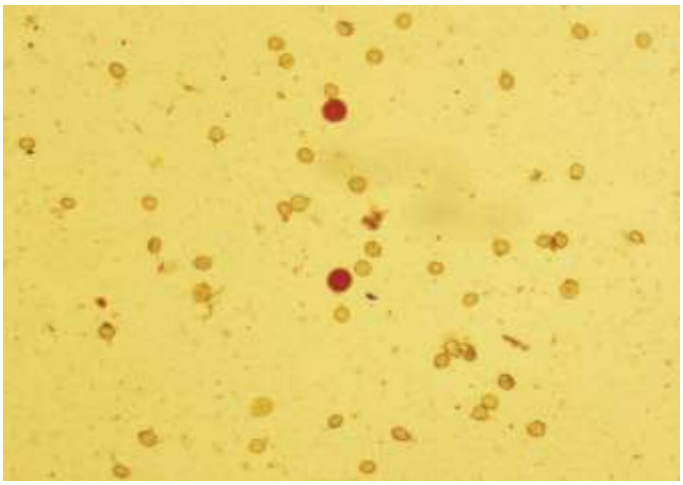
Entry	Days to flowering	Days to maturity	Plant height (cm)	No. of branches	No. of capsules	Seed yield (g/plot)
RT346 x S0449	33	82	65	4.5	85	145
NIRMALA x GRT 83128	36	82	77	3.6	39	116
NIRMALA x JHS 1610	34	83	78	4.3	58	136
IS 8156 x DS 5	34	83	76	4.1	64	107
GRT 8609 x HT 2	32	82	72	2.8	48	108
NIRMALA x SI 21380	34	81	76	8.5	68	106
SI 349 x DS 5	34	82	68	5.2	61	101
GRT 83128 x DS 5	34	82	68	3.6	41	132
SAVITRI x G 25	33	81	74	8.6	112	99
SWETHA ©	39	94	98	6.4	78	96
GT 10 ©	36	86	88	5.2	74	98
TKG 22 ©	34	81	76	3.8	62	92

During *rabi* season, a set of 160 hybrids was evaluated along with checks. In summer, a set of 120 hybrids was evaluated in ABD along with checks. In set-II, NIC 3389 x VRI 2 was found superior for seed yield followed by SI 1036 x VRI 2. For oil content, NIC 16324 x TMV 7 (49.6%) was found superior followed by NIC 8060 x VRI 2 (48.2%). In set-III, DSTA x VRI 2 was superior for seed yield followed by KMR 48B x VRI 2. For oil content, KMR 48 B x VRI 2 (50.8%) was found superior followed by IS113A x VRI 2 (49.4%). For capsule number IC14-20 x VRI2 was found superior (102). In set-IV, IS848a x VRI2 was found superior for seed yield followed by NIC840 x VRI2. For oil percent, Ic205207 was the best (48.6%).

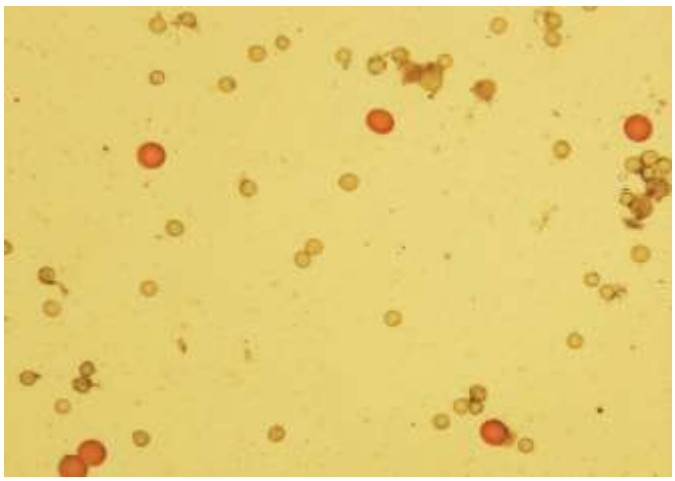
Synthesized 500 new crosses (*kharif*-120, *rabi*-220 and summer-160) with various combinations involving good agronomic base and donors. Multiplied 450 lines for use in hybridization programme.

Development of stable Cytoplasmic Genetic Male Sterile (CGMS) system in sesame through wide hybridization

Six F_1 s of interspecific crosses were raised in field and the observed pollen sterility ranged between 60.4 and 73.7%, *S. malabaricum* (ISMB-5) x GT-10 (73.2%), *S. malabaricum* (ISMB-6) x TKG-22 (71.5%), *S. malabaricum* (ISMB-7) x GT-10 (60.4%), *S. malabaricum* (ISMB-8) x TKG-22 (64.6%), *S. malabaricum* (ISMB -9) x GT-10 (70.2%), *S. malabaricum* (ISMB-10) x TKG-22 (73.7%). Backcrosses were made using the male sterile F_1s and respective recurrent parents (GT-10 or TKG-22). Apart from backcrosses, 6 paired interspecific crosses were initiated using wild accessions (6 different accessions of *S. malabaricum* collected from Gujarat) as female parents with TKG-22 and GT-10 as male parents).



ISMB -6 x TKG-22 (69.3%)

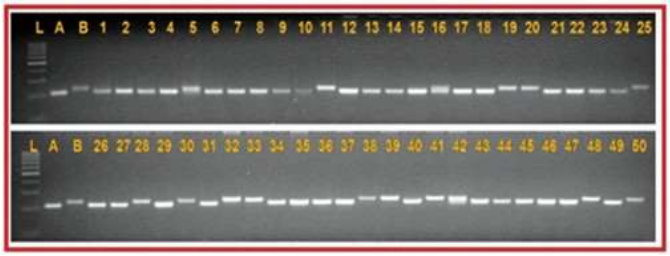


ISMB -7 x GT-10 (73.3%)

Molecular polymorphism studies in Indian sesame

A working set of 400 SSR markers was developed and was screened for their amplification in 50 Indian genotypes and PCR conditions were optimized with respect to annealing temperature and magnesium chloride concentration. Out of 400 SSRs, 68 were polymorphic among 50 Indian sesame genotypes. Among 68 polymorphic SSRs, only 4 markers showed polymorphism

among 20 released varieties but with low PIC. Publicly available 200 SSR markers specific to sesame were assigned to linkage groups based on *in silico* analysis using publicly available sesame genome sequence information.



Polymorphism of an SSR marker, SIM-117, among 50 Indian sesame genotypes including released varieties. A: TKG22; B: Shwetha; 3: TKG-21; 4: VRI(SV)-2; 5: HT-2; 6: G-Til-10; 7: G-Til-2; 8: TMV-7; 9: JTS-8; 10: Tiolottama; 11: JLT-408; 12: Savithri; 13: RT-351; 14: Nirmala; 15: Hima; 16: RT-346; 17: RT-127; 18: DS-5; 19: Pragathi; 20: RT- 125; 21: NIC-161848; 22: GRT-8609; 23: NIC-16426; 24: NIC-7835; 25: S-003116; 26: ES-37; 27: SI-1225; 28: S-0449; 29: KIS-375; 30: RT-103; 31: IS-446-1-84; 32: G-43; 33: IS-113-A; 34: NIC-17477-1; 35: G-25; 36: SI-101-184; 37: INT-135-115; 38: ES-178-2; 39: ES-62; 40: SI-2192; 41: IS-289; 42: ES-303311; 43: NIC-16264; 44: NIC-8282; 45: GRT-8392; 46: GRT-8368; 47: IS-475; 48: NIC-3181; 49: SI-76-1; and 50: KIS-398.

Spectrum of variability in yield-contributing traits

A collection of 800 sesame genetic resources including varieties, germplasm accessions and breeding lines was evaluated for agro-morphological traits and a subset of 150 genotypes was selected based on yield and yield-contributing traits. A wide spectrum of variability was recorded for number of branches (0-17), number of capsules per node (1-6), number of locules per capsule varied (4-6), internodal length (2-15 cm), plant height (20-125 cm), height till basal bearing (4-74 cm) 50% flowering (20-60 days) and physiological maturity (90-120 days).

Table showing range of yield-contributing traits and genotypes with genotypes recording minimum and maximum values

Trait	Range	Genotypes with low phenotypic values	Genotypes with high phenotypic
Plant height (cm)	20-125	Swetha-1	SI-2192-1
No. of branches	0-17	DS-5-1, DS-5-2, RT-351-1,RT-351-2	G-TIL-2-1
No. of capsule/node	1-6	Many	DS-5-3, RT-351-2, RT-351-4, RT-351-5
No. of capsules	10-482	HT=75-1, JLT408-1	G-TIL-10-1
No. of locules/capsule	4-6	Many	SI=2192-1
No.of internodal length (cm)	2 – 15	NIC-161848-1,TKG-22-3-1,Swetha-1	IS-113-A-1, G-43-1
Days to 50% flowering	20-60	Few (12)	Many
Days to physiological maturity	90-120	Few (8)	Many
Height of basal capsule (cm)	4-74	IS-113-A-1	ES-303311-1

CROP PRODUCTION

Variation among 54 sesame varieties under rainfed conditions for phenology, leaf temperature, and yield components were quantified. Pot dry down experiment with high and low foliage sesame varieties was carried out to assess the relationships between water uptake (transpiration) and capsule yield. Low foliage (LF) lines RT-46, RT-51, RT-125 had high transpiration (Tr) under well-watered condition but there was no relationship with Tr compare with high foliage (HF) YLM-66, SIM SIM-2 and 3. However, though Tr was less under stress, it has negative regression (R^2= 0.607) with leaf weight indicating that LF genotypes had better capacity in water uptake under stress condition which in turn might have contributed greater transpiration efficiency (TE).

(a)

(b)

Estimation (gravimetric) of genotypic transpiration variations in selected sesame high and low foliage types; plant before stress imposition (a); soil surface mulched with polythene sheet to arrest evaporation (b).

Core collection of sesame (313 Accessions) obtained from NBPGR and 45 released sesame varieties form different AICRP centres were evaluated in field during late *rabi* season 2016 for physiological efficiency under irrigated and drought (limited irrigation using water meter) conditions. The core collection included five wild types having large variation for plant height, no of branches, branching pattern, leaf type and area, types in basal leaf, phenology, flower colour, petal colour, capsule number per axis, capsule length, number of locules for capsule and capsule number per plant. Measured oil content in the seeds of available sesame varieties, drawn from the *kharif* experiment had ranged from 45 to 50 %.

Biochemical compounds in Sesame

Forty sesame lines were evaluated for sesamin and tocopherol content. NIC-7897 recorded maximum sesamin (26 g/kg in MeOH Extract) and tocopherol content (52.7 g/mg) in MeOH Extract) while minimum sesamin (1.6 g/kg in MeOH Extract) and tocopherol (1.0 g/mg in MeOH Extract) was observed in EC-10043.

OTHER SCIENTIFIC ACTIVITIES

Central Sector Scheme for Plant Variety Protection and Farmers Rights Authority

DUS testing trial of Castor

Two farmers varieties of castor were raised in *kharif*, 2016 and data were recorded for 30 DUS traits in accordance with the DUS test guidelines.

DUS testing trial of Sunflower

DUS hybrid trial comprising of 8 candidates and 5 reference entries, R lines trial of 5 candidates and 3 reference entries, A/B lines trial of 4 candidates and 4 reference entries were conducted and entries were characterized for 30 traits in accordance with the DUS test guidelines.

DUS testing trial of Safflower

One farmer's variety and 2 reference varieties were raised and characterized for 25 DUS traits.

Agriculture Knowledge Management Unit (AKMU)

The AKMU of this institute has regularly updated the websites through pertinent databases on prices and arrivals of IIOR mandated crops for the major APMC's; AIRP and FLD releases, press gleanings, tender documents, employment opportunities, photographs of the various events. During the year under report, the unit had developed mobile apps on "IIOR at a glance" and on " ICAR IIOR Castor" that are accessible to the stakeholders through Google play.

Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell has facilitated to review the progress of all the ongoing projects by Research Advisory Committee (RAC). It has also facilitated to review the experiments carried out under 25 Institute projects and 16 External funded projects in field as well as in IRC meetings both in *kharif* and *rabi*. After thorough review in IRC, it was decided to close 3 Institute projects and start 4 new projects. RPPs of 28 Institute research projects were reviewed as per the IRC recommendations and submitted to Director for approval. The database on publications updated and maintained. Five project proposals were evaluated for submitting to different funding sources. Six monthly reports on targets and achievements in HYPM have been uploaded. Under Institute Technology Management Unit (ITMU), database of commercialisable technologies, and IP assets were updated. The MoA for transferring the technology through licensing was finalized after discussing with the NBA officials. .Facilitated for the agreement with NBA for taking the approval for obtaining Indian Patent on 2 applications. The replies to the different queries of CIB&RC on Bt-1 and *B.bassiana* data were sent to the respective licensee. One proposal of the scientist for data generating for licensing and one patent application were processed. Facilitated to conduct one ITMC meeting and preparing proceedings. The ITMU of this Institute processed several proposals to license technologies to bio-pesticide entrepreneur.

Frontline demonstrations (FLDs) and extension activities on oilseeds funded by NMOOP

The implementation of the Annual Action Plan (AAP) on FLDs and other extension activities

by all the oilseed Institutions/Directorates/ Project Coordinating Units and centres was monitored, which resulted in laying out of 6832 demonstrations, out of the sanctioned 7380 FLDs across nine oilseed crops. Inputs dealers are the primary source of information on agriculture for the farmers. Hence, in order to improve the knowledge of input dealers on oilseed production technologies, 43 trainings were conducted for input dealers, agricultural officers and extension workers out of the 75 training allotted. The details of FLDs on oilseeds and oilseed based cropping systems conducted by Indian Institute of Farming System Research (IIFSR), Modipuram are given below.

Progress of FLDs 2016-17

Institute/AICRP	Physical progress						
	FLDs					Trainings	
	Approved		conducted		Total	Approved	Conducted
	Kharif	*Rabi*	*Kharif*	*Rabi*			
ICAR-Indian Institute of Soybean Research, Indore	1100	-	1137	-	1137	5	5
ICAR-Directorate of Rapeseed-Mustard, Bharatpur	-	1800	-	1800	1800	10	10
ICAR-Directorate of Groundnut Research, Junagadh	450	300	293	200	493	20	03
ICAR- Indian Institute of Oilseeds Research							
Castor	150	50	150	50	200	4	4
Safflower	-	755	-	755	755	4	4
Sunflower	100	600	100	600	700	12	12
Sesame	200	-	-	200	200	-	-
IIOR (Total)						**20**	**20**
Project Coordinator (Sesame), Jabalpur	450	200	300	67	367	10	4
Niger	200	0	155	-	155	0	0
PC (Linseed), Kanpur	0	900	-	900	900	5	2
ICAR-Indian Institute of Farming Systems Research (IIFSR), Modipuram	16	109	16	109	125	5	5
Total	**2666**	**4714**	**2151**	**4681**	**6832**	**75**	**43**

TMC MM 1.6: e Kapas network and technology documentation

A total of 142 voice advisories were disseminated to 11,237 registered farmers in nine districts of Telangana. The advisories were developed on pre-sowing, sowing, crop production, crop protection, harvest and post-harvest technologies besides weather alerts and market information on cotton during *kharif* 2016-17. The content for voice advisory was aggregated from IMD, CICR, CRIDA, ICAR, TS AGRISNET and ARMARKNET websites and feedback from registered farmers in various districts. It was edited, developed into a script (Telugu) for 30 seconds time duration, recorded and disseminated through e kapas advisory

system. More than 74% success was observed in delivery of voice advisories to the farmers.

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

Demonstrations on best management practices (BMPs) of sunflower (279 acres) and sesame (235 acres) were conducted in seven districts of three states. The soil samples collected from the selected farmers under the project were analysed by the Agricultural Development Labs, Zuari Agro-chemical Limited and the results are presented below. The critical elements in each village were identified and based on the STCR equation for the district the nutrients were provided in the BMPs.

Critical Soil fertility status of study villages in Andhra Pradesh, Telangana Karnataka and West Bengal

State	District	Mandal	Village	Soil type	Critical element identified
Andhra Pradesh (Sesame)	Kadapa	B.matam	Chowdharivari palli	Black Clay loam (pH= >8.0)	Phosphorus and Sulphur
	Prakasam	Giddalur	Diguvametta thanda		
		Komarrole	Yerrapalle		
Telangana (Sesame)	Khammam	Vemsoor	Kandukuru	Clay loam (pH= 7.0-8.0)	Phosphorus and Sulphur
Karnataka (Sunflower)	Bagalkot	Badami	Gonal	Red sandy loam (pH= 6.5-8.0)	Zinc and Boron
			Manglur	Black clay loam (pH= 7.3-8.0)	Sulphur and Iron
	Koppala	Koppala	Bettagere	Red sandy loam (pH= 6.5-7.5)	Phosphorus and Boron
West Bengal (Sesame)	West Medinapur	Binpur	Kankoo Jyothsna	Loamy (pH=5.0-6.3)	Lime and Boron application
		Chakonavan	Khirpai	Loamy (pH=5.2-6.3)	Low in Ca, lime application
	Bankura	Chatna	Brindavanpur	Loamy (pH=5.5-6.3)	Lime and Zinc application
			Barshi	Loamy (pH=5.0-6.3)	Lime application
		Sonamukhi	Parbatiya Bhairabdanga	Loamy (pH=5.0-6.2)	Lime and Boron application
			Dubrajhati Kalyanpor	Loamy (pH=5.2-6.0)	Lime and Boron application

The results of the demonstrations on sunflower BMPs are presented below. The adoption of BMPs has resulted in more than double the seed yields of sunflower as compared to the state average yield in Karnataka. Whereas, in West Bengal the increase in seed yield with BMPs was 44% as compared to the state average yield.

Ten training programmes to farmers and four field days were conducted involving farmers, extension personnel and agricultural department personnel.

Village-wise yields of sunflower with BMPs as compared to district and State yields

State/ district	Village	Seed Yield (kg/ha)			
		BMPs	FP	DAY	SAY
Karnataka					
Bagalkot	Gonal	1172	875	574	548
	Manglur	1225	1072	-	-
Koppala	Bettagiri	950	750	599	-
West Bengal					
West Medinapur	Kankoo	1860	1260	1280	1293
	Jyothsna	1740	1375	-	-
Bankura	Brindavanpur	1800	1300	1387	-
	Barshi	2000	1490	-	-

BMPs = Best Management Practices; FP = Farmers practice; DAY= District average yield; SAY = State average yield

Sunflower hybrid DRSH-1 following BMPs in Bettagiri village

Sunflower hybrid DRSH-1 following BMPs in Barshi village

The results of the demonstrations on sesame BMPs are presented below. The adoption of BMPs in sesame has resulted in 26 to 157% increase in seed yield at various locations as compared to the state average yields.

Productivity potential of BMPs of sesame conducted during rabi/summer 2015-16

Villages	Seed yield (kg/ha)						
		FPY	Increase over FPY	DAY	Increase over day	SAY	Increase over SAY
Choudarivaripalli	525	425	23.5	350	50.0	325	61.5
Lingaladinnapalli	560	475	17.9		60.0		72.3
Diguvametta thanda	490	400	22.5		40.0		50.8
Kottapalli	410	350	17.1		17.1		26.2
Yerrapalle	510	400	27.5		45.7		56.9
Rajupalem	550	460	19.6		57.1		69.2
Kandukur	900	750	20.0	400	125.0	350	157.1
Khirpai	1800	1350	33.3	795	126.4		84.6
Parbatiya	1650	1050	57.1	780	111.5	975	69.2
Bhairabdanga	1780	1200	48.3		128.2		82.6
Dubrajhati	1700	1250	36.0		117.9		74.4
Kalyanpur	1650	1100	50.0		111.5		69.2

BMPsy = Best Management Practices Yield; FPY = Farmers practice yield; DAY= District average yield; SAY = State average yield

Sesame field day at Kandukuru, Telangana

Sesame field day organized at Kirpai, West Bengal

Under the project entitled "Competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana", the activities included appraisal of the copping systems in the selected villages (Pirampally, Gattepalli and Ramur Thanda); collection of household survey; awareness on the importance of soil fertility an imparting skill development in soil sampling; conducting awareness camps on the importance of Integrated Nutrient management, conducting crop production technology oriented capacity building programmes, arranging exposure visits to oilseed demonstration plots, provision of literature on importance of soil fetility and testing and method of soil sampling for soil testing, making arrangements for breeder seed/ Truthful labelled seeds of important oilseeds and pulses.

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 3.30 q breeder seed of castor (SKP-84, SKI-215, DCS-107, PES-262 and PCS-4) was

produced by various centres against a target of 1.97 q of DAC indent. Breeder seed of sunflower (DRSF-113, CMS 234A, 234B, CMS-17A, 17B, CMS-335A, 335B RHA 6D-1 and RHA-95-C-1) was produced to the tune of 22.7 q against a target of 1.91 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".

IIOR also produced about 16.0 q breeder seed of Soybean var. JS 93-05 during the *kharif* season as per the indent of TSSDC.

Production of Sunflower hybrid, DRSH-1

Seed of sunflower hybrid DRSH-1 was produced both at IIOR-ICRISAT and Narkhoda farms during rabi/ summer 2016-17. The total seed yield was about 4.5 q.

Production of Castor hybrids

Castor hybrid seed production of DCH-177 and DCH-519 was undertaken in about 40 acres with farmers participation at Konkala village of Waddepally Mandal , Mahaboobnagar district, Telangana State during *rabi* 2016-17 and about 120 q seed was produced.

Seed production of Sesame var. GT-10

About 40 q of sesame certified seed of GT-10 was produced by IIOR in farmers field at Nirmal and is being supplied to State Department of Tripura for demonstrations and spread in north-eastern states.

Seed production of Safflower var. PBNS-12

About 150 q seed of Safflower var. PBNS-12 was produced under TSP-Seed production of ICAR Seed project in about 50 acres of tribal farmers of Indravelly mandal, Adilabad district Telangana State during *rabi* 2016 in collaboration with Ekalavya Foundation. The tribal farmers were supplied with inputs *viz*., seed, fertilizer, pesticides, solar sprayers etc.

Trainings organized in Seed Production

- A field day cum seed production training in hybrid castor was organized for 600 farmers on 27 Jan 2017 at castor seed production fields of Konkala village, Mahabubnagar Dist.
- To disseminate the seed production technologies, a Field Day–cum-Training Programme was organised on 24-03-2017 at Chityal village Nirmal dostrict in the sesame seed production farmers' fields. The participation included farmers, scientists, extension personnel, NGOs etc. About 200 farmers and extension personnel from surrounding villages of Nirmal mandal & district and Indravelly, Gudihatnoor, Echoda mandals of Adilabad district participated.
- 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.
- Skill Development training on seed production of oilseed crops was organized for diploma graduates during Feb 2017.

Breeder/ Foundation seed production at IIOR

Crop	Parent/ Variety	Quantity (q)
Castor	DPC-9	1.50*
	M-574	1.00*
	DCS -107	5.16
Sunflower	DRSF-108	0.20
	DRSF-113	1.00
	CMS 243 A	0.96
	CMS 243 B	0.46
	RHA 6 D-1	1.00*

* Expected

AICRP ON
CASTOR, SUNFLOWER AND SAFFLOWER

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

Castor

- Four trait-specific accessions *viz.*, RG-4018, RG-1587, RG-4025 and RG-3999 with higher seed yields across locations (2237-2354 g/kg/ha) than GC-3 (2200 kg/ha) identified in a multi-location evaluation trial conducted under rainfed and irrigated conditions.
- The high ricinoleic accession, RG-3799 (91% ricinoelic acid) yielded (2364 g/net plot) at par with GC-3 (2416 g/net plot) across locations in a multi-location evaluation trial.
- A non-spiny extra-early maturing castor germplasm accession, RG-19/IC0612166 (INGR15008) was registered with Plant Germplasm Registration Committee (PGRC), NBPGR, ICAR.
- JI 434 and JI442 identified as promising good combiners for multiple traits at Junagadh
- Two new pistillate lines *viz.*, PPL-23/2, PPL-9 developed at Palem
- About 242 hybrids were produced in 9 centres including IIOR Hyderabad.
- ANDCH 15-08, PHT-BP-16-9, JHB-1066, SHB-1029, YRCH-16032 and PHT-II-230 (Yield ranging from 2460-6872 kg/ha and percent of increase over the best check ranging from 16-64) were identified as promising preliminary hybrids at six centres *Viz*. Anand, Bhavanipatna, Junagadh, SK Nagar, Yethapur, and IIOR, Hyderabad
- Preliminary evaluation under rainfed conditions of 26 hybrids, contributed by six centres, indicated that NAUCH-1605 and NAUCCH-1601 at Hiriyur and IIORCH-16-02 and JHB-1013 at Yethapur were promising
- In multi location trials SHB-1004, SCH-53, JHB-1018, SLCH-158, SHB-974, RHC-426, JHB-1027 and JI-422 reported to give higher seed yield and JI-423,Maharaja-9,ICH-68, DCH-1720 and RHC-426 were reported wilt resistant and gave higher seed yield
- A total of 3.3 q of breeder seed of varieties and parental lines of castor was produced against the DAC indent of 1.97 q by various centers. Besides, at IIOR, Hyderabad, 70 q each of DCH-177 and DCH-519 hybrids and 5 q of DCS-107 were produced.
- At Junagadh, application of Pendimethalin 1 kg/ha (pre-emergence) + Quizalofop ethy1 0.050kg/ha (post – emergence at 25 DAS) + HW at 40 & 60 DAS resulted in higher seed yield (4123 kg/ha), higher weed control efficiency (73.30 %), lower dry weed weight (343 kg/ha), lower weed index (11.22 %), and higher net returns (` 91901/ha).
- At S.K.Nagar and Kanpur, pre-emergence application of Pendimethalin followed by hand weeding (HW) at 40 and 60 DAS recorded significantly higher seed yield.
- At Yethapur, two castor hybrids *viz.*, DCH -177 (1296 kg/ha) and YRCH -1 (1261 kg/ha) performed equally effective in recording higher seed yield over other genotypes in rice fallow.
- In studies on minimizing the frost damage through appropriate planting time at Mandor, indicated that early (10th July) or delayed (10th August) sowing significantly reduced the seed yield compared to timely (25th July) sown crop (3817 kg/ha).

- Application of 20-40 kg P_2O_5 + seed treatment either with biophos or PSB were equally effective in influencing the seed yield, yield attributes and realizing higher economic returns.
- At Junagadh, 75% RDK through MOP + 25% through castor meal resulted in significantly higher seed yield (4293 kg/ha). At Mandor, application of 25% RDK through MOP + 75% through castor meal resulted in higher seed yield (4128 kg/ha). At Bawal, application of 100% RDK through enriched castor meal recorded highest seed yield (3653 kg/ha) of castor
- The FLDs conducted over the locations on whole package demonstrations (2058 kg/ha) during *kharif* 2016, recorded an overall increase in seed yield by 25% as compared to farmers practice (FP) (1646 kg/ha) with the additional net returns (ANR) of ` 13,070/ha. The B:C ratio was 3.17 and 2.86 with IT and FP, respectively.
- Temperatures between 22.5 and 28^{0}C at RH between 80-92% with continuous rainfall during 2nd week of September favoured *Botryotinia* gray mold development and gradually reached to a maximum severity of 95% by 30th September at Hyderabad.
- In pathogenic variability of Fusarium wilt pathogen, AP-56, AP-156, AP-200, 48-1 genotypes recorded resistant reaction with isolates from Hyderabad, Palem, S. K. Nagar, while differential reaction was observed with AP-163.
- In artificial screening of accessions against wilt, RG 155, RG-386, RG-1624, RG-2781, RG-3042 showed ≤ 20% wilt incidence at Hyderabad, S.K. Nagar and Palem. RG-3243 showed low (20.5%) gray mold severity under artificial epiphytotic conditions at Hyderabad while RG-111, RG 2821, RG-2976, RG-2822 x RG-2386-P72 showed < 20% root rot at Junagadh.
- Seed treatment and soil application of *Trichoderma harzianum* showed high germination percentage, low disease incidence and higher seed yield followed by seed treatment with carbendazim at Yethapur. Seed treatment with combination of *P. flouorescens* + *T. harzianum* significantly recorded low root rot and high seed yield at Junagadh.
- Spraying of Propiconazole 1ml/lt was found effective in control of gray mold in on-farm demonstration in fields of Amanagal mandal in Telangana state.
- Among entries of National screening nursery - wilt, the following wilt resistant genotypes (0-20%) showed varied reaction in different sick plots.
- RG-3095 and RG-3132 confirmed resistant to leafhopper (hopper burn grade of 1 on 0-4) at Palem, Yethapur and IIOR, Hyderabad
- Parental lines *viz*., DPC-25, DCS-114 SKI-215 and SKI-336 were found resistant to leafhopper (hopper grade of 1 on 0-4 scale) at Palem, Yethapur and IIOR, Hyderabad.
- The newer insecticide, clothianidin 50WDG @ 0.1g/l found effective against leafhopper (74.9 to 98.0% reduction over untreated control) and resulted in higher seed yields of 1617 and 1368 kg/ha with cost benefit ratios of 1: 1.51 and 1: 2.11 at Palem and IIOR, Hyderabad, respectively.

MAJOR RECOMMENDATIONS

- HCH-6 – Castor hybrid released for Karnataka and Pragathi - Castor variety released for Telangana.
- YRCH-2 castor hybrid was identified for cultivation in Tamil Nadu by the State Variety Release Committee,
- GCH-8, a wilt resistant hybrid was identified by Varietal Identification Committee for irrigated and rainfed castor growing areas of the country
- Under irrigated conditions of South Gujarat, pre-emergence application of pendimethalin

1 kg/ha followed by one hand weeding at 40 DAS was effective in realizing higher castor seed yield in *rabi*.

- 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) realized higher castor seed yield (3506 kg/ha) with high profitability (B: C ratio 3.86).
- Application of 30 kg N/ha (25 %) of RDN and full dose of P (50 kg/ha) as basal dose and remaining 90 kg N/ha (75%) N applied in five equal splits through drip-fertigation at 0.8 Epan at an interval of 12 days starting after cessation of monsoon realized higher seed yield with high profitability of castor.

SUNFLOWER

- Released hybrid, PDKVSH-952 for Vidarbha region and its parents registered with NBPGR, New Delhi and TAS-82 registered with PPV & FR Authority, New Delhi by Akola.
- Genotypes CMS-335A, CMS-852A, CMS-853A, CMS-10A, CMS-127A, IM-850A, CMS-338A, CMS-400A, FMS-821A, CMS-62A, CMS-243A, CMS-207AB were identified as downy mildew resistant and genotypes EC-289730, EC-398675, EC-399978, EC-399499, IC-526371, EC-625798, EC-625733, TSG-92, SCG-8, TSG-114, SCG-26, SCG-61, SCG-56 with high seed yield showed field tolerance to Alternaria leaf spot.
- At Raichur, genotypes PM-66, PM-81 and PM-82 were identified as tolerant to powdery mildew in screening under greenhouse conditions.
- AKSFI-16-12 (1427 kg/ha and oil content 38.1%) at Akola, SS-1319 (1726 kg/ha) at So;apur was found to be significantly superior to all 4 checks while entries AKSFI-16-10 (1386 kg/ha), AKSFI-16-13 (1369 kg/ha) and AKSFI-16-9 (1329 kg/ha) were at par with each other with regard to seed yield.
- 734 hybrids were evaluated at multilocations
- KBSH-78 (2359 kg/ha) at multilocations of Karnataka, CSFH-15026 (2727 kg/ha) at Coimbatore, HSFH-1573 (2697 kg/ha) at Hisar , SHT-13 (2385 kg/ha) at Akola, Savilivihir, DK-3849 (2370 kg/ha) at Ludhiana, SVSH-498 (2066 kg/ha) at Raichur found promusing,
- A total of 4.93 q of breeder seed was produced against an indent of 1.91 q.
- Thinning and plant protection were the critical production factors limiting (~47%) sunflower productivity and profitability in Tarai region of Uttarakhand.
- Ridges and furrow land configuration at Akola, Latur, Raichur and Savalvihir; BBF at Nandyal along with RDF recorded higher seed yield and higher moisture retention under rainfed condition.
- The hydrophilic polymer hydrogel was promising in increasing soil moisture and seed yield in most of the locations under rainfed condition.
- Among the released hybrids of sunflower, PSH-1962 followed by LSFH-171 were found promising for spring season in IGP region.
- Pre-emergence application of Pendimethalin @ 1.0 kg ai/ha as pre-emergence spray followed by hand weeding or power weeding at 30 DAS was the best at Coimbatore.
- The FLDs on sunflower conducted during *rabi*/ spring showed that the mean seed yield increased by 19% with improved technology (1598 kg/ha) as compared to farmers' practice (1347 kg/ha).
- During *kharif* 2016, IT (1488 kg/ha) showed 33% increase in mean seed yield as compared to farmers practice (1118 kg/ha) indicating huge potential for enhancing the yield of sunflower during *kharif*.
- Optimum temperatures for high oleic acid accumulation were 33.4 C maximum temperature

and 22.9 C minimum temperature with a mean of 28.2 C based on response surface model (RSM).

- Entries that showed less incidence to the diseases Alternaria (Al), necrosis (Ne), powdery mildew (Pm), downy mildew (Dm), charcoal rot (Ch) and collar rot (Co) were : IOSH 14-07 for Al, Ne, Co; IOSH 14-02 for Ch, Ne, Dm; CSFH-12205 for Al, Ne, Dm; CSFH-13075 for Al, Ch, Co; LG-5401 for Al, Ch, Co, Dm; S-2216 for Al, Ne, Ch, Dm; LSFH-2491 for Al, Ne, Pm; S-2328 and SS-204 for Al, Ne, Dm; AHT: CSFH-12250, S2150, CSH-12205 for Al, Ne; NSFH-1016, KSFH-473, KSFH-474 for Al, Ne, Dm.
- For management of *Sclerotinia* collar rot -seed treatment with *Trichoderma viride* of PAU (0.4%) + *Pseudomonas fluorescens* (0.4%) and soil application of *T. viride* @ 2.5 kg/ha found effective
- *Apis dorsata* was the most predominant pollinator on sunflower under Bengaluru conditions followed by *A. florea* (19.4%), *A. cerana* (14.9%), *Xylocopa* sp. (2.7%), *Trigona* sp (2.0%), *Megachile* sp. (1.6%) and *Ceratina* sp. (0.8%).

MAJOR RECOMMENDATIONS

- One variety, Phule Bhaskar for Maharashtra and three hybrids, Prabhat for Andhra Pradesh, PSH-1962 for Punjab and RSFH-1887 for Karnataka.
- Apply Pendimethalin @ 1.0 kg a.i/ha (PE) + Propaquizofop @ 62 g a.i/ha at 15-20 DAS (PoE) followed by one intercultivation at 30 DAS for realising higher sunflower seed yield and higher weed control efficiency and economics in Vertisols at Raichur.
- Site specific (soil test based) target yield NPK + S + limiting micronutrient (B) to the rabi sunflower increased the system yield, gross return, net return and BCR in groundnut – sunflower cropping system in Alfisols at Bengaluru.
- Seed treatment with *Pseudomonas fluorescens* (Pf1) @ 10 g/kg seed followed by spray of Hexaconazole / Propiconazole @ 0.1% at 45 days and *P. fluorescens* (Pf1) @ 1.0% at 60 DAS is effective for the management of Alternaria leaf spot in sunflower as it reduced the disease incidence by 25-63% and increased seed yield by over 40%.
- Seed priming with Carbendazim @ 2 g/kg + Thiamethoxam @ 4 g/kg and foliar spray of Propiconazole @ 0.1% + Thiamethoxam @ 0.04%) reduced the incidence of Alternaria and necrosis and increased yields by 26-34%.
- Spray of Difenconazole (0.05%) at 45 DAS for controlling powdery mildew disease in *rabi* at Dholi

SAFFLOWER

- GMU 758 (617 kg/ha) at Annigeri under rainfed conditions and GMU 1810-2, GMU 2453, GMU 2968 and GMU 37589 1095-1395 kg/ha) recorded higher seed yield uder irrigated conditions.
- Germplasm accessions GMU 1437 (38.5%), GMU 2039 (35.5%), GMU 2444 (35.5%) and GMU 3530 (35%) recorded oil content ≥35% at IIOR, Hyderabad.
- RSS-2011-1-1 and NARI-SD-128-3 recorded 50% flowering at 50-53 days and recorded 16 % and 12% higher seed yields, respectively than the check JSI-99.
- NARI-H-55 at Phaltan recoreded higher seed yield by 55% than the check
- Six CMS lines *viz.*, A-133-IA, A-133-IIA, A-148, A-348, A-152 and A-662 developed by IIOR, Hyderabad exhibited 98-100% male sterility at IIOR, Hyderabad.
- Two CMS lines, AKS CMS 2A and AKS CMS 3A developed at Akola centre showed 98.38 and 100% male sterility at Akola.
- Three populations *viz.*, PBNS-140, PBNS-142 and PBNS-143 developed at Parbhani gave 16.7- 30.9%

higher seed yield (1187-1328 kg/ha), respectively over the best check, PBNS-12 (1017 kg/ha).

- Wilt resistant varieties, W-521-3 and ISF-48 developed by IIOR, Hyderabad recorded higher seed yield
- The entry, ISF-764 recorded 26% higher seed yield (1753 kg/ha) than the best check, A1 (1391 kg/ha) and 37% higher oil yield (524 kg/ha) than A1 (382 kg/ha).
- The high oleic entries, ISF-1(75 %), ISF-2 (76 %) and non-spiny entry, ISF-763 gave 9 to 22% to higher seed yield and 19-27% higher oil yield than the respective checks
- SSF-1350 gave 15.4% higher oil yield (521 kg/ha; oil content: 30.49%), NARI-113 recorded 11.6% higher oil yield (504 kg/ha; oil content: 33.93%) and SSF-12-40 gave 11.5% higher oil yield (504 kg/ha; oil content: 32.35%) than A1.
- At the national level, the non-spiny entry, SPP-70 recorded 15.9% higher seed yield (1060 kg/ha) than the non-spiny check, NARI-6 (915 kg/ha).
- In AHT-I, The hybrid, DSH-256 yielded at par with A1 but recorded 22.7% higher seed yield (1574 kg/ha) than hybrid check, NARI-H-23 (1283 kg/ha).
- DSH-263 gave 20.9% higher seed yield (1551 kg/ha) than NARI-H-23 and registered 10.1% higher oil yield (457 kg/ha) than NARI-H-23 and 6.6% higher oil yield than A1.
- A total of 65.45q of breeder seed of 8 varieties was produced against the assigned target of 13.6 q breeder seed and besides 512.2 q of seed was available with centres.
- Non-spiny hybrid NARI-NH-1 recorded highest safflower equivalent yield compared to spiny safflower and other competing rabi crops and its intercropping systems at all the centres *viz*. Annigeri, Indore, Parbhani, Phaltan, Raipur, Solapur and Tandur.
- Application of fertilizer based on STCR equation along with Zn and S resulted in significant yield improvement at Annigeri and Tandur.
- 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.
- FLDs on whole package (improved cultivar, recommended dose of fertilizers and need based plant protection) under irrigated conditions, recorded a mean safflower seed yield of 952 kg/ha in FLDs and 645 kg/ha in farmers' practice (FP) plots. Under rainfed conditions, FLDs recorded a mean safflower yield of 923 kg/ha and 808 kg/ha in FP.
- The entries W-521-3, W-521-5 and W-521-9 were found free from wilt incidence and the germplasm line GMU-5094 was moderately resistant in Uniform Disease Nursery at Tandur.
- Fusaric acid at 25 ppm concentration was able to differentiate resistant and susceptible genotypes of safflower to wilt and can be used for confirmation of resistance in laboratory (Parbhani and IIOR, Hyderabad).
- *T. harzianum* Th4d SC @ 2ml/kg and cymoxanil 8% + mancozeb 64% @ 0.2% were most effective and recorded significantly low incidence of Fusarium wilt (17.6 & 18.2% respectively) at IIOR, Hyderabad.
- Carbendazim + mancozeb, azoxystrobin, iprodione + carbendazim at Solapur and azoxystrobin at Parbhani were effective in management of Alternaria leaf spot.
- Under multi-location testing, SSF-714, SSF-682 and SAF-13-40 were found resistant at Akola and Solapur and SAF 1335, SAF 1356, GMU 1628 confirmed resistance to aphid at Akola and Solapur centres.

MAJOR RECOMMENDATIONS

- For effective and economical management of Phytophthora damping-off and seedling blight of safflower 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.
- Substitute 100% P of either greengram or safflower with PSB + 5 t FYM/ha for sustaining greengram-safflower system productivity in Vidarbha region of Maharashtra and northern transition zone of Karnataka.
- Substitute 50% P of greengram with PSB and 100% NP to safflower for sustaining greengram-safflower system productivity in Vidarbha region of Maharashtra.
- Apply 100% NP of both the crops in greengram-safflower system through inorganic source for sustaining greengram-safflower system productivity in Northern Transition zone of Karnataka.
- Newer insecticides, Thiomethoxam 25WG @ 125 g/ha, Acetamiprid 20 SP @ 100g/ha and Clothianidin 50 WDG @ 10ml/ha were compatible with the fungicide (Carbendazim 12% + Mancozeb 63%) 75 WP without any phytotoxicity, physical changes and alteration in their efficacy in safflower

ICAR-IIOR

वार्षिक प्रतिवेदन

Annual Report
2016-17

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
- Appointments/Promotions/Transfers/Superannuations
- Personnel

EXTENSION AND OTHER ACTIVITIES

Tribal Sub-Plan

Tribal sub-plan programme was implemented in 60 villages of 14 districts spanning over 8 states *viz.* Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Rajasthan, West Bengal, Gujarat and Chattisgarh, with the objective of reducing poverty among the schedule tribe population and creation of productive assets for them. Under this programme, 889 Schedule Tribe farmers were benefitted through demonstrations of latest released varieties/hybrids of castor, sunflower and safflower with improved technologies conducted in association with NGOs *viz.,* Viksit Rythu Sankshema Samstha (VRSS), Ekalavya Foundation, REEDS and Agri-Biotech Foundation (ABF) and AICRP centres *viz.,* Nimpith, Yethapur, Hiryur, Mandor, Raipur, Navasari, Palem and Tandur. These farmers were also trained about the improved cultural practices to cultivate these crops. The farmers were given all the inputs such as seed, fertilizer and pesticides. Periodically, the programmes were monitored by the scientists concerned by visiting the fields.

North Eastern Hill Region

In order to exploit the NEH region for expanding area of the IIOR mandate crops, the programe was carried out for NEH states. The main objective of the programes was to identify suitable variety/hybrid through evaluation for yield performance at SASRD, Nagaland University, Medziphema; ICAR Research Complex for NEH region, Nagaland; ICAR-NOFRI, Tadong, Gangtok, Sikkim; College of Agriculture, Lembucherra, Tripura; ICAR AP center, Basar, Arunachal Pradesh. Latest released varieties/hybrids of sunflower, castor, niger and sesame were evaluated. Field days were organized at ICAR-NOFRI, Tadong, Sikkim and SASRD, Medziphema, Nagaland on 17th March, 2017 and 20th March, 2017, respectively which were attended by State government officials, farmers, subject matter specialists of ICAR-KVK located in these states and staff of concerned organizations. The yield of sunflower hybrids ranged from 1002 kg/ha (DRSH-1) to 1218 kg/ha (KBSH-53) at Medziphema and 709 kg/ha (LSFH 171) to 1466 kg/ha (KBSH-53) at Jharapani, Nagaland; 1013 kg/ha (DRSH-1) to 1931 kg/ha (KBSH 44) at Lambuchera, Tripura and 954 kg/ha (DRSH-1) to 1492 kg/ha (KBSH 44).

Mera Goan Mera Gaurav (MGMG)

Mera Goan Mera Gaurav programme as launched by the Honourable Prime Minister of India was initiated with an 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 con-

cerned 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.
- Encouraging 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.
- Explaining 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.
- Conducting of field demonstrations to adopt of new technologies.
- Disseminating of mobile based crop wise information from time to time to the selected farmers.
- Training the farmers on seed production activities.
- Organizing time to time interface meeting with the farmers to solve the field problems.

Radio/Television programme

Scientist	Topic	Date of broadcast
Dr. G.D. Satish Kumar	Kharif prodduthirugudu pantalo adhika digubadi saadhincha taaniki melakuvalu	July 24, 2016
Dr. C. Lavanya	High yielding castor varieties and hybrids	October 8, 2016
Dr. A.R.G. Ranganatha	Technologies to maximize sesame production	October 15, 2016

EDUCATION AND TRAINING

Details of students working for Ph.D. (2016-17)

Name of the student	Title of thesis	Discipline	University
	Major advisor: **Dr. M. Sujatha**		
M.Tarakeswari	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
P. Sai Sudha	Tissue culture studies on identification of candidate gene(s) responsible for organogenesis in castor	Botany	AU, Vishakhapatnam
	Major advisor: **Dr. V. Dinesh Kumar**		
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**		
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
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
	Major advisor: **Dr. P. Kadirvel**		

Training Programmes Organized

High oleic safflower crop management

A two-day training programme on "High oleic safflower crop management" for capacity building of field level officers sponsored by Marico Ltd., was organized during 23-24 August 2016 at IIOR, Hyderabad. Ten dignitaries from Marico Ltd. and 44 field level officers from Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh and Telangana participated in the programme. The major focus of the training was on cultural aspects including agronomic practices, disease and insect management and seed production of the pipe-line oleic safflower varieties.

Seed Production in Castor, Sunflower, Safflower, Sesame and Niger

- A field day cum seed production training in hybrid castor was organized for 600 farmers on 27th Jan 2017 at castor seed production fields of Konkala village, Mahabubnagar Dist.
- To disseminate the seed production technologies, a Field Day–cum-Training Programme was organised on 24th March 2017 at Chityal village Nirmal district in the sesame seed production farmers' fields. The participation included farmers, scientists, extension personnel, NGOs etc. About 200 farmers and extension personnel from surrounding villages of Nirmal mandal and district and Indravelly, Gudihatnoor, Echoda mandals of Adilabad district participated.
- Model Training Course on "Plant Health Management for Increasing Oilseeds Production'', 21-28 September 2016, sponsored by Directorate of Extension at ICAR-IIOR, Hyderabad.
- Skill development training on seed production of oilseed crops was organized for diploma graduates during Feb 2017.
- Training programme on "Mass Production of Bio-pesticides" for ten unemployed rural youth aimed at Skill and Entrepreneurship Development, 6-13 February, 2017 at ICAR-IIOR, Hyderabad.
- 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.

Field day cum training programme

Successfully conducted sesame field day at Kirpai village of West Midnapur district, W.B on 17th May 2016. Dr. Dutta, consultant from NMOOP and about 80 farmers participated in the training programme. Monitored sesame fields in Bankura from 18th to 19th May, 2016 and gave training to farmers on sesame cultivation

Field days

Conducted sunflower and sesame field day at Hegdoli village on 7th March, 2017. About 120 farmers participated in the field day programme.

Germplasm-cum-Breeders Day Organized

Safflower Germplasm-cum-Breeders day

Safflower germplasm cum breeders' day was organised on February 28, 2017 at IIOR-ICRISAT Farm. Seven breeders from AICRP-Safflower centres attended the programme. The scientists observed the variability among the germplasm accessions and selected accessions for utilization in breeding. Participants also visited plots for evaluation of parental lines, hybrids and other trait specific breeding material in different generations.

Sunflower Germplasm-cum-Breeders Day

The germplasm-cum-breeders day of sunflower was organized on January 21, 2017 at IIOR, Hyderabad. A total of 452 trait specific germplasm accessions supplied by IIOR, Hyderabad and seven AICRP centres were raised and exhibited in field. The main purpose of this activity during the year was to raise all the promising inbreds for confirmation of the trait and enable the developers to register the promising germplasm with PGRC, NBPGR. These included early, dwarf, high yield, high oil content, CMS, R lines and inbreds reported for tolerance to *Alternaria*, leafhopper and powdery mildew. Twelve breeders of different AICRP centres participated in the field day and selected the trait specific germplasm.

Castor Kisan Mela

National Castor Kisan Mela was conducted on 24th February, 2017, during which large scale field demonstrations, farmer-scientist interaction, exhibition, etc., were organized. The event included felicitation of best castor farmers nominated from different states like Gujarat, Rajasthan, Uttar Pradesh, Karnataka, Tamil Nadu, Telangana, Odisha, etc. An exhibition was organized involving seeds, fertilizers, pesticides, bio-agents, silk worm, products from other ICAR and SAU centres. A crop cafeteria was raised demonstrating the castor hybrids and varieties released either for all castor growing regions of the country *viz.*, DCH-519, DCS-107 or states like Gujarat (GCH-7, GC-3), Tamil Nadu (YRCH-1) and Telangana (PCH-111), along with the best management practices including drip irrigation system.

AWARDS AND RECOGNITIONS

Best Worker Award

Based on the decision taken in the 58th Senior Officers Meeting held at this Directorate on 8th June 2010, the IIOR awards consisting of cash and citation are being given on IIOR Foundation Day, on 1st August of every year. These awards are given from the annual interest that accrued from the fixed deposit of Rs.5.00 lakhs which was received towards ICAR Best Institute Award, 2008. 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, 2016.

Name/Designation	Category
Mrs. B. Usha Kiran, Scientist, Biotechnology, Dr. Praduman Yadav, Scientist, Biochemistry	Best Research Paper (Certificate and cash – ` 1000/- each team)
Mr. L. Krupakar, T-5, Crop Production	Technical (Certificate and cash – ` 3000/-)
Ms. J.Vijayalakshmi Bhushan, Assistant	Administration (Certificate and cash – ` 3000/-)
Sri D.Balaiah, SSS, Rajendranagar Farm	Skilled Supporting Service (Certificate and cash – ` 3000/-)
Ms. M. Venkatamma, TSCL	Temporary Status Labour (Certificate and cash – ` 1000/- each)
Mr. B. Ramesh, TSCL, Narkhoda Farm	
Ms.G. Pentamma, TSCL, Rajendranagar Farm	

Other Awards

- Dr. M. Sujatha, Pr. Scientist has been awarded the International travel grant from the Department of Science and Technology, GOI for participation in the 19th International Sunflower Conference organized from 29th May to 3rd June 2016 at Edirne, Turkey.
- Dr. M.Y. Dudhe, Scientist has been awarded the INSA Travel Fellowship-2016 for participation in the 19th International Sunflower Conference organized from 29th May to 3rd June 2016 at Edirne, Turkey.
- Dr. M. Sujatha, Pr. Scientist has been continued as Board member of International Sunflower Association for another term of 4 years from 2016-2020.
- As part of IIOR Foundation Day, best Research paper award was given for the two research articles. Usha Kiran, B., Mukta, N., Kadirvel, P., Alivelu, K., Senthilvel, S., Kishore, K., Varaprasad, K.S. 2017. Genetic diversity of safflower (*Carthamus tinctorius* L.) germplasm revealed by SSR markers. Plant Genetic Resources: Characterization and Utilization. 15 (1): 1-11; 2. Praduman Y and Murthy, I.Y.L.N. Calibration of NMR spectroscopy for accurate estimation of oil content in Sunflower, Safflower and Castor seeds. Current Science. 110(1); 73-76.
- Ms. C. Lalitha secured first position in Carroms, Dr. Pushpa H.D, secured second position in Javeline throw, Ms. B. Usha Kiran

and Ms. B. Swaroopa Rani secured second position in Shuttle Badminton (Doubles) in the ICAR Inter-Institutional Tournament (South Zone) at Hyderabad from 22-26 August, 2016.

- Dr. Ratna Kumar, Sr. Scientist has been awarded with Certificate of Reviewing Award-2016, Environmental and Experimental Botany (Elsevier), The Netherlands.
- Dr. Ratna Kumar, Sr. Scientist has been awarded with Reviewer Excellence Award-2017, by Agriculture Research and Communication Journals, India.
- Dr. G. Suresh, Pr. Scientist was awarded with FELLOW-2016 of the Range Management Society of India, Jhansi during National Symposium (March 03-04, 2017) at RVSKVV, Gwalior, MP.
- Dr. P. Duraimurugan, Sr. Scientist received Reviewer Excellence Award in recognition of significant and outstanding contribution to the Journals (Legume Research – An International Journal & Indian Journal of Agricultural Research), Agricultural Research Communication Center, Karnal, Haryana.

Recognitions

- Dr. M. Sujatha, Pr. Scientist served as member of the scientific committee constituted for the 19th International Sunflower Conference for reviewing the articles.
- Dr. M. Sujatha, Pr. Scientist chaired a Session and conducted the proceedings during the 19th International Sunflower Conference organized from 29 May to 3 June 2016 at Edirne, Turkey.
- Dr. M. Sujatha, Pr. Scientist is recognized as IBSC expert for Nuziveedu Seeds Limited, Hyderabad from 2016 for a period of 3 years.
- Dr. M. Sujatha, Pr. Scientist is appointed as member of the accreditation committee of the National Certification System of Tissue Culture raised plants (NCS-TCP) of DBT/ BCIL.
- Dr. V. Dinesh Kumar, Pr. Scientist is recognized as external expert on the IBSC of DuPont Pvt Ltd and ICRISAT from 2016 for a period of 3 years.
- Dr. V. Dinesh Kumar, Pr. Scientist is on the RAC Committee of IISR, Indore for a three year term.
- Mr. H.H. Kumaraswamy, Scientist is recognized as Editorial Board Member for International Journal of Agricultural Sciences, Published by Bioinfo Publications.
- Dr. J. Jawahar Lal, Scientist is nominated as Editorial Board member of Journal of International Academic Research for Multidisciplinary Approach.
- Dr. Ratna Kumar, Sr. Scientist has been selected as Member Editorial Board-Journal of Functional and Environmental Botany.
- Dr. P. Duraimurugan, Sr. Scientist recognized as Editorial Board Member, Journal of Food, Agriculture and Environment, WFL Publisher (Science and Technology), Finland.
- Dr. P. Duraimurugan, Sr. Scientist is a DBT nominee in the Institutional Biosafety Committee (IBSC) of M/s. Seed Works International Pvt. Ltd., Medchal Mandal, Telangana.

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 specifi inbreds and parental lines in sunfl (*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 saffl	Mrs. B. 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-specifi 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
104-11	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
104-14	Synthesis and evaluation of polymers for seed health and productivity of oilseed crops	Mrs. K S. V. P. Chandrika
104-15	Assessment of physiological efficiency in Sesame (*Sesamum indicum* L.) under drought	Dr. P. Ratna Kumar
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. P. Satya Srinivas
106-2	Production and characterization of protein hydrolysates from safflower seed and validation of their utility in animal nutrition	Dr. Praduman Yadav

Project code	Project title	Project leader
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	Mrs. P. Madhuri
107-17	Institutional Convergence for enhancing the production of safflower and creation of Value chain under varied agro ecological regions of the country.	Dr.S.V.Ramana Rao
108-1	Development of stable cytoplasmic genetic male sterile system in Sesame through wide hybridization	Dr. J. Jawahar Lal

Externally Funded Projects

Sponsor	Project title	Principal Investigator
ICAR-NPTC	Development of transgenic castor for resistance to lepidopteran pests	Dr. M. Sujatha
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
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
ICAR Network Project	*Phytophthora, Fusarium* and *Ralstonia* diseases of horticulture and agricultural crops	Dr. R.D. Prasad
ICAR plan	Seed production in agricultural crops	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, IIOR Dr. R. Makandar, UoH
DBT	Discovery of genome-wide SNPs and its use in developing a reference linkage map and association analysis in castor	Dr. Senthilvel Senapathy, IIOR Dr. Sanjay K. Shahi, Xcelris Genomics Ltd.,
DST	Crop management options to make safflower cultivation profitable for small farmers through enhanced utilization of petals	Dr.P.Padmavathi
DST	Molecular tagging and mapping of powdery mildew resistance in sunflower (*Helianthus annuus* L.)	Dr.M.Sujatha
Central Sector Project	Protection of Plant Varieties and Farmers Rights Authority	Dr. N. Mukta
NMOOP, DAC	Frontline demonstration on oilseed crops	Dr.G.D.Satish Kumar

Sponsor	Project title	Principal Investigator
TMC, DAC	EKAPAS Network and technology dissemination	Dr.G.D.Satish Kumar
NMOOP, DAC	Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer	Dr.G.D.Satish Kumar
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
ICAR Network	Consortium Research Platform on Agro-biodiversity- Safflower	Dr.N. Mukta
DST	Proactive mitigation of grey mold disease of castor in Telangana state using dynamical forecast	Dr.R.D. Prasad
ICAR	Competitive oilseeds production technologies for improving profitable and socio-economic conditions of small holders in rainfed oilseed production system of Telangana	Dr. S.V. Ramana Rao

MEETINGS AND EVENTS

Annual Group Meeting on Sunflower, Sesame and Niger, 2016

The Annual Group Meeting on Sunflower, Sesame and Niger was held at University of Agricultural Sciences,Raichur, Karnataka on April 14-16, 2016 to review the results of research conducted during 2015-16 and formulate the strategies to increase the production and productivity of sunflower, sesame and niger for the year 2016-17. The introductory session was chaired by Dr. P.M. Salimath, Hon'ble Vice-Chancellor, UAS, Raichur, and the other dignitaries who shared the dais were Dr. B.M. Chittapur, Director of Research, Dr. B.V. Patil, Director of Extension, UAS, Raichur. The inaugural session started by paying homage to late Padmasri Dr. M.V. Rao who rendered Yeoman service to Indian agriculture in general and oilseeds sector in particular. Dr. I. Shankergoud, Associate Director of Research, UAS, Raichur welcomed the delegates and introduced the chairman of the session and other dignitaries on the dias. Dr. B.M. Chittapur, Director of Research, UAS, Raichur in his introductory remarks informed the house about the historical perspective of the University with reference to research in oilseeds. Dr. B.V. Patil, Director of Extension and Former Vice-Chancellor, UAS, Raichur felt that, in order to reduce oilseeds import in the country, it is essential to solve location specific problems limiting the production and productivity. He expressed concern over the drastic decline in the area under sunflower during the past four years. He emphasized the need to promote sesame, as organic sesame is giving maximum net profit without additional inputs. Dr. K.S. Varaprasad, Director, IIOR, Hyderabad gave a comprehensive account of present status of sunflower oilseeds situation in the country and presented the highlights of sunflower rearch results of 2017. Dr. A.R.G. Ranganatha, Principal Scientist, IIOR & Ex-Project Coordinator (S&N) presented the research achievements of sesame and niger and emphasized the importance

of heterosis breeding for sesame improvement. The Chairman, Dr. P.M. Salimath, Hon'ble Vice-Chancellor, UAS, Raichur in his remarks stated that there is no major transformation in oilseeds and legumes as that happened in cereals. He expressed concern over the four-fold low production in sesame and sunflower crops compared to the neighbouring countries and a drastic decline (50%) in acreage under niger. In order to increase the productivity, researchers must identify/develop genotypes which are more productive for seed and oil yield.

Annual Group Meeting on Castor, 2016

The Annual Group Meeting of Castor was held at ICAR-IIOR, Hyderabad on May 12-14, 2016 to review the results of research conducted under AICRP (Castor) during 2015-16 and formulate the strategies to increase the production and productivity of castor for 2016-17. The Introductory session of the group meeting was Chaired by Padmasree Dr. E.A. Siddiq Hon. Chair Professor (Biotech.), ANGRAU, Ex-National Professor, ICAR & Former DDG (CS), ICAR; Dr. Ch. Srinivas Rao, Director ICAR-CRIDA as Guest of Honour. Dr. Kolhatkar, Director, DOD; Dr. Sarath Babu, Head, NBPGR Regional Station, Hyderabad also presented in the meeting. Dr. K.S. Varaprasad, Director, ICAR-IIOR, Hyderabad welcomed the dignitaries and participants and presented the overview of research achievements made during 2015-16. Dr. Ch. Srinivasa Rao, Guest of Honour, in his address mentioned that castor is one of the most important crop as a contingent crop and advised contingency seed production should start in good monsoon period so that we can be prepared during contingent situations. He emphasized importance *in situ* conservation measures under rainfed conditions to improve yields of rainfed crops. He suggested certain researchable issues like physiological changes occur by application of thio-urea leading to higher yields, validation of *in situ* conservation of moisture coupled with improved seed and natural resource management technologies in FLDs and program on castor in agroforestry systems. Chairman Dr. E.A. Siddiq in his remarks stressed upon integrated approach for enhancing production and productivity by combating biotic and abiotic stresses. He said that 85% of production is being exported and only 15% used for local indicating research on value addition is important which not only generate employment but also increase the farmer income. Further, he also emphasized on the climatic changes, for which castor is one of the resilient crop needs further strengthening in research for best adaptability.

Institute Research Committee

IRC meeting of the Institute was held during 25-27, June, 2016 under the Chairmanship of Dr. K. S. Varaprasad, the then Director, IIOR. In this IRC, the research results of the projects conducted during *kharif*, 2015 were presented by the Principal Investigator of the respective projects which were reviewed. *Rabi*-IRC meeting of this Institute was held during 23-24 September, 2016 under the Chairmanship of Dr. A. Vishnuvardhan Reddy, Director, IIOR. In this IRC, the research results of the projects conducted during *rabi*, 2015 were presented by the Principal Investigator of the respective projects which were reviewed. Progress made under all the externally funded projects was presented to the house. During the deliberations, several recommendations were made to improve the technical programmes. Besides, *kharif* field IRC was conducted at Narkhoda farm on 12-09-2016 to review the progress of the field experiments. Dr. A. Vishnuvardhan Reddy, Director, IIOR & Chairman, IRC monitored the *kharif* field experiments. Scientists of IIOR participated in the field visit and scientists conducting the field trials at Narkhoda farm explained the experiments. Field IRC was also held on January 6, 2017 to review the experiments conducted during *rabi,* 2016.

ICAR- IIOR Foundation Day Celebrations

IIOR Foundation Day was observed on 1st August 2016. The Foundation Day Lecture on "Climate Change and Indian Agriculture: Impacts and Adaptation strategy in Oilseed Crops" was delivered by Dr. B. Venkateshwarlu, Vice Chancellor. VNMKV, Parbhani. Dr V. Praveen Rao, VC, PJTSAU, Hyderabad presided the function. In this celebration, 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, retired officials of IIOR and dignitaries from other local organizations. In the forenoon, for the benefit of the staff, Dr. A. Ahmad Giroz, MD, Care Hospital delivered the lecture on "An overview of Diabetes".

Annual Group Meeting on Safflower and Linseed, 2016

The Annual Group Meeting of Safflower was held at College of Agriculture, VNMKV, Parbhani RVSKVV, Indore during September 2-4, 2016 to review the results of research conducted under AICRP (safflower) and Linseed during 2015-16 and formulate the strategies to increase the its production and productivity in 2016-17. The inaugural session was graced by the presence of Dr. B. Venkateswarlu, Vice Chancellor, VNMKV, Parbhani, Dr. J.S. Sandu, DDC (CS), Dr. N.B. Singh, ADG (O&P), Dr. D.P. Waskar, Director of Research, VNMKV, Parbhani. The inaugural session commenced with the Director of Research Dr. D.P. Waskar welcoming the audience. The Chief Guest Dr. J.S. Sandhu, DDG (CS) released a publication on "Weed Management in Linseed" brought out by the PC Unit, Kanpur. This was followed by a detailed presentation of the research highlights in safflower by Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. The research highlights on Linseed was presented by Dr.P.K.Singh, Project Co-ordinator, Linseed. The ADG (O&P), Dr B.B.Singh highlighted that emphasis on the development of short duration varieties/ hybrids and diversification should be further intensified. He urged that crop management technologies and seed production should be high on the research priority to make it more farmer friendly. The Chief Gust, Dr J.S. Sandhu, DDG (CS) emphasized on encashing the advantage on the climate resilient nature of safflower and linseed. He advised that demand driven research that is acceptable by the farmers should be a key driver for increasing the productivity of these crops.The Chairman, Dr. B. Venkateswarulu, Vice-Chancellor, VNMKV, emphasized that the research agenda should be in accordance with the demand for the commodity i.e fibre in linseed. In this direction, he urged that PPP mode should be explored for creation of global quality linen in the country for meeting the national and international requirement. He opined that safflower crop has high vintage value in the context of reduced moisture regimes in the recent years.

Institute Management Committee

The 39th and 40th meetings of the Institute Management Committee were held on October 5, 2016 and March 22, 2017, respectively under the Chairmanship of Dr. A. Vishnuvardhan Reddy, 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

Vigilance Awareness Week for the year 2016 was observed from 31 October to 5 November 2016. The main theme of observance of Vigi-

lance Awareness Week – 2016 was "Public participation in promoting integrity and eradicating corruption". The VIGILANCE PLEDGE in Hindi and English was administered at IIOR to all the scientists, officers and staff on October 31, 2016. During the occasion of observance of Vigilance Awareness Week, bi-lingual banners and posters of slogans against corruption were displayed. Besides, a notice regarding the complaints on vigilance matters was prominently displayed to draw the attention of everyone at IIOR.

A sensitization workshop on "Public participation in promoting integrity and eradicating corruption" was conducted on 4 November, 2016 at the Narkhoda farm of IIOR and talks were delivered by Dr K.S. Varaprasad, Dr M.V.R Prasad and Dr V. Ranga Rao, Ex-Directors of IIOR. Reports of corruption in the country were discussed and participants were cautioned about the need to exercise at individual employee level to prevent acts of corruption. All the scientists, officers and other staff participated. Farmers of MGMG and villagers also participated in the workshop. Post the talk; opinions were solicited from the participants on the theme and in support of the talk in one's personal development.

Research Advisory Committee

The 30th RAC meeting was held during October 3-4, 2016 at IIOR, Hyderabad under the Chairmanship of Dr. V. Ranga Rao, Former Director (DOR) IIOR, Hyderabad.The other members of RAC attended the meeting were Dr. D.K. Yadava, Head (SST), IARI, New Delhi; Dr. Ajay Arora, PS, Division of Plant Physiology,IARI,New Delhi; Dr. B.S. Dwivedi, Head (SS &AC), IARI, New Delhi; Dr. R. Srinivasan, Retd., Professor & PD -NRCPB, , New Delhi; Dr. K Purna Chandra Rao,Ex-Principal Scientist, ICRISAT; Shri Ayyagari Bhumayya, Nirmal, Telangana and Dr. Premraj Yadav, Shamshabad, RR district, Telangana. Dr. A. Visnuvardhan Reddy, Director, IIOR welcomed the Chairman and Members of RAC. It was followed by the presentation on Action Taken Report on the recommendations of 29th RAC meeting by Dr. V. Dinesh Kumar, Member Secretary, RAC. The crop and discipline wise research highlights pertaining to them were presented by the respective PIs. The committee visited the experimental farms at Narkhoda and Rajendranagar farms on afternoon of 4th October, 2016.. 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
Ms. KSVP Chandrika and Dr. Praduman Yadav	FTIR and FTNIR spectroscopy	Thermo Fisher Scientific Ltd, Mumbai	September 26-27, 2016
Dr. P. Ratna Kumar	Physiological and molecular aspects of improving crop adaptations to drought	GKVK, Bengaluru	February 27 to March 11, 2017
Dr. P. S. Srinivas	Competency enhancement for HRD nodal officers of ICAR	NAARM, Hyderabad	February 13-15, 2017
Shri M. Bhaskar Reddy	Workshop on RTI Act 2005	ISTM, New Delhi	June 30, 2016 to July 1, 2016
Smt.P.Madhuri	Big data analytics in Agriculture	NAARM, Hyderabad	June 13-22, 2016
Smt. B. Swarna Kumari, Shri S.Shamdas, Shri P.R. Varaprasada Rao	Reservation in service including reservation roster and reservation register	NAARM, Hyderabad	April 27-29, 2016
Sri P. Srinivasa Rao	Cyber security	IASRI, New Delhi	September 28 to October 5, 2016
Sri G. Raghunath	J-Gate	Veterinary College, VAFSU, Bengaluru	January 27, 2017

A. Physical targets and achievements

S. No.	Category	Total No. of Employees	No. of trainings planned for 2016-17 as per ATP	No. of employees undergone training during			% realization of trainings planned during 2016-17
			s		Oct. 2016 -March 2017	April 2016 -March 2017	
1	2	3	4	5	6	5+6=7	7/4x100=8
1	Scientific	42	10	2	5	7	70
2	Technical	42	18	2	3	5	28
3	Administrative & Finance	25	7	4	0	4	57
4	SSS	20	10	0	0	0	0
	Total	**129**	**45**	**8**	**8**	**16**	**36**

B. Financial targets and achievements (All employees)

S. No.	RE 2016-17 for HRD			Actual Expenditure 2016-17 for HRD	% Utilization
	Plan	Non plan	Total		
	(Lakh Rs.)			(Lakh Rs.)	2016-17
	1	2	3	4	4*100/3=5
1	0	0.46	0.46	0.46	100

Category: Scientific Staff

S. No	Name of employee	Designation	Discipline/ Section	Name of training programme attended	Duration (days)	Organizing institution	Actual expenditure incurred(`)
1	Ms. P. Madhuri	Scientist	Computer Applications	Big data application in agriculture	10	NAARM, Hyderabad	0
2	Ms. B Gayatri	Scientist	Nematology	Economic importance of plant parasitic and entomopathogenic nematodes	5	NIPHM, Hyderabad	0
3	Dr. Sujatha TP	Scientist	Biotechnology	Bioinformatics tools and techniques in agriculture	10	NAARM, Hyderabad	0
4	Sri H.H. Kumara swamy	Scientist	Biotechnology	Advanced computational and statistical tools for Omics data analysis	21	IASRI, New Delhi	0
5	Dr. P. Ratna Kumar	Senior Scientist	Plant Physiology	Physiological and molecular aspects for improving crop adaptation to drought	13	UAS Bengaluru	0

Trainings attended include other than ATP for 2016-17 also

Category: Technical Staff

S. No	Name of employee	Designation	Discipline/ Section	Name of training programme attended	Duration (days)	Organizing institution	Actual expenditure incurred(`)
1	Sri. P.S.Rao	TO	Computer application	Cyber security	10	IASRI, New Delhi	7879
2	Sri. N. Vasanth	TA, T-3	Farm management	Agrometeorological data collection analysis and management	10	CRIDA, Hyderabad	0
3	Sri. B.V. Rao	STA, T-5	Photography	CEP for technical officers of ICAR	13	NAARM, Hyderabad	0

S. No	Name of employee	Designation	Discipline/ Section	Name of training programme attended	Duration (days)	Organizing institution	Actual expenditure incurred(`)
4	Sri. G. Balakishan	ACTO	Farm management	GAP for enhancing resource use efficiency and farm productivity	5	IARI, New Delhi	0
5	Sri. Y. R. G. Reddy	TO, T-6	Farm management	GAP for enhancing resource use efficiency and farm productivity	5	IARI, New Delhi	0

Category: Administration Staff

S. No	Name of employee	Designation	Discipline/ Section	Name of training programme attended	Duration (days)	Organi-zing in-stitution	Actual expenditure incurred (`)
1	Ms. B. Swarna Kumari	SAO	Admin	Reservation in service including roster and reservation register	3	NAARM, Hyderabad	0
2	Sri. S. Shamdas	AAO	Admin	Reservation in service including roster and reservation register	3	NAARM, Hyderabad	0
3	Sri. P.R.V.P. Rao	Assistant	Admin	Reservation in service including roster and reservation register	3	NAARM, Hyderabad	0
4	Sri. G. Chandraiah	PS	Admin	Enhancing efficiency and behaviour skills for stenos/PS and PAs	7	NAARM, Hyderabad	0

Trainings attended include other than ATP for 2016-17 also

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

Name	Programme	Venue	Date
Sri H.H. Kumaraswamy	Third training workshop for Institutional Bio-safety Officers focusing on "Public Awareness through Bio-safety Portal and Stewardship during Confined Field Trials of Regulated Genetically Engineered (GE) Plants "	BCIL, New Delhi	April 13, 2016
Dr. K. Anjani, Dr. C. Lavanya, Dr. M. Santha Lakshmi Prasad, Dr.G. Suresh Dr.P. Duraimurugan	"Oil and Fats International India 2016" organized conference entitled "Fostering market growth and facing challenges in the oils and fats industry"	International Convention Centre, Madhapur, Hyderabad, India.	April 13-14, 2016
Ms. P. Madhuri	Implementation of E-Procurement through CPP portal	NAARM, Hyderabad	April 26, 2016
Dr. P. Padmavathi	Participated in Brainstorming meeting on "Future needs of Research, Education and Extension in Agrometeorology"	CRIDA, Hyderabad	April 29-30, 2016
Dr. G. Suresh	Workshop on "Monsoon Prediction and Climate Change-Implications for Climate Action Plan of Telangana State"	Water Technology Centre, PJTSAU, Hyderabad	June 4, 2016
Dr. S.N.Sudhakara Babu	Workshop to Review the status of nutrient use efficiency (NUE) in different crops	Krishi Bhawan, ICAR, New Delhi	June 21, 2016
Dr. I.Y.L.N. Murthy	FLDs on Oilseeds – Way forward workshop	IIOR, Hyderabad	June 27, 2016
Dr. G. Suresh	National level Meeting on OECD Seed Schemes	TSSCA, at HICC, Hyderabad	July 4, 2016
Dr. M. Sujatha, Sri H.H. Kumaraswamy	Fourth training workshop for Institutional Bio-safety Officers focusing on "Confined Field Trials of Regulated Genetically Engineered (GE) Plants".	BCIL, New Delhi	July 5, 2016.
Dr. I.Y.L.N. Murthy	FAI National workshop on "Need for reforms in fertilizer policy for sustaining soil health through balanced fertilization"	Hyderabad	July 5, 2016
Dr. N. Mukta	Awareness Workshop on 'Guidelines for access to biological resources under Biological Diversity Act, 2002'	NAARM, Hyderabad	July 15, 2016
Dr. I.Y.L.N. Murthy	NMOOP meeting with Agricultural Secretary	Krishi Bhavan, New Delhi	August 3, 2016
Dr. M. Lakshminarayana	XI Annual Review Meeting of ICAR Seed Project Seed production in Agricultural crops	G.B.Pant University of Agriculture & Technology	August 17-18, 2016

Name	Programme	Venue	Date
Dr. P. Duraimurugan	International Conference on Agri-cultural Sciences & Food Techno-logies for Sustainable Productivity and Nutritional Security	University of Agricultur-al Sciences, Bengaluru	August 25 -27, 2016
Dr. R.D. Prasad	Annual group meeting of AICRP safflower and linseed	Parbhani , Maharashtra	August 25-27, 2016
Dr. P. Duraimurugan	International Conference on "Microbiology, Agriculture and Environmental Sciences"	St. Pious X Degree & PG College for women, Nacharam, Hyderabad	September 1-3, 2016
Dr.M.Sujatha, Dr.V. Dinesh Kumar, Sri. H.H. Kumaras-wamy	IV South Asia Bio-safety Conference	MoECC & BCIL, Taj Krishna, Hyderabad	September 19-21, 2016
Dr. M. Sujatha, Sri H.H. Kumaraswamy	Fifth training workshop for Institutional Bio-safety Officers focusing on “Guidelines for Drafting Crop Specific Standard Operating Protocols for Confined Field Trials of Regulated Gene-tically Engineered (GE) Plants”	BCIL, Hyderabad	September 22, 2016
Dr. R.D. Prasad	CABI Brainstorming Session on Harmonization of Seed Movement, Regulations and Procedures	NBA, Chennai	September 22, 2016
Dr. I.Y.L.N. Murthy, Dr. G.D. Satish Kumar	NMOOP farmer’s meet on launching of pro-cessed and bottled sunflower oil	Kothalpur, West Bengal	September 26, 2016
Sri G. Raghunath	Krishi-An Institutional Repository Tool for dissemination of Agriculture knowledge	PJTSAU, Hyderabad	September 29, .2016
Dr. S.V.Ramana Rao & Dr. G. Suresh	Interface Meeting with stakeholders of Sesame in Bundelkhand Region	KVK, Jhansi, Tikam Garh	October 4-7, 2016
Dr. G.D. Satish Kumar	Workshop on “Strategies for pulses production in Eastern states” organized by DAC & FW, GOI.	Bhubaneswar, Orissa	October 7, 2016
Dr. S.V. Ramana Rao, Dr. Pushpa H.D	Kisan mela, 2016	University of Agril. & Horticultural Science), Shivamogga, Karnataka	October 21-25, 2016
Dr. S.N.Sudhakara Babu, Dr. P. Lakshmamma	International Conference on climate Change, Water and Food Security	WALMTARI-ICRISAT at ICRISAT	November 2 – 3, 2016
Dr. S.N.Sudhakara Babu	Farmers Training on Best Management Practic-es for Increasing Sunflower Productivity”	Koppal and Bagalkot, Karnataka	November 2016
Dr. G.D. Satish Kumar	Workshop on “Doubling of income by 2022”	MANAGE, Hyderabad	November 2-3, 2016
Dr.HP.Meena, Dr. M.Y. Dudhe, Dr. N. Mukta, Dr.Praduman Yadav, Dr. S. Senthilvel	1st International Agro-biodiversity Congress	ISPGR and Biodi-versity International at New Delhi	November 6-9 2016

Name	Programme	Venue	Date
Dr. R.D. Prasad	ISMPP 38th Annual conference and National Symposium on "Challenges towards Plants health under Changing Climate Scenario for Sustainable Agriculture"	BCKV, Mohanpur, Nadia, West Bengal, India	November 24-26, 2016
Dr. IYLN. Murthy, Dr. Aziz Qureshi, Dr. G.D.S.Kumar	Soil health card distribution and awareness on Soil testing	Koppal, Karnataka state	December 5, 2016
Ms. P. Madhuri	Review meeting on ERP solutions	NAARM, Hyderabad	December 13, 2016
Dr. G.D. Satish Kumar	"Developing voice based advisories and short videos for mobile based dissemination" during the Model Training Course	Indian Institute of Oil Palm Research, Pedavegi	December 21, 2016
Dr. M. Padmaiah, Dr. IYLN. Murthy, Dr.V.Dinesh Kumar, Dr. R.D. Prasad	Jai Vigyan Jai Kisan programme	Vittaipalli village, Telangana	December 23, 2016
Dr. M. Santha Lakshmi Prasad	National Symposium on "Diagnosis and Management of Plant Diseases: Integrated Approaches and Recent Trends" organized jointly by Indian Phytopathological Society and ICAR Research Complex for NEH Region, Umiam	ICAR Research Complex for NEH Region, Umiam, Shillong, Meghalaya.	January 09-11, 2017
Director and All scientists	Brain storming session on"Climate Smart Technologies for Enhancing Vegetable Oil Production"	IIOR, Hyderabad	January 19-21, 2017,
Dr. V. Dinesh Kumar	Regional Science Exhibition 2016-17	Jubilee Hills Public School, Hyderabad	January 15-16, 2017
Dr. S. Chander Rao	Sunflower Germplasm day	IIOR, Hyderabad	January 21, 2017
Dr. I.Y.L.N. Murthy	National Castor Kisan Mela	SK Nagar, Gujarat	January 23, 2017
Dr. C. Sarada	Data management of ICAR research data repository for knowledge management initiative.	NASC Complex, New Delhi	January 24-25, 2017
Dr. S.V. Ramana Rao	Krishi Mela	IGKV, Raipur	January 26-30, 2017
Dr. S.V. Ramana Rao	Kisan Mela	IIMR, Hyderabad	February 9, 2017
Dr. P. S. Vimala Devi	Fifth National Conference on "Biological Control: Integrating Recent Advances in Pest and Disease Management"	NBAIR, Bengaluru	February 9-11, 2017
Dr. M.Y. Dudhe	Brainstorming Session on "Role of Plant Breeding & Genetics in meeting Sustainable Development Goals".	ISGPB at IARI, New Delhi	February 11, 2017

Name	Programme	Venue	Date
Dr. S.V. Ramana Rao	Review workshop on the Farmers FIRST programme	ATARI , Hyderabad	February, 13, 2017
Dr. S.N.Sudhakara Babu	Skill Development Training on Seed Production Technologies for Oilseed Crops for Diploma in Agriculture participants	IIOR, Hyderabad	February 6-18, 2017
Dr. P. Padmavathi	3rd National Brassica Conference 'Enhancing oilseed Brassica Production through climate smart technologies'	IARI, New Delhi.	February 16-18, 2017
Dr. P. Duraimurugan	Regional Workshop on "Skill Development in Agriculture – Kaushal Vikas Se Krishi Vikas	Organized by MANAGE, Hyderabad at NAARM, Hyderabad	February 20, 2017
Director and All scientists	National Castor Kisan Mela	IIOR, Hyderabad	February 24, 2017
Dr. N. Mukta	11th Review Meeting of DUS test centres	Protection of Plant Varieties and Farmers Rights Authority, New Delhi at IGKVV, Raipur.	February 27, 2017
Dr. G. Suresh	New Directions in Managing Forage Resources and Livestock Productivity in 21st Century: Challenges and Opportunities"	RVSKVV, Gwalior	March 3-4, 2017
Dr. P. S. Vimala Devi	Action Seminar - International Women's Day	NIRD, Hyderabad	March 8, 2017
Dr. S.V. Ramana Rao	Krishi Unnathi Mela	IARI, New Delhi	March 14-17, 2017
Dr. S.N. Sudhakara Babu, Sri H. H. Kumaraswamy	Workshop on "Phase II Bio-safety Capacity Building: Outcomes and Way Forward"	Ministry of Environment Forests & climate Change, New Delhi,	March 15, 2017.
Dr. G.D. Satish Kumar	Review meeting of frontline demonstrations on oilseeds and presented the report of sunflower, safflower and castor FLDs con-ducted during 2014-15 to 2016-17 and the plan of action for 2017-18.	DRMR, Bharatpur	March 3, 2017
Dr. S.V. Ramana Rao	National sensitization cum review workshop on the Farmers FIRST programme	NAARM, Hyderabad	March 18-19, 2017
Dr. C. Sarada	Krishi Portal Data Management Workshop	NAARM, Hyderabad	March 24, 2017
Dr.A.Vishnuvardhan Reddy, Dr. I.Y.L.N. Murthy, Dr.M. Lakshminarayana, Dr.ARG Ranganatha	Sesame Field Day	Chityal Village, Nirmal	March 24, 2017
Dr. P. Padmavathi	Participated in Group Monitoring Workshop under TIASN program (DST)	NBRI, Lucknow, U.P	March 31, 2017

International Conferences

Name	Programme	Venue	Date
Dr.P.Duraimurugan	Technology for sustainable productivity and nutritional security held	UAS., Bengaluru	August 25-27, 2016
Dr.P.Duraimurugan	Microbiology, Agriculture & Environmental Sciences 2016	Nacharam, Hyderabad	September 1-2, 2016
Dr.A.Vishnuvardhan Reddy, Dr.Senthilvel Senapathy, Dr.N.Mukta Dr.H.P. Meena. Dr.Praduman Yadav	International Agro-Biodiversity Conference	New Delhi	November 6-9, 2016
Smt.KSVP. Chandrika	Agrochemicals Research and Education in India : Appraisal and Road Map for Future	ICAR-IARI, New Delhi	November 15-17, 2016
Dr.Ch.Sarada, Dr.K.Alivelu, Smt.P.Madhuri, Dr.Kadirvel Palchamy Dr. Lakshmi Prayaga	ISAS - 70th Annual International Conference-Statistics and Big Data Bioinformatics in Agricultural research	ICRISAT, Hyderabad	November 21-23, 2016
Dr.G.Suresh Dr.P.Padmavathi	For sustainable Management of Natural Resources, Environment, Energy and Livelihood security to achieve zero hunger challenge	New Delhi	November 22-26, 2016
Dr.P.Padmavathi	Agronomy Congress	IARI, New Delhi	November 22-26, 2016
Dr.R.D.Prasad, Dr.M.A.Aziz Qureshi	14th International workshop on *Trichoderma* and *Gliocdadium* (TG 2016)	Nagpur	November 27-30, 2016
Dr.G.Annapurna	10th Hindi Conference & Workshop	Hindi Academy Delhi at Mysore	February 8-10, 2017
Dr.P.Lakshmamma, Dr.Lakshmi Prayaga, Dr.G.D. Satish Kumar	Inter Drought – V – International Conference	HICC, Hyderabad	February 21-25, 2017
Dr.G.Suresh	New Directions in Managing Resources in 21st Century	RVSKVV, Gwalior	March 3-4, 2017

International Conference

Name	Training Programme	Venue	Date
Dr. M. Sujatha, Dr. M.Y. Dudhe	19th International Sunflower Conference	Edirne, Turkey	May 29 to June 3, 2016

हिनददी पखवाडा सिरोि

संस्ान मेें 14-28 ससिंबर, 2016 िक हहनददी पखवाडे का आयोजन ककया गया। इस दौरान

रवसभनन प्रतियोगगिाओं े समरण जसै शक्ि,

शबदानुवाद, एक समनट, शु्लिेख और सामानय
ज्ान का आयोजन ककया गया। इन प्रतियोगगिाओं मेें संस्ान के वैज्ातनक, अगधकाररयों एवं सटटॉफ सदसयों ने भाग सलया।

पखवाडे का समापन समारोह 30 ससिंबर, 2016

को डटॉ आईवाईएलएन मूतिर्ष प्रभारदी तनदेशक की

अधयक्षिा मेें आयोकजि ककया गया। समारोह का

आरंभ डटॉ. मुरलिा, प्रधान वैज्ातनक एवं उपाधयक्ष,

राजभाा कायाषिनवयन ससमति के सवागि से हुआ।
ितिपश्ाि मुरलिा जी ने राजभाा ररपोटषि प्रसिुि की। उनहोंने बिाया कक कै से तनयसमि रुप से कायशालाओं का आयोजन ककया जा रहा है। समय से प्रगति ररपोटषि भेजी जा रहदी है। कायाषिनवयन ससमति की बैठकें समय पर आयोकजि की जा रहदी है ितिा सलए गए तनणयों को करना हमारा संवैधातनक दातयतव है। राजभाा का सममान, राष्ट्र का सममान है। उनहोंने सभी से

फाइलों पर प्रतिहदन कुछ हटपपणणयाँ हहनददी मेें करने का आग्रह ककया।

श्ी. प्रददीप ससह, सहायक तनदेशक (रा.भा) के धनयवाद ज्ापन से कायक्रम का समापन हुआ।

राजभाा कारशाला

भाकृ अनुप - भारिीय तिलहन अनुसंधान संस्ान

मेें हहनददी का कायसाधन ज्ान प्रापि अगधकारदी

ितिा ाररयों के सलए प्रतयेक तिमाहदी मेें क
म्षि

कायाषिकनवि ककया जा रहा है। संस्ान मेें राजभाा प्रोतसाहन योजना

कायशाला क्रमशः जून 22, 2016, ससिंबर 17, 2016 हदसंबर 17, 2016 और म्षि 18, 2017 को आयोजन ककया गया।

राजभाा् कारषिनवरन समिति की बैठक

्लाई जा रहदी है कजसमेंं ारदी काफी कम्षि उतसाह

से भाग ले रहे है। पखवाडे के दौरान आयोकजि राजभाा् कायशाला की संक्षपि ररपोटषि भी प्रसिुि की गई।

इसके पश्ाि तनदेशक महोदय डॉ. मूतिषि ने सभी प्रतियोगिाओं के रवजेिाओं मेंं नगद पुरसकारों का रविरण ककया। अपने अधयक्षीय संबोधन मेंं आपने कहा कक हहनददी हमारदी राजभाा् है। हहनददी मेंं काम

:- तनयमानुसार प्रतयेक तिमाहदी मेंं राजभाा् कायाषिनवयन ससमति की बैठक क्रमशः जून 29, 2016 ससिंबर 17, 2016 हदसंबर 30, 2016

िि्ा म्षि 20, 2017 आयोकजि की गई। बैठक मेंं सलए गए तनणयों का कायाषिनवयन सुतनकश्ि ककया।

राजभाा् पुरसकार :- राष्ट्रदीय ग्रामीण रवकास एवं पं्ायिी राज संस्ान मेंं 15 नवंबर, 2016 को आयोकजि नगर राजभाा् कायाषिनवयन ससमति की बैठक मेंं संस्ान को राजभाा् पुरसकार से सममातनि ककया गया।

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Meena, H.P., Sujatha, M., Pushpa, H.D. and Varaprasad, K.S. 2016. Broadening the genetic base of cultivated sunflower (*Helianthus annuus* L.) in India through prebreeding. Proceedings of the 19th International Sunflower Conference, Edirne, Turkey, pp. 504.

Mukta, N., and Praduman, Y. 2016. Evaluation of USDA core set of safflower (*Carthamus tinctorius* L.) germplasm for identification of trait specific accessions. *In:* IAC (2016), Abstracts Book, 1st International Agrobiodiversity Congress, November 6-9, 2016, New Delhi, India pp. 159.

Murthy, I.Y.L.N. Oilseed Production technologies. ATARI, Jodhapur, July 29, 2016 Praduman

Y, Chandrika, K.S.V.P., Jawahar Lal, J. and Mukta, N. 2016. Evaluation of sesame (*Sesamum indicum* L.) genotypes for identification of trait specific accessions for biochemical constituents. *In:* IAC (2016), Abstracts Book, 1st International Agrobiodiversity Congress, Nov 6-9, 2016, New Delhi, India pp. 160.

Pushpa, H.D., Sujatha, M., Meena, H.P., Pramesh, D., Chander Rao, S. and Varaprasad, K.S. 2016. Molecular breeding for major diseases of sunflower in India: Present status and future needs. In: Proceedings of the 19th International Sunflower Conference, Edirne, Turkey, pp. 505.

Senthilvel S, Gosh A, Shaik M, Shaw RK, Bagali P. 2016. Genome-wide SNP analysis reveals only a moderate level of molecular diversity in castor. 1st International Agrobiodiversity Conference, November 06-09, 2016, New Delhi, pp 229.

Sujatha, M. and Kumaraswamy, H.H. 2016. Issues and Concerns in Biosafety of Transgenic Crops: A Case Study of Castor. In: Proceedings of "4th South Asia Annual Biosafety Conference" organized by BCIL, India and ILSI Research Foundation, Washington, USA, at Hyderabad, India, September 19-21, 2016.

Technical Bulletins and Popular Articles

Alivelu, K., Padmavathi, P., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Satish Kuamr, G.D., Sarada, C. and Ramana Rao, S.V. 2017. Safflower management practices.(English) Ref : Extension folder-11.

Alivelu, K., Padmavathi, P., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Satish Kuamr, G.D., Sarada, C. and Ramana Rao, S.V. 2017. Kusuma.Yajamanya Paddathulu (Telugu) Ref : Extension folder-14.

Alivelu, K., Padmavathi, P., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Satish Kuamr, G.D., Sarada, C. and Ramana Rao, S.V. 2017. Kusum(Hindi). Ref : Visthara patrika-17.

Chander Rao, S. 2017. Important diseases in Oilseed crops and their management on 14/2/17 in the training program on "Seed Production Technologies in Oilseed crops under Skill and Entrepreneurship development Programme" 6-13 February 2017, organized by ICAR- IIOR, Hyderabad.

Chandrika, KSVP., Anupama Singh, Prasad, R.D. and Praduman Yadav. 2017. Prominence of Seed Coating for Biotic and Abiotic Stresses. Popular Kheti, 5(1): 44-46.

Jawahar Lal, J., Satish Kumar, G.D., Padmaiah, M. and Suresh, G. 2016. Nuvvula saagu Yaajamanyam. Nuvvula saagu Extension bulletin-4. p. 16.

Kumar, G.D.S., Suresh, G., Bsappa, H., Chan- der Rao, S., Madhuri, P., Alivelu, K. and Ramana Rao, S.V. 2017. Proddutirugu- du Yajamanya Paddathulu. (Telugu) Ref: Extension folder-13.

Kumar, G.D.S, Purushotham Reddy, M. and Duraimurugan, P. 2016. Cotton Cultivation – Frequently Asked Questions, Extension Bulletin No. 5. ICAR-IIOR, Hyderabad, India. pp. 28.

Kumar, G.D.S. and Purushotham Reddy, M. 2016. Knowledge transfer to farmers using mobile based voice advisories: A case of e kapas. India International Science Festival, National Physical Laboratory, New Delhi.

Kumar, G.D.S. and Varaprasad, K.S. 2016. Frontline demonstrations on oilseeds. (Eds.).ICAR-IIOR, Hyderabad. P 88.

Kumar, G.D.S., Md.A.Aziz Qureshi, Sudhakara Babu, S.N. and Hareesh Kumar, S. 2016. Best Management Practices in Sunfl for maximiz- ing yield in dry lands. Inter Drought- V International Conference, Hyderabad.

Kumar, G.D.S., Purushotham Reddy, M. and Duraimurugan, P. 2016. *Pathi Saagulo Rythula Sandehalaku Samadhanalu* (Telugu). *(Vistharana Patrika*-5*).* Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad. p 36.

Kumar, G.D.S., Suresh, G., Basappa, H., Chander Rao, S., Madhuri, P. and M. Padmaiah. 2017. Prodduthirugudu Yajamanya Paddathulu. ICAR-IIOR, Rajendranagar, Hyderabad.

Kumar, G.D.S., Suresh, G., Basappa, H., Chander Rao, S., Praduman Yadav and Madhuri, P. 2017. Surajmukhi Prabhandan Prakriya. ICAR-IIOR, Rajendranagar, Hyderabad.

Kumar, G.D.S., Suresh, G., Basappa, H., Chander Rao, S., Madhuri, P. and Padmaiah, M. 2017. Sunfl Management Practices. ICAR-IIOR, Rajendranagar, Hyderabad.

Kumar, G.D.S., Suresh, G., Basappa, H., Chander Rao, S., Madhuri, P., Alivelu, K. and Ramana Rao, S.V. 2017. Proddutirugudu Yajamanya Paddathulu (Telugu). Ref : Extension folder-13

Kumar, G.D.S., Suresh, G., Bsappa, H., Chan- der Rao, S., Madhuri, P. and M. Padmaiah. 2017. Sunflower Management Practices(English). Ref: Extension folder-10

Kumar, G.D.S., Suresh, G., Bsappa, H., Chander Rao, S., Meena, H.P., Praduman Yadav and Madhuri, P. 2017. Surajmukhi (Hindi). Ref: Extension folder-16.

Lavanya, C. 2017. Technical manual on "Seed production in castor" in Telugu under Skill Development Training programme at IIOR from 6-19th February, 2017.

Md. Aziz Qureshi, A., Padmavathi, P., Lakshmamma, P., Alivelu, K., Satish Kumar, G.D. and Ramana Rao, S.V. 2017. Bhoosaara pareeksha-Aavasyakatha. Ref: FFP-Vistaranapatrika-1.

Padmaiah, M., Suresh, G. and Murthy, I.Y.L.N. 2016 Cheurkulo antarpantaga nuvulla sagu vyavasaya padipantalu, September, p.22.

Padmavathi, P., Alivelu, K., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Kumar, G.D.S., Praduman Yadav, Meena, H.P. and Padmaiah, M. 2017. Safflower: Package of Practices (English).

Padmavathi, P., Alivelu, K., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Kumar, G.D.S., Praduman Yadav, Meena, H.P. and Padmaiah, M. 2017. Safflower: Package of Practices (Telugu).

Padmavathi, P., Alivelu, K., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Kumar, G.D.S., Praduman Yadav, Meena, H.P. and Padmaiah, M. 2017. Safflower: Package of Practices (Hindi).

Prasad, R. D., Raoof, M. A., Senthilvel, S., Dinesh Kumar, V., Praduman, Y., Bhuvaneswari, R. and Varaprasad, K.S. 2016. Gray mold of castor. Technical Bulletin, ICAR-IIOR, Hyderabad. 30 p.

Prasad, R. D., Senthilvel, S., Dinesh Kumar, V., Pradyuman Yadav., Bhuvaneswari, R., Raoof, M.A and Varaprasad, K. S. 2016. Gray Mold of Castor, Technical Bulletin, ICAR-IIOR, Hyderabad, pp 29.

Qureshi, M.A., Padmavathi, P., Lakshmamma, P., Alivelu, K., Satishkumar, G.D. and Ramana Rao, S.V. 2017. Bhusara pareeksha- Aavasya-katha (Telugu) Ref : FFP-Vistaranapatrika-1

Sudhakara Babu, S.N. 2017. Crop Cafeteria on Annual Oilseed Crops – Hindi/English. 2017. Castor Kisan Mela of NMOOP, at Feb 19, 17. ICAR-IIOR, Hyderabad.

Sarada, C., Padmaiah, M., Lavanya, C., Suresh, G., Satish Kumar, G.D., Duraimurugan, P., Santhalakshmi Prasad, M., Alivelu, K. and Ramana Rao, S.V. 2017. Castor management practices (English). Ref: Extension folder-9.

Sarada, C., Padmaiah, M., Lavanya, C., Suresh, G., Satish Kumar, G.D., Duraimurugan, P., Santhalakshmi Prasad, M., Alivelu, K. and Ramana Rao, S.V. 2017. Amudamu Yajamanyap-addathulu (Telugu). Ref: Extension folder-12.

Sarada, C., Padmaiah, M., Lavanya, C., Suresh, G., Satish Kumar, G.D., Duraimurugan, P., Santhalakshmi Prasad, M., Alivelu, K. and Ramana Rao, S.V. 2017. Arand (Hindi). Ref: Extension folder-15.

Sarada, C., Padmaiah, M., Suresh, G., Satish Kumar, G.D., Duraimurugan, P., Santha Lakshmi, M., Lavanya, C., Prabhakaran, A.J., Meena, H.P., Praduman Yadav, Alivelu, K. and Ramana Rao, S.V. 2017. Extension folder 9: Castor management practices.

Sarada, C., Padmaiah, M., Suresh, G., Satish Kumar, G.D. Duraimurugan, P., Santha Lakshmi, M., Lavanya, C., Prabhakaran, A.J., Meena, H.P. Praduman Yadav, Alivelu, K. and Ramana Rao, S.V. 2017. Extension folder 15: Arand Prabhadan Prakriya (in Hindi).

NAAS Strategy Paper

National Academy of Agricultural Sciences (NAAS) 2017. Sustaining soybean productivity and production in India. Strategy Paper No.4. Convener: S.M. Virmani; Co-conveners: K.V. Rao, G. Obi Reddy, G. Ravindra Chary, V.S. Bhatia and P. Padmavathi, 52 pages.

Training Manuals

- Vimala Devi, P. S. 2016. "*Bacillus thuringiensis* (Bt) for management of Lepidopteran Pests " in Training manual of ICAR sponsored short course on "Advances in ecofriendly pest management strategies in millets" 22-31 August, 2016. ICAR-IIMR Publ. No. 11/ 2016-17, pp. 88-93.
- Vimala Devi, P. S.. 2017. Training manual in telugu on "Mass Production of Biopesticides".
- Duraimurugan, P., Santha Lakshmi Prasad, M., Srinivas, P. S., Md. Aziz Qureshi, A., Padmaiah, M. and Vishnuvardhan Reddy, A. 2016. Training Manual on "Plant Health Management for Increasing Oilseeds Production'' (21 to 28th September 2016), ICAR-Indian Institute of Oilseeds Research, Hyderabad, India. pp. 300.
- Sudhakara Babu, S.N. Manual – Skill Upgradation Training on Seed Production Technologies for Oilseeds for Diploma in Agricultural participants, February, 2017.
- Lakshmynarayana, M., Jawahar Lal., Manjunatha, T. and Kadirvel, P. 2017. Model Training Course Manual on "Seed production in castor, sunflower, safflower, sesame and niger (3-10 January 2017), sponsored by DOE, DAC, New Delhi and held at ICAR-IIOR, Hyderabad.

Developed Mobile Applications

- ICAR-IIOR at a Glance
- ICAR-IIOR Castor
- ICAR-IIOR Sunflower
- ICAR-IIOR Safflower
- Freely available Mobile apps for Technology transfer. K. Alivelu, C.Sarada and P. Padmavathi in Training Manual on "Plant Health Management for Increasing Oilseeds Production"28-21th September, 2016 conducted by ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad.pp.270-277

Presentations in Conference / Symposia/ Trainings

Name of the Scientist(s)	Title / Conference / Place / Date(s)
Dudhe, M.Y. and Sujatha, M.	Four decades of sunflower genetic resources activities in India. Presented during the 19th International Sunflower Conference held from 29 May to 3 June 2016 at Edirne, Turkey.
Sujatha, M.	Approaches for improvement of resistance to powdery mildew in sunflower (*Helianthus annuus* L.). Presented during the 19th International Sunflower Conference held from 29 May to 3 June 2016 at Edirne, Turkey.
Duraimurugan, P., Lavanya, C. and Lakshminarayana, M.	Field screening of mutant selections of castor parental line, DPC-9 against leafhopper, *Empoasca flavescens* (Cicadellidae: Homoptera). International Conference on Agricultural Sciences and Food Technologies for Sustainable Productivity and Nutritional Security. July 25, 2016.
Jawahar Lal, J.	Delivered a lecture and gave training to KVK and Dept.Agril officials (35 participants) from NEH region at Assam Agril University, Jorhat from 1 - 3 September 2016.
Ranganatha, A.R.G.	Delivered lecture in the training programme on "Seed Production in Sesame" on September 15, 2017.
Anjani, K.	Delivered a talk on 'Seed production in safflower" during a training programme on 'Seed production in oilseeds' organized at ICAR-IIOR under NMOOP, DAC & FW during 15-16th September, 2016.
Sujatha, M. and Kumaraswamy, H.H.	Oral presentation of the paper "Issues and Concerns in Biosafety of Transgenic Crops: A Case Study of Castor" during the 4th South Asia Annual Biosafety Conference at Hyderabad, India during September 19-21, 2016.
Sujatha, M.	Delivered a lecture on Transgenics in IPM during the Model Course on "Plant Health Management for Increasing Oilseeds Production" on 26th September 2016 at ICAR-IIOR, Hyderabad.
Mukta, N. and Praduman, Y	Presentation of poster on Evaluation of USDA core set of safflower (*Carthamus tinctorius* L.) germplasm for identification of trait specific accessions in 1st International Agrobiodiversity Congress, November 6-9, 2016, New Delhi, India.
Praduman Y, Chandrika, K.S.V.P., Jawahar Lal, J. and Mukta, N.	Presentation of poster on Evaluation of sesame (*Sesamum indicum* L.) genotypes for identification of trait specific accessions for biochemical constituents in 1st International Agrobiodiversity Congress, November 6-9, 2016, New Delhi, India.
Dudhe, M.Y., Sujatha, M., Varaprasad, K.S.	Challenges in augmentation, multiplication, conservation and utilization of sunflower genetic resources in India. 1st International Agrobiodiversity Congress, November 6-9, 2016, New Delhi, India.
Meena, H.P., Sujatha, M., Soni, P.K., Pushpa H.D, Varaprasad, K.S.	Cytomorphological and molecular characterization of interspecific hybrids between *Helianthus annuus* and *H. argophyllus* T &G. 1st International Agrobiodiversity Congress, November 6-9, 2016, New Delhi, India.
Senthilvel, S.	Delivered a lecture entitled "Tools for associating DNA marker with a trait" on 01.11.16 in the training programme on 'Bioinformatics Tools and Techniques in Agriculture' held at NAARM, during 01-10 November 2016.
Dinesh Kumar, V.	Delivered a lecture "Transcriptomics and its applications in agriculture" on November 10, 2016 to the participants of National workshop on Bioinformatics Tools and Techniques in Agriculture organized by NAARM, Hyderabad from November 1-10, 2016.
Sujatha, M	Delivered a lecture on DNA Fingerprinting in Seed Production in Oilseed Crops at the Model Training Course from 3-10 January 2017 on Seed Production in Castor, Sunflower, Safflower, Sesame and Niger on 5th January 2017 at ICAR-IIOR, Hyderabad.

Name of the Scientist(s)	Title / Conference / Place / Date(s)
Ranganatha, A.R.G.	Delivered lecture in the training programme on "Seed Production in Sesame and Niger" on January 7, 2017.
Santha Lakshmi Prasad, M., Naresh, N., Sujatha, K. and Sujatha, M.	Population dynamics of Alternaria species causing leaf blight of sunflower. Paper presented during the National Symposium on Diagnosis and Management of Plant Diseases: Integrated Approaches and Recent Trends, from 9-11th January, 2017 at Meghalaya.
Dinesh Kumar, V.	Delivered a lecture "Hybrid purity assessment using molecular markers with special reference to oilseed crops" on January 10, 2017 to the participants of training programme on seed production in castor, sunflower, safflower, sesame and niger at ICAR-IIOR, Hyderabad.
Sudha P.S., Padmavathi T.A.V., Kumar O.A., Chakravarty N., Vineeth K.V., Krishna Mohan, Sivarama Prasad, L., Boney Kuriakose, Vishnu Raja, Sujatha, M. and Reddy, V.B.	Comparative analysis of transcriptome during organogenesis in sunflower, jatropha and castor, three important oilseeds. Presented at PAG XXV held at San Diego, USA, from 14-18 January 2017.
Dinesh Kumar, V.	Delivered an invited lecture on 'Improvement of Brassicas using wild species' on January 25, 2017 to the participants of ICAR short course on "Prebreeding using wild species for sustainable yield in crops" held at Indian Institute of Rice Research, Rajendranagar, Hyderabad.
Sujatha, M	Delivered a lecture on Prebreeding in Oilseeds using Wild Species at the ICAR sponsored Short Course on Prebreeding using Wild Species for Sustainable Yield in Crops organized at ICAR-IIRR, Hyderabad from 16-26 January 2017.
Anjani, K.	Presented a lecture on " Safflower-morphology/phenology, floral biology etc. on 07th February, 2017 during Skill Development Training Programme on Seed Production Technologies on Oilseed Crops held from 6-19 Feb 2017 at ICAR-IIOR, Hyderabad. Also imparted one day training to participants on pollination/crossing techniques, etc. in safflower on February 1, 2017.
Ranganatha, A.R.G.	Delivered lecture on sesame morphology, seed production and roughing technologies theory and practicals on sesame on Seed Production Technologies of Oilseed crops on February 13, 2017.
Kumaraswamy, H.H.	Delivered an invited lecture on the topic "Floral Morphology, Floral Biology and Phenological Stages of Sesame" in Skill Development Training course on "Hybrid Seed Production in Oilseeds" organized by ICAR-IIOR, Hyderabad, during February 6 – 18, 2017.
Anjani, K.	Presented a research article on "Influence of severe drought on oleic acid content and seed yield of high oleic Indian safflower varieties" during Inter Drought-V International Conference organized by ICARISAT from 21-25 February 2017, Hyderabad.
Lavanya, C.	Model training course on "Seed production in castor, sunflower, safflower, sesame and niger" from 3-10th January 2017. Seed production of castor in "Skill development training programme on Seed production in oilseed crops" from 6-19th February, 2017 under the GoI sponsored "Skill and entrepreneur-ship Development Programme."
Ratnakumar, P. and Minhas, P.S.	Plant Bio-regulators for Minimize Pulse Crop Yield Losses under Abiotic Stress Conditions. National Seminar on self-sufficient pulses for eastern India, at BAU, Sabour.

Name of the Scientist(s)	Title / Conference / Place / Date(s)
Chandika, KSVP	Role of biopolymers in plant health management of oilseed crops at ICAR-IIOR, on September 26, 2016, under model training on "Plant Health Management for Increasing Oilseeds" DoE, GOI.
Siddiqua Mehraj, Sharma, H.S.K., Aziz Qureshi, M.A. and Laxminarayana, P.	Quantity-Intensity relationship and potential buffering capacity of soils of Nalgonda district.. *In*. 81th Annual convention of Indian Society of Soil Science, October 20-23, 2016 at RVSKVV, Gwalior. Pp24.
Mehraj, Sharma, H.S.K., Aziz Qureshi, M. A and Laxminarayana, P.	Potassium status and potassium fractions of the soils of Nalgonda District. Siddiqua. *In*. 81th Annual convention of Indian Society of Soil Science, October 20-23, 2016 at RVSKVV, Gwalior. Pp24.
Aziz Qureshi, A.	Nutrient Management in Onion and Garlic. *In*: Symposium on "Edible Allium: Challenges and future strategies for sustainable production " November 7-9, 2016, at Jalna, Maharashtra.
Chandika, KSVP	"National Symposium on Agrochemicals Research and Education in India: Appraisal and Road Map for Future" on November 15-17, 2016 held at ICAR-IARI, New Delhi.
Vikas Kumar, Anupama and Chandrika, KSVP	Characterization and Swelling Properties of Fast Swelling Novel Guar Gum Polyacrylate/ Bentonite Superporous Composites. National Symposium on Agrochemicals Research and Education in India: Appraisal and Road Map for Future. November 15–17, 2016, ICAR-IARI, New Delhi.
Suresh G., Aziz Qureshi and Ramulu, V. 2016.	Enhancing the productivity of *rabi* castor (*Ricinus Communis L.*) through drip-fertigation. Paper presented during 4th International Agronomy Congress on "Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge", from 22-26 November 2016 at New Delhi.
Padmavathi, P.	Presented paper (poster) on "Oilseed based cropping systems productivity in response to land configuration practices in Vertisols under rainfed conditions' in 4th International Agronomy Congress "Agronomy for sustainable management of natural resources, environment, energy and livelihood security to achieve zero hunger challenge, 22 to 26 November 2016 at IARI, New Delhi.
Aziz Qureshi, A. and Prasad, R.D.	Evaluation of identified Trichoderma strains for imparting salinity tolerance in sunflower. *In:* 14th International workshop on "*Trichoderma* and *Gliocladium*- Principles and Practices" during 27-30th November 2016 at Nagpur, Maharashtra, India.
Padmavathi, P.	Delivered lecture on 'Agronomic management of certified and foundation seed production of sesame, niger and safflower in a training programme "Seed production in castor, sunflower, sesame and niger" held at IIOR, Hyderabad from 3 to 10th January 2017.
Satish Kumar, G.D., Qureshi, Md A.A., Sudhakara Babu, S.N. and Hareesh Kumar, S.	Best Management Practices in Sunflower for maximizing yield in dry lands. Inter Drought-V International Conference organised by ICRISAT, Hyderabad from 21-25th February 2017.
Padmavathi, P.	Presented paper (poster) on "Productivity and economics of intercropping of safflower in mustard, linseed, coriander and chickpea under rainfed conditions' in 3rd National Brassica Conference 'Enhancing oilseed Brassica Production through climate smart technologies' February 16-18, 2017 at IARI, New Delhi.
P. Lakshmamma, Lakshmi Prayaga and K. Alivelu	Poster presented on "Selection of identified good root and drought tolerant germplasm of castor (*Ricinus communis* L.) for their performance in *kharif* without irrigation" at International Conference on Inter Drought-V organized by ICRISAT at Hyderabad, from February 21-25, 2017.

Name of the Scientist(s)	Title / Conference / Place / Date(s)
Ratnakumar, P., Govindasamy, V. and Minhas, P.S.	Yield enhancement through bio-fertilizer priming and effect of bio-regulators in soybean under moisture stress. InterDrought-V organised by ICRISAT, Hyderabad from 21-25th February 2017.
Suresh, G., Padmavathi, P. and Praduman Yadav	Potential of safflower meal as animal feed. In: Abstarcts : National Symposium on "New Directions in Managing Forage Resources and Livestock Productivity in 21st Century: Challenges and Opportunities" jointly organized by Range Management Society of India, Jhansi (UP) & RVSKVV, Gwalior (MP) from (March 3-4, 2017 at RVSKVV, Gwalior.
Padmavathi, P.	Presented Research Achievements under the DST funded Project "Crop management options to make safflower cultivation profitable for small farmers through enhanced utilization of petals" at Group Monitoring Workshop under TIASN program (DST), 31 March 2017 held at NBRI, Lucknow, U.P.
Suresh, G.	Efficient weed management practices for seed production in oilseed crops. Lecture delivered in Model Training Course on Seed production in Castor, Sunflower, Safflower, Sesame and Niger. Sponsored by Directorate of Extension, DAC, New Delhi.
Vimala Devi, P.S.	Lead paper on "Perspectives on the use of *Bacillus thuringiensis* for effective management of insect pests" presented at the Fifth National Conference on "Biological Control: Integrating Recent Advances in Pest and Disease Management" organized by NBAIR, Bengaluru, 9-11 February, 2017.
Duraimurugan, P., Lavanya, C. and Lakshminarayana, M.	Screening of mutant selections of castor parental line, DPC-9 against leafhopper, *Empoascaflavescens* (Cicadellidae: Homoptera) under field conditions. In: Proceedings of International Conference on Agricultural Sciences and Food Technologies for Sustainable Productivity and Nutritional Security", 25 to 27 August2016, University of Agricultural Sciences, Bengaluru, pp. 83.
Duraimurugan, P., Sampathkumar, M. and Srinivas, P.S.	Evaluation of synthetic kairomonal attractants against lepidopteran pests of castor. In: Proceedings of "International Conference on Microbiology, Agriculture and Environmental Sciences, 1-3 September 2016, St. Pious X Degree & PG College for Women, Nacharam, Hyderabad.
Duraimurugan, P., Anjani, K. and Lakshminarayana, M.	Screening of castor germplasm for susceptibility to capsule borer, *Conogethespunctiferalis* Guenee (Crambidae: Lepidoptera). In: : Proceedings of "International Conference on Microbiology, Agriculture and Environmental Sciences, 1-3 September 2016, St. Pious X Degree & PG College for Women, Nacharam, Hyderabad.
Ranjan K.S., Senthilvel, S., Shaik, M., Prasad, R.D., Santha Lakshmi Prasad, M. and Kadirvel, P.	Genome wide association analysis for Fusarium wilt resistance in castor (*Ricinus communis* L.). International conference on Agricultural sciences and food technologies for sustainable productivity and nutritional security, 25-27 August, 2016, University of Agricultural Sciences, Bengaluru.
Sujatha, M., Kadirvel, P., Chander Rao, S and Varaprasad, K.S.	Approaches for improvement of resistance to powdery mildew in sunflower (Helianthus annus L) Proceedings of 19th International Sunflower Conference, 29 May-3 June, Edirin,Turkey.
Pushpa H.D., Sujatha, M., Meena, H.P., Pramesh, D., Chander Rao, S. and Varaprasad, K.S.	Molecular breeding for major diseases of Sunflower in India; Present status and future needs Proceedings of 19th International Sunflower Conference ,29 May-3 June , Edirin, Turkey.

Name of the Scientist(s)	Title / Conference / Place / Date(s)
Santha Lakshmi Prasad, M., Naresh, N., Sujatha, K. and Sujatha, M.	Population dynamics of Alternaria species causing leaf blight of sunflower. In: Abstracts of "National Symposium on "Diagnosis and Management of Plant Diseases: Integrated Approaches and Recent Trends" organized jointly by Indian Phytopathological Society and ICAR RC for NEH Region, Umiam from January 09-11, 2017 at ICAR Research Complex for NEH Region, Umiam, Shillong, Meghalaya.
Prasad, R.D., Rakesh, P., Uma Devi, G. , Yamuna, C. and GowriPriya, N.	Combination of seed polymers, fungicides, biocontrol agents for seed health management in oil seed crops". In: Abstracts of ISMPP 38th Annual conference and National Symposium on "Challenges towards Plants health under Changing Climate Scenario for Sustainable Agriculture" organized at BCKV, Mohanpur, Nadia, West Bengal, India from 24-26, November 2016.
Prasad, R.D., Dinesh Kumar, V., Aziz Qureshi, A., Lakshmamma, P. and Yamuna, C.	*Trichoderma* and Plant Health Management". In: Abstracts of 14th International Workshop on *Trichoderma* and *Gliocladium* (TG 2016) held at Nagpur, India from 1 to 3rd December 2016.
Madhuri, P.	Oral Presentation on "Information Management of Prices and Arrivals of Castor in Major APMCs of India", in the 70th International conference on Statistics & Big Data Bioinformatics in Agricultural Research, organized by Indian Society of Agricultural Statistics at ICRISAT, Patancheru, Hyderabad during 21-23rd November 2016.
Ramana Rao, S.V.	Delivered a lecture on " Utilization of Kiosk in Dissemination of Information on Plant Health Management – A Demo" in the Model Training Course on "Plant Health Management for Increasing Oilseeds Production" organized by IIOR in collaboration with Directorate of Extension at IIOR on 28th September, 2016.
Alivelu, K., Prasad, R.D., Padmavathi, P., Sarada, Ch. and Lakshmamma, P.	Presented a paper entitled "A Neural Network for Prediction of Alternaria Leaf Spot Disease in Safflower (*Carthamus tinctorius*) Based on Weather Data" in Indian Society of Agricultural Statistics-70th International Conference at ICRISAT, Patancheru, Hyderabad during 21-23rd November, 2016.
Kumar, G.D.S.	Presented the progress report on the project "Bridging the production gaps in potential districts of sunflower and sesame through dynamic technology transfer" at G.B. Pant University of Agriculture & Technology, Pantnagar, Uttar khand on 13th August, 2016.
Murthy, I.Y.L.N.	Lecture delivered in Model training course on Impact on the productivity and quality of oilseed crop through secondary and micronutrients sponsored by Directorate of Extension, DAC, New Delhi.

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, social science and utilization of oilseed crops. An amount ` 13,89,424.00 was spent in 2016-17 to acquire 64 books and subscription of 56 periodicals, Crop science database and AGRIS on CD, AGRICOLA and biological and Agricultural Index. A total of 35 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 285 electronic article delivery though e-mails have been brought out and circulated to all scientists working in AICRO (Sunflower, Safflower, Castor and Sesame) centres across different state 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 Indiagristate.com (Agriculture and Plant Science Protocols has subscribed for the year 2016-17.

Civil Works

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

1. ``Central Laboratory Complex" construction work is under progress by CPWD.
2. Renovation modification of Old Glass House at Rajendranagar.
3. Repairs of Scooter shed and Farm Store shed at Rajendranagar.
4. Providing accommodation for UPS System – 30 KVA at Rajendranagar.
5. Wall paneling and partitioning in equipments facility at back side of main building at Rajendranagar.
6. Re-carpetting of B.T. Roads at Rajendranagar Farm.
7. Re-carpetting of B.T. Roads at Narkhoda Farm.
8. Minor repairs & Misc. works in Crop Protection Laboratory at Rajendrnagar.
9. Renovation of Physiology Lab at Rajendranagar.
10. Renovation of VIP dining room in the Hostel.
11. Renovation and repair of ladies toilet and minor repairs in the toilets at Rajendranagar.

VISITORS

During the year under report, about 2974 visitors including farmers and students from Telangana, Gujarat, Tamil Nadu, Karnataka, Maharashtra, Kerala and Haryana visited this Institute and interacted with the scientists. This includes 670 farmers from Karnataka, Tamil Nadu, Telangana, Andhra Pradesh, Madhya Pradesh, Maharashtra and Uttar Pradesh. About 14 international visitors from NIRD&PR, Hyderabad have also visited IIOR.

In addition to the above the following VIPs/ Dignitaries have also visited the Institute during the period under report:

Dr. Mangala Rai, Former Secretary, DARE & Director General, ICAR visited ICAR-IIOR on December 24, 2016.

24/2/2016	Mangala Rai		What a great job done. Congratulations and all the best wishes. Mangala

Prof. Eskandar Zand, Deputy Minister of Agriculture & Head of Agricultural Research, Education and Extension, Iran; Prof. Javad Mozafari Hashjin, Director General, Academic Relations and International Affairs, AREEO; Dr. Babak Nakhoda, ABRI, AREEO and Dr. Mohammadinejhand, Director, RTIPP, University of Sh. Bahonar, Kerman, Iran visited ICAR-IIOR on February 23, 2017.

Date	Name & Address	Contact Nos.	Remarks
23/02/2015	Prof. Eskandar Zand, Deputy Minister of Agriculture, and Head of Agricultural Research, Education and Extension (AREEO) accompanied by: 2. Prof. JAVAD MOZAFARI HASHJIN Director General, Academic Relations and International Affairs, AREEO 3. Dr. Babak Nakhoda, ABRI, AREEO 4. Dr. Mohammadreza Jorod, Director RTIPP, University of Sh. Bahonar Kerman, Iran	+98-2240 2015 +98-2240 2015	We were very pleased to visit Indian Institute of Oilseed Research in Hyderabad. We were impresed with high quality research being conducted on oilseed crops. We think we share similar research agenda in this area and interested in having Strong collaboration oilseed research. We wish best of success for these wonderful colleagues here. E. Zand B. Nakhoda Javad Jafari

Shri S.K. Pattanayak, IAS, Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Govt. of India visited ICAR-IIOR on March 7, 2017.

A team of visitors comprising Ms. Inga Elise Bruteig, Mr. Ulf Hanno Pichl, Ms. Toril Loennechen Moen, Ms. Maja Stade Aaronaes, Ms. Astrid Berge, Ms. Sunniva Margrethe Due Aagaard from Norway along with Mr. Rupam Mandal and Mr. Prakash Nelliyat from National Biodiversity Authority and G. Sailu from Telangana State Biodiversity Board have visited IIOR on March 9, 2017 to understand the ABS mechanism.

APPOINTMENTS / PROMOTIONS / TRANSFERS / SUPERANNUATIONS

Appointment

Name	Post	Date
Dr. I.Y.L.N. Murthy	Director (Acting)	01.07.2016
Dr. A. Vishnuvardhan Reddy	Director	03.08.2016

Promotion

Name	Post	Promoted to Post	Date
Shri P.Srinivasa Rao	Technical Officer T-5	Sr.Technical Officer T-6	01.01.2013
Shri Surender Prasad	Sr.Tech.Asstt. T-4	Technical Officer T-5	01.01.2010
Shri B.V.Noble	Technical Officer T-5	Sr.Technical Officer T-6	01.07.2013
Shri V.Y.Swamy	Tech.Assistant Driver T-3	Sr.Technical Assistant T-4	01.01.2016
Dr.G.Annapurna	Technical Officer T-5	Sr.Technical Officer T-6	29.06.2011
Sri B.Giri	UDC	MACP-II	02.03.2016
Dr.G.D.Satish Kumar	Senior Scientist (Agril.Extension)	Principal Scientist	30.11.2014
Dr.K.Alivelu	Senior Scientist (Ag. Statistics)	Next higher grade	09.12.2012
Smt.P.Madhuri	Scientist (Computer Applications)	Next higher grade	19.01.2012
Dr.J.Jawaharlal	Scientist (Plant Breeding)	N ext higher grade	15.12.2013
Dr.Hari Prakash Meena	Scientist (Plant Breeding)	Next higher grade	11.05.2014
Smt.B.Usha Kiran	Scientist (Ag.Biotechnology)	Next higher grade	10.02.2014
Shri G.Raghunath	Senior Technical Officer	Assistant Chief Technical Officer (T-7/8)	01.04.2015
Shri G.Srinivas Yadav	Personal Assistant	MACP-II	24.10.2016
Dr.Praduman Yadav	Scientist (Biochemistry)	next higher grade	11.05.2014
Shri V.Sambasiva Rao	Senior Technical Officer	Assistant Chief Technical Officer (T-7/8)	09.05.2016

Superannuation

Name	Post	Date
Dr.K.S.Varaprasad	Director	30.06.2016 (AN)
Sri J.Balram	Senior Technician	31.08.2016 (AN)
Dr.M.Padmaiah,	Principal Scientist	31.12.2016 (AN)
Sri K.Ramulu,	Skilled Support Staff	28.02.2017 (AN)
Ms.J.Vijaya Lakshmi Bhushan,	Assistant	31.03.2017 (AN)

PERSONNEL
(as on March 31, 2017)

Dr. K.S. Varaprasad	Director	(Upto 30th June, 2016)
Dr. A. Vishnuvardhan Reddy	Director	(From 3rd August, 2016)

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 (Genetics & Cytogenetics)
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 (Pl.Breeding)
Mrs. B.Usha Kiran	Scientist (Biotechnology)
Dr. Sujatha T.P.	Scientist (Biotechnology)
Dr. J. Jawaharlal	Scientist (Pl.Breeding)
Dr. Hari Prakash Meena	Scientist (Pl.Breeding)
Dr. T.Manjunatha	Scientist (Pl.Breeding)
Dr. K.T.Ramya	Scientist (Pl.Breeding)
Dr. H.D.Pushpa	Scientist (Pl.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	Pr.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 Qureshi	Pr.Scientist (Soil Science)
Dr. P. Ratna Kumar	Senior Scientist (Pl.Physiology)
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) (deputation with UAS, Dharwad)
Dr. R. Durga Prasad	Pr.Scientist (Pl.Pathology)
Dr. M. Lakshminarayana	Pr.Scientist (Agric.Entomology)
Dr. S.C hander 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. Shaik Shoukat Ali	Technical Officer
Mr. Ch. Anjaiah	Senior Technician
Mr. S. Saida Reddy	Senior Technician

Social Sciences

Dr. M. Padmaiah	Head & Pr. Scientist (Agric. Extension) (upto 30th December, 2016)
Dr. S.V. Ramana Rao	Head & Pr.Scientist (Agric.Economics)
Dr. Ch. Sarada	Pr.Scientist (Agric.Statistics)
Dr. G.D. Satish Kumar	Pr.Scientist (Agric.Extension)
Dr. K. Alivelu	Sr.Scientist (Agric.Statistics)
Mrs. P. Madhuri	Scientist (SS) (Computer Applications)
Mr. B. Krishna	Senior Technical Officer
Mr. B. Kistaiah	Technical Officer
Mr. G.Srinivas Yadav	Personal Assistant

Support Services

AKMU Cell

Mr. P. Srinivasa Rao	Senior Technical Officer

Library and Documentation

Mr. G. Raghunath	Asst. Chief Technical Officer
Mr. V. Sambasiva Rao	Asst. Chief Technical Officer

Art & Photography

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

Technical Coordination Cell

Mrs. R. Raji	Personal Assistant

Farm Section

Mr. M. Bhaskar 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	Technical Officer (Electrician)

Mr. A. Srinivasa Raju	Technical Assistant (AC 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	Technical Officer
Mr. M. Ramulu	Technical Officer

Administration

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

Audit & Accounts

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