ICAR-IIOR

Annual Report 2018-19

भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान

ICAR-Indian Institute of Oilseeds Research

राजेंद्रनगर, हैदराबाद-500 030, तेलंगाना राज्य Rajendranagar, Hyderabad-500 030, Telangana State

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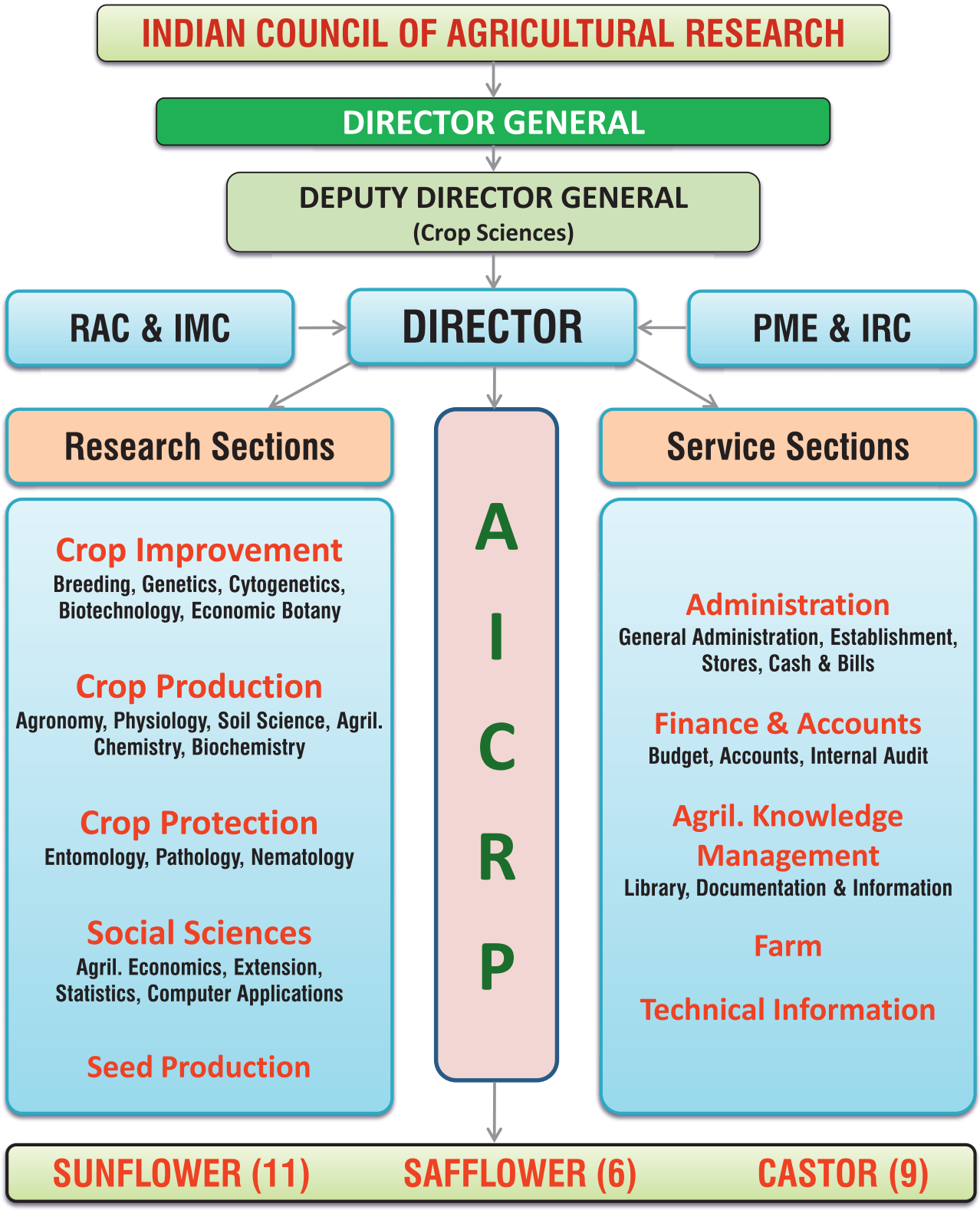

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वार्षिक प्रतिवेदन
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ICAR-IIOR Annual Report

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Cover page photos (clock-wise from top)

- ICH-66, high yielding and wilt resistant castor hybrid
- Seed production of sesame variety, Shweta Til
- ISF-1, the first high oleic safflower variety released in India through public-private partnership; MAS assay for high oleic trait in safflower
- Demonstration of foliar application of boron in sunflower

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Preface

It gives me immense pleasure to present the ICAR-IIOR Annual Report 2018-19, highlighting the significant achievements made under research, extension and training programmes organized during the year. The year had deficit rainfall (up to 47%) during rainy and post-rainy seasons and higher minimum temperatures in peninsular India. Despite a 10% decline in the area under oilseeds over the previous year, the production remained unaltered at 31.5 m. tonnes with productivity enhancement of 90 kg/ha.

It is a matter of great pride for the institute and AICRP (Oilseeds) for the significant achievements made in the development of varieties and hybrids. In castor, 5 hybrids were notified (GCH-8, YRCH-2, GCH-9, JC-4 and JC-24) and a hybrid (ICH-66) and a variety (YTP-1) were identified for release. Two sunflower hybrids LSFH-171 and COH-3 were notified for release. In safflower, DSH-185 and PBNS-86 were notified and ISF-764 and ISF-1 (the first high oleic variety) were identified for release. The other salient achievements include: registration of four genetic stocks in castor and safflower with PGRC, ICAR-NBPGR; demonstration of better moisture conservation, higher system productivity, profitability in *kharif* greengram followed by zero till castor with surface mulch of greengram residues; development of thrips damage rating scale to screen for host plant resistance in castor for the first time; isolation and identification of a virulent isolate of *Bacillus thuringiensis* effective against the fall armyworm *Spodoptera frugiperda*. As a major step towards facilitating availability of improved varieties and hybrids to the farmers, a total of 416.6 q of quality seed was produced both on-farm and participatory mode. A DAC&FW sponsored "Oilseeds Seed Hub" with participation of 35 centres on nine oilseed crops is being coordinated at IIOR with a total budget outlay of Rs. 5091.18 lakhs for a total production of 60,825 q of seed for 2018-19 and 2019-20.

The major focus during the year was on farmer-centric programmes and capacity building of farmers and other stakeholders. A total of 7522 demonstrations in FLDs across nine oilseed crops were conducted; 11 trainings and 34 on-station and off-station capacity building programs were organized; promising hybrids of sunflower and sesame were evaluated in NEH states for area expansion; large plot oilseed live-crop demonstrations at institute farms showcasing improved cultivars of oilseed crops under best management practices and distribution of soil health cards to 175 farmers was also carried out. A NMOOP, DAC, Govt. of India sponsored National Seminar on "Road Map of Vegetable Oil Production by 2022" was organized at the Institute. Under Mera Goan Mera Gaurav (MGMG), and tribal sub-plan (TSP) programmes, farmers were periodically updated about various agricultural activities to enhance their income besides facilitating linkages with ICAR institutes, SAUs, Department of Agriculture and NGO's. The Institute also received recognition for the work on microbial pesticides and the Rajabhasha award for implementation of Hindi. There were four deputations abroad of scientific personnel to China, Turkey and Vienna.

I place on record my sincere gratitude and reverence to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. A.K. Singh, DDG (CS), ICAR; Dr. S.K. Chaturvedi, former Asst. Director General (O&P) Acting; Dr. A.K. Chakrabarty, Asst. Director General (O&P) Acting and Dr. D.K. Yadava, ADG (Seeds), ICAR for their visionary guidance and unstinted support in executing the mandate of the Institute. I express my gratefulness to the Chairman and Members of the IIOR-Research Advisory Committee and also the Quinquennial Review Team for the critical assessment and improving the research programmes. I appreciate the efforts of all Heads of Sections Drs. M. Sujatha, G. Suresh, P.S. Vimala Devi, S.V. Ramana Rao, S.N. Sudhakara Babu, Shri. Shitanshu Kumar and Shri. K. Srinivasa Rao and the I/c TIO Dr. Lakshmi Prayaga for the inputs and compiling the report of their respective sections. My sincere appreciation goes to Dr. M. Sujatha 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, PS for secretarial assistance, Shri. P. Srinivasa Rao, PA for page setting and services of Shri. Pradeep Singh, Assistant Director (OL) for translation of the Annual Report in Hindi is acknowledged.

IIOR, Hyderabad
July 03, 2019

(A. Vishnuvardhan Reddy)
Director

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ICAR-IIOR

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2018-19

Executive Summary

Executive Summary

Major Achievements (2018-19)

Hybrids/varieties released

- ICH-66: High yielding and wilt resistant castor hybrid for rainfed regions of peninsular India
- DSH-185: First public sector CMS safflower hybrid, notified by Govt. of India, for all India cultivation
- ISF-1: First safflower variety with high oleic acid content (76%) for all India
- ISF-764: High yielding safflower variety for all India

Germplasm registered

- Castor germplasm accession, RG-57 (INGR19019) for high ricinoleic acid content (91%)
- Castor germplasm accession, RG-631 (INGR19018) for leafhopper resistance
- Castor pistillate line, IPC-15 (INGR19017) for early maturity and distinct morphological characters
- Safflower genetic stock, SFS-9943 (INGR19023) for high oil content (34.7%)

Technologies developed / assessed

- SNP markers linked to Fusarium wilt resistance in castor germplasm lines, RG-27 and RG-2944
- Seed priming technology based on biopolymer chitosan + *Trichoderma harzianum* Th4d for management of Fusarium wilt (castor) and Macrophomina root rot (safflower)
- Mobile Apps on seed production technologies in castor, safflower and sesame
- Impact assessment study revealed that castor hybrid, GCH-7 covered 2.56 lakh ha and provided yield advantage of 4.13 q/ha, additional net returns of Rs. 15,624/ha and additional production of 10.56 lakh tonnes during Quinquennium Ending 2016 over 2010 in Gujarat

Major highlights of the results under various research projects and outreach activities are summarized theme-wise.

Crop Improvement

Germplasm – Maintenance, Evaluation and Enhancement

Castor

- A total of 62 trait-specific inbred lines were supplied to AICRP centres and breeders.
- Two accessions, RG-57 (INGR19019) - a high ricinoleic acid type and RG-631 (INGR19018) - a leafhopper resistant accession have been registered with Plant Germplasm Registration Committee, ICAR.
- A total of 77 trait specific inbred lines with superior yield potential, which included extra early (21), early (6), pistillate (8), high ricinoleic acid content (6), wilt resistance (2), root rot resistance (1), wilt and root rot resistance (3), capsule borer tolerance and wilt resistance (5), capsule borer tolerance (17) and leafhopper resistance (8) were developed from germplasm accessions.

Sunflower

- A total of 2851 accessions comprising of indigenous and exotic collections of inbreds, populations, pre-bred lines, CMS, restorers *etc.* are maintained.

- A total of 395 accessions including 337 pre-bred lines were augmented from USDA, USA under an international collaborative project with the University of British Columbia, Canada.
- In an evaluation trial of USDA pre-bred lines, two lines (PI-686707 and PI-686758) were found promising with high seed yield (>35 g/plant) and oil content (39%).
- The germplasm catalogue containing characterization and evaluation data of 2149 accessions was published and distributed to all the AICRP sunflower breeders.

Safflower

- A set of 272 germplasm accessions were rejuvenated, 179 promising accessions were multiplied and 206 accessions were supplied to indenters for evaluation, screening against wilt, aphid and salinity tolerance at multilocations.
- Ten accessions (IC-253215, IC-337678, IC-338171, IC-406143, EC-337543, IC-337805, IC-337833, IC-338209, IC-406029 and IC-499965) were identified for high seed yield (34.3 - 44.2 g/plant) and oil yield (11.4 -13.8 g/plant).
- Two accessions (EC-398229 and EC-736501) were identified for high oil content (36.2 and 40.2%, respectively).

Sesame

- A set of 320 germplasm accessions were evaluated for agronomic traits. Oil content ranged from 28-53%. The accession IC-526435 showed highest oil content (53%) as well as high test weight (4.0 g). Six accessions *viz.,* IC-526435, IS-104, IS-344, IC-264692, KMR-85 and IS-349 were found promising for yield and related traits.

Niger

- Seed multiplication and maintenance of 335 germplasm accessions was done by sibbing and top. Ten best performing accessions were identified for random matting.

Pre-breeding

- In safflower, a set of 95 interspecific inbred lines derived from crosses between *Carthamus tinctorius* and wild species *C. oxyacantha*, *C. palaestinus*, *C. turkestanicus*, *C. creticus* and *C. lanatus* were identified for resistance to Fusarium wilt.
- Ten interspecific inbred lines (ISF-324 to ISF-333) recorded 22-45% higher seed yield (28.9-32.8 q/ha) than the best check, A-1 in different trials under rainfed conditions.
- Development of CGMS system in sesame is in progress using interspecific crosses between *Sesamum indicum* x *S. malabaricum*. In BC_5 generation, progenies with about 83% male sterility have been recovered.

Parental Lines - Development, Characterization and Evaluation

Castor

- IPC-15 (INGR 19017), an early maturing (85 DAS of primary spike) pistillate line with distinct morphological characters like papaya leaf type, non-spiny and loose capsules has been registered with PGRC, ICAR.
- A set of 41 new pistillate lines was evaluated and a subset of six lines (IPC-33, DPC-23, DPC-21, DPC-24, DPC-17 and IPC-35) was promising with 12-33% higher seed yield over the check, M-574.
- A set of 109 new monoecious lines was evaluated and a subset of 13 lines was promising. ICS-304, ICS-311, ICS-315, ICS-316 and ICS-318 had higher test weight (>32 g/100 seeds); ICS-321 had higher oil content (51.7%); ICS-303, ICS-304, ICS-315 and ICS-318 were highly resistant to Fusarium wilt. ICS-252 (38%), ICS-257 (72%) and ICS-261 (97%) had superior performance over the best check, DCS-107 in terms of seed yield.
- Two gene pools, for development of graymold resistant lines and pistillate lines have been subjected to random mating.

Sunflower

- New restorer lines *viz.,* RGP-21-P_4-S_{1-3} and RGP-50-P_2-S_1 were found to be free from powdery mildew infection.

Varietal Development

Safflower

- The variety, ISF-764 recorded 16 and 19% higher seed yield (20 q/ha) and 25 and 27% higher oil yield (6.2 q/ha) than the checks, A-1 and PBNS-12, respectively and was identified for All India release.
- ISF-1 with 76% oleic acid, is the first Indian high oleic variety identified as a speciality type variety for All India release. ISF-1 has oil content of 30.5% and recorded 12.4 q/ha seed yield under rainfed conditions; 18.6 q/ha under irrigated conditions and 16.3 q/ha at all India level.
- ISF-112-15 (spiny variety) and ISF-1258-15 (non-spiny variety) were promoted to AVT-I and AVT-II of AICRP (Safflower), respectively.
- SPP-70 and ISF-763 (non-spiny varieties) were developed, which gave 19 and 15% higher seed yield (13.67 q/ha; 13.66 q/ha) than the non-spiny check, NARI-6 (11.26 q/ha; 11.94 q/ha) at the national level.
- Twelve high oil inbred lines (35-40% oil content) gave 23.9-34.4 q/ha seed yield and 8.9-12.6 q/ha oil yield. Four high oil inbred lines (35-39% oil content) namely, ICI-2562-16-8, ICI-2711-16-7, ICI-2670-16-12 and ICI-2407-16-36 recorded 9-33% higher seed yield (28.2-34.4 kg/ha) and 14-32% higher oil yield (10.9-12.6 q/ha) than the best check, A-1.
- Registered SFS-9943 (INGR19023), a high oil inbred line, with PGRC, ICAR; it exhibited 35-39% oil content at 11 locations.

Sesame

- Multiparent F_1 hybrids involving eight parents were developed to incorporate favorable alleles from improved varieties and germplasm accessions.
- Four white seeded pure lines *viz.*, IC-202-1, IOS-1001, EC-33474 and CT-46 were found promising for yield (900-1235 kg/ha) and oil content (42-48%) compared to the check, TKG-22 (yield: 800 kg/ha; oil content: 40%).
- Outcrossing due to honey bees ranged from 20-38% across seven genotypes (5 varieties and 2 germplasm accessions) tested.

Hybrid Development

Castor

- ICH-66, a new castor hybrid was identified for cultivation in rainfed castor growing regions of peninsular India. It is a high yielding hybrid (1560 kg/ha) with 15-18% higher seed yield over the checks, DCH-177 (1363 kg/ha) and DCH-519 (1324 kg/ha), pooled over 20 centres under rainfed conditions. It is resistant to wilt and leafhopper with oil content of 48.6%.
- A set of 118 hybrids were evaluated in preliminary yield trials. Of these, 11 hybrids (ICH-880, ICH-901, ICH-904, ICH-909, ICH-884, ICH-887, ICH-888, ICH-941, ICH-741, ICH-725, ICH-739) were found promising for high seed yield.
- A set of 235 new experimental hybrids were made involving several promising pistillate and male lines.

Sunflower

- Hybrid entry IIOSH-15-10, which showed 7.8% and 26.2% seed yield and 10.7% and 13.4% oil yield superiority over the check hybrids, KBSH-44 and DRSH-1, respectively was promoted from AHT-I to AHT-II in AICRP trial.
- Hybrid entry IIOSH-15-20, which showed 10.3% and 24.8% seed yield and 23.9% and 22.5% oil yield superiority over the check hybrids, KBSH-44 and DRSH-1, respectively and high level of resistance to downy mildew was promoted from IHT to AHT-I.
- Six experimental hybrids *viz.*, IOSH-460, IOSH-434, IOSH-463, IOSH-475, IOSH-566 and IOSH-572 were found to be promising for seed yield and oil content in preliminary yield trial.
- A total of 600 new experimental hybrids were synthesized.

Safflower

- CMS-based hybrid, DSH-185 has been notified [Notification No. 1379 (E)] by Department of Agriculture and Cooperation, Ministry of Agriculture & Farmers' Welfare, Government of India. This is the first public sector CMS based safflower hybrid to be released in India.
- Three hybrids *viz.*, ISH-400, ISH-401 and ISH-402 were promoted from IHT to AVHT-I of AICRP (Safflower).
- Seven CMS-based safflower hybrids recorded 10-24% higher seed yield (45.4-45.9 q/ha) than the recently notified hybrid, DSH-185, and 20-34% higher seed yield than the best high yielding check variety, A-1.

Molecular Breeding and Biotechnology

Castor

- Resistance to Fusarium wilt in castor germplasm lines RG-1354 and RG-2874 was found to be conferred by non-allelic genes, which can be pyramided into a single genetic background for achieving durable resistance.
- SNP markers linked to Fusarium wilt resistance in germplasm lines RG-27 (Rc_30146-1221543 and Rc_29706-482910) and RG-2944 (Rc_30152-1185440, Rc_30152-1283827, Rc_29852-1074057 and Rc_30061_63432) were identified.
- Four putative genomic regions linked to reniform nematode resistance in JC-12 were detected in a preliminary QTL mapping study.

Sunflower

- Phenotyping and genotyping of back cross progenies of crosses involving ARM 243A/CMS 234A with *Helianthus praecox* (PRA 1823) with 59 polymorphic sunflower SSR primers showed close association of ORS 801 primer (260 bp) with powdery mildew resistance.

Safflower

- Allelic information of a set of 215 SSR loci was determined in the association mapping panel and identified significant marker-trait associations ($P < 0.05$) explaining more than 10% phenotypic variance (R^2) for seed oil content, kernel oil content, hull content, seed size and 100-seed weight.
- A set of 280 RILs of the cross: CO-1 x EC-523368-2 were phenotyped for reaction to aphid for detection of QTLs.
- A set of six safflower selections developed by marker-assisted backcrossing (MABC) of high oleic allele, 'ol' were evaluated for seed yield, oil content and fatty acid composition. Seed yield of backcross selections was comparable with the standard check varieties. The oil content ranged between 32.8% and 35.5% and the oleic acid content ranged between 72.1% and 84.7%. The selection, BC_2F_6-38-9-4 showed highest oil yield (11 g/plant) and oleic acid content (84.7%).

Sesame

- Sesame genomic resource was augmented with an additional set of 74 polymorphic SSR markers which amplified a total of 95 alleles among 20 sesame genotypes, with an average of 3.51 alleles per marker locus and the PIC values ranged from 0.34 to 0.52.

Seed Production

- A total of 416 q of quality seed of parental lines, varieties and hybrids of castor, sunflower, sesame and safflower was produced under Seed Production of Agricultural Crops (SPAC) and Oilseeds Seed Hub programmes both on station and through participatory approaches.
- Mobile Apps on seed production technologies in castor, safflower and sesame were developed for the benefit of seed producer organizations, researchers, industry and farmers.

DUS Testing

- DUS testing of one new candidate and one farmers' variety of castor was undertaken along with two reference varieties for each candidate under the Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority.

Crop Production

Conservation Agriculture

- Different tillage practices *viz.,* conventional tillage, reduced tillage and zero tillage did not show significant influence on growth, yield attributes and seed yield of castor under rainfed conditions. Seed yield of castor was significantly influenced due to different intercropping systems under the background of conservation agricultural practices. Sole castor recorded significantly higher castor seed yield (1064 kg/ha) followed by castor + groundnut (813 kg/ha); castor+green gram and castor+red gram (635 kg/ha) intercropping systems.

Cropping System Research

- The system productivity (in terms of safflower equivalent yield) was the highest with soybean-safflower (1500 kg/ha) and the lowest with green gram-safflower (850 kg/ha). Significant differences were not observed in system productivity of normal duration soybean (JS 335)-safflower (1450 kg/ha) and short duration soybean (JS 93-05)-safflower (1550 kg/ha).

Resource Use Efficiency

- In maize (*kharif*) – castor (*rabi*) cropping system, highest seed yield of *kharif* maize (6165 kg/ha) was recorded with integrated organic manures (goat + poultry + FYM) to supply 30 kg N/ha for each crop that was at par with use of 150% RDF to both crops in the system and NPK + crop residue use. The performance of *rabi* castor in terms of growth and yield was similar to that of maize for different nutrient management practices.
- *Kharif* green gram followed by zero till castor with green gram residues as surface mulch resulted in better moisture conservation, soil cover, higher yield of both crops and system productivity, profitability (net returns Rs.1,33,000/ha) and reduced cost of cultivation. Groundnut, maize and sunflower performed better after groundnut while sesame, safflower and castor performed better after maize.
- Nano citrates and oxides/ sulphides stabilized with citrates were standardized for both Fe and Zn using solid state grinding followed by ball milling using planetary ball mill for different durations and evaluated in groundnut and soybean by using white sand technique.

Abiotic Stress Tolerance

- Castor germplasm accessions, RG-2048, RG-2127, RG-2147, RG-2169, RG-2850, RG-1628 and variety 48-1 had <30% reduction in seed yield and <1.0 drought susceptibility index (DSI) under drought stress imposed from 60 days after planting to till harvest. The accessions, RG-2048, RG-1628 and variety 48-1 performed better with less reduction in seed yield and low DSI under imposed drought stress for two consecutive years.
- Among 59 castor parental lines screened for drought tolerance under field conditions, 16 parental lines with 31-51 g/plant seed yield, <51% reduction in seed yield under moisture stress and with <1.0 DSI were found promising.
- Three sunflower genotypes *viz.,* CSFH-12205, CO-2 and KBSH-44 were found to be salt tolerant at two locations (Gangavathi and Machilipatnam).
- A set of 82 selected lines of sesame core set was screened for drought tolerance traits and the genotypes IC-96240, IC-20445, IC-132176, IC-204622, IC-132171, JCSDT-112, JCSDT-116, IC-205368 showed high seed yield and capsule number under stress and irrigated conditions. Oil content varied from 38 to 52% among these accessions.
- Three sesame genotypes *viz.,* JCSDT-26, IC-204090 and IC-204622 were identified with potential root traits for location specific variety development.

Best Management Practices

- Performance of new castor hybrids under Best Management Practices indicated that cultivation of ICH-66 castor hybrid resulted in highest gross returns (Rs. 93,518/ha); net returns (Rs. 48,936/ha) and profitability (B:C ratio 3.11) followed by ICH-538, DCH-519 and DCH-177.

Quality and Value Addition

- Developed a FT-NIR protocol for measuring the oil content of safflower seed kernels.
- Protein hydrolysates from safflower seed cake were prepared and characterized.

Crop Protection

Host Plant Resistance

Screening Methods

- A thrips damage rating scale (visual estimation scale) was developed for the first time in castor to screen for host plant resistance.
- Symptom mapping due to leafhoppers and a suitable susceptible check (NDCMS-2A/2B) have been identified to measure the resistance reaction of sunflower genotypes against leafhopper.
- A methodology (adjusting sowing time during July II FN + planting one infester row of Prachi after 2 rows of test entries) for mass screening of sesame genotypes for resistance to leaf webber and capsule borer under field conditions was developed.

Sources of Resistance

- Nineteen castor parental lines *viz.,* DPC-15, M-571, M-574, RG-589, P3-207, 1445-1, 1450-1, 1509-2, 1510-1, 1511-1, 1540-3, 1566-2, 1880-1, 1924-1, 1889-1, JI-226, JI-315, 2015-1 and JI-340 showed highly resistant reaction to wilt (<10% wilt incidence) under wilt sick plot.
- Five castor inbred lines (RG-2800-2, RG-2800-4, RG-2774-1, RG-2774-2 and RG-898-6) were found resistant to wilt with <20% wilt incidence as compared to 98.9% wilt incidence in susceptible check, JI-35.
- Forty-seven experimental hybrids of castor showed highly resistant reaction to wilt (<10% wilt incidence) under sick plot.
- Seven castor germplasm accessions *viz.,* RG-1922, RG-2661-7-3-5-6, RG-2787-181-12, RG-2787-89-20, RG-2746-1, RG-2976 and RG-3795 recorded <20% wilt incidence and were confirmed resistant reaction to wilt by sick pot method.
- Wilt reaction of castor genotypes to isolates of *F. oxysporum* f.sp. *ricini* revealed that the genotypes DCS-107 and GC-3 showed resistant reaction to isolates from Hyderabad, SK Nagar and susceptible reaction to Palem isolate, while AP-163 showed susceptible reaction to isolate from Hyderabad and resistant reaction to Palem and SK Nagar isolates.
- Two castor germplasm lines *viz.,* RG-907 and RG-1963 with moderate resistance to graymold were identified.
- Five castor parental lines *viz.,* MCI-8, JI-226, JI-227, JI-338 and JI-340 were found resistant to leafhopper.
- Four castor lines (MCI-8, IPC-34, IPC-35 and P_3-116) were found promising against thrips.
- Two sunflower breeding lines *viz.,* TSG-403 and TSG-391 were found resistant to leafhoppers with an injury grade of 1.0.
- Four safflower breeding lines *viz.,* ISF-2471-17, ISF-2413-17, ISF-2258 and ISF 2342 and three germplasm lines GMU-821, GMU-824 and GMU-3740 were found resistant to wilt.
- Safflower variety Girna was found resistant to aphid with an aphid infestation index of 2.0 (on 1.0-5.0 scale).
- Among 29 sesame genotypes screened against root rot by sick pot method, two genotypes S-0448 and IS-24-A recorded <20% root rot while the check variety VRI-1 recorded 62.4% disease incidence.

Mechanism of Resistance

- Choice tests revealed that the castor line, ICS-295 showed antixenosis (non-preference) mechanism of resistance for oviposition to *Achaea janata* and *Spodoptera litura*. Antibiosis mechanism of resistance was observed when the larvae of *A. janata* and *S. litura* were reared on leaves of ICS-295 with significantly prolonged larval and pupal duration.

Chemical Management

- One spray of 0.1% propiconazole or 0.1% pyraclostrobin+fluxapyroxad was found very effective with >85% reduction in graymold severity in castor.

Bio-agents

- Entomopathogenic nematodes (EPNs), *Heterorhabditis indica* and *H. bacteriophora* @ 200 infective juveniles per larva were found effective against late instar larvae of major insect pests of castor *viz., Spodoptera litura* (tobacco caterpillar), *Conogethes punctiferalis* (capsule borer) and *Liriomyza trifolii* (leaf miner) under laboratory bioassays.
- Isolates of *Bacillus thuringiensis* (DOR Bt-197) and *Nomuraea rileyi* promising against the fall armyworm, *Spodoptera frugiperda* were identified.

Bio-polymers for Seed Health

- *Trichoderma* was entrapped in pre-polymers and polymeric films were developed and evaluated under pathogenic conditions. Both the polymers (p-1 and p-2) and in combination with *T. harzianum* (Th4d) resulted in reduction of Macrophomina root rot, *Aspergillus,* Fusarium disease incidence in soybean, safflower, groundnut and castor by 30-100% and 50-80% under *in vitro* and *in vivo* conditions, respectively.
- Coating of castor seed with the biopolymer chitosan + *T. harzianum* Th4d formulation resulted in low Fusarium wilt incidence (40%), increased germination (96.6%) and vigour index (3139) as compared to pathogen check (80% disease incidence, 73.3% germination and vigour index of 1690).
- Safflower seed priming with the biopolymer chitosan + *T. harzianum* Th4d formulation resulted in reduction of Macrophomina root rot incidence by 53.4% and increased germination of 100% over 60% disease incidence and 70% germination in pathogen check.

Social Sciences

Impact Assessment of Oilseed Technologies

- The study on impact assessment of GCH-7 in Gujarat revealed that the hybrid covered 2,55,850 ha for Quinquennium Ending (QE) 2016 over 2010 providing yield advantage of 4.13 q/ha and average additional net returns of Rs. 15,624/ha and additional production of 10.56 lakh tonnes.
- The average TFP of castor in Gujarat for the period 2010-2017 was 2.11 *vis-à-vis* 1.63 over period 2000-2009. The higher TFP with output indices greater than the input indices for the period 2010-2017 is a testimony of the impact of technology (GCH-7) in Gujarat.
- Kinked exponential growth rates also revealed increase of 8.61 and 10.40% in area and production of castor in Gujarat.
- Markov chain analysis employed to study the performance of castor *vis-à-vis* competing crops (rice, wheat, bajra, maize, cotton, arhar, gram and groundnut) for the period 1996-97 to 2017-18 revealed the retention of castor area in the major castor growing districts in Gujarat to the extent of 89.7% clearly indicating the supremacy of castor hybrid technology.

Development of Prediction Models

- Analysis of the long term time series of weather parameters *viz.,* Maximum temperature, Minimum temperature and rainfall (1950-51 to 2017-18) for developing models to predict yield responses to climate change in oilseed crops revealed significantly decreasing trend with respect to annual and seasonal monsoon rainfall besides a significant warming trend. In castor crop, the analysis revealed that despite variations in area and production, an increasing trend in yield was evidenced from 1950 to 2017.
- A castor graymold prediction model has been developed and integrated with decision support system (DSS) that enables sending SMS alerts to farmers.

Knowledge Management

- The castor knowledge management portal was exclusively developed with five major domains and sub-domains under the respective main domains to access information on germplasm resources, seed production, breeding research, production technologies, pests and diseases, success stories, FAQs, market prices of major APMCs, varieties and hybrids suited for different states, government schemes available for farmers, farm innovations, statistics on area, production and productivity.

Demonstrations of Oilseed Technologies

- Frontline demonstrations on nine oilseed crops and oilseed based farming systems were conducted over an area of 7522 acres and 39 training programmes were conducted.
- IIOR has conducted FLDs with improved technologies over an area of 418 acres. The improved cultivars of castor (DCH-519), sunflower (DRSH-1) and sesame (GT-10, YLM-66 and Shwetha Til) were demonstrated, apart from agronomic interventions such as optimum seed rate, spacing, foliar application of Boron, nutrient management and need based plant protection.
- Three field days, three exhibitions and 32 training programmes were organized to demonstrate the productivity potential of improved technologies and create awareness among staff of Department of Agriculture, farmers, scientists of KVK and other stakeholders.
- Under the Farmers FIRST Programme, skill development in soil sampling was imparted to 138 households in two villages. Soil health cards (149) were prepared for major crops (12 major, micro and secondary nutrients) and distributed to the farmers in three villages. Complete technology assemblage of castor, paddy, sorghum, red gram, green gram, chilli, bhendi and tomato was demonstrated to the farmers. Rajasri birds as backyard poultry with complete technology support led to average consumption of eggs per household per week as 3-4 times and monthly imputed value of eggs @ Rs. 6/- was Rs. 300-420/-.
- Facilitated in creation of the FPO "Vikarabad Farmer Producer Organization" by NABARD through the support of NGO (SWEET) with 498 enrolled members and 218 share capital members.

ICAR-IIOR

Annual Report
2018-19

The Institute

- Mandate
- Staff Position
- Financial Statement

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.

Vision

Enhanced production of sunflower, safflower, castor and sesame through knowledge based interventions.

Mission

Contributing to the sustained growth of oilseeds production by harnessing frontier scientific tools and through generation, refinement, validation and dissemination of improved technologies in sunflower, safflower and castor.

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, 2019

Category	Sanctioned	Filled	Vacant
Scientific	43*	37	6
Technical	49	33	16
Administrative	29	22	7
Skilled supporting	25	17	8
Total	**146**	**109**	**37**

*including one RMP

Financial Statement

Allocation and Expenditure

Head of Account	Allocation (Rs. in lakhs)			Expenditure (Rs. in lakhs)		
	IIOR Unified Budget	AICRPO (OS + S&N + LIN)	TOTAL	IIOR Unified Budget	AICRPO (OS + S&N + LIN)	TOTAL
A. GRANT IN AID - CAPITAL						
Works	24.65		24.65	24.65		24.65
Equipment	23.25	5.75	29.00	23.23	5.75	28.98
Information & Technology	3.65		3.65	3.65		3.65
Library	9.54		9.54	9.54		9.54
Vehicle & Vessels	0.00		0.00	0.00		0.00
Furniture	20.91		20.91	20.91		20.91
SC-SP	25.00		25.00	24.92		24.92
B. GRANT IN AID – SALARIES						
Establishment Charges	2055.32	2449.00	4504.32	2022.55	2449.00	4471.55
Wages	491.00		491.00	459.06		459.06
Overtime Allowance	0		0.00	0		0.00
Pension	772.69		772.69	764.35		764.35
C. GRANT IN AID – GENERAL						
TA	24.95	61.23	86.18	24.95	61.23	86.18
Res. & Operational Expenses	266.86	235.77	502.63	266.85	235.77	502.62
Administrative Expenses	193.14		193.14	193.14		193.14
Miscellaneous Expenses	5.05		5.05	5.05		5.05
Need Based Research						
N.E.H.	54.00	312.85	366.85	54.00	71.25	125.25
TRIBAL SUB-PLAN	30.00	57.00	87.00	30.00	50.45	30.00
SC - SP	80.00	0.00	80.00	80.00	0.00	80.00
Total	**4080.01**	**3121.60**	**7201.61**	**4006.85**	**2873.45**	**6829.85**

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

Head of Account	AICRP (Sunflower, Safflower & Castor)		AICRP (Sesame & Niger)		AICRP (Linseed)	
	Allocation (in lakhs)	Expenditure (in lakhs)	Allocation (in lakhs)	Expenditure (in lakhs)	Allocation (in lakhs)	Expenditure (in lakhs)
Grants for Capital	0.00	0.00	0.00	0.00	5.75	5.75
Grants for Salaries	1344.00	1344.00	535.00	535.00	570.00	570.00
Grants for General	140.00	140.00	77.00	77.00	80.00	80.00
TSP	37.00	37.00	10.00	10.00	10.00	3.45
NEH (Salaries)					62.85	62.85
NEH (General)					250.00	8.40
Total	**1521.00**	**1521.00**	**622.00**	**622.00**	**978.60**	**730.45**

Resource Generation

Particulars	Amount (in lakhs)
Sale of Farm Produce	2.08
Sale of Old Vehicles & Machine Tools	1.31
Sale of IIOR Publications & Tender forms etc.	0.26
Rent	7.53
License Fee	0.31
Interest earned on Loans & Advances	1.51
Leave Salary & Pension Contribution	9.08
Analytical testing charges	3.22
Interest earned on STDR	69.41
Receipts from service rendered/Sale of Tech.	0.25
Unspent balance of grants	0.00
Training	0.49
Miscellaneous receipts	9.18
Total	**104.63**

Funds Received for Externally Sponsored Projects

Particulars	Fund	
	Receipt	Expenditure
DBT Projects	17.00	1.43
DST Projects*	17.10	17.86
International Collaboration	29.84	8.35
Deposit Schemes	3535.74	3046.60
Total	**3599.68**	**3074.24**

*Under DST Projects (for 2 out of 3 Projects) previous year unspent balances have been utilized for expenditure.

ICAR-IIOR

Annual Report
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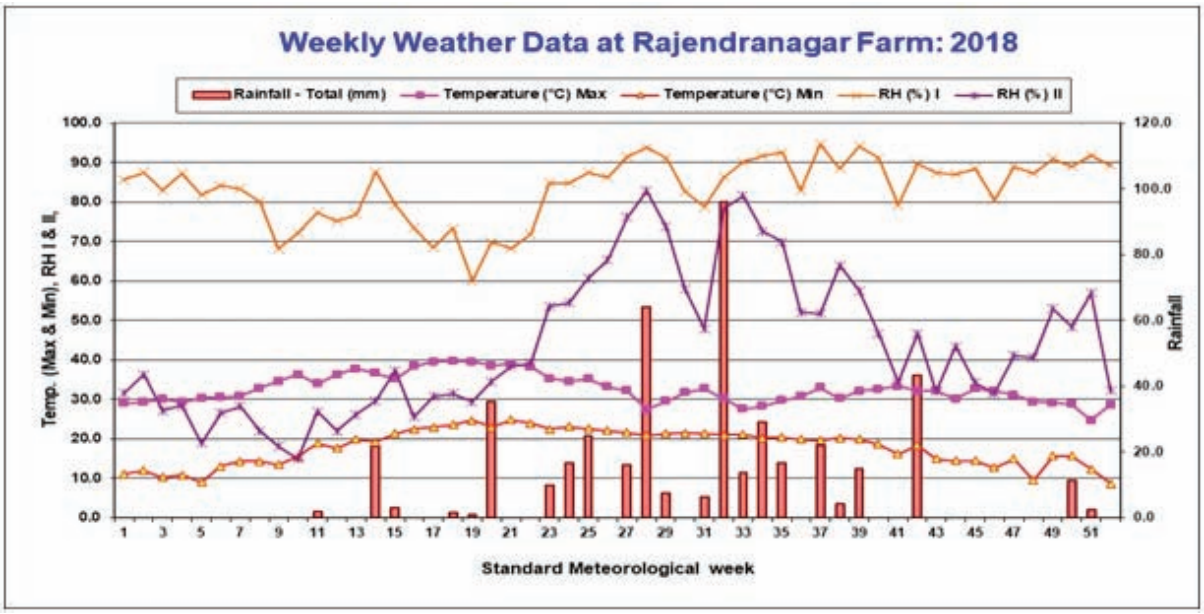
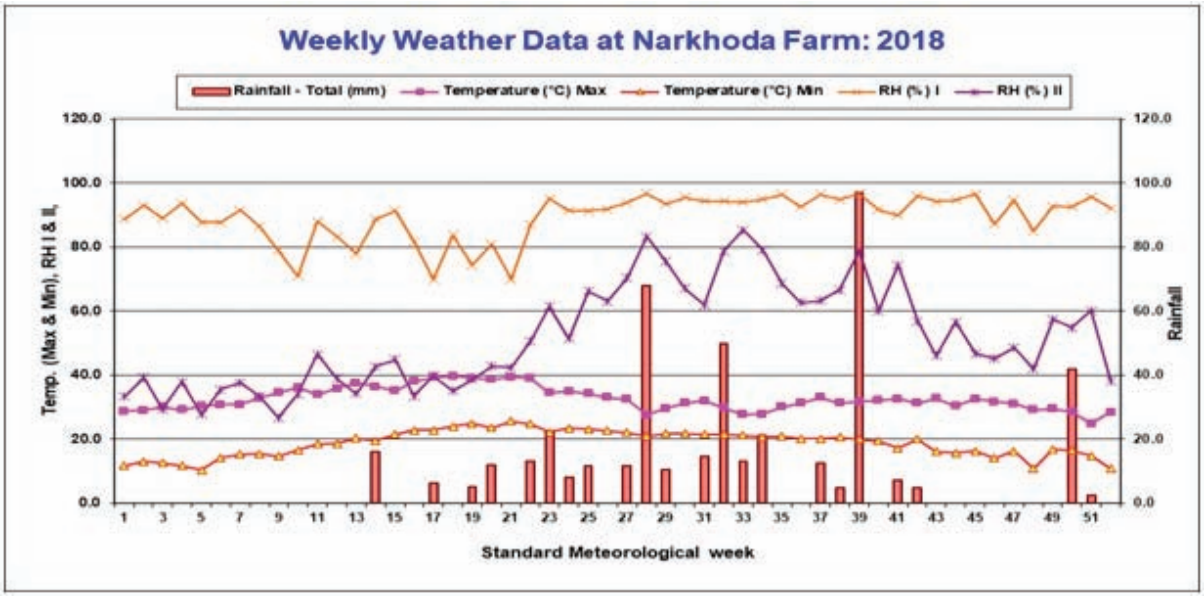
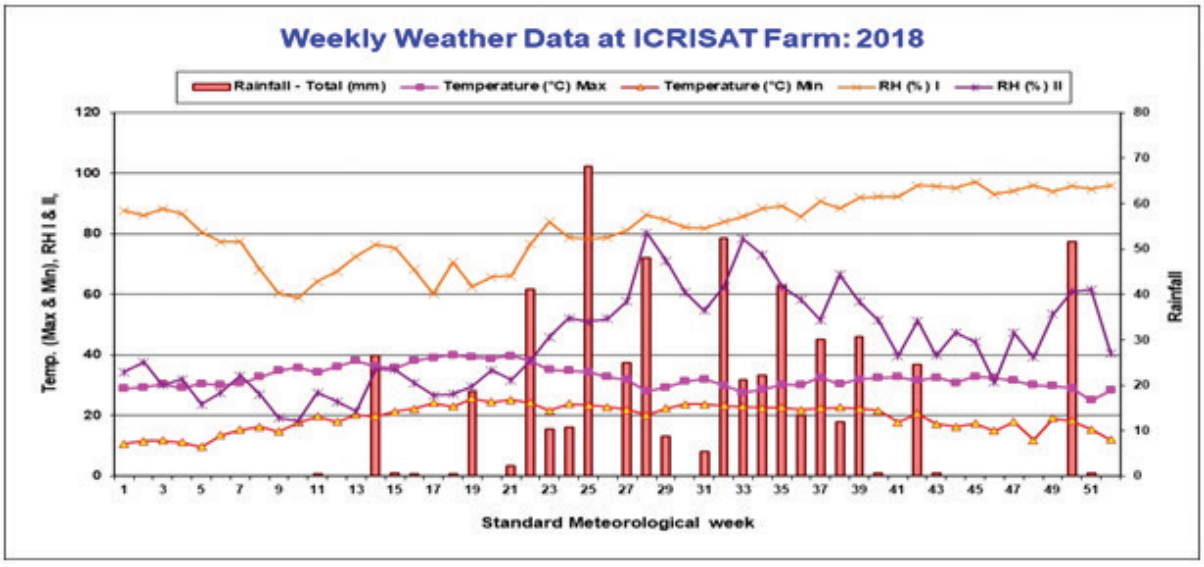
Research Achievements

- Crop Improvement
- Crop Production
- Crop Protection
- Social Sciences
- AICRP on Oilseeds


Weekly Weather Data at Rajendranagar Farm: 2018
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at Narkhoda Farm: 2018
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at ICRISAT Farm: 2018
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week

Crop Improvement

Germplasm

Maintenance, Evaluation and Enhancement

IIOR has the mandate of maintaining, characterizing, cataloguing, and distributing the germplasm accessions/ lines of the oil seed crops namely castor, sunflower, safflower sesame and niger, for crop improvement efforts. The primary gene pool is the main source of specific traits that are to be incorporated into elite lines through breeding activities. Under germplasm evaluation, main emphasis has been given to the identification of trait specific germplasm lines in the mandate crops. Being predominantly rainfed crops, there is a felt need to incorporate moisture stress tolerance in the improved varieties/hybrids and therefore, germplasm screening for this trait has been an important activity across the mandate crops. Similarly, efforts have been made to identify the germplasm lines that can contribute for yield enhancing traits as well as high oil content. Apart from these, germplasm sources have been identified for specific traits in different crops. In castor, the traits of importance for plant breeding are earliness, resistance to diseases such as wilt, root rot and graymold, tolerance to insect pests such as leafhopper, tobacco hairy caterpillar, capsule borer and leaf miner; in sunflower, the traits of significance are resistance to powdery mildew, leaf spot and necrosis diseases, and tolerance to leafhopper; in safflower, germplasm screening is basically carried out for aphid tolerance and wilt and leaf spot resistance; and in sesame, the emphasis has been to identify germplasm lines that are resistant to phyllody, root rot and *Antigastra*. Once the germplasm lines for specific traits of interest are identified and confirmed, they are multiplied, evaluated at different locations and seasons and then shared with the breeders of the institute as well as AICRP centers. The well characterized germplasm lines are registered with Plant Germplasm Registration Committee, ICAR for their wider utility and protection. The institute also owns the responsibility of rejuvenating the working germplasm periodically and depositing the material with NBPGR for long term storage. DUS testing has been carried out for the candidate varieties received from PPV&FRA as per the stipulated guidelines. The activities carried out by germplasm units are summarized here.

Castor

Germplasm conservation

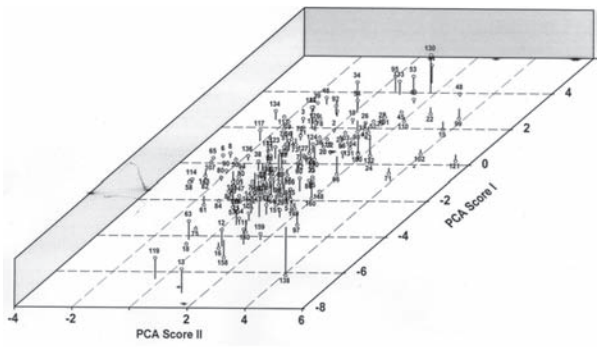
Deposited seeds of 532 accessions for medium-term conservation in the gene bank of ICAR-IIOR, Hyderabad.

Germplasm supply

Supplied seeds of 1461 accessions and 62 trait-specific inbred lines to different centres for various activities under AICRP (Castor). In addition, best 20 accessions were supplied to two new centres of AICRP (Castor) *viz.,* Ananthapuramu and Bengaluru and nine trait-specific inbred lines were supplied to castor breeders at ICAR-IIOR, Hyderabad.

Evaluation and seed multiplication of trait-specific accessions

A total of 201 accessions including 186 trait specific accessions were multiplied and evaluated for phenological traits and seed yielding ability under rainfed conditions at ICAR-IIOR, Hyderabad. Wide diversity among the 186 trait-specific germplasm accessions was revealed by principal component analysis.



Principal component analysis showing wide diversity among 186 promising accessions

Out of the 186 promising accessions, 15 accessions were found promising for high seed yield under rainfed conditions at ICAR-IIOR, Hyderabad with 12-91% increase in seed yield over the check.

Number of promising castor accessions multiplied

Specific trait	No. of accessions*	Specific trait	No. of accessions*
Wilt resistance	22 (3)	High ricinoleic acid	26 (1)
Root rot resistance	11 (2)	High ricinoleic acid and extra early	1
Botrytis tolerance	1	Drought tolerance	23 (1)
Wilt-root rot resistance	4 (3)	Salinity tolerance	2
Resistance to wilt and root rot, moderate resistance to graymold	1 (1)	Early maturity	1 (1)
Leafhopper resistance	14 (2)	Extra-early	1 (1)
Wilt and leafhopper resistance	1 (1)	Long primary spike	1
Leafminer resistance	5 (2)	High seed yield	7
Thrips resistance	5	High seed weight	2
Leafhopper and thrips resistance	1	Prolonged longevity	23
Whitefly resistance	2	Wilt differentials (putative)	6

*Figures in parenthesis indicate number of registered accessions

Seed yield of trait-specific castor accessions under rainfed conditions

Accession	Specific-trait	NN	DF	100-seed weight (g)	Seed yield		
					kg/plot	q/ha	Increase over check (%)
RG-311	Wilt resistance	14	44	31.9	1.7	38	91
RG-1624	Wilt resistance	20	54	37.4	1.2	26	30
RG-155	Wilt resistance	13	43	31.6	1.3	28	42
RG-1922	Wilt resistance	14	48	37.0	1.1	25	25
RG-3477	Leafhopper resistance	17	54	38.7	1.2	26	32
RG-3489	Leafhopper resistance	15	49	32.8	1.0	23	14
RG-3503	Thrips resistance	15	49	36.4	1.2	27	34
RG-89	Drought tolerance	11	42	30.6	1.1	24	20
RG-289	Drought tolerance	13	42	24.1	1.3	27	38
RG-2481	Drought tolerance	15	44	33.4	1.0	22	12
RG-29	Prolonged longevity	14	56	34.1	1.3	28	40
RG-1594	Prolonged longevity	10	40	30.9	1.6	34	71
RG-1663	Prolonged longevity	16	55	35.3	1.0	22	12
RG-3445	High yield	17	55	22.9	1.1	24	24
RG-3432	Wilt differential	17	55	30.8	1.1	24	20
DCS-9	Check	12	42	26.2	0.1	20	-

Plot size: 9 sq.m; NN: number of main stem nodes; DF: days to 50% flowering

Development of trait-specific inbred lines

Extra-early inbred lines: A set of 21 extra-early and six early inbred lines were developed, which flowered in 32-38 days and matured in 84-89 days while the early check, DCS-9 took 44 days for flowering and 105 days to reach maturity. Nine extra-early and four early inbred lines recorded 4.0-19.5 q/ha and 5.2-14.7 q/ha seed yield, respectively at first picking (90 days after sowing, DAS) while no yield could be realized from the checks, DCS-9 and GC-3 at 90 DAS in multi-location evaluation trial under rainfed and irrigated conditions. Three extra-early inbred lines, ICIRG-26-1-3-2-5, ICIRG-22-7-2-10-3 and ICIRG-22-7-2-10-7 gave 24.2-28.0 q/ha seed yield at 120 DAS and seven extra-early and early inbred lines recorded 19.3-22.3 q/ha seed yield at 120 DAS while the early duration check, DCS-9 and high yielding check, GC-3 recorded 15.6 and 16.5 q/ha at 120 DAS, respectively.

In addition, 11 inbred lines derived from extra-early gene pool flowered in 34-38 days and reached maturity in 84-89 days. Eight inbred lines *viz.*, EE-GP-SEL-28-8, EE-GP-SEL-28-14, EE-GP-SEL-72-7, EE-GP-SEL-72-4, EE-GP-SEL-74-15, EE-GP-SEL-73 -14, EE-GP-SEL-63-15 and EE-GP-SEL-73-2 gave 18-68% higher total seed yield (24.4-34.7 q/ha) than the early check, DCS-9 (20.7 q/ha) under rainfed conditions at 180 DAS.

High ricinoleic type inbred lines: High ricinoleic acid content of six inbred lines has been confirmed in multi-location evaluation trial conducted under rainfed and irrigated conditions. Ricinoleic acid content was 90-92% in the inbred lines while it was 88% in the check, DCS-9. Three inbred lines *viz.*, ICIRG-66-825-1, ICIRG-66-825-7 and ICIRG-226-29-2-2 recorded 7-21% higher seed yield (31-35 q/ha) than the check, DCS-9 (29 q/ha)

Phenological traits, oil content and yield potential of extra-early and early inbred lines of castor in multi-location trial

Inbred line	NN	DF	DM	Oil (%)	Seed yield (kg/plot*)		Seed yield (q/ha)		
					90 DAS	120 DAS	90 DAS	120 DAS	Total
Extra-early									
ICIRG-22-7-2-10-3	9	34	86	45	2.6	1.1	18.3	7.3	25.6
ICIRG-22-7-2-10-7	8	33	85	46	2.8	1.2	19.5	8.5	28.0
ICIRG-15-5	7	34	84	43	0.8	0.5	5.4	3.5	8.9
ICIRG-15-3	7	34	84	43	0.6	0.9	4.0	6.2	10.2
ICIRG-26-1-2-3-14	8	34	86	46	2.0	1.0	13.9	6.7	20.6
ICIRG-26-1-3-2-5	8	34	88	46	2.0	1.5	13.6	10.5	24.2
ICIRG-26-1-4-5-7	7	32	87	46	1.3	1.8	8.9	12.3	21.2
ICIRG-26-1-4-5-8	7	33	87	47	1.6	1.5	11.2	10.2	21.4
ICIRG-17-2-7-15-6	8	32	85	45	2.4	0.8	16.7	5.6	22.3
Early									
ICIRG-187-3-2-3-5	10	37	89	47	1.8	1.0	12.2	7.1	19.3
ICIRG-187-6-2-1-3	10	38	89	46	2.1	1.0	14.7	6.7	21.4
ICIRG-190-2-1-9-14	9	37	86	46	1.5	1.4	10.3	9.6	19.9
ICIRG-1591-1	9	35	89	45	0.8	0.5	5.2	3.5	8.8
DCS-9 (Early Check)	12	44	105	45	0.0	2.2	0	15.6	15.6
GC-3 (Check)	16	47	109	45	0.0	2.4	0	16.5	16.5

*Plot size: 10.8 sq.m (rainfed); 14.4 sq.m (irrigated); NN: number of main stem nodes; DF: days to 50% flowering; DM: days to maturity; DAS: days after sowing

Phenological traits, oil content and yield potential of high ricinoleic type inbred lines of castor in multi-location trial

Inbred line	NN	DF	DM	Oil content (%)	Ricinoleic acid (%)	Seed yield (kg/plot)*	Seed yield (q/ha)
ICIRG-66-2511-3	17	52	119	45	91	2.62	25
ICIRG-66-825-1	16	52	115	45	92	3.41	31
ICIRG-66-825-7	17	51	119	45	91	3.54	31
ICIRG-226-29-6-2	14	48	115	46	91	2.80	29
ICIRG-226-29-7-2	12	44	114	45	90	2.83	28
ICIRG-226-29-2-2	12	44	114	46	91	3.32	35
DCS-9 (Check)	13	45	114	46	88	3.14	29

*Plot size: 10.8 sq.m (rainfed); 14.4 sq.m (irrigated); NN: number of main stem nodes; DF: days to 50% flowering; DM: days to maturity

Wilt resistant inbred lines: One wilt resistant inbred line, ICIRG-3425-5 was confirmed for its resistance to wilt in wilt sick plots at ICAR-IIOR (Hyderabad), PJTSAU (Palem) and SDAU (SK Nagar). It recorded 115% higher seed yield (2103 kg/ha) than the check, DCS-9 (978 kg/ha) under rainfed conditions at ICAR-IIOR, Hyderabad. One inbred line, ICIRG-2746-1 exhibited resistance to wilt (11.1% incidence) by sick pot method under glasshouse conditions at ICAR-IIOR, Hyderabad.

(a) Reaction of ICIRG-2746-1 to wilt; (b) Reaction of susceptible check (DCS-9)

Root rot resistant inbred line: One inbred line, ICIRG-2719-10, was confirmed for resistance to root rot (19.44% incidence) in glasshouse when screened using stem tape inoculation technique.

Wilt and root rot resistant inbred lines: One inbred line, ICIRG-2787-181-12 was confirmed for its resistance against Fusarium wilt (11-18% incidence) in wilt sick-pot culture in glasshouse at ICAR-IIOR, Hyderabad and SK Nagar; and was also confirmed for its resistance to Macrophomina root rot (6.67% incidence) when screened using stem-tape inoculation method in glasshouse.

Two wilt and root rot resistant inbred lines *viz.*, ICIRG-2787-152-9 and ICIRG-2787-192-12 were confirmed for their resistance to root rot (6.67 and 20% incidence) in glasshouse where the susceptible check had 89% root rot and the resistant check had 10% root rot; these inbred lines were confirmed for resistance to wilt (10-16% incidence) in wilt-sick pot in glasshouse at ICAR-IIOR, Hyderabad and SK Nagar and moderate resistance at Palem earlier. The wilt and root rot resistant inbred lines, ICIRG-2787-181-12 and ICIRG-2787-192-12 gave 22 and 16% higher seed yield (12.5 q/ha and 11.9 q/ha) than DCS-9 (10.2 q/ha) under rainfed conditions at ICAR-IIOR, Hyderabad.

Capsule borer and wilt resistant inbred lines: Five capsule borer tolerant inbred lines *viz.*, ICIRG-2800-2, ICIRG-2800-4, ICIRG-2774-1, ICIRG- 2774-2, and ICIRG-898-6 exhibited resistance to wilt (13.3-18.4%) in wilt sick plot.

Leafhopper resistant inbred lines: Three inbred lines *viz.*, ICIRG-2661-7-9-1-1, ICIRG-2661-7-5-1-7 and ICIRG-2661- 16-2-2 (0-2 hopperburn on 0-4 scale) were confirmed for resistance to leafhopper in the second consecutive year at four locations. In addition, five inbred lines *viz.*, ICIRG-3432-4, ICIRG-2661-17-6-1-9, ICIRG-2661-7-5-1-2, ICIRG -2661-7-5-2 and ICIRG-3600-14 were found highly resistant to leafhopper (0 hopper burn grade on 0-4 scale).

Eight leafhopper resistant inbred lines recorded 13-149% higher seed yield (1109-2434 kg/ha) than DCS-9 (978 kg/ha). The inbred lines, ICIRG-2661-7-3-5-6, ICIRG-2661-7-9-1-7 and ICIRG-631-8-sp gave 67, 87 and 149% higher seed yield (1636, 1830 and 2434 kg/ha) than DCS-9 (978 kg/ha).

Performance of leafhopper resistant inbred lines of castor under rainfed conditions

Entry Inbred line	NN	DF	100-seed weight (g)	Total yield (kg/plot*)	Total yield (q/ha$)
ICIRG-2661-7-3-5-6	14	49	34.6	1.5	16.4 (67)
ICIRG-2661-7-5-1-7	20	60	38.2	1.1	12.3 (26)
ICIRG-2661-7-5-1-8	18	42	38.4	1.0	11.01 (13)
ICIRG-2661-7-9-1-7	15	49	37.1	1.5	18.3 (87)
ICIRG-2661-17-6-1-9	14	49	35.1	1.6	17.4 (78)
ICIRG-631-8-sp	10	38	34.7	2.2	24.3 (149)
ICIRG-631-13-nsp	13	49	38.7	1.4	15.2 (55)
ICIRG-3060-14-sp	12	38	35.3	1.0	11.4 (17)
DCS-9 (Check)	9	49	30.8	0.9	9.8
SEm±	1	2	1.4	0.2	

*Plot size: 9 sq.m; NN: number of main stem nodes; DF: days to 50% flowering; $figures in parentheses indicate percent increase over check

Capsule borer tolerant inbred lines: Seventeen inbred lines *viz.,* ICIRG-2800-1 to ICIRG-2800-8, ICIRG-2774-1 to ICIRG-2774-3 and ICIRG-898-1 to ICIRG-898-6 were confirmed for their tolerance to capsule borer in the third consecutive year in different dates of sowing (17/7/2018, 7/8/2018 and 23/8/2018) under infester row technique. The damage in tolerant inbred lines ranged from 2.4-12.7% while it was 72.2-84.5% in susceptible checks at different dates of sowing. Sowing in August was found to be ideal for screening against capsule borer.

ICIRG-2800-2 *ICIRG-2774-1* *ICIRG-898-2* *DCS-9 (susceptible check)*

Capsule borer damage in resistant inbred lines of castor

Capsule borer damage at different dates of sowing in castor inbred lines

Inbred line	Capsule damage (%) at different dates of sowing		
	17/07/2018	07/08/2018	23/08/2018
ICIRG-2800-1	6.1	3.7	5.8
ICIRG-2800-2	3.2	6.1	5.6
ICIRG-2800-3	3.9	5.6	9.3
ICIRG-2800-4	5.7	8.2	8.2
ICIRG-2800-5	4.1	5.1	8.8
ICIRG-2800-6	4.7	4.7	6.4
ICIRG-2800-7	8.5	7.4	8.0
ICIRG-2800-8	4.5	8.1	7.0
ICIRG-2774-1	2.8	2.7	3.8
ICIRG-2774-2	5.8	2.4	7.8
ICIRG-2774-3	5.0	7.6	7.9
ICIRG-898-1	6.8	8.0	12.7
ICIRG-898-2	8.3	7.3	8.1
ICIRG-898-3	5.0	7.8	8.0
ICIRG-898-4	9.5	7.3	8.8
ICIRG-898-5	7.8	4.3	6.3
ICIRG-898-6	8.4	6.3	8.0
48-1 (R-check)	4.4	6.4	5.3
DCS-9 (S-check)	72.2	80.2	84.5

Stabilization of pistillate lines selected from castor germplasm

Eight pistillate lines sown in *kharif* 2018 stably expressed pistillate trait up to 5-6th order spikes; two of them namely, 10-p3-p2-p7-p8-p2-p2-p1-p1 and 18-p13-p2-p2-p1-p8-p4-p1-p3-p1, exhibited 'S' pistillate trait in all spikes with only a few 'ISF' production even when sown in early summer.

Sunflower

Genetic resources in the gene bank at IIOR

A total of 2851 accessions are being maintained in the gene bank including wild species. The availability of genetic resources in the gene bank at IIOR is summarized.

Genetic resources available in IIOR gene bank

Germplasm Accessions	Number
GMU	1200
Exotic collections (EC)	350
DRSI (Inbreds)	300
DRSF (Populations)	5
PS (Prebred sunflower)	154
CMS (A and B)	25
Restorers	72
Gene pool (GP) for high oil, yield and autogamy	350
Augmented germplasm from USA	395
Total	**2851**

A set of 700 accessions were multiplied and 67 accessions including genetic stocks were supplied to different researchers as per their demand. A total of 650 accessions were deposited in medium term storage and 101 accessions in the long term storage of NBPGR, New Delhi.

Augmentation, evaluation and multiplication of pre-bred lines

The international collaborative project proposal with the University of British Columbia (UBC), Canada was approved by ICAR in February, 2018. A consignment of 395 accessions including filler material, 337 pre-bred lines, 8 checks and other genotypes were received from USDA, USA. Following quarantine clearance, evaluation of 337 pre-bred lines was taken up of which one line, PI-686802 and two checks AMES-31946 and AMES-31976 failed to germinate. Wide variability was observed for morphological traits and 18 accessions with high seed yield and medium oil content were identified. Two accessions PI-686707 and PI-686758 were identified with 39% of oil content and with >35 g of seed yield/plant. Some of the accessions were late maturing (~80 days for 50% flowering).

Morphological variability in the pre-bred lines

PI-686662

PI-686691

Promising sunflower pre-bred lines identified with high seed yield and medium to high oil content

Accession	Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
PI-686756	80	120	72	7	5	30	38
PI-686758	69	114	117	16	8	38	39
PI-686767	75	106	107	9	6	35	36
PI-686778	65	109	105	15	6	34	34
PI-686783	80	123	109	19	5	31	39
PI-686818	80	121	121	14	6	39	36
PI-686827	81	116	119	18	6	44	36

Accession	Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
PI-686502	74	117	152	13	5	44	37
PI-686553	73	109	86	6	5	37	35
PI-686663	69	107	104	15	6	35	37
PI-686665	69	109	111	13	6	35	33
PI-686671	74	112	126	16	6	34	34
PI-686681	70	109	112	12	5	33	38
PI-686704	71	112	106	12	5	40	36
PI-686707	63	105	110	16	6	39	39
PI-686741	59	102	117	13	6	38	34
Ames 31950 (Check)	69	106	93	16	5	21	36
Ames 31956 (Check)	68	105	83	9	6	7	33
Ames 31960 (Check)	72	101	114	17	8	6	26
Ames 31962 (Check)	71	108	63	15	7	4	36
Ames 31968 (Check)	54	97	79	7	4	7	32
DRSF-113 (Check)	63	99	136	19	8	27	33
Range	53-83	84-113	42-165	4-19	2-9	2-44	25-39

Evaluation of germplasm accessions

Thirty Five promising germplasm accessions with high seed yield and oil content were evaluated for reconfirmation. Eight accessions were identified with more than 30 g of seed yield/plant coupled with medium oil content (>30%). Six accessions were identified with 37% oil content and the promising accessions are listed.

Promising sunflower accessions identified for high seed yield and oil content

Accession	Days to maturity	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
Accessions with high seed yield (>30 g/plant)						
GMU-101	90	130	13	6	39	31
GMU-125	94	88	11	3	35	34
GMU-169	87	134	18	4	33	36
GMU-251	98	121	8	6	32	34
GMU-272	83	128	13	6	36	35
GMU-396	93	87	8	7	39	35
GMU-928	91	102	10	6	34	32
GMU-1102	97	90	11	4	36	31
Accessions with 37% oil content						
GMU-466	92	100	10	5	10	37
GMU-663	90	100	9	5	12	37

Accession	Days to maturity	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
GMU-1091	100	100	15	6	8	37
GMU-1106	95	118	9	4	9	37
GMU-1140	90	146	8	7	10	37
DRSF-113 (Check)	97	143	19	7	23	33
Range*	80-110	64-144	3-20	2-7	2-39	24-37

*values are given for the entire set of accessions

Multi-location evaluation of germplasm accessions

Based on the previous year's data, promising genotypes were selected for multi-location evaluation trial during *kharif* 2018-19. A total of 28 accessions including inbreds with high seed yield and oil content, exotic germplasm lines and two checks (DRSF-113 and LTRR-341) were evaluated at Akola, Latur, Nandyal, Raichur, Bengaluru and Coimbatore in RBD with two replications. The genotype GP4-2844 (46.3 g/plant) recorded highest seed yield over the check DRSF-113 (36.3 g/plant). In total, five accessions recorded higher seed yield per plant over the check, DRSF-113.

Multiplication of promising trait specific accessions to be used as checks

One of the major concerns in the sunflower programmes is the non-availability of suitable checks for some of the traits. Based on evaluation studies done for 2-3 years, 24 lines were identified as material that could be used as reference genotype. Accordingly, powdery mildew resistant line (PM-81), powdery mildew susceptible line (PS-2023), *Alternaria helianthi* tolerant line (HA-124A/B), *A. helianthi* susceptible line (TSG-208), high oil lines with more than 40% oil content (GP-4-1424, TSG-339, CMS-300 A/B), leafhopper resistant lines (TSG-207, TSG-24, HAR-9, TSG-212, TSG-401, TSG-217, GMU-339), multiple resistant line with purple disc (HAR-9), high oleic acid content of more than 82% (TSG-17); early maturity (TSG-355), high seed yield (TSG-292- RHA 348, TSG-411, GMU-689, GMU-804, LTRR-341) and high photosynthetic rate (TSG-332) were multiplied for their utilization as appropriate checks in experiments across the AICRP system. The resistant and susceptible checks for powdery mildew and *A. helianthi* (4 lines and 10 g each) were supplied to five AICRP centres with pathologists (Akola, Raichur, Nandyal, Coimbatore and Bengaluru) for further multiplication and utilization in the screening trials.

Preparation of sunflower germplasm catalogue and distribution

Characterization and evaluation of 2149 IIOR accessions was completed during 2011-13. Characterization of 1100 accessions received from NBPGR, New Delhi was carried out at Latur and Bengaluru centres during 2013-14 as per DUS guidelines. The germplasm catalogue comprising data for 3126 accessions has been prepared and distributed to the sunflower breeders for effective utilization of promising inbreds and germplasm accessions in the breeding programmes.

Development of sunflower germplasm core

Establishment of a core collection that represents genetic diversity of the entire collection with minimum loss of its original diversity and minimum redundancies is an important task for gene-bank curators and crop breeders. The passport data on the characterization and evaluation of 2149 IIOR sunflower accessions collected during 2011-13 was used to develop the sunflower core set. The 'R software' based package "ccChooser" was used and phenotypic data (agronomic, morphological, phenological) was subjected to analysis. The Ward cluster analysis and D3 allocation method proved to be the most optimal and efficient in developing the sunflower core collection from the dataset. The core collection created as a result of these methods was characterized with lowest dD% (5.080867) value and relatively low value of MD% (0.78302285). Based on this strategy, a total of 216 accessions constituted the core collection which is approximately 10% of the entire collection.

Safflower

A total of 6970 safflower germplasm accessions are conserved in the Short Term Storage Module at IIOR, Hyderabad. Each year viability testing is undertaken for accessions conserved for six years to ascertain the need for further multiplication. Under this activity, a set of 174 accessions were tested; of which, 59% accessions recorded germination ≥85%. A total of 272 safflower germplasm accessions which included 71 with low viability and 201 with low seed quantity were rejuvenated.

Seed multiplication was undertaken for 179 promising accessions. Fifty seven accessions from USDA were sown for seed multiplication and initial characterization for flower colour and spininess. A total of 206 accessions were supplied to indentors for evaluation, screening against wilt, aphids and salinity tolerance at multilocations. This also includes 21 trait specific accessions (14 for high oil content; 7 for high seed yield) given to AICRP (Safflower) breeders of six centres for utilization during *rabi* 2018-19.

Among the 44 accessions evaluated during *rabi* 2017-18, 10 accessions *viz.,* IC-253215, IC-337678, IC-338171, IC-406143, EC-337543, IC-337805, IC-337833, IC-338209, IC-406029 and IC-499965 were identified for high seed yield ranging from 34.3 - 44.2 g/plant and oil yield ranging from 11.4 -13.8 g/plant whereas the checks recorded seed yield of 37 g/plant and oil yield of 10.6 - 10.8 g/plant.

Two accessions *viz.,* EC-398229 and EC-736501 (GMU-7616) were identified for high oil content (36.2 and 40.2%, respectively) compared to 28.9 - 38.7% in the checks. Seven promising lines recording oil yield ≥11.7 g/plant were sown for confirmation during *rabi* 2018-19 along with 14 breeding lines and four checks.

Promising safflower accessions for oil yield

Accession	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches/plant	No. of effective capitula/plant	Diameter of primary capitula (mm)	No. of seeds / primary capitula	100-seed weight (g)	Hull content (%)	Oil content (%)	Seed yield/plant (g)	Oil yield/plant (g)
IC-253215	84	129	85.6	12	34	22.6	27	5.9	47.5	27.8	44.2	12.3
IC-406143	88	130	88.8	16	44	22.2	34	4.4	43.8	32.3	42.8	13.8
IC-338171	87	129	89.9	11	37	21.5	30	4.8	42.5	31.2	41.3	12.9
IC-337678	84	123	79.2	15	46	20.8	23	5.8	46.5	28.9	40.5	11.7
IC-337805	84	126	91.6	12	38	20.8	29	4.5	44.2	30.9	40.0	12.4
IC-499965	85	128	86.9	10	33	21.5	27	5.2	46.8	30.6	38.2	11.8
IC-337833	88	129	102.1	13	38	22.3	31	5.2	41.9	32.1	37.5	12.1
EC-337543	86	126	87.3	14	37	21.5	32	4.0	42.5	31.5	36.8	11.6
IC-338209	89	129	80.3	12	37	21.5	30	5.1	41.4	31.5	36.6	11.5
IC-406029	84	126	90.9	12	34	24.0	42	4.0	40.3	33.0	34.3	11.4
A-1 (Check)	90	129	91.1	12	37	20.9	26	5.3	46.9	29.3	37.0	10.8
PBNS-12 (Check)	86	127	90.7	16	30	20.7	24	5.5	43.6	28.9	36.7	10.6

Evaluation of promising safflower accessions

Three accessions *viz.,* GMU-7850 (Odisha), GMU-7855 (Odisha) and GMU-7847 (Desi Kusubey, landrace from Karnataka) were identified with on par performance to checks in terms of seed and oil yield/plant based on the performance over two years (2016-17 and 2017-18). The seed yield ranged from 27.7 - 32.6 g/plant in these accessions as against 27.1 - 30.8 g/plant in checks whereas oil yield ranged between 7.8 and 9.8 g/plant in the accessions as against 7.0 - 8.8 g/plant in the checks.

Promising safflower accessions identified from Odisha and Karnataka

Accession	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of primary branches/plant	No. of effective capitula/plant	Diameter of main capitula (mm)	100-seed weight (g)	Oil content (%)	Seed yield/plant (g)	Oil yield/plant (g)
GMU-7850 (IC-620499)	83	126	76	15	58	19.7	5.0	30.2	32.6	9.8
GMU-7855 (IC-620505)	85	129	72	16	65	17.6	4.6	29.0	27.7	8.0
GMU-7847 (Desi Kusubey)	97	88	131	8	29	22.2	4.8	27.6	28.2	7.8
A-1 (Check)	91	134	87.8	10	33	19.6	7.2	25.8	27.1	7.0
Bhima (Check)	91	133	80.9	12	43	19.5	7.2	28.6	30.8	8.8

Fifty nine of the 63 accessions collected from Maharashtra germinated; of these, 10 accessions *viz.,* GMU-7907, GMU-7871, GMU-7869, GMU-7917, GMU-7881, GMU-7862, GMU-7905, GMU-7882, GMU-7880 and GMU-7879 were identified for seed yield ranging from 35.4 to 66.8 g/plant as compared to 27.7- 35.1 g/plant in the checks during the first year of evaluation (2017-18). Oil yield for these accessions ranged from 10.8 to 19.2 g/plant compared to 7.3 to 10.2 g/plant in the checks. Early flowering (70-72 days to 50% flowering) was recorded in two accessions from Maharashtra *viz.,* GMU-7898 and GMU-7899 whereas GMU-7879 flowered and matured 10 days earlier than the checks. A set of 26 germplasm accessions, which included seven of the promising accessions listed above were raised along with four checks for confirmation of seed and oil yield during *rabi* 2018-19.

Diversity in safflower germplasm collection from Maharashtra

Sesame

A set of 1900 germplasm accessions received from PC unit, Jabalpur were evaluated for oil content which ranged from 26.7 to 52.5%. A set of 320 germplasm accessions were evaluated for agronomic characters during *kharif* 2018 and summer 2019. During *kharif* 2018, seed yield ranged from 1.1-18.3 g/plant, oil content ranged from 28 to 53.1% and test weight ranged from 2.8 to 4.0 g. Highest oil content was found in the accession IC-526435 (53.1%). Yield related traits such as plant height ranged from 81.6 to 298.6 cm with the number of capsules per plant ranging from 59-149. Number of primary branches ranged from 2 to 6 while the number of secondary branches ranged from 2 to 12. Capsule length ranged from 2.5 to 3.4 cm. There were 20 early maturing (85 days) and three late maturing accessions (96 days). Six accessions *viz.*, IC-526435, IS-104, IS-344, IC-264692, KMR-85 and IS-349 were found promising for yield and related traits, which could be used in the breeding programmes. A subset of 90 accessions was characterized for 22 morphological characters based on descriptors of The International Plant Genetic Resources Institute (presently Biodiversity International). In this, 23 accessions had capsules more than 3.0 cm in size and 22 accessions with more than one capsule per node.

Niger

Seed multiplication and maintenance of 335 germplasm accessions was done by sibbing.

The top 10 best performing accessions were used for random mating to develop random mating cycle I.

Elite niger accessions with high oil content

Accession	Seed yield per plant (g)	Oil content (%)
N-36	2.5	40.1
N-289	3.2	39.1
N-108	3.0	39.6
N-209	4.1	39.2
N-214	3.0	38.7
N-201	3.9	38.6
N-227	3.3	38.5
N-228	3.1	38.5
N-174	3.3	38.4
N-282	2.7	38.4
IGPN-2004 (Check)	3.1	38.3
JNC-28 (Check)	3.4	37.14

Germplasm registration

During the year, four genetic stocks were registered with PGRC, New Delhi for specific traits. These include three in castor and one in safflower developed at ICAR-IIOR.

Niger maintenance through sibbing

Germplasm/genetic stocks registered with PGRC, New Delhi (2018-19)

Crop	National identity	Donor identity	INGR No.	Pedigree	Developer	Unique features
Castor (*Ricinus communis*)	IC-0625992	IPC-15 (DPC-15)	19017	Selection from the segregating population of NES-6 x DCS-12	C. Lavanya, G. Balakishan and P. Duraimurugan	Pistillate line with papaya leaf type, non-spiny capsules and resistant to leafhopper
	IC-0546708	RG-631	19018	Punjab-1	K. Anjani, P. Duraimurugan and M. Lakshminarayana	Resistant to leafhopper
	IC-0628058	RG-57	19019	RG-57 is a morpholo-gically distinct selection from a wild type collec-tion, 1077-2 collected from Dantiwada, Gujarat	K. Anjani and Praduman Yadav	High ricinoleic acid content (91%)
Safflower (*Cartamus tinctorius*)	IC-0625999	SFS-9943	19023	[(PI537701 x PI544042) x PI560165) x PI537701] x PI537701	K. Anjani and Praduman Yadav	High oil content (34.7%)

Pre-breeding

Pre-breeding activities utilizing the wild species have been carried out in safflower and sesame. In safflower, emphasis has been to utilize wild species to transfer Alternaria leaf spot as well as Fusarium wilt resistance. In sesame, the wild species are basically used for developing cytoplasmic-genetic male sterility system to pave the way for hybrid development. The results obtained under these activities are summarized.

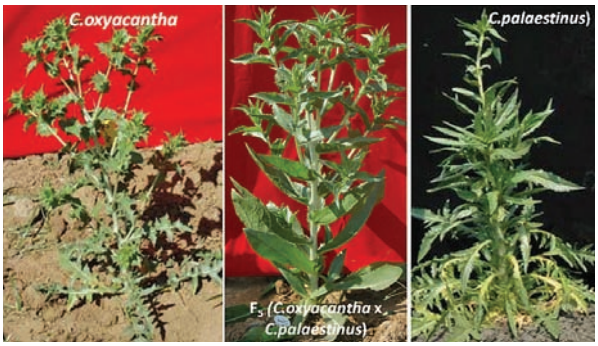
Safflower

Pyramiding of wilt resistance from *Carthamus* species into cultivated safflower

Ninety five interspecific inbred lines in F_5-F_7 generations derived from crosses between *C. tinctorius* and wild species, *C. oxyacantha*, *C. palaestinus*, *C. turkestanicus*, *C. creticus* and *C. lanatus*, and crosses between *C. tinctorius* and (*C. oxyacantha* x *C. palaestinus*) exhibited resistance to Fusarium wilt in wilt sick plot.

Interspecific line from (A-1 x C. palaestinus) cross (centre) and the parents (left and right)

Interspecific line from (Nira x C. turkestanicus) cross (right) and both parents (left and centre)



Interspecific line from (C. oxyacantha x C. palaestinus) cross (centre) and both parents (left and right)

High yielding interspecific inbred lines

Five F_7 inbred lines *viz.*, ISF-324, ISF-325, ISF-326, ISF-327 and ISF-328 recorded 22-45% higher seed yield than the best check, A-1; five F_6 inbred lines *viz.*, ISF-329, ISF-330, ISF-331, ISF-332 and ISF-333 recorded 23-33% higher seed yield than the best check, A-1.

Generation advancement: Fourteen interspecific and five intraspecific families in F_4 generations and four high oil containing F_5 families and two high oil containing S_4 families from national crossing programme (NCP) gene pool were advanced to next generations.

High oil type F_5 and S_4 families of safflower

F_5 and S_4 family	Seed yield (g/plant)	100-seed weight (g)	Oil content (%)
ISF-197	48.1	5.0	35
ISF-207	41.2	3.6	35
ISF-216	40.9	4.2	35
ISF-232	47.3	4.0	36
ISF-300	51.2	4.6	35
ISF-307	45.4	4.2	36
A-1 (Check)	27.0	6.1	28
PBNS-12 (Check)	24.0	5.5	29

Yield performance of wilt resistant interspecific inbred lines of safflower

Inbred	Seed yield (kg/plot*)	Seed yield (kg/ha$)	100-seed weight (g)	DF	DM	Oil content (%)
F_7 inbred lines						
ISF-324	3.3	2889 (27)	3.6	89	126	28
ISF-325	3.3	2962 (30)	3.4	85	125	28
ISF-326	3.2	2836 (25)	3.8	90	127	28
ISF-327	3.1	2760 (22)	3.4	89	127	27
ISF-328	3.7	3280 (45)	3.6	88	124	29
A-1 (Check)	2.6	2267	6.0	87	126	28
F_6 inbred lines						
ISF-329	3.3	2889 (23)	3.4	88	124	31
ISF-330	3.3	2962 (26)	4.4	84	123	26
ISF-331	3.5	3136 (33)	5.4	83	126	27
ISF-332	3.4	3060 (30)	5.0	83	124	28
ISF-333	3.5	3080 (31)	5.2	85	127	28
A-1 (Check)	2.7	2355	6.0	87	126	27

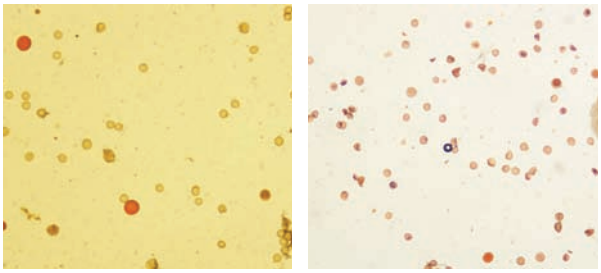
*Plot size: 11.25 Sq.m; $: figures in parentheses indicate percent increase over check; DF: days to 50% flowering; DM: days to maturity

Sesame

Development of cytoplasmic genetic male sterile lines in sesame

As part of the programme on development of CGMS system in sesame, crosses were made with *Sesamum malabaricum* and cultivated sesame male sterility observed in different backcross generations are presented below.

Backcross generations	Range of pollen sterility (%)	Mean sterility (%)
BC_5F_{1-}(ISMB-2 x GT-10) F_1 x GT-10 -1-1-1-2-1-1	76.2 – 83.1	78.8
BC_5F_{1-} (ISMB-3 x GT-10) F_1 x GT-10-1-1-1-2-1-1	75.3 – 84.4	80.6
BC_3F_{1-} (ISMB-7 x GT-10) F_1 x GT-10-1-1-1-2	83.3 – 87.8	86.1
BC_1F_{1-}(G-3 x TKG-22) F_1 x TKG-22-1-1-1	82.8 – 88.1	84.4



Pollen sterility in the backcross progenies of S. malabaricum x cultivated sesame (GT-10)

Development of segregating populations from interspecific crosses

Wide crosses involving wild species *viz.,* Shweta Til x *S. mulayanum* (IC-43144-1) and GT-10 x *S. mulayanum* (IC-43144-1) were forwarded to raise 129 and 186 F_2 plants, respectively. In the crosses IC-204444 x *S. mulayanum* (IC-43144-1), IC-132035 x *S. mulayanum* and its reciprocal, F_1 plant mortality was observed and in *S. mulayanum* (IC-43144-1) x *S. malabaricum,* germination was normal. However, F_1 mortality was severe and only two plants survived with very few filled capsules.

Parental Lines

Development, Characterization and Evaluation

IIOR plays a pivotal role in developing parental lines using available germplasm and the phenotyping facilities, and then supplying the enhanced breeding lines to the co-operating centers to develop finished products. In castor and sunflower, where predominantly hybrids are cultivated, parental line development with additional ancillary traits like resistance to stresses and suitability for different agro-ecological situations has been an important activity. In castor, development of diverse pistillate and male (monoecious) lines has been the primary activity. Different approaches have been adopted to develop these lines and the stable lines developed have been characterized for their combining ability as well as other agronomic traits such as wilt resistance, earliness, moisture stress tolerance, *etc.* In sunflower, the focus has been to identify and develop parental lines with good combining ability, resistance to powdery mildew, tolerance to moisture stress and salinity, and high oil content. Results obtained under different activities are summarized.

Castor

Development of pistillate lines

Development of new pistillate lines was pursued through gene pool and recombination breeding methods for the purpose of diversifying breeding programmes. For development of gene pool, cycle 1 of random mating of F_1 has been generated by crossing Rb-13-1854 as female parent with pollen mixed from three female parents *viz.,* DPC-9, SKP-84 and JP-86.

For recombination breeding, four crosses were effected between selected plants from the progenies of double crosses and also 11 progenies were advanced to F_2 from two double crosses *viz.,* [(DPC-25 x Rb-13-1854) x (CNES-1 x NES-6)] and [(DPC-21 x DCS-106) x (JP-77-1 x DPC-21)]. A total of 21 selections were advanced to BC_1F_2 from three backcrosses [(CNES-1 x FC-8) x CNES-1), (CNES-1 x ICS-186) x CNES-1) and (M619 x FC-8) x M619]. Seventy one selections were advanced to F_3 from six bi-parental crosses (Rb 13-1854 x DPC 25, CNES-1 x NES-6, JP-77-1 x DPC-21, DPC-21 x DCS-106, DPC-25 x Rb 13-1854 and M-619 x 48-1).

Among the three F_1s of pistillate x pistillate lines, DPC-23 x DPC-21 yielded high (324 g/pl) compared to two other crosses, DPC-16 x M-571 (240 g/pl) and SL x DPC-25 (195 g/pl) and F_2 was generated for further selection.

A recombinant pistillate source, Kh-13-154 identified in an inter-varietal cross was used to generate diverse breeding material through backcrosses using three pistillate lines *viz.,* DPC-9, DPC-19 and M-574 as recurrent parents. Among the set of F_1, BC_1F_1, P_1, P_2 of three crosses evaluated, BC_1F_1 of Kh-13-154 x DPC-19 recorded highest seed yield (285 g/plant) compared to the other two backcrosses. F_2 and BC_1F_2 populations were generated using recurrent parents, DPC-9, DPC-19 and M-574.

Evaluation of new pistillate lines

A set of 41 pistillate lines were evaluated in two sets. In set-I, 26 pistillate lines were evaluated for agro-morphological characters in late *kharif* of 2018. In this set, IPC-33 recorded 13% yield increase over the best check, M-574 (3092 kg/ha) in a RBD with two replications and plot size of 10.8 sq.m. Three pistillate lines *viz.,* IPC-33, IPC-35 and IPC-37 yielded significantly over SKP-84 (1947 kg/ha), while all the three were on par with the second best check, DPC-9 (2704 kg/ha). Five new pistillate lines *viz.,* IPC-31, IPC-36, IPC-34, IPC-38 and IPC-39 were *on par* with SKP-84 (1947 kg/ha) for seed yield. IPC-30, DPC-22, IPC-38 and IPC-37 recorded significantly higher oil content (48.5-49.4%) compared to the highest seed yielding check, M-574 (45.6%).

Promising pistillate lines of castor for seed yield and components under irrigated conditions (Set-I)

Line	Plant height up to primary raceme (cm)	No. of nodes to primary raceme	Effective spike length (cm)	No. of capsules per primary spike	100-seed weight (g)	Seed yield (kg/ha)	Oil content (%)
IPC-33	54	11	59	87	36	3507	46.4
IPC-34	61	11	64	102	25	2553	47.2
IPC-35	44	10	43	35	24	3189	46.1
IPC-36	46	11	49	75	30	2218	45.5
IPC-37	47	11	39	55	39	2763	48.5
IPC-38	63	14	58	79	26	2382	48.8
IPC-39	41	10	56	79	33	2280	44.5
DPC-9 (Check)	52	12	45	83	32	2704	47.8
M-574 (Check)	43	13	64	87	32	3092	45.6
SKP-84 (Check)	58	20	71	136	32	1947	47.3
Mean	54	12.1	51.6	82	30.8	2518	46.9
CD (P=0.05)	12	1.8	8.1	24.2	3.5	620	1.6
CV (%)	13	9	10	18	7	15	2

In set-II, 15 new pistillate lines were evaluated for agro-morphological characters during *rabi* 2017-18. In this set, DPC-23 (33%), DPC-21 (31%), DPC-24 (28%), DPC-17 (14%) and IPC-35 (12%) were promising compared to the best check, M-574 (551 kg/ha) in a RBD of three replications and plot size of 10.8 sq.m. Pistillate lines like DPC-23 (47%), DPC-21 (47%), and DPC-19 (47%) recorded oil content on par with the checks, SKP-84 (47.5%) and DPC-9 (47%).

Promising pistillate lines of castor for seed yield and components in late *kharif* under rainfed conditions (Set-II)

Line	Plant height up to primary raceme (cm)	No. of nodes to primary raceme	Effective spike length (cm)	100-seed weight (g)	Oil content (%)	Seed yield (kg/ha)
DPC-23	38	8	22	27.1	47.1	735
DPC-21	78	19	74	30.7	47.0	722
DPC-24	79	19	76	27.7	46.3	706
DPC-17	96	16	52	44.5	46.6	627
IPC-35	64	11	49	30.7	45.0	618
DPC-19	88	18	71	29.3	47.0	573
IPC-38	70	15	47	28.1	46.7	572
M-574 (Check)	45	17	56	29.6	46.1	551
DPC-9 (Check)	61	14	32	28.1	47.4	543
SKP-84 (Check)	80	18	42	30.1	47.5	351
Mean	73	15	46	28.7	45.3	479
CD (p=0.05)	14.5	2.12	5.97	6.31	11.97	112
CV (%)	15.9	8.6	7.9	13.4	16.11	14.3

Agro-morphological characterization of new pistillate lines

Seven new pistillate lines developed from diverse parents through pedigree method of selection have been stabilized. Four pistillate lines *viz.*, IPC-41, IPC-42, IPC-44 and IPC-45 were early flowering with node number ≤13, while IPC-40, IPC-44, IPC-45 and IPC-46 had high 100-seed weight (≥33 g/plant).

Pedigree and agro-morphological traits of newly developed pistillate lines

Line	Parentage	Agro-morphological characters
IPC-40	Selection from RHC-247	R_2SP, dwarf, cup shaped leaf, condensed nodes, branching, medium spike, PNN-13-15, DF 50%: 60 days, PSL: 41 cm, 100-seed weight: 42.5 g, oil content: 48.3%
IPC-41	DPC-9 x JP-84	G_3SP, normal plant, flat leaf, long spike, branching, PNN: 8-13, DF 50%: 48 days, PSL: 74 cm, 100-seed weight: 25.5 g, oil content: 48.5%
IPC-42	M-574 x PPL-206	G_2SP, dwarf, early, cup shaped leaf, medium spike, PNN: 9-12, DF 50%: 46 days, PSL: 50 cm, 100-seed weight: 26 g, oil content: 46%
IPC-43	DPC-9 x JP-84	R_0SP, normal plant, flat leaf, long spike, branching, PNN: 13-15, DF 50%: 45 days, PSL: 54 cm, 100-seed weight: 28.5 g, oil content: 48.6%
IPC-44	NES-6 x Jupally	R_2SP, short, early, flat leaf, small spike, branching, PNN: 7-9, DF 50%:43 days, PSL: 18 cm, 100-seed weight: 39 g, oil content: 48%
IPC-45	M-574 x JP-86	R_2SP, dwarf, cup shaped leaf, medium spike, branching, PNN: 8-12, DF 50%: 48 days, PSL: 44 cm, 100-seed weight: 33.5 g, oil content: 46.7%
IPC-46	RG-1581-1 x DCS-78	G_3NSP, flat leaf, normal plant, long spike, branching, PNN: 14-16, DF 50%: 65 days, PSL: 65 cm, 100-seed weight: 39.5 g, oil content: 48.3%

PNN- Node number to primary spike, DF 50%-Days to 50% flowering of primary spike, PSL-Primary spike length

Improving drought tolerance in pistillate lines

To incorporate the drought tolerance traits from accessions with <1 DSI, 18 crosses were made during the previous year with different pistillate lines and were evaluated this year for drought tolerance traits. Among the 18 crosses, two crosses of DPC-9 with RG-27 and RG-72 showed better drought tolerance with low DSI (<1) compared to the check, DCH-519 (DSI-1.04). These crosses were used to generate backcross material using the recurrent parent. BC_1F_1 was high yielding (191 g/plant) with longer total and effective primary spike (54 cm) and high 100-seed weight (34 g) and was advanced to the next generation.

Development of monoecious lines

A total of 15 progenies were selected from 39 F_3 families based on desired agro-morphological traits and advanced to F_4 generation. A total of 40 selections were advanced to F_3 generation from six bi-parental crosses involving the monoecious lines *viz.*, ICS-161, ICS-164, ICS-186, FC-166, FC-167, NES-6, JP-77-1 and R15-1215.

A total of 58 single plants were selected from 28 progenies of double cross and 12 progenies of three-way crosses grown in *kharif* 2018-19 and were advanced to F_5 generation based on morphological characters and yield components such as total and effective primary spike length (50-70 cm), node number to primary (12-15) and effective spikes per plant (5-8).

Promising monoecious lines

A total of 24 monoecious lines were developed from diverse germplasm lines and elite inbred lines through recombination breeding. Five lines *viz.*, ICS-304, ICS-311, ICS-315, ICS-316 and ICS-318 recorded 100-seed weight of more than 32 g. Oil content (%) was highest (51.7%) in ICS-321 and the wilt incidence (%) was zero in ICS-303, ICS-304, ICS-315 and ICS-318.

Agro-morphological traits and reaction to wilt of promising monoecious lines of castor

Line	Pedigree	Traits	DF 50%	PSL (cm)	SW (g)	Oil content (%)	Wilt (%) @ 150 DAS
ICS-296	(DCS-9 x RG-1155) x DCS-9	G_2SP, PNN:14-17	62	57	25.0	46.8	12
ICS-298	DCS-9 x K9-739	R_2SP PNN: 14-18	66	48	24.5	45.8	9
ICS-300	VP-1 x K9-784	G_3SP, PNN: 12-16	54	46	21.5	47.2	15
ICS-301	(RG-761 x DCS-96) x DCS-96	M_3SP, PNN: 13-15	51	33	29.5	49.0	18
ICS-302	(RG-799 x DCS-96) x DCS-96	G_2SP, PNN: 14-15	63	55	29.5	48.5	18
ICS-303	(RG-799 x DCS-96) x DCS-96	G_2SP, PNN:12-16	63	49	30.5	46.9	0
ICS-304	(RG-799 x DCS-96) x DCS-96	G_2SP, PNN: 14-16	64	58	32.5	47.7	0
ICS-305	(RG-799 x DCS-106) x DCS-106	G_2SP, PNN: 13-15	65	38	28.0	47.9	8
ICS-306	Yellow x DCS-9	R_2SP, PNN: 12-16	56	33	26.5	46.5	16
ICS-307	Yellow x DCS-9	G_2SP, PNN: 12-13	54	19	31.0	47.3	16
ICS-308	Sowbhagya x RG-1582	G_3SP, PNN: 14-17	66	42	24.5	46.8	18
ICS-309	RG-1581-1 x DCS-102	R_3SP, PNN: 13-16	63	50	29.5	48.2	23
ICS-310	Chintamani x RG-1582-4	G_2SP, PNN: 13-15	59	52	25.0	45.7	18
ICS-311	RG-2820 x DCS-94	G3SP, PNN: 12-15	59	59	33.0	48.0	15
ICS-312	DCS-97 x DCS-94	R2SP, PNN: 11-15	58	69	26.0	47.4	6

Line	Pedigree	Traits	DF 50%	PSL (cm)	SW (g)	Oil content (%)	Wilt (%) @ 150 DAS
ICS-313	RG-1582-3 x DCS-78	R2SP, PNN: 10-14	56	40	24.5	45.4	16.6
ICS-314	RG-1582-3 x PCS-43	G2SP, PNN: 10-14	64	42	30.0	47.0	2.2
ICS-315	RG-1582-5 x JC-3	G2SP, PNN: 15-17	66	47	34.0	46.3	0
ICS-316	DCS-94 x RG-3105	G2SP, PNN:15-16	61	63	33.5	42.0	3
ICS-317	DCS-94 x RG-3105	G2SP, PNN: 15-16	67	39	26.5	43.0	14.2
ICS-318	DCS-94 x RG-3105	G2SP, PNN: 15-17	64	46	37.5	48.0	0
ICS-319	DCS-9 x RG-2672	R2SP, PNN: 14-15	58	55	27.0	46.5	8.8
ICS-321	48-1 x RG-2991	R2SP, PNN: 14-17	62	38	27.5	51.7	4.8
ICS-322	VP-1, G3SP x RG-761 R2SP	R3SP, PNN: 14-16	60	45	26.5	46.5	14.8
48-1 (Resistant check)							11.8
JI-35 (Susceptible check)							96.9

PNN-Node number to primary spike, DF 50%-Days to 50% flowering of primary spike, PSL-Primary spike length, SW-100-seed weight, DAS-Days after sowing

Evaluation of new monoecious lines for agronomic characters

A set of 85 new monoecious lines were evaluated in three sets. In set-I, 19 monoecious lines (ICS-232 to ICS-251) developed through recombination breeding were evaluated in unreplicated plots of three rows (16.2 sq.m plot size) during *kharif* 2018. Among them, four male lines *viz.*, ICS-232 (36%), ICS-240 (50%), ICS-244 (40%) and ICS-246 (38%) were significantly superior to the check, 48-1 (928 kg/ha) while none of them was superior to the best check, DCS-107. Multi-location trials indicated that ICS-241 (66%) and ICS-244 (19%) were promising compared to the best check, DCS-107 at Yethapur (835 kg/ha) and Palem (1220 kg/ha).

Promising monoecious male lines of castor developed through pedigree method of selection (Set-I)

Entry	Plant height up to primary spike (cm)	No. of nodes to primary raceme	Days to 50% flowering of primary spike	Total primary spike length (cm)	Effective primary spike length (cm)	Seed yield (kg/ha)	Oil content (%)
ICS-232	48	9.7	56.5	44.7	43.9	1262	40.7
ICS-240	92	13.6	41.5	28.6	27.8	1392	42.5
ICS-244	98	14.8	50.0	53.8	53.8	1297	44.6
ICS-246	109	16.1	54.0	41.7	37.5	1286	44.7
48-1 (Check)	132	17.1	59.0	36.0	33.2	928	49.7
DCS-107 (Check)	124	16.1	60.0	39.0	38.0	1331	48.6
CD (P=0.05)	42.9	NS	9.2	9.8	9.6	324	5.6
CV (%)	20.7	12.6	8.7	12.8	13.1	16.3	6.1

In set-II, 35 new recombinant inbred monoecious lines (ICS-252 to ICS-286) developed through single seed descent method of selection were evaluated in unreplicated plots of three rows each of 16.2 sq.m plot size during *kharif* 2018. Among them, ICS-252 (38%), ICS-257 (72%) and ICS-261 (97%) were significantly superior to the best check, DCS-107 (1240 kg/ha).

Promising monoecious male lines of castor developed through single seed descent method (Set-II)

Line	Plant height up to primary spike (cm)	No. of nodes to primary raceme	Days to 50% flowering of primary spike	Total primary spike length (cm)	Effective primary spike length (cm)	Seed yield (kg/ha)	Oil content (%)
ICS-252	85	15	54	33	29	1455	45.3
ICS-257	96	15	59	41	41	1819	44.8
ICS-261	84	15	47	38	32	2076	46.6
DCS-107 (Check)	94	17	60	38	38	1240	45.2
48-1 (Check)	93	16	59	41	40	1055	45.4
CD (P=0.05)	24.3	1.9	6.4	6.3	7.7	398	2.4
CV (%)	11.7	5.7	5.9	7.4	9.4	19.8	2.6

In set-III, 31 new inbred lines were evaluated during *kharif* 2018 for their agronomic potential. The field trial was conducted in RBD with three replications. The promising inbred lines were identified in terms of earliness, number of spikes, productive spike length and seed yield.

Promising monoecious lines of castor identified in the preliminary evaluation trial (Set-III)

Line	No. of nodes to primary raceme	Days to 50% flowering of primary spike	Plant height up to primary spike (cm)	Total primary spike length (cm)	Effective primary spike length (cm)	No. of spikes per plant	100-seed weight (g)	Seed yield (g/ plant)	Oil content (%)
ICS-330	10	43	63.6	26.8	15.5	10	27.6	114.8	48.3
ICS-335	16	54	103.4	38.2	37.1	6	34.6	105.2	46.9
ICS-349	15	55	127.9	45.3	43.9	6	23.7	104.8	44.3
ICS-356	15	50	56.1	50.0	47.7	7	22.8	99.8	45.1
ICS-336	10	43	47.2	32.5	30.5	8	34.9	99.5	47.3
DCS-107 (Check)	16	55	81.9	36.5	36.2	4	31.6	96.3	45.6
48-1 (Check)	15	52	110.0	34.3	34.0	4	28.9	72.7	45.9
SEm ±	0.8	2	10.4	4.1	4.5	1.3	1.3	9.2	1.1
CD (P=0.05)	1.6	3.7	21.2	8.5	9.2	2.7	2.6	18.7	2.3
CV (%)	9	3.9	14.4	11.9	15.1	21.3	4.4	12.7	2.4

Assessing the combining ability of parents

A total of 11 new inbred lines were tested for their combining ability using four pistillate lines *viz.*, M-571, DPC-14, DPC-20 and DPC-25. Among the evaluated testers, ICS-339 was found to be a good combiner for days to 50% flowering, total number of spikes, 100-seed weight and seed yield. ICS-325 was a good combiner for days to 50% flowering, total number of spikes and productive spike length. ICS-326 and ICS-327 were identified as good combiners for days to 50% flowering, total number of spikes and seed yield.

In another set, nine male lines were tested for their combining ability using five pistillate lines *viz.*, DPC -18, DPC-20, DPC-27, DPC-28, DPC-29. The DPC-18 was identified as a promising line.

GCA effects for seed yield in a line x tester (5 x 9) analysis of 45 castor hybrids

Line	Estimate	Testers	Estimate
DPC-18	188.2*	DCS-9	-72.8*
DPC-20	-5.6	DCS-78	-32.9
DPC-27	-5.3	DCS-89	58.1
DPC-28	-19.7	DCS-94	-19.1
DPC-29	-157.6*	DCS-107	9.3
S.E (gca line)	17.3	DCS-108	-118.8*
S.E. (gi-gj) line	24.5	DCS-119	237.1*
		DCS-121	27.1
		48-1	-87.9
		S.E. (gca for tester)	23.3
		S.E. (gi-gj) tester	32.9

*Significant at 5% level

Gene pool for developing parental lines with graymold resistance

A random mating population was generated through open pollination (three cycles) among the progenies derived by intercrossing five resistant lines (CI-1, CI-2, RG-1963, RG-558-1 and RG-3088-1) and two agronomically superior pistillate lines (M-574 and SKP-84). This gene pool would serve as a base population for development of graymold resistant parental lines in castor.

Sunflower

Evaluation and confirmation of trait specific inbreds

A total of 400 trait specific inbreds received from AICRP centres and ICAR-IIOR, Hyderabad were raised for validation. High oil content (>37%) was recorded in COSF-6B (38.8%) followed by COSF-7B (37.6%) and COSF-3B (37.1%) while in 14 inbreds had oil content of >35%. Four inbreds namely, NDI-7 (50 days), ID-1-1 (51 days), TSG-339 (52 days) and R_3 Brown (52 days) were early flowering types. Inbred RGP-93-P_1-S_3 was a late type (76 days to 50% flowering) coupled with medium oil content (35.5%). This inbred can be utilized for development of full season or long duration hybrids.

Agronomic traits in a few selected promising trait specific inbreds of sunflower

Inbred	Days to 50% flowering	Plant height (cm)	Head diameter (cm)	No. of leaves/ plant	Seed yield / plant (g)	100-seed weight (g)	Oil content (%)
COSF-6B	62	103.0	10.0	31	16.5	3.8	38.8
COSF-7B	63	112.4	10.4	28	18.9	3.6	37.6
COSF-3B	61	111.0	11.2	30	17.6	4.6	37.1
GP6-11	57	140.0	11.0	24	17.9	3.1	37.1
TSG-391	68	146.6	9.0	44	12.6	3.1	36.5
RCR-72	59	121.0	11.4	31	18.5	3.7	36.6
CMS-335B	61	125.0	11.6	28	14.3	3.5	35.1
RGP-93-P1-S3	76	133.6	10.8	27	6.8	3.3	35.5
NDI-7	50	115.0	10.4	25	14.6	5.6	36.2
GP6-1116	54	134.2	11.0	23	20.3	4.0	35.5
ID-1-1	51	107.6	12.2	20	17.6	5.8	35.7
TSG-339	52	86.9	6.2	16	13.6	4.3	35.6
HA-302B	56	103.0	9.6	17	10.0	7.1	36.1
R_3Brown (Br)	52	87.2	7.8	25	6.4	3.1	36.3
R-83	56	122.0	6.4	15	7.6	2.9	36.9
R-393	56	131.4	8.2	20	11.0	4.1	36.1
R-630	55	96.8	11.6	23	8.3	3.4	35.8
RHA-6D-1 (Check)	62.5	106.2	7.1	23	7.6	3.5	36.8
LTRR-341 (Check)	61.1	103.9	9.9	26	14.4	4.8	29.7
ARM-243B (Check)	62.8	134.7	11.1	30	18.3	5.4	29.7
DRSF-113 (Check)	57.8	137.4	11.5	28	16.7	6.0	29.8

Further, a total of 10 lines (4 from Coimbatore, 3 from Raichur and 3 lines from IIOR, Hyderabad) reported to be resistant to powdery mildew were screened along with susceptible (COSF-13B and DRSF-113) and resistant (PM-81) checks during *rabi* 2018-19. Of the four powdery mildew resistant accessions from Coimbatore (CSFI-13022, CSFI-13023, CMS-335, CMS-343B), none of the accessions was free from the disease. The Raichur line PM-61 was found to be moderately susceptible to powdery mildew while the newly developed restorer inbred lines RGP-21-P_4-S_{1-3} and RGP-50-P_2-S_1 from IIOR, Hyderabad and the check PM-81 were completely free of the disease even up to maturity.

Resistance to powdery mildew of the newly developed inbreds RGP-21-P4-S1-3 and RGP-50-P2-S1

Susceptible (COSF-13B) and resistant (PM-81) checks

Varietal Development

In safflower and sesame, predominantly the focus has been for the development of varieties. In safflower, emphasis has been given to derive inbred lines from populations, originated from either bi-parental crosses, multiple crosses, and interspecific crosses, with traits such as high oil content, resistance to diseases like wilt and leaf spot, short duration, and high oleic acid. Two varieties, ISF-764 with high seed yield and ISF-1 with high oleic acid (~76 %) have been identified for release. In sesame, concerted efforts have been made to develop elite breeding lines from the existing variability and also to create additional variability by effecting multi-parent crosses. Progress made under different activities are presented briefly.

Safflower

Development of inbred lines through recombination breeding

Of the 12 parental lines evaluated in two trials, five spiny lines recorded 19-40% higher seed yield than A-1 in trial-I and three parental lines namely, ISF-317, ISF-319 and ISF-320 recorded 14, 22 and 16%, respectively higher seed yield than A-1 in trial-II.

Performance of high yielding inbred lines of safflower

Line	Seed yield (kg/plot*)	Seed yield (kg/ha)$	DF	DM	Oil content (%)
Trial-I					
[(Nira x IP-16) 2-58-7-25]	3.9	2150 (37)	86	126	32
ISF-6974	3.4	1867 (19)	84	124	29
ISF-116	3.7	2031 (30)	86	127	33
ISF-849-sel-16	3.7	2050 (31)	89	129	33
ISF-11-103-p1-p2	4.0	2194 (40)	82	124	28
A-1 (Check)	2.8	1567	86	126	29
Trial-II					
ISF-317	2.7	2387 (14)	87	126	29
ISF-319	2.9	2547 (22)	89	127	31
ISF-320	2.7	2427 (16)	89	127	31
A-1 (Check)	2.4	2093	87	127	27

*Plot size: 11.25 Sq.m; $: Figures in parentheses indicate percent increase over check; DF: Days to 50% flowering; DM: Days to maturity

Development of inbred lines from Recurrent Introgressive Population Enrichment (RIPE) population

Thirty one individual plant selections (IPS) from 4th cycle possessed 35-41.2% oil content and recorded 41-95 g seed yield per plant and 4-6 g of 100-seed weight. A total of 126 individual plant selections (IPS) were made from 16 selections in S_0 generation derived from 3rd cycle RIPE population. Seed yield among the 126 IPS ranged from 120-162 g/plant, oil content varied between 26 and 40.2% and 100-seed weight was between 3.0 and 6.8 g.

A total of 162 individual plant selections (IPS) were made from 13 selections in S_1 generation derived from 2nd cycle RIPE population. The oil content among IPS was between 25 and 37%, seed yield ranged between 59 and 74 g/plant and 100-seed weight was between 3.2 and 7.6 g. A total of 104 individual plant selections (IPS) were made from 11 selections in S_2 generation derived from 1st cycle RIPE population. Seed yield, 100-seed weight and oil content among

104 selections ranged from 51-61 g/plant, 4.8-6.7 g and 29-38.64%, respectively.

Development of short duration inbred lines

Two short duration inbred lines, ISF-866 and ISF-867 flowered in 76 days and matured in 116 and 118 days while the normal duration check, A-1 and short duration check, JSI-99 flowered in 85 and 67 days and matured in 125 and 112 days, respectively. Both the short duration inbred lines could yield very high as compared to JSI-99 but could not out yield A-1. Two BC_1F_3 families, ISF-828 and ISF-837 (DF: 69, 67; DM: 113, 111) possessing 32 and 31% oil content gave higher seed yield than JSI-99.

Performance of short duration inbred lines of safflower

Line	Seed yield (kg/plot*)	Seed yield (kg/ha)	DF	DM	100-seed weight (g)	No. of capsules/ plant	Oil content (%)
ISF-866	0.8	1148	76	116	4.8	26	28
ISF-867	1.1	1659	76	118	3.8	26	28
ISF-833	0.5	793	69	113	5.4	17	32
ISF-837	0.6	889	67	111	4.4	15	31
A-1 (ND-Check)	1.5	2252	85	125	6.0	26	28
JSI-99 (SD-Check)	0.5	770	67	112	5.4	11	29

*Plot size: 6.25 sq.m.; DF-Days to 50% flowering, DM-Days to maturity, ND-Normal duration, SD-Short duration

Development of high oil inbred lines

Eighty six inbred lines possessed 35-39.5% oil content. Twelve best high oil lines possessing 35-38.6% oil content were evaluated in ARBD. Seed yield among these 12 lines ranged from 2393 to 3437 kg/ha and oil yield was between 885 and 1263 kg/ha. Four inbred lines namely, ICI-2562-16-8, ICI-2711-16-7, ICI-2670-16-12 and ICI-2407-16-36 having 35-39% oil content recorded 9-33% higher seed yield (2822-3437 kg/ha) and 14-32% higher oil yield (1091-1263 kg/ha) than the best check, A-1.

Performance of high seed yielding and high oil type inbred lines of safflower

Line	Seed yield (kg/plot*)	Seed yield (kg/ha$)	Oil content (%)	Oil yield (kg/ha)	100-seed weight (g)	DF	DM
ICI-2562-16-8	1.9	2822 (9)	39	1091 (14)	3.8	92	130
ICI-2711-16-7	2.0	2978 (15)	38	1143 (20)	3.8	94	135
ICI-2670-16-12	3.6	3236 (25)	35	1129 (18)	3.6	93	137
ICI-2407-16-36	2.3	3437 (33)	37	1263 (32)	3.4	93	133
A-1 (Check)	1.7	2581	27	956	6.7	87	131
PBNS-12 (Check)	1.7	2474	29	917	5.5	90	133

*Plot size: 11.25 sq.m.; $-Figures in parentheses indicate percent increase over check, DF-Days to 50% flowering, DM-Days to maturity

Multi-location testing and registration of high oil inbred line

The high oil inbred line, SFS-9943 was tested at multi-locations under both rainfed and irrigated conditions. It recorded 35-39% oil content at 11 locations while the checks, A-1 and PBNS-12 gave 24-29 and 24-30% oil content and the line was registered (INGR19023) with Plant Germplasm Registration Committee of ICAR.

Oil content (%) of promising safflower line SFS-9943 and checks (A-1, PBNS-12) at different locations

Centre	SFS-9943	A-1	PBNS-12	Centre	SFS-9943	A-1	PBNS-12
	Rainfed				Irrigated		
Akola	35	24	24	ICAR-IIOR	38	25	27
Buldana	36	26	28	Latur	37	25	26
Gulbarga	35	28	31	Parbhani	37	27	28
Solapur	37	25	28	Phaltan	37	26	27
Somnathpur	35	27	28	Raipur	39	29	30
Tandur	37	28	28	Mean	37	26	28
Mean	36	26	28				

Development of high oil-high oleic lines

Oil content has been enhanced to 35-40.8% in 78 high oleic lines possessing 73-83.5% oleic acid. These inbred lines recorded 637-1818 kg/ha seed yield and 208-747 kg/ha oil yield. The inbred line, ICI-3385-16-22 recorded the highest seed yield (1818 kg/ha) and oil content (40.8%) followed by ICI-4733-16-13 recording 1742 kg/ha seed yield and 38.8% oil content while the check, A-1 recorded 1773 kg/ha seed yield and 27% oil content.

Performance of breeding lines with high oil content

A set of 30 breeding lines produced from Indian and exotic germplasm crosses were evaluated in replicated trial during *rabi* 2017. A subset of eight lines with high oil content ranging from 36.6 to 39.8% were identified. Particularly, the selection F_4-55 showed high oil yield with oil content of 38.5% and comparable seed yield with standard check varieties.

Yield performance of safflower breeding lines with high oil content

Line	Pedigree	Seed yield/plant (g)	Oil content (%)	Oil yield/plant (g)
F_4-8	Bhima x EC-755660	23.0	38.7	8.9
F_4-55	Bhima x EC-755675	27.7	38.5	10.7
F_4-125	PBNS-12 x EC-755664	24.6	36.6	9.1
F_4-157	PBNS-12 x EC-736501	24.5	38.2	9.5
SAF-20A	NARI-57 x EC-736500	17.6	36.4	6.4
SAF-20B	NARI-57 x EC-736500	23.1	38.7	9.0
SAF-39A	NARI-57 x EC-736500	24.5	39.8	9.8
THS-86-2-1	PBNS-12 x EC-736487	19.8	39.6	7.9
A-1 (Check)		24.6	29.8	7.4
Bhima (Check)		28.3	32.1	9.0
PBNS-12 (Check)		32.5	30.2	9.9
NARI-57 (Check)		15.3	37.2	5.8
F-value		NS	19.6**	NS
LSD		-	2.3	-

** Significant at 1% level

Varieties under testing

One spiny variety, ISF-112-15 was promoted to AVT-I and one non-spiny variety, ISF-1258-15 was promoted to AVT-II of AICRP (Safflower). Two non-spiny varieties, SPP-70 and ISF-763 giving 19 and 15% higher seed yield (1367 kg/ha; 1366 kg/ha) than the non-spiny check, NARI-6 (1126 kg/ha; 1194 kg/ha) at national level under rainfed conditions were developed.

Three years mean performance of safflower varieties, SPP-70 and ISF-763 in AICRP trials

Variety	Seed yield (kg/ha) (3 years weighted mean)			Oil yield (kg/ha) (3 years weighted mean)		
	Rainfed	Irrigated	National	Rainfed	Irrigated	National
SPP-70	863 (15)	1662 (23)	1367 (19)	231 (1.4)	473 (10.5)	380 (8)
NARI-6 (NSP Check)	743	1349	1126	226	428	351
ISF-763	1068 (19)	1555 (13)	1366 (15)	331 (10)	537 (11)	439 (10)
NARI-6 (NSP Check)	900	1381	1194	300	484	398

Values in parentheses indicate percent increase over check, NARI-6; NSP-Non-spiny

Release of varieties

High yielding variety: ISF-764 was identified for release on all India basis by Central Variety Release Committee during Combined Varietal Identification meeting held on 16th August 2018. At national level ISF-764 recorded 16 and 19% higher seed yield (2005 kg/ha) and 25 and 27% higher oil yield (618 kg/ha) than the checks, A-1 and PBNS-12, respectively.

Three year mean performance of safflower variety ISF-764 in AICRP trials

Variety	Seed yield (kg/ha) (3 years weighted mean)			Oil yield (kg/ha) (3 years weighted mean)		
	Rainfed	Irrigated	National	Rainfed	Irrigated	National
ISF-764	1583 (25;13)	2274 (17;22)	2005 (16;19)	483 (38;21)	703 (22;29)	618 (25;27)
A-1 (National Check)	1353	2003	1750	379	580	502
PBNS-12 (Variety Check)	1426	1879	1703	414	534	487

Values in parentheses indicate percent increase over A-1 and PBNS-12, respectively

High oleic variety: ISF-1 has been identified for all India release by Central Variety Release Committee during Combined Varietal Identification meeting held on 16th August 2018. The ISF-1 is the first high oleic type (76%) safflower variety developed in India. It recorded 12.4 q/ha seed yield under rainfed conditions and 18.6 q/ha under irrigated conditions and 16.3 q/ha at all India level.

Sesame

Hybridization to create variability

Multi-parent F_1 hybrids involving eight parents were developed to incorporate favorable alleles from improved varieties and germplasm accessions. The list of multiparent hybrids are presented.

(GT-2 x HT-1)/(IC-132201 x IC-500472)//(RT-351 x TKG-22)/IC-96160 x 204618)
(IC-96227 x IC-132201)/IC-96160 x IC-204618)//(TSS-6 x VRI-3)/(HIMA x SHWETA TIL)
(IC-132201 x IC-204613)/(VRI-3 x HT-1)//(GT-2 x E-8)/(PHULE TIL x RT-351)
(PHULE TIL x RT-351)/GT-2 x E-8)//(IC-204613 x IC-500473)/IC-132201 x IC-96160)
(IC-96160 x IC-96227)/(IC-204618 x IC-500472)//(RT-351 x TKG-22)/(IC-132201 x IC-204613)
(GT-2 x HT-1)/(RT-351 x TKG-22)//(IC-132201 x IC-96160)/(PHULE TIL x VRI-3)
(HT-1 x RT-351)/(GT-2 x TKG-22)//(HIMA x TSS-6)/(RAJESHWARI x E-8)
(RAJESHWARI x E-8)/(TSS-6 x VRI-3)//(IC-204613 x IC-500473)/(IC-96227 x IC-204618)

Also two four-way cross hybrids [(IC-204300 x IC-14136)/(EC-118591 x EC-343403) and (EC-343403 x IC-204444)/(EC-118591 x IC-14136)] were developed using germplasm accessions, which were found promising for drought tolerance.

Development of elite breeding lines

A set of F_2 populations of 15 crosses were raised during *kharif* 2018, among them five populations exhibited significant variability. Plants which yielded >80 capsules/plant, >15 g seed yield/plant, plant height of >110 cm with six branches and with oil content of $\geq$ 48% were selected from the F_2 populations.

Number of plants with superior agronomic traits selected in each cross in sesame

Cross	Selections made from the total population
IS-49-1A x RT-346	106/768
CT-55 x CT-57	107/568
EC-30344-1B x TKG-22	105/437
S-195 x CT-57	168/684
H-33 x GOWRI	108/476

Twenty four stable lines from different crosses and germplasm selections were evaluated for yield superiority along with the checks Shweta Til, TKG-22 and GT-10. The oil content ranged from 37-48%. Seed yield in the trial ranged from 470-1090 kg/ha. Three lines from the cross DSS-9 x Madhavi recorded highest seed yield, 10.9 q/ha with 34.5% higher seed yield over best check, TKG-22 (8.1 q/ha) followed by DSS-9 x JLS-O5-03 which recorded seed yield of 10.6 q/ha with 33% higher seed yield and DSS-9 x TKG-22 recorded a seed yield of 10.2 q/ha with 30% higher seed yield over the best check with an oil content of 48%, 46% and 50%, respectively.

Study on rate of natural cross pollination

Sesame is a self-pollinated crop, but cross pollination occurs due to insects and predominantly, the honey bees. An experiment was conducted to estimate the percent of cross pollination. Flowers to which honey bee visited were tagged in a set of seven genotypes (5 varieties: Krishna, Shweta Til, EC-133857, JLT-108, Kanak and 2 germplasm accessions: E-8 and IC-205776) and the capsules of those flowers were harvested. Additionally, 50 flower buds from each variety was tagged and selfed using glue technique. A crop was raised using seeds from honey bee visited flowers, selfed flowers, open pollinated flowers and seeds of capsules that were before selfing or honey bee visit. Any plant differing from the morphology of plants from self-pollinated capsule and plants from original seed lot was considered as out cross type. The observations suggest that the visits of honey bees to the flowers resulted in outcrossing that ranged from 20-30%.

Outcrossing frequency (%) in sesame under different polllination methods

Genotypes	Honey bee visited plants and percent outcrossing	Self-pollinated plants and percent outcrossing	Open pollinated plants and percent outcrossing
Krishna	31/97 (32%)	0/42 (0%)	12/96 (12%)
Shweta Til	21/106 (20%)	0/45 (0%)	10/99 (10%)
EC-133857	34/114 (30%)	0/41 (0%)	12/106 (11%)
JLT-408	32/114 (28%)	2/42 (4.8%)	9/128 (7%)
Kanak	36/128 (28%)	0/41 (0%)	18/109 (16%)
E-8	26/112 (24%)	0/42 (0%)	19/141 (13%)
IC-205776	34/89 (38%)	3/38 (7.9%)	24/125 (19%)

Hybrid Development

In castor breeding programme the focus has been to develop wilt and leafhopper resistant high yielding hybrids with different durations. Many of the promising hybrids, identified in the previous years were evaluated for their superiority over national checks and the superior ones have been advanced to next level of testing. Also, ICH-66 hybrid has been identified for release for its cultivation in peninsular India under rainfed conditions. In sunflower, superior experimental hybrids developed in the institute have been identified at different levels of testing under the AICRP system and advanced to next level of evaluation. Additionally, in both castor and sunflower, many experimental hybrids have been developed for further evaluation. In safflower, with the availability of exploitable CGMS system, attention has been paid to identify high yielding CMS based hybrids with high seed yield and oil content. Also, the first CMS based hybrid DSH-185 has been notified by DAC&FW, Ministry of Agriculture and Farmers. A summary of the results obtained under different activities in the pipeline of hybrid development is presented.

Castor

Development of experimental hybrids

A total of 235 new crosses were generated using the following pistillate lines and male lines in *rabi* 2018-19. Seed of three hybrids *viz.,* ICH-266, ICH-440 and ICH-588, were produced for AICRP coordinated trial-IVHT 2019-20.

Pistillate and monoecious lines used for generation of experimental castor hybrids

Female lines	Male lines
M-571, M-574, M-619, DPC-9, DPC-14, DPC-15, DPC-16, DPC-18, DPC-19, DPC-20, DPC-21, DPC-22, DPC-23, DPC-25, DPC-27, DPC-28, DPC-29, IPC-30, IPC-31, IPC-33, IPC-34, IPC-35, IPC-36, IPC-38, IPC-39, IPC-40, IPC-41, IPC-42,IPC-44, IPC-46, JP-86, JP-96, NES-6, CNES-1, SKP-84, JP-77	DCS-109, ICS-125, ICS-127, ICS-304, ICS-310, ICS-312, ICS-313, ICS-313, ICS-316, ICS-318, ICS-320, ICS-322, 48-1, DCS-78, DCS-89, DCS-94, DCS-102, DCS-104, DCS-105, DCS-107, DCS-108, DCS-109, DCS-110, DCS-112, DCS-118, DCS-119, DCS-120, DCS-121, DCS-9, ICS-324, ICS-325, ICS-341, ICS-346, ICS-348, ICS-349, ICS-350, ICS-351, ICS-353, ICS-354, ICS-355, ICS-356

Preliminary evaluation of castor hybrids during *kharif* 2018

A set of 89 new experimental hybrids generated during *rabi* 2017 were evaluated in two sets during *kharif* 2018 in RBD with three replications with DCH-177, DCH-519 and GCH-8 as checks.

In the Set-I of 44 hybrids being evaluated, four hybrids were found promising with significantly higher seed (10.4 to 25.7%) and oil (15.6 to 26.8%) yield than the best check, GCH-8.

Performance of promising castor hybrids identified in the preliminary evaluation trial (Set-I)

Hybrid	No. of nodes to primary spike	Days to 50% flowering of primary spike	Plant height up to primary spike (cm)	Total primary spike length (cm)	Effective primary spike length (cm)	No. of spikes/plant	100-seed weight (g)	Seed yield (g/plant)	Oil content (%)
ICH-880	10	45	94.5	37.5	29.3	8	29.0	95.4	46.9
ICH-901	13	49	121.8	39.6	35.7	5	33.8	86.6	47.3
ICH-904	12	43	104.9	41.5	33.0	5	34.8	86.6	49.4
ICH-909	11	46	100.4	47.7	27.9	5	40.1	83.8	48.7
GCH-8	13	43	86.8	38.7	38.7	5	29.5	75.9	46.5
SEm ±	0.6	1.3	10.9	4.3	3.8	0.7	0.9	5.3	0.6
CD (P=0.05)	1.8	2.5	21.6	8.4	7.6	1.4	1.8	10.5	1.3
CV (%)	9.9	3.6	16.7	14	15.5	7.9	3.7	11.6	1.7

In the set-II of 45 hybrids being evaluated, ICH-887 (DPC-23 x DCS-86) recorded 66% increase in seed yield (1294 kg/ha) over the best check, DCH-177 (779 kg/ha)). Two other hybrids *viz.*, ICH-888 (DPC-18 x DCS-121) and ICH-941 (DPC-27 x DCS-89) were found promising with 49% and 42% increase in seed yield over the best check.

Promising castor hybrids in preliminary evaluation trial during *kharif* 2018 (Set-II)

Hybrid	Plant height up to primary spike (cm)	No. of nodes to primary spike	Days to 50% flowering	Total primary spike length (cm)	Effective primary spike (cm)	100-seed weight (g)	Seed yield (kg/ha)	Oil content (%)
ICH-884	73	12.5	46	39.7	33.3	29.8	1025	47.4
ICH-887	90	14.9	50	38.1	34.9	29.9	1294	47.4
ICH-888	74	13.2	43	41.5	34.1	25.8	1161	46.8
ICH-941	78	12.4	48	45.9	43.1	29.8	1110	48.3
DCH-177 (Check)	63	13.8	44	37.8	35.8	29.9	779	47.6
DCH-519 (Check)	87	16.8	63	43.8	43.4	29.2	543	46.5
GCH-8 (Check)	73	14.0	56	42.3	42.3	31.9	704	49.0
SEm+	6.3	0.68	1.9	4.1	4.1	3.26	90	1.44
CV (%)	8.4	4.85	3.9	10.5	10.9	12.2	13	3.1

Preliminary evaluation of castor hybrids during *rabi* 2018-19

Twenty nine hybrids were evaluated in two sets in a RBD of two replications. In set-I, among 12 advanced hybrids evaluated, ICH-741 and ICH-725 were 66% and 54% superior in seed yield compared to the best check, DCH-519 (1908 kg/ha), respectively.

Promising castor hybrids in advanced evaluation of hybrids during *rabi* season (Set-I)

Hybrid	Plant height up to primary spike (cm)	No. of nodes to primary spike	Effective primary spike length (cm)	No. of capsules on primary spike	100-seed weight (g)	Seed yield (kg/ha)	Oil content (%)
ICH-741	86	13	53	92	33.0	3174	47.7
ICH-725	61	12	51	76	33.7	2931	47.9
ICH-739	63	12	47	76	35.5	2729	49.4
DCH-519 (Check)	61	16	54	89	33.5	1908	47.5
GCH-7 (Check)	43	11	40	87	32.5	1316	48.0
CD (p=0.05)	15.7	1.3	11.24	23.2	3.4	915	1.12
CV (%)	11.9	4.9	10.8	13.6	4.8	17.6	1.12

In set-II of 17 hybrids evaluated, ICH-347 (DPC-21 x JI-340) and ICH-368 (M-571 x DCS-89) were significantly superior to the best check, GCH-7 (2170 kg/ha).

Promising castor hybrids in advanced evaluation during *rabi* season (Set-II)

Hybrid	Plant height up to primary spike (cm)	No. of nodes to primary raceme	Total primary spike length (cm)	Effective primary spike length (cm	100-seed weight (g)	Seed yield (kg/ha)
ICH-347	102	13	60	54	33.4	2797
ICH-368	111	14	59	59	35.2	2533
GCH-7 (Check)	113	15	68	63	34.7	2170
CD (p=0.05)	40.1	2.5	11.4	9.5	2.6	299.3
CV (%)	19.2	10.0	9.2	8.1	3.7	7.2

Confirmatory yield trial of promising castor hybrids during *kharif* 2018

In confirmatory yield trial, 40 experimental hybrids along with three checks (DCH-177, DCH-519 and GCH-8) were evaluated under rainfed conditions in a RBD of three replications in a plot size of 21.60 sq.m. There was severe moisture stress during the period of July, 2018 to March, 2019 with a total rainfall of approximately 450 mm. There was also significant variation between replications due to soil fertility variation leading to CV of 23% and the CD for total yield was non-significant. Despite these constraints, few hybrids like ICH-382 (2896 kg/ha), ICH-169 (2429 kg/ha), ICH-243 (2427 kg/ha), ICH-239 (2416 kg/ha), ICH-277 (2328 kg/ha), ICH-170 (2320 kg/ha), ICH-1009 (2302 kg/ha) and ICH-26 (2298 kg/ha) were found promising than the best check, GCH-8 (1819 kg/ha). These hybrids had better yielding ability under moisture stress with good branching, more number of spikes, 100-seed weight and stay green nature.

Performance of promising castor hybrids in the confirmatory yield trial

Hybrid	No. of nodes to primary spike	Plant height up to primary spike (cm)	Days to 50% flowering of primary spike	Effective primary spike length (cm)	No. of capsules in primary spike	Seed yield (kg/ha)				100-seed weight (g)	Oil content (%)
						110 days	150 days	240 days	Total		
ICH-382	14	102	48	37	63	602	1334	960	2896	30	49.1
ICH-169	15	93	47	40	64	695	987	747	2429	33	48.3
ICH-243	13	74	46	46	67	703	878	845	2427	27	48.0
ICH-239	14	105	48	28	65	845	705	867	2416	33	47.4
ICH-277	14	109	47	30	61	800	658	869	2328	39	47.7
ICH-170	13	84	48	33	68	816	859	644	2320	34	47.8
ICH-1009	14	108	50	31	63	740	862	700	2302	30	49.2
ICH-26	14	92	47	37	69	875	942	481	2298	34	48.6
ICH-284	14	104	49	34	79	1028	592	599	2219	32	47.3
GCH-8	12	89	47	38	68	872	638	309	1819	31	48.4
DCH-519	15	94	50	35	69	700	486	398	1584	27	46.9
DCH-177	10	50	39	39	58	648	321	175	1144	25	47.3
CV (%)	5.6	10.6	2.8	8.7	12.7	20	32	48	23	5.07	-
LSD at 5%	1.2	15.3	2.1	5	13.2	NS	360	391	NS	2.5	-

Release of hybrid

The hybrid ICH-66 has been identified by Combined Varietal Identification Committee Meeting of Oilseed Crops under Crop Science Division of ICAR on 16th August, 2018, for cultivation in rainfed castor growing regions of peninsular India. ICH-66 is a high yielding, wilt and root rot resistant hybrid. It has longer effective primary spike length (45 cm) and better 100-seed weight (29.0 g) under rainfed conditions compared to the checks DCH-177 (39 cm and 27.3 g) and DCH-519 (44.8 cm and 26.4 g).

ICH-66 - A new castor hybrid suitable for rainfed cultivation in peninsular India

Sunflower

Synthesis of experimental hybrids

To strengthen the AICRP breeding programmes towards development of superior inbreds/hybrids, and facilitate exchange of CMS lines across centres, 80 CMS lines were procured from AICRP centres in addition to those available at IIOR. Totally, 124 CMS lines along with the maintainers were raised for maintenance and multiplication. Twenty promising CMS lines (A/B) were supplied to the new centres at Tornala and Bhubaneshwar for initiating the heterosis breeding programme. Multiplied and distributed CMS and R lines obtained from USDA-USA to Raichur (8 CMS A/B, 17 R lines), Bhubaneshwar (20 CMS A/B, 21 R lines), Akola (18 CMS A/B, 16 R lines), IIOR (24 lines to breeders; 104 to physiologist), Latur (21), Hisar (4 early maturing lines), Nandyal (21), Tornala (20 CMS A/B, 21 R lines), Ludhiana (6 CMS A/B, 25 R lines) for strengthening the hybrid breeding programmes. A total of 600 new experimental hybrids were generated during *kharif* 2018 and *rabi* 2018-19, using existing CMS and R lines and those obtained from USDA.

Evaluation of hybrids for seed yield and yield contributing traits

New hybrids generated during *rabi* 2017-18 were evaluated during *kharif* 2018 in an augmented design using KBSH-44 and DRSH-1 as checks. Out of 220 hybrids evaluated, 20 hybrids were found promising with significantly higher seed yield than the national checks.

Performance of promising sunflower hybrids in the preliminary evaluation trial

Hybrid	Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	No. of leaves/plant	Seed yield/plant (g)	100-seed weight (g)	Volume weight (g/100 ml)	Oil content (%)
IOSH-409	54	86	171.8	14.2	33	43.2	8.0	43.6	38.2
IOSH-413	53	84	187.2	17.2	41	45.9	7.6	44.4	39.4
IOSH-416	55	85	182.0	16.8	35	45.2	5.0	42.4	38.6
IOSH-434	55	85	183.0	17.2	37	50.6	6.1	44.1	39.0
IOSH-443	57	87	189.2	17.6	43	46.2	5.9	39.5	40.0
IOSH-445	57	87	190.6	18.6	44	49.5	6.3	44.9	39.1
IOSH-460	56	86	195.8	17.6	33	57.4	4.3	46.5	39.5
IOSH-463	56	86	185.0	17.4	33	50.6	6.3	44.5	37.6
IOSH-475	53	83	186.4	16.8	28	49.5	6.4	44.1	38.1
IOSH-479	56	86	185.8	20.0	39	47.0	8.2	47.1	38.6
IOSH-493	56	86	195.4	17.0	43	45.8	6.6	46.1	38.1
IOSH-499	53	83	202.2	18.0	42	48.0	8.0	46.8	38.2
IOSH-500	55	85	192.6	16.4	44	49.9	6.9	45.1	38.0
IOSH-572	55	85	164.4	15.0	25	48.0	5.8	38.1	38.3
IOSH-566	55	85	200.0	17.6	33	49.4	6.0	47.8	38.3
IOSH-572	57	87	199.0	16.2	35	49.6	5.8	46.5	39.7

Hybrid	Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	No. of leaves/plant	Seed yield/plant (g)	100-seed weight (g)	Volume weight (g/100 ml)	Oil content (%)
IOSH-594	54	86	176.6	17.2	29	48.5	6.0	47.6	38.2
IOSH-605	59	89	175.4	15.6	30	48.1	6.7	40.3	38.1
IOSH-609	57	87	193.4	17.6	28	48.2	7.3	45.8	38.6
IOSH-615	54	85	161.0	21.0	23	48.1	7.9	44.5	38.5
KBSH-44 (Check)	57.2	86.1	176.6	16.3	33	35.5	7.0	43.1	32.7
DRSH-1 (Check)	56.7	86.4	196.1	16.2	33	41.7	6.7	44.0	38.6
Mean						32.8			
CD at 5%						4.5			
CV (%)						17.81			

Promising early and late duration sunflower hybrids

Hybrid promoted from IHT to AHT-I

IIOSH-15-20, a new hybrid with 10.3% and 24.8% seed yield and 23.9% and 22.5% oil yield superiority over the check hybrids, KBSH-44 and DRSH-1, respectively in AICRP trial and with 0% downy mildew incidence was promoted from IHT to AHT-I.

Sunflower hybrid promoted from IHT to AHT-I

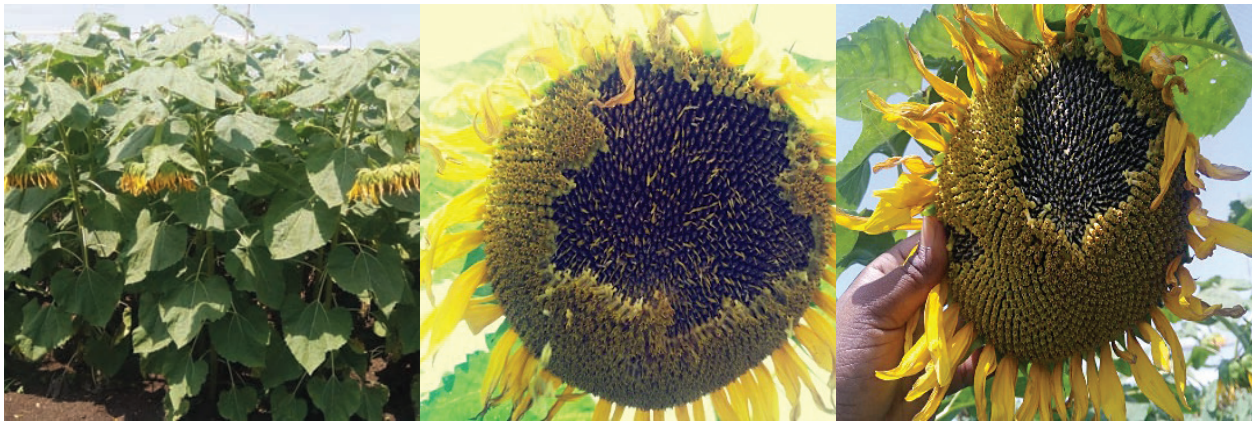
Hybrid	Overall seed yield (kg/ha)	Seed yield superiority % over	Overall oil yield (kg/ha)	Oil yield superiority % over	Downy mildew (%)
IOSH-15-20	2411	110.3	902	122.5	0.0
KBSH-44 (National Check)	2186	100.0	728	98.6	40.0
DRSH-1 (National Check)	1932	85.5	736	100.0	90.0
CD (P=0.05)	97				
CV (%)	10.8				

Hybrid promoted from AHT-I to AHT-II

Entry IIOSH-15-10 was promoted from AHT-I to AHT-II with 7.8% and 26.2% seed yield and 10.7% and 13.4% oil yield superiority over the check hybrids, KBSH-44 and DRSH-1, respectively in AICRP trial. This hybrid has good central filling as well.

Sunflower hybrid promoted from AHT-I to AHT-II

Hybrid	Overall seed yield (kg/ha)	Seed yield superiority % over	Overall oil yield (kg/ha)	Oil yield superiority % over	Downy mildew %
IOSH-15-10	2050	107.8	704	110.7	5.0
KBSH-44 (National Check)	1902	100.0	636	100.0	40.0
DRSH-1 (National Check)	1619	81.6	621	97.3	90.0
CD (P=0.05)	107		48		
CV (%)	11.4		13.4		



Sunflower hybrid IOSH-15-10 with good central filling

Seed multiplication of entries for IHT and AHT trials

Seeds of a total of five entries were multiplied during *rabi* 2018-19 and late *rabi* 2018-19. Seeds of two entries *viz.,* IOSH-15-20 and IOSH-15-10 (5.0 kg seed each) were multiplied for AHT-I and AHT-II trials while 5.0 kg seed of three new entries (IOSH-413, IOSH-460 and IOSH-566), each were multiplied during late *rabi* 2018-19 for IHT (*kharif* 2019) trial.

Safflower

Development of CMS-based hybrids

High yielding hybrids: Of the 59 new hybrids evaluated in four trials, seven hybrids recorded 10-24% higher seed yield than the recently notified hybrid, DSH-185, and 20-34% higher than the best high yielding check variety, A-1 under rainfed conditions at ICAR-IIOR, Hyderabad. Three hybrids *viz.,* ISH-400, ISH-401 and ISH-402 have been promoted from IHT to AVHT-I of AICRP (Safflower).

Notification of Hybrid

The first CMS-based safflower hybrid, DSH-185 has been notified (Notification No. 1379 (E) by Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Performance of new safflower hybrids under rainfed conditions

Hybrid	Seed yield (kg/plot*)	Seed yield (kg/ha)$	Oil content (%)	Oil yield (kg/ha)*	DF	DM	100-seed weight (g)
Trial-I							
ISH-413	3.1	4585 (11, 21)	33	1535 (30, 36)	81	123	4.8
ISH-417	3.2	4681 (13, 23)	31	1455 (23, 28)	83	126	5.2
ISH-419	3.1	4585 (11, 21)	31	1434 (21, 26)	81	124	5.4
ISH-423	3.1	4541 (10, 20)	32	1433 (21, 26)	82	126	5.2
DSH-185 (HC)	2.8	4133	30	1181	86	126	5.4
A-1 (VC)	2.6	3796	29	1132	83	125	6.2
Trial-II							
ISH-425	0.6	941 (24, 34)	33	314 (35, 59)	81	126	5.0
ISH-427	0.6	844 (12, 20)	32	280 (20, 42)	80	125	5.4
ISH-428	0.6	933 (23, 33)	32	295 (27, 50)	79	124	6.0
DSH-185 (HC)	0.5	756	31	220	83	125	5.4
A-1 (VC)	0.5	704	28	197	86	127	6.0

*Plot size: 6.75 sq.m; $: figures in parentheses indicate percent increase over DSH-185 and A-1, respectively;
DF: days to 50% flowering; DM: days to maturity; HC: hybrid check; VC: variety check

Molecular Breeding and Biotechnology

Molecular breeding has been adopted to address the traits that are difficult to phenotype or where pyramiding the genes that impart same phenotype is important. Developing genomic resources has been the focus in molecular breeding programmes in castor, safflower and sesame. Establishing marker–trait associations has been the primary activity in castor. The traits being addressed through MAS are wilt resistance, nematode resistance and graymold tolerance. Both bi-parental populations and association mapping panels have been employed to identify and map markers associated with wilt and also efforts have been made establish the allelic relationship of wilt resistance genes from germplasm sources. In safflower, during this year, focus has been on developing additional genomic resources including the *de novo* genome sequencing and annotation, and identification of additional SSR markers with high PIC, association mapping of QTLs for agro-morphological and quality traits, phenotyping of mapping population for aphid resistance and field evaluation of high oleic lines developed by marker-assisted backcrossing. In sesame, concentration has been on developing SSR based marker system. Continued efforts are being made to develop a reliable in vitro regeneration protocol in castor and further screening of progenies derived from *in planta* transformed lines have been carried out. A brief summary of the progress made under different programmes pursued during 2018-19 are presented.

Castor

Allelic relationship of wilt resistance genes in castor germplasm sources

The allelic relationship of wilt resistance genes in two germplasm sources *viz.*, RG-1354 and RG-2874 was studied by evaluating the F_2 population of the cross RG-1354 × RG-2874 for wilt resistance during *kharif* 2017. The results indicated that these two resistant sources carry non-allelic genes. To confirm the results, a larger population of 180 F_2 plants was raised in the wilt sick plot of IIOR during *kharif* 2018. The reaction of individual plants to Fusarium infection was scored at 150 days after sowing. Out of 180 F_2 plants, 171 were resistant and 9 were susceptible. The observed ratio of resistant and susceptible individuals matched well with the expected ratio of 15:1 (χ^2=0.265), if the

independent dominant genes are responsible for wilt resistance in the parents. Based on the evaluation for two years, it is confirmed that the resistant sources, RG-1354 and RG-2874 carry non-allelic genes, which can be pyramided into a single genetic background to provide durable resistance to wilt.

SNP markers linked to wilt resistance genes in castor

The putative SNP markers linked to wilt resistance in genome-wide association analysis were tested in two independent F_2 populations. One hundred F_2 plants of RG-27 × JI-35 and 76 F_2 plants of RG-2944 × JI-35 were evaluated for wilt resistance by raising the plants in the permanent wilt sick plot of IIOR and scoring their reaction at 150 DAS. The DNA was extracted from the leaves collected from the seedlings grown in the sick plot before they succumbed to wilt. All the F_2 plants were genotyped using the SNP markers putatively linked to wilt resistance. The comparison of genotypic and phenotypic data indicated that two SNP markers *viz.,* Rc_30146-1221543 and Rc_29706-482910 co-segregated with the observed phenotype in RG-27 × JI-35. Similarly, four SNP markers *viz.,* Rc_30152-1185440, Rc_30152-1283827, Rc_29852-1074057 and Rc_30061_63432 co-segregated with the observed phenotype in RG-2944 × JI-35.

Mapping of genomic regions linked to reniform nematode resistance in castor

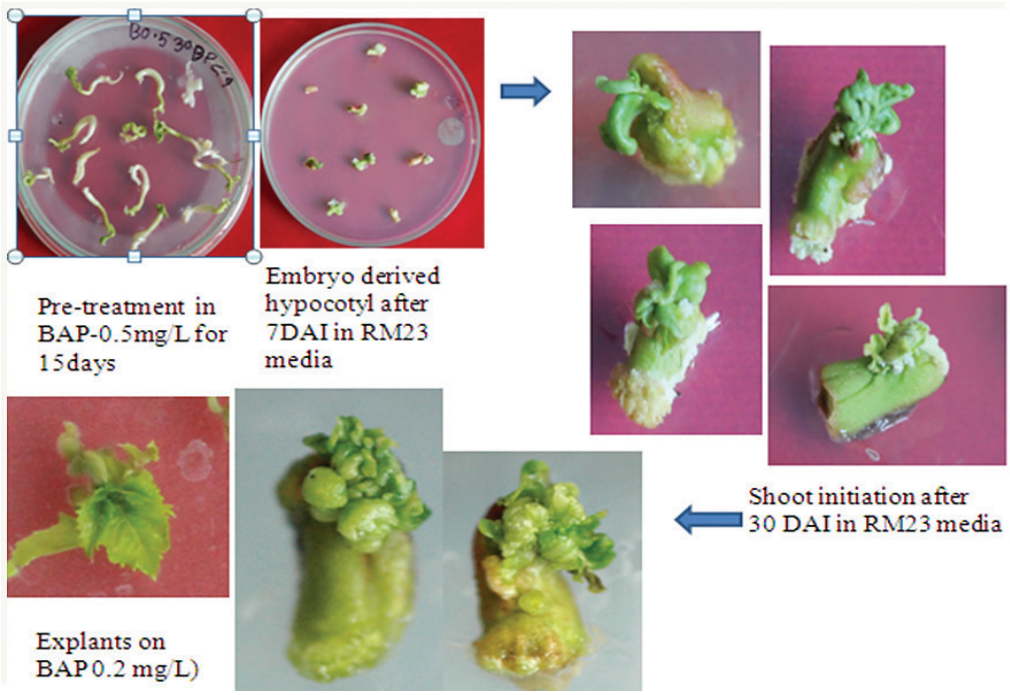
A set of 96 recombinant inbred lines (RIL) of JC12 × 48-1 was evaluated for resistance to reniform nematode (*Rotylenchulus reniformis*) in pots with artificial inoculation of nematodes (500 nematodes / 250 g of soil). The scoring for nematode resistance was done on the basis of number of juveniles harvested per gram of soil at 45 days after inoculation. The genotypic data for 957 SNP markers generated earlier was used for constructing the linkage map. QTL analysis performed using QTL Cartographer V2.5 revealed four genomic regions linked to reniform nematode resistance (LOD 3.3 to 4.5). These QTLs explained 9 to 13% of total phenotypic variance indicating the complex nature of the trait in castor.

QTLs associated with reniform nematode resistance in castor line JC-12

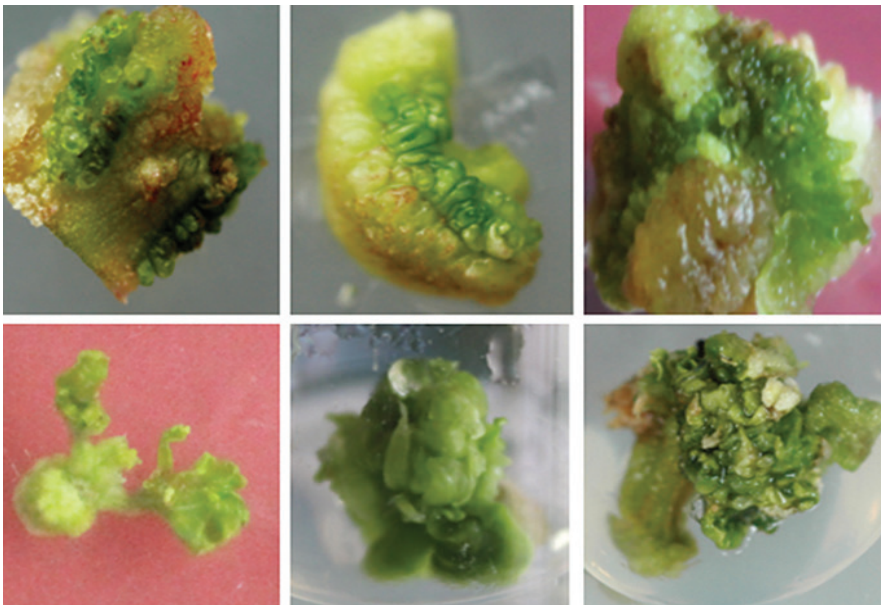
Linkage group	Marker	LOD score	R^2
3	Rc_29949-26898	4.46	0.13
5	Rc_29647-244577	4.25	0.12
6	Rc_28151-12413	4.29	0.12
8	Rc_29666-381712	3.34	0.09

Optimization of regeneration and transformation protocols to realize graymold resistant transgenic castor

Tissue culture studies: As the shoot initials obtained from embryo axes derived hypocotyl explants from previously reported media combinations did not develop further into elongated shoots, other media combinations were tried for initiating organogenesis. Different explants viz., seedling derived cotyledons, hypocotyls and embryo axes derived hypocotyls were evaluated for their response on 104 different hormonal combinations for direct regeneration and organogenesis. Embryo derived hypocotyls responded better than other explants and 10 hormonal combinations (RM4, RM5, RM6, RM7, RM11, RM13, RM23, RM27, RM28, RM30) showed shoot like structures from embryo derived hypocotyls.



Shoot initiation from hypocotyls in RM23 media



Shoot initiation from hypocotyls in RM6 media

***In planta* transformation work:** Screening of progeny of 30 T_1 plants of *in planta* transformed castor plants in the green house for the presence of transgene(s) identified three plants positive for complete cassette of *EBP*1 transgene using component specific, and construct specific PCRs. Confirmed the presence of transgene *EBP*1 in the T_2 progeny plants from 10 *EBP*1 transgene positive T_1 plants. Screened T_2 progeny plants of eight T_1 plants that were positive of *EBP*1 transgene and three T_1 plants positive for *BIK*1 transgene and identified positive plants. T_3 progeny seeds collected from *EBP*1 gene positive T_2 progeny plants will be screened further for transgenicity.

Sunflower

Backcrossing and generation advancement of the crosses involving ARM 243 x *H. praecox*

Powdery mildew has become a serious problem on sunflower and among the sources of resistance being identified, the diploid annual *H. praecox* has been adequately characterized at the molecular level using transcriptomics and proteomics. Fifty progeny rows of the crosses involving ARM 243A/CMS234A with *H. praecox* (PRA 1823) were raised and based on the phenotyping for powdery mildew reaction, 20 lines were selected for further analysis and generation advancement. PCR analysis using sunflower specific SSR primers was done to identify molecular markers associated with powdery mildew resistance in lines derived from 2023A x PRA-1823. A total of 244 primers were tested on parental lines of which 59 primers exhibited polymorphism between the parents. These 59 primers were tested on the resistant bulks and from these, four primers (ORS 801, 1024, 1079 and 1180) showed banding pattern matching with resistant parent (PRA-1823) and resistant bulks. Validation of these 4 primers on 69 resistant plants from three lines showed close association of ORS 801 primer with the trait. All the resistant plants showed the same amplicon size (260 bp) as that of the resistant parent (PRA-1823) and resistant bulks.

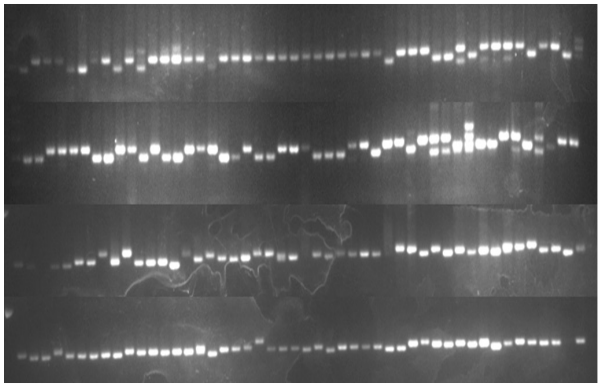
Safflower

Development of genomic and genetic resources

Screening of newly developed SSR markers: Genomic SSRs were predicted in the genome assembly using MISA tool. Primers for subset of 500 micro-satellite (>30 bp) loci were synthesized and tested for amplification and polymorphism in a parental panel of 24 safflower germplasm lines. 136 (27.2%) primers were polymorphic and PIC value ranged between 0.24 and 0.76.

Phenotyping of germplasm mapping panel for kernel oil content, oil content and hull content and their associations: The kernel oil content ranged from 50.7 (GMU-1161) to 65.5 (EC-736511) in safflower germplasm mapping panel (240 lines) and oil content from 24.3 (GMU-1161) to 48.4 (EC-736500-1) and hull content from 26.3 (EC-736500-1) to 56.1 (GMU-1241). The analysis indicated that though there was a high correlation between seed oil content and kernel oil content (0.68), the negative correlation between kernel oil content and hull content (-0.38) was not significant indicating that scope exists for selecting lines with high kernel oil content despite high hull content.

Genotyping of germplasm mapping panel using SSR markers: To identify marker-trait associations in safflower, the safflower germplasm mapping panel comprising of 240 germplasm accessions was genotyped with 250 SSR markers. Genotyping of mapping panel using microsatellite markers revealed significant genetic diversity in the panel. Out of 250 primers, 214 were polymorphic. The SSR markers generated a total of 638 alleles with an average of 3.02 alleles per locus. The number of alleles per locus ranged from 2 to 16.



SSR profile of germplasm mapping panel with ct337 primer

Association analysis of agronomic traits, oil content and quality: For preliminary understanding, association mapping was performed using phenotypic data for 10 traits (*viz.*, seed oil content, kernel oil content, oleic acid, linoleic acid, number of capitula per plant, number of seeds/capitula, hull content, seed size, seed yield, 100-seed weight) available for two growing seasons (2016-17 and 2017-18) with the genotypic data through General Linear Model. Seventeen significant marker-trait associations ($P < 0.05$) were identified; of which, several marker-trait associations had R^2 value of >10% (phenotypic variance explained). Many marker trait associations were also observed between traits (*viz.*, seed oil content, kernel oil content, hull content) that showed positive or negative correlation in their phenotypic values.

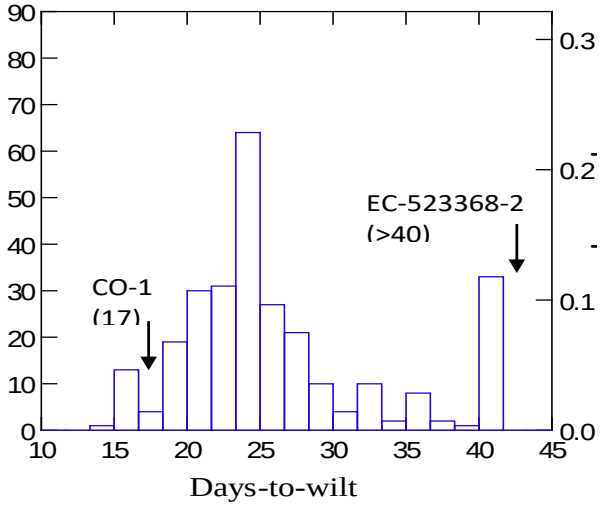
Molecular characterization of CMS sources of safflower

To ascertain differences among safflower CMS sources (A-133-1A, A-133-1B, AKS-CMS2A, AKS-CMS3A, NARI-CMS1A, NARI-CMS2A) from IIOR, PDKV, Akola and Nimbkar Agricultural Research Institute, Phaltan (Maharashtra), organellar profiling in general and mitochondrial and cholorplast genome profiling in particular was followed. All the CMS lines were checked for pollen sterility and the lines showed sterility. A total of 33 primers that included three REP primers: ERIC, BOX, REP universal primers and 20 different gene specific mitochondrial (mt) DNA specific primer pairs and 10 choloroplast specific primers were used to study the polymorphism between the genotypes. Among the primers tested, mitochondrial and chloroplast primers failed to show differences in the A, B and donor lines tested. ERIC primer also failed to disclose polymorphism. The BOX and REP primers showed polymorphism with NARI CMS 2A and other CMS lines. The donor of NARI CMS 2A was *C. palaestinus*. With the primers tested, NARI CMS2A was found to be from a different source while all other CMS lines were from a common cytoplasmic source.

Phenotyping of RIL population for reaction to safflower aphid

A set of 280 F_8-RILs (CO-1 x EC-523368-2) were screened against aphids as per the standard screening protocol in two replications. Symptoms of aphid damage on plants was monitored daily and the day on which at least 80% of plants in each RIL wilted was recorded as 'days-to-wilt' after aphid infestation. The days-to-wilt of RILs after aphid infestation ranged from 14 to 40 with an average of 26.1. The parents of the RILs, CO-1 had days-to-wilt of 17 while EC-523368-2 did not die even at 40 days after infestation. The RIL population displayed a good level of variability for the reaction to aphid. The variability was quantitative with some level of skewness. Mapping of QTLs associated with aphid resistance using this RIL population is in progress.

Differential reaction of F_8- RILs of CO-1 x EC-523368-2 in safflower



Frequency distribution of phenotypic values (days-to-wilt) of F_8-RILs of the cross: CO-1 x EC-523368-2 in safflower

Field evaluation of high oleic lines developed by marker-assisted selection (MAS)

A set of six safflower selections developed by marker-assisted backcrossing of high oleic allele, 'ol' were evaluated for seed yield, oil content and fatty acid composition during *rabi* 2017. Seed yield of backcross selections was comparable with the standard check varieties. The oil content ranged from 32.8% to 35.5% and the oleic acid content ranged from 72.1 to 84.7%. The selection, BC_2F_6-38-9-4 showed highest oil yield (11 g/plant) coupled with high oleic acid content (84.7%).

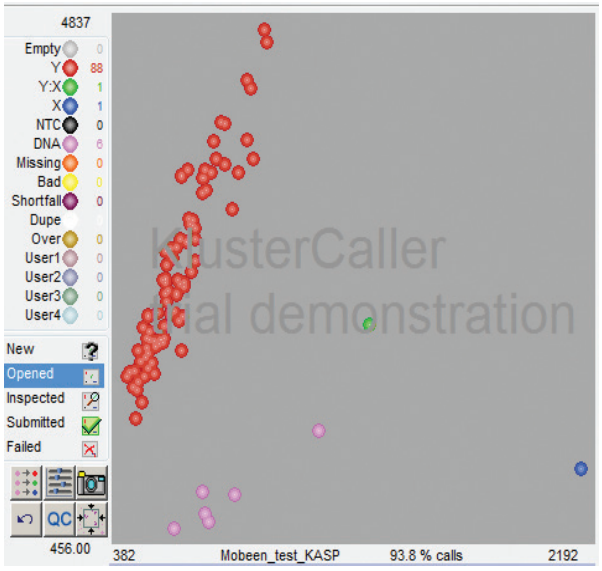
Yield performance of high oleic safflower lines developed by MAS

Line	Seed yield/ plant (g)*	100-seed weight (g)	Oil content (%)	Oil yield (g)	Fatty acid composition (%)			
					Palmitic acid	Stearic acid	Oleic acid	Linoleic acid
BC1F6-39-3-3	28.1 (53)	3.9	35.5	10.0	4.7	2.1	77.6	15.4
BC2F6-38-1-7	30.7 (46)	5.1	33.6	10.3	4.9	1.9	72.1	20.9
BC2F6-38-9-4	32.7 (60)	5.2	33.6	11.0	4.4	1.8	84.7	8.9
BC2F6-38-14-15	31.7 (45)	5.2	34.1	10.8	4.7	1.8	82.1	11.2
BC3F4-16-12	30.2 (34)	4.8	33.7	10.2	4.8	1.8	79.4	13.8
BC3F4-16-27	30.0 (42)	4.8	32.8	9.8	5.0	2.2	80.5	12.1
A-1 (Check)	30.3 (57)	5.3	29.7	8.9	6.0	3.0	23.1	67.7
Bhima (Check)	32.6 (47)	5.2	31.6	10.2	5.5	2.0	26.1	66.1
PBNS-12(Check)	35.3 (33)	5.1	29.6	10.4	6.2	2.9	21.5	69.2
NARI-57(Check)	18.3 (64)	3.3	35.7	6.5	7.5	2.8	17.9	71.5
F-value	3.8 ns	20.4**	13.1**	3.0 ns	26.3**	3.5 ns	46.3**	41.8**
LSD	-	0.4	1.7	-	0.5	-	12.4	12.4

*Mean of two replications; values in brackets: plant stand/replication

The allelic status (*ol*) of high oleic lines was confirmed by genotyping several plants in each of the backcross lines. Out of 228 plants (across six lines) genotyped by high oleic allelic specific marker assay (KASP), 224 plants confirmed the presence of target allele. Only four off-types were found.

Line	No. of plants genotyped by KASP	High oleic (*ol*) +ve plants	Off-types
BC_1F_6-39-3-3	38	38	0
BC_2F_6-38-1-7	33	31	2
BC_2F_6-38-9-4	42	42	0
BC_2F_6-38-14-15	40	39	1
BC_3F_4-16-12	42	41	1
BC_3F_4-16-27	33	33	0

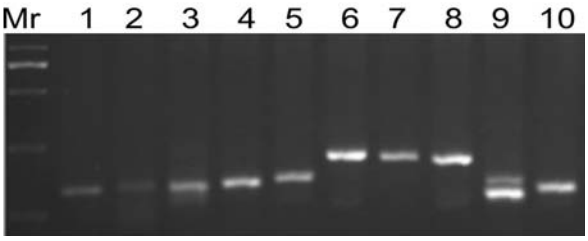


Genotyping of high oleic allele (ol) in safflower breeding lines developed by MAS

Sesame

Screening/optimization of amplification conditions for a set of 100 SSR markers

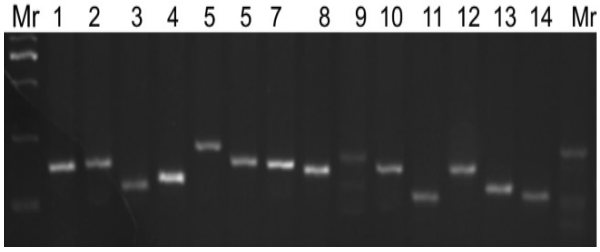
An additional set of 100 SSR markers were optimized for robust amplification in Indian sesame genotypes. The optimization was carried out with respect to annealing temperature and magnesium chloride concentration. Out of 200 SSRs, 74 markers showed robust amplification. In the following figure, ten microsatellite markers, *viz.*, SIM 514, SIM 612, SIM 421, SIM 465, SIM 559, SIM 346, SIM 670, SIM 143, SIM 501 and SIM 473 showed robust amplification at annealing temperature of 50^{0}C and magnesium chloride concentration of 2.5 μl in a reaction volume of 25 μl, using template of genomic DNA of sesame genotype, RT-351.



Amplification of RT-351 with SSR markers
1) SIM 514, 2) SIM 612, 3) SIM 421, 4) SIM 465, 5) SIM 559, 6) SIM 346, 7) SIM 670, 8) SIM 413, 9) SIM 501 and 10) SIM473

Validation of amplified/optimized SSR markers through polymorphism analysis

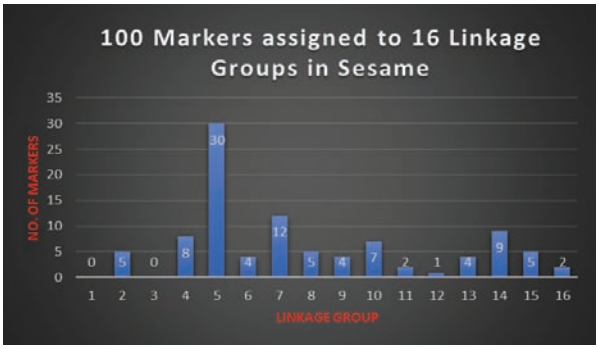
Each of the 74 SSR markers were analysed for polymorphism using a panel of 20 Indian sesame genotypes. In the following figure, marker SIM 614 shows the polymorphic alleles amplified from the genomic DNA of 14 sesame genotypes. Out of 74 SSR markers, 27 SSRs were polymorphic and amplified a total of 95 alleles among the 20 genotypes, with an average of 3.51 alleles per marker locus. PIC values ranged from 0.34 to 0.52 among the 20 genotypes.



Polymorphism with SIM 614 in sesame genotypes
1) ES-62, 2) ES-303311, 3) MT-75, 4) GRT-8368, 5) G-TIL-10, 6) G-TIL-2, 7) DS-5, 8) 12-JUN, 9) TMV, 10) JLT-408, 11) Savithri, 12) NIC-16426, 13) RT-351, 14) RT-103

Assigning of linkage groups to the amplified SSR markers using *in silico* approach

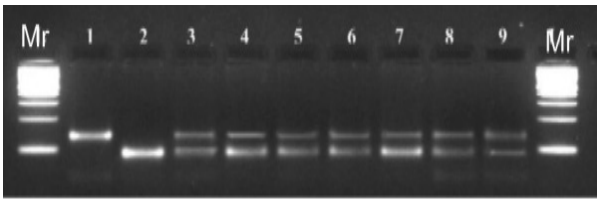
Computational analysis of sesame specific SSRs: An additional set of 100 SSRs were computationally analyzed using sesame genome sequence database. In the database, there are 16 linkage groups (LGs). As depicted in the following figure, 100 SSR markers were mapped to 14 LGs. LG5 had maximum markers (30 SSRs) while LG12 had minimum markers (1 SSR). LGs 1 and 3 had none of the markers assigned.



In silico assigning of markers to sesame linkage groups

Towards developing genetic linkage map of sesame

For development of fine maps and linkage/association maps, the prerequisite is the availability of a skeleton map. In order to develop an SSR skeleton map in Indian sesame genotypes, crosses were made between the parents which showed parental polymorphism for 105 SSR markers (Krishna x JLT 408 and the reciprocal). As depicted in the following figure, microsatellite marker loci hybridity was confirmed using the marker SIM 45 to genotype nine F_1 individuals.



Molecular confirmation of hybridity. 1-9 are nine F1 individuals genotyped with SSR marker SIM 45.

Identification and stabilization of genotypes for mapping of various agronomic traits

In order to develop appropriate mapping population, the most important and critical requirements is the availability of a pair of contrasting and genetically stable genotypes. Towards this end, 106 selected and selfed sesame genotypes were evaluated for the contrasting traits. The selected genotypes exhibited a wide spectrum of variability: plant height was in the range of 31.6-120 cm; number of primary branches ranged from 0-8; number of secondary branches was in the range of 0-10; number of capsules per node exhibited the range of 1-6; number of capsules per plant ranged between 1 and 143; number of locules per capsule varied from 4 to 8; capsule length was

in the range of 0.5-5 cm; capsule width ranged from 0.24 to 1.8 cm; inter-nodal length ranged from 3 to 12 cm; basal bearing was in the range of 5-33 cm; time taken for flower initiation ranged between 28 and 70 days; seed weight per plant varied between 0.13 g and 15 g; fresh weight per plant was recorded in the range of 11-127 g; dry weight per plant was found between 0.8 g and 51.6 g; harvest index ranged from 0.01 to 0.75; and seed oil content varied between 15.8 and 44.7%.

Variability in yield-contributing traits and genotypes recording minimum and maximum values in a panel of genetically stabilized sesame genotypes

Trait	Range	Min. Recorder	Max. Recorder
Plant height (cm)	31.6-120	NIC-16426-P4-P5-P2	DS-5-P8-P5-P3
Primary branches (#)	0-8	NIC-16426-p6-p9-p2	GTIL-10-p5-p7-p9
Secondary branches (#)	0-10	Many	GTIL-10-p6-p5-p1
Capsules/node (#)	1-6	IS-446-1-84-p3-p8-p4	RT-351-p7-p8-p6
Capsules (#) per plant	2-143	MT-75-P1-P6-P5	G-TIL-10-P1-P5-P3
Locules/capsule (#)	4-8	Many	SI-2192-p4-p6-p1
Capsule length (cm)	0.5-5	JLT-408-P3-P4-P1	12-JUN-P1-P6-P4
Capsule width (cm)	0.24-1.8	Thilothama-p2-p3-p6	G-TIL-2-P9-P2-P5
Internodal length (cm)	3 – 12	DS-5-p5-p7-p1	IS-113-A-p4-p8-p5
Basal bearing (cm)	5-33	NIC-16426-P4-P6-P2	DS-5-P1-P7-P6
Days to flower initiation (#)	28-70	G-TIL-2-p7-p5-p3	JLT-408-P5-P3-P9
Seed weight per plant (g)	0.13-15	SI-1687-1-p6-p9-p2	RT-351-p6-p1-p3
Fresh weight (g)	11-127	SAVITHRI-P5-P1-P6	G-TIL-10-P1-P5-P3
Dry weight (g)	0.8-51.6	G-43-p5-p3-p9	SAVITHRI-P5-P1-P6
Harvest index	0.01-0.75	RT-351-P6-P1-P3	SI-1687-1-P6-P9-P2
Seed oil content (%)	15.8-44.7	G-43-P2-P1-P3	12-JUN-P4-P7-P1

Seed Production

The institute has the mandate of producing the nucleus, breeder and foundation seeds of the parental lines of hybrids released from the institute. Quantities of different types of seeds as per the DAC indents have been produced. Apart from this, under the seed hub project, huge quantities of certified seeds of varieties/hybrids in the seed chain have been produced to meet the requirements of the farmers of the country. Highlights of the different activities undertaken in seed production aspect are presented.

A total of 416 q of quality seed of parental lines, varieties and hybrids of castor, sunflower, sesame and safflower was produced during the year. Seed was produced both under Seed Production of Agricultural Crops (SPAC) and oilseeds seed hub programmes on station and through participatory approaches.

Seed production of different oilseed crops

Crop	Variety/ Parent/ Hybrid	Seed production (q)
Castor 	DCS-107 (Variety) (Breeder seed)	1.00
	DPC-9 (Parental line)	1.00
	M-574 (Parental line)	1.00
	DCS-9 (Parental line)	0.50
	DCS-78 (Parental line)	0.50
	ICS-164 (Parental line)	0.05
	ICH-66 (Hybrid)	20.00
	DCH-519 (Hybrid)	202.70**
	DCH-177 (Hybrid)	83.80**
	Total	**311.0**
Sunflower 	DRSF-113 (Variety) (Breeder seed)	0.10
	DRSF-108 (Variety) (Breeder seed)	0.05
	ARM-243 A (Female parent)	0.50
	ARM-243 B (Female maintainer line)	0.25
	6D-1 (Male parent)	0.25
	DRSH-1 (Hybrid)	12.00
	Total	**13.15**
Sesame 	YLM -66 (Variety)	1.50
	Shweta Til (Variety)	15.00
	CUMS-17 (Variety)	5.00
	GT-10 (Variety)	1.50
	Total	**23.00**
Safflower 	NARI-96 (Variety) (Breeder seed)	1.20
	ISF-764 (Variety)	60.30*
	DSH-185 (Hybrid)	5.00
	CMS-133A (Female line)	1.50
	B-195 (Maintainer line)	0.50
	1705-p22 (R line)	1.00
	Total	**69.50**
Grand total	**2018-19**	**416.65**

*=Participatory seed production of IIOR **=Participatory certified seed production under Oilseeds Seed hub

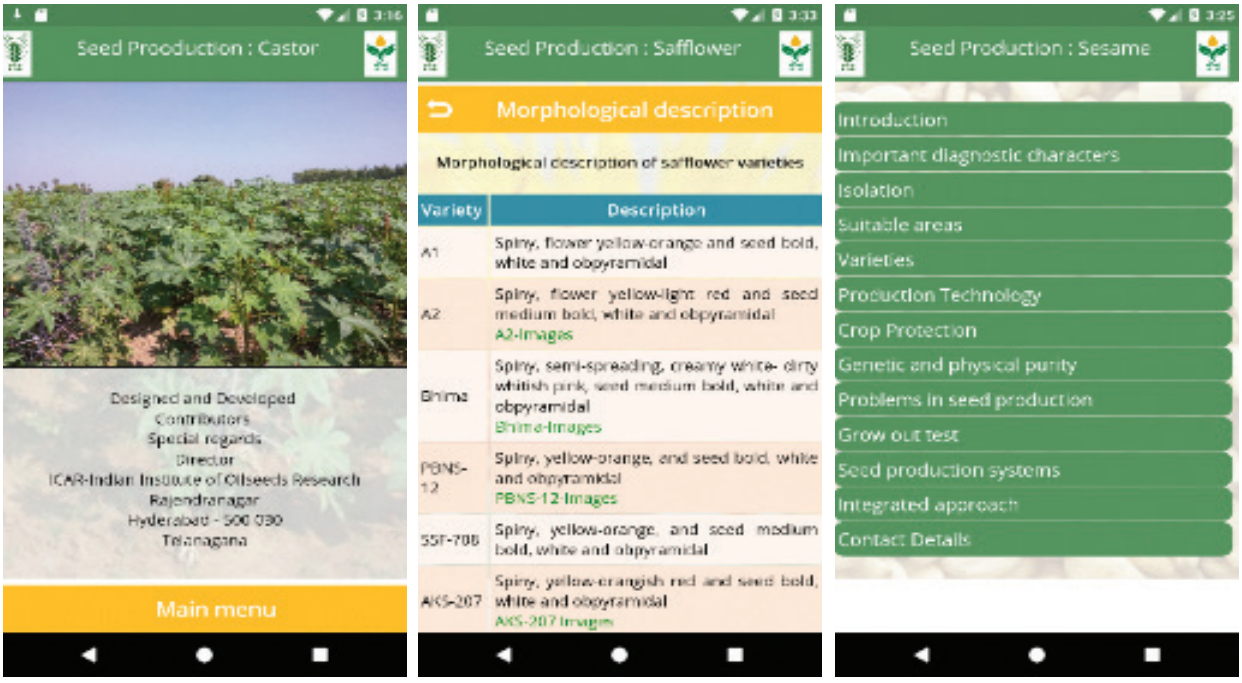
In addition to breeder seed, 250 g each of the nucleus seed of DPC-9, M-574 and SKP-84; 1 kg of nucleus seed of ICS-164 in castor and nucleus seed of parental lines of the sunflower hybrid DRSH-1 [ARM-243A (1.5 kg) and B (1.5 kg) and RHA-6D-1 (1.0 kg)] was produced during *rabi* 2018-19.

A new DAC&FW project on Oilseeds Seed Hub titled "Creation of Seed Hubs of Oilseeds for Enhancing Quality Seeds Availability of Major Oilseeds" was sanctioned for 2018-20 with a budget of Rs.5091.18 lakhs with ICAR – IIOR as the Coordinating unit. The total production target of certified seed of the nine oilseeds is 60825 q (2018-19 = 24695 q). Each seed hub is provided with a budget support of Rs.150 lakhs (Rs.100 lakhs as revolving fund and Rs.50 lakhs for creation of infrastructure, storage godown and processing equipment). ICAR-IIOR is one of seed hubs for castor and sunflower. For 2018-19, IIOR has produced 900 q of certified castor seed of DCH-519 and DCH-177 hybrids against a target of 1300 q. For sunflower, against a target of 100 q, the production achieved was 20 q.

Mobile Apps on seed production technologies

User friendly 'Mobile Apps' on seed production techniques in castor, safflower and sesame were developed for the benefit of seed producer organizations, researchers, industry and farmers. The purpose of developing the Apps is to acquaint the user in the steps to be followed for seed production of the aforesaid crops. The app available under Google play store can be installed on Android supported mobiles.

The Apps provide crop wise information on suitable soil type, sowing time, spacing, seed rate, seed treatment, fertilizer requirement, plant protection measures, isolation distances for varieties and hybrids, sex expression, state-wise varieties, maintenance of genetic and physical purity, seed standards, rogueing etc., pertaining to seed production.



Mobile Apps on seed production technologies in oilseed crops

DUS Testing

Under the Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority, DUS testing of one new candidate and one farmers variety was undertaken along with two reference varieties for each candidate in castor. Data was recorded for 30 DUS traits. Initial characterization of one new farmers' variety of castor was also undertaken.

Conservation Agriculture

Conservation agriculture aims at achieving sustainable agriculture and improved livelihoods of farmers through the application of the three basic principles: minimal soil disturbance, permanent organic soil cover (crop residue or cover crops) and crop rotations in sequences and/or associations. In the long-term, conservation agriculture has been found to render several benefits including soil conservation with improved soil health, high rain water use efficiency, climate change mitigation and adaptation, improved biodiversity, resilience to climate shocks and higher economic returns. Keeping this in view a field experiment was initiated to assess the potential of conservation agricultural practices in castor based cropping systems and the results are presented.

Development of conservation agricultural practices for castor based cropping systems

During the first year of field experimentation on conservation agriculture under rainfed conditions in shallow Alfisols, three tillage treatments *viz.,* (i) conventional tillage - one disc plough + two cultivators + rota tiller; (ii) reduced tillage - one cultivator + one rota tiller (no disc plough); (iii) zero tillage - no tillage and herbicidal weed management in main plots and four intercropping systems *viz.,* sole castor (cv. DCH-519); castor + redgram (cv. Hanuma) (for grain and cut *in situ* spread) (1:1); castor + greengram (cv. WGG-42) (for grain and uprooted and *in situ* spread) (1:3) and castor + groundnut (cv. K-6) (1:3) were imposed. The soil conditions after preceding *rabi* safflower were maintained undisturbed for imposing proper tillage practices as main plot. Sowings were taken up in zero and reduced tillage treatments through till-planter cum herbicide applicator designed especially for zero and reduced tillage conditions.

During the crop growth period a rainfall of 454 mm was received in 42 rainy days as against normal 730 mm in 51 days (38% deficit rainfall). Long dry spell during seed filling stage coupled with high temperatures (36-38^{0}C) has influenced the performance of castor and associated crops.

Initial soil fertility analysis indicated that the soil reaction (pH 8.1) and salinity levels (EC 0.29 dS/m) were normal for the cultivation of oilseed crops. The experimental soil was low in organic carbon (0.38%), available N (212 kg/ha) and medium in available phosphorus (17.2 kg/ha). Available K (280 kg/ha) was high, available sulphur (15.6 mg/kg) and micronutrient (Zn, Cu, Fe, Mn) contents were in the optimal range (1.68-7.10 mg/kg).

Imposing tillage treatments in undisturbed soil after harvest of preceding rabi crop

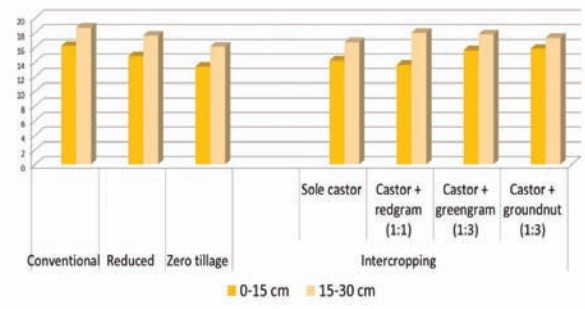
Planting through till-planter cum herbicide applicator designed for reduced and zero tillage

Different tillage practices did not show significant influence on growth, yield attributes and seed yield of castor under rainfed conditions. The performance of castor in terms of plant height (96.8 cm), number of branches (5.4), number of nodes (14.7), spike length (37.2 cm) and 100-seed weight (25.7 g) was found

numerically higher in conventional tillage practices compared to reduced and zero tillage practices. However, spike length and seed yield of castor differed significantly due to adoption of different intercropping systems. The performance of castor was found superior in terms of plant height (95.4 cm), number of branches (6.3), number of nodes (14.5), spike length (39.6 cm) in castor + redgram (1:1) intercropping system followed by sole crop of castor and castor + groundnut (1:3) and lowest growth attributes were recorded in castor + greengram intercropping system. Conventional tillage recorded numerically higher seed yield (878 kg/ha) followed by reduced tillage (812 kg/ha) and the lowest seed yield was recorded in zero tillage conditions (779 kg/ha).

Seed yield of castor was significantly influenced due to different intercropping systems. Sole castor recorded significantly higher castor seed yield (1064 kg/ha) followed by castor + groundnut (813 kg/ha); castor + greengram and castor + redgram (635 kg/ha) intercropping systems. The oil content (%) of castor was not significantly influenced due to different treatments imposed and it ranged from 43.9-44.6%.

Soil moisture content was relatively higher in conventional tillage systems (16.2% at 0-15 cm; 18.7% at 15-30 cm depth). The lowest soil moisture content was recorded in zero-tillage system (13.4% at 0-15 cm and 16.1% at 15-30 cm). Moisture content (%) was intermediate in reduced tillage. Among intercropping systems; at 0-15 cm depth, castor-groundnut recorded highest soil moisture content (15.8%). This was followed by castor + greengram intercropping (15.6%), sole castor (14.2%) and castor + redgram (13.6%). Similar trend was followed at 15-30 cm soil depth.



Soil moisture content (%) as influenced by tillage practices in castor based cropping systems

Sole castor under conventional tillage

Castor + redgram under reduced tillage

Cropping System Research

System approach to agriculture involving sequential cropping helps in bringing stability to the production through better use of resources, taking care of soil health problems, reduced production costs and enhanced yields of the component crops in the system. Short duration legume or cereal or *kharif* fallow preceding to safflower is a common practice in safflower growing regions of the country in Vertisols. Greengram-safflower or fallow-safflower are popular in rainfed regions whereas soybean-safflower is popular in irrigated regions. Broad bed and furrow (BBF) method of land configuration ensures moisture conservation and timely sowing of safflower under zero tillage conditions. In this direction, sustainability of safflower based cropping system productivity under BBF was carried out and the results are presented.

Assessing safflower based cropping system productivity under different crop geometry and IPNM practices

The field experiment was conducted in Vertisols under rainfed conditions with three safflower based cropping systems *viz.*, greengram (WGG-42)-safflower (PBNS-12), short duration soybean (JS 93-05)-safflower and normal duration soybean (JS-335)-safflower. Safflower was cultivated with zero tillage after the *kharif* crops. In each cropping system (main plot), six treatment combinations *viz.*, two spacing levels and three fertilizer levels were tested in factorial combination as sub-plot in split plot design with two replications. The two spacings were 2 rows and 3 rows on each broad bed (120 cm) and furrow (30 cm) land configurations. The three fertilizer levels consisted of no fertilizer, 50% recommended fertilizer + biofertilizers (Azotobacter/ Azospirillum + PSB) and 100% recommended fertilizer + biofertilizers (Azotobacter/Azospirillum + PSB). The rainfall received during cropping season (June to February) was 536 mm. Greengram and soybean crops were sown on 27 June 2018. Safflower was sown on 20 September 2018 and 15 October 2018 in greengram and soybean as preceding crops, respectively. Greengram crop was affected due to continuous rains during flowering time. The productivity of soybean varieties, JS 93-05 and JS-335 was 900 and 850 kg/ha, respectively. The system productivity in terms of safflower equivalent yield was the highest with soybean-safflower (1500 kg/ha) and the lowest was with greengram-safflower (850 kg/ha). Significant differences were not observed between normal duration soybean (JS-335)-safflower (1450 kg/ha) and short duration soybean (JS 93-05)-safflower (1550 kg/ha) system productivity. Significant differences were not found with respect to moisture use. Relative water content, chlorophyll and canopy temperature were measured in safflower at vegetative and flowering stages. Significant variations were observed among the treatments in terms of RWC and leaf temperatures indicating better plant water status and stay greenness under residual moisture with different doses of nutrient application.

Resource Use Efficiency

Resource use efficiency is a measure of factor productivity in terms of output (seed yield) per unit of input (resource) or totality of inputs as combination. Use efficiency of sources of plant nutrients and moisture, mainly depend on the capacity of soils and nature of crops grown under a specific season with defined management practices. Resource use pattern is being assessed through long term field experiment (LTFE) in emerging cropping systems in oilseeds. Furthermore, Fe and Zn based nano system is being evaluated to improve nutrient use efficiency.

Long-term fertilizer studies in maize-castor cropping system in Alfisols

The fixed plot field experiment initiated during *kharif* 1999 with the response of major, secondary and micronutrients on a long-term basis in Alfisols was assessed for the first time in maize (*kharif*) – castor (*rabi*) cropping system. The highest seed yield of *kharif* maize (6165 kg/ha) was recorded with integrated organic manures (goat + poultry + FYM) to supply 30 kg N/ha for each crop that was at par with use of 150% RDF to both crops in the system and NPK+crop residue use. The integrated organic treatment recorded significantly highest fresh and dry stover yields and test weight. The treatment recorded highest soil fertility parameters. The maize yield was on par with use of FYM alone (5759 kg/ha) and 150% RDF (5483 kg/ha). After the harvest of maize, all the soil fertility parameters were higher with organic manure treatments significantly among them was the highest organic carbon (OC) content of 1.24 and 1.38% while the initial OC was 0.43%. Among other inorganic INM treatments, the OC ranged from 0.44 to 0.50. The INM treatment with FYM along with RDF recorded an OC of 0.57%. Very high levels of available P, K and S were recorded in the organic manure treatments. The soil Zn content was significantly higher only when Zn has been applied along with RDF. The performance of *rabi* castor in terms of growth was similar to that of maize for different nutrient management practices.

Assessing productivity, profitability and resource use pattern of emerging cropping systems involving oilseeds

A cropping system trial with major *kharif* and *rabi* crops was assessed under protective irrigation in Alfisols for their productivity, economics, resource use pattern to identify suitable cropping system to match resources requirement options. During *kharif* major crops of the

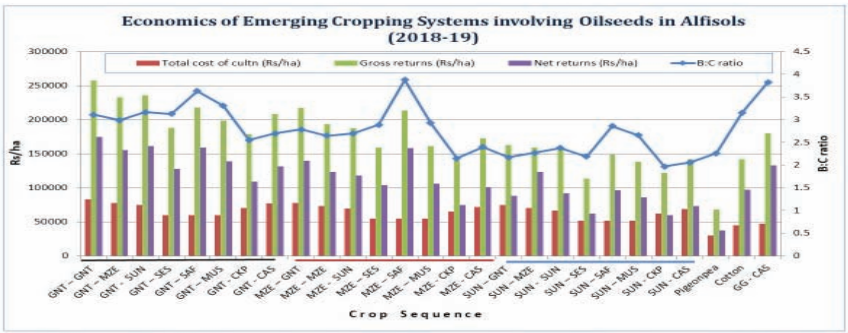
region *viz.*, maize, groundnut, sunflower, pigeonpea, cotton and greengram-castor were grown while during *rabi* after each of maize, sunflower and groundnut, eight *rabi* crops *viz.*, sunflower, chickpea, maize, sesame, safflower, groundnut, mustard and castor were grown whereas *kharif* cotton and pigeonpea were continued for two seasons under protective irrigation. In greengram – castor system (GG-CAS), castor was established zero till at harvest of greengram in August with its residues as surface mulch.

Kharif green gram followed by zero till castor with green gram residues as surface mulch provided better moisture conservation, soil cover, higher yield of both crops and system productivity, profitability and reduced cost of cultivation. The system (GG-CAS) recorded highest net returns (Rs.1.33 lakhs/ha). Among *rabi* crops, chickpea was poor performer at all preceding crops' background resulting in lower economic returns. Groundnut, maize and sunflower performed better after groundnut while sesame, safflower and castor performed better after maize.

Productivity of competing cropping systems

Kharif crops	*Kharif* crop yield (kg/ha)	Seed yield of *rabi* crops (kg/ha)							
		Groundnut	Maize	Sunflower	Sesame	Safflower	Mustard	Chickpea	Castor
Groundnut	3094	1914	5342	2561	477	1909	1335	445	1246
Maize	7193	1857	4933	2101	623	2890	1409	466	1359
Sunflower	2158	1384	4447	2130	401	1855	1555	633	1293
Pigeonpea	1939								
Cotton	2839								
Green gram-castor	(663 + 3305)								

The highest cost of cultivation was recorded in cropping systems involving groundnut that has also given higher profitability due to high yields. Despite the higher number of irrigations required for greengram-castor sequence, the sequence is highly profitable with low cost of cultivation and with highest B:C ratio of 3.8 followed by maize-safflower cropping system with similar resource requirement but with higher cost of cultivation. Safflower as *rabi* crop provided higher profitability at all the three preceding *kharif* crops *viz.*, groundnut, maize and sunflower. Land utilization index was highest with greengram-zero till castor system. Overall, the grengram-zero till castor followed by maize-safflower and groundnut-safflower were better than pigeonpea or cotton in shallow Alfisols. This system also avoids Botrytis threat to castor due to its sowing in late *kharif*. The short duration *kharif* green gram enriches soil fertility besides providing nutritious pulse.

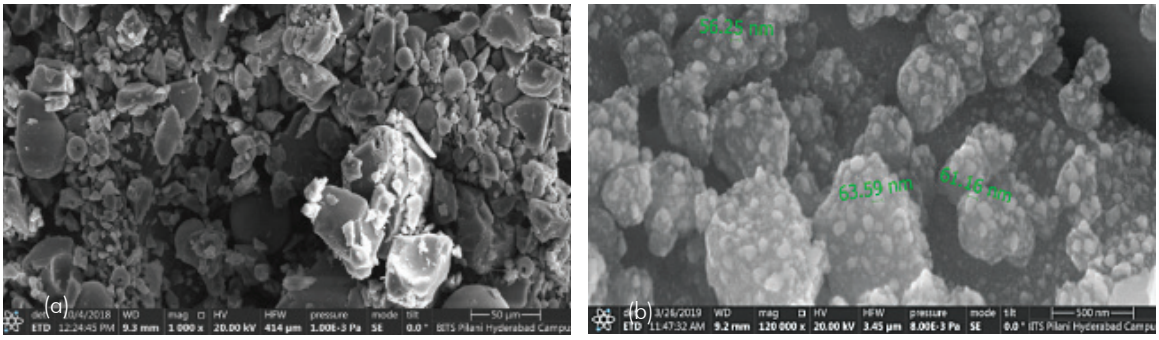


Number of irrigations: Groundnut based: 9-11; Maize based: 9-11; Sunflower based: 8-10; Greengram-Castor: 12; Pigeonpea: 8; Cotton: 10

Land Utiliztion (% year): Groundnut based: 64-87; Maize based: 58-83; Sunflower based: 50-75; Greengram-Castor: 75; Pigeonpea: 58; Cotton: 69

Fabrication of Fe and Zn nanosystems as efficient nutrient source

Nanocitrates and oxides/sulphides stabilized with citrates are being standardized for both Fe and Zn using solid state grinding followed by ball milling using planetary ball mill for different durations. The nanocitrates were evaluated in both groundnut and soybean by using white sand technique. The results indicated more nutrient accumulation in plant compared to microcitrate form. Through SEM, nanosize was evaluated and aggregation was observed.



SEM characterization of (a) Fe micro system, and (b) Fe nanosystem

Abiotic Stress Tolerance

Abiotic stresses like drought and salinity are the limiting factors for oilseeds production under rainfed conditions. Occurrence of drought at the most sensitive stage severely limits crops yields. Therefore, identification of drought tolerant lines and traits contributing to tolerance is a prerequisite of such breeding programmes. Towards this direction, castor, sunflower and sesame genotypes were screened and sources of resistance to drought and salinity were identified which are elaborated.

Castor

Confirmation of drought tolerance

Fourteen germplasm accessions identified for root growth along with two checks were sown in field during November, 2018 in split plot design. As 43.5 mm rainfall was received at 44 DAS, the crop was considered to be in drought condition from 60 DAS and continued till harvest. Also, as there was water scarcity, even the irrigated treatment was given minimal water and that too at prolonged intervals. Though, there was reduction in crop growth with drought stress at 120 DAS, reduction was significant only for plant height, total dry matter (TDM) and specific leaf area (SLA) while the specific leaf weight (SLW) increased significantly under stress.

Effect of stress on crop growth parameters at 120 DAS (after 60 days of stress)

Character	Treatments		CD (0.05)		
	Control	Stress	Irrigations	Genotypes	Interaction
Plant height (cm)	99.1	85.6	7.5	8.3	11.7
Node number/plant	13	14	NS	1.7	NS
Stem girth (mm)	22.3	20.7	NS	2.6	NS
Secondary branches/plant	2	1	NS	0.65	NS
TDM (g/plant)	133.8	102	12.9	14.9	21.3
SCMR	57.5	48.9	NS	NS	NS
SLA (dm^2/g)	0.275	0.229	0.001	0.02	0.03
SLW (g/dm^2)	3.706	4.437	0.187	0.288	0.408
RWC (%)	82.8	79.9	NS	2	2.8
MSI	120.5	123.5	NS	28.6	40.4

Drought stress reduced spike growth and seed yield of primary spikes but the reduction was not significant. However, secondary spike weight and seed weight reduced significantly with drought stress. Tertiary branch production was seen in eight genotypes in control but seed filling was not observed.

Genotypes with <30% reduction in seed yield under stress and with <1.0 DSI include RG-2048, RG-2127, RG-2147, RG-2169, RG-2850, RG-1628 and 48-1. Among these, only RG-2048, RG-2850 and 48-1 recorded seed yield ≥40 g/plant under drought stress. During both the years (2017-18 and 2018-19), RG-2048, RG-1628 and 48-1 performed better with less reduction in seed yield under stress and low DSI.

Yield components of different order spikes under drought stress in castor

Character	Treatments		CD (0.05)		
	Control	Stress	Irrigations	Genotypes	Interaction
Primary spike					
Effective spike length (cm)	23.2	21.3	NS	5.4	NS
Capsule number/spike	38.0	40.0	NS	10.5	NS
Spike weight (g)	59.8	52.0	7.2	8.9	12.6
Seed weight (g)	33.8	29.4	NS	5.5	7.9
Secondary spike					
Spike number	1.0	1.0	NS	0.4	0.6
Effective spike length (cm)	9.6	9.7	NS	2.2	NS
Capsule number/spike	23.0	21.0	NS	3.0	4.9
Spike weight (g)	46.9	14.2	3.1	5.1	2.7
Seed weight (g)	25.5	7.5	0.77	2.7	3.8

Percent reduction in seed yield under drought stress and DSI of castor germplasm accessions

Accession	Total seed yield (g/plant)		Percent reduction in seed yield	Drought susceptibility index (DSI)
	Control	Stress		
RG-415	102.3	56.9	44.4	1.17
RG-1617	81.4	34.1	58.1	1.54
RG-1618	66.9	31.1	53.5	1.42
RG-2048	54.0	45.2	16.2	0.43
RG-2074	86.4	49.1	43.2	1.14
RG-2124	67.1	21.2	68.4	1.81
RG-2127	30.9	23.8	22.9	0.61
RG-2147	40.4	29.4	27.3	0.72
RG-2155	52.1	28.7	44.9	1.19
RG-2169	27.1	22.9	15.2	0.40
RG-2714	56.5	30.2	46.6	1.23
RG-2850	35.1	39.8	-13.2	-0.35
RG-1628	36.7	33.4	9.1	0.24

Accession	Total seed yield (g/plant)		Percent reduction in seed yield	Drought susceptibility index (DSI)
	Control	Stress		
NAUCI-3	59.2	35.4	40.3	1.07
48-1	66.8	45.0	21.8	0.86
DCH-519	107.6	43.2	59.8	1.58
Mean	59.3	36.9	37.8	1.00
CD (0.05)			CV (%)	
Irrigations	6.3		a) 9.3 (for irrigation levels)	
Genotypes	6.2		b) 7.8 (for genotypes)	
Interaction	9.0			

Evaluation of hybrids along with parents for root growth (poly bags)

A set of 10 genotypes (including four hybrids along with parents) were grown in poly bags to study the root growth during late *kharif* 2018 in CRBD with three replications and three plants per replication. Plants were maintained till 90 DAS. Data on plant growth, root traits (length, volume and weight) and TDM were recorded. TDM showed positive correlation with all shoot and root traits except root length.

Growth parameters and root traits of castor genotypes in poly bags at 90 DAS

Geno-types	Plant height up to primary spike (cm)	No. of nodes to primary spike	Stem girth (mm)	Root characters (per plant)			TDM (g/ plant)	SCMR
				Root length (cm)	Root volume (ml)	Root dry weight (g)		
DCS-9	50.0	9	17.8	99.2	80.4	14.4	101.1	48.5
DPC-9	42.9	9	19.4	113.8	121.6	20.3	106.4	50.3
DCH-177	51.5	8	19.0	130.2	100.7	17.4	115.3	53.9
DCS-78	69.2	13	21.0	98.8	135.6	23.2	136.8	54.9
M-574	51.7	16	17.8	104.3	121.1	19.5	112.0	51.1
DCH-519	86.4	16	20.5	110.2	151.9	25.9	130.9	58.6
DCS-107	73.8	17	20.2	107.1	174.6	29.7	117.2	62.5
DPC-15	32.3	7	21.7	80.2	97.1	15.2	121.8	55.6
ICS-164	82.7	17	23.9	93.7	120.6	21.9	135.3	57.4
ICH-66	69.9	14	23.1	115.8	126.8	22.3	142.3	52.9
Max.	86.4	17	23.9	130.2	174.6	29.7	142.3	62.5
Min.	32.3	7	17.8	80.2	80.4	14.4	101.1	48.5
CD (0.05)	5.40	2.1	2.2	16.1	18.0	6.3	28.5	6.5
CV (%)	5.18	10.0	6.2	8.9	8.6	17.7	13.7	7.0

TDM – Total dry matter; SCMR – SPAD chlorophyll meter reading

DCS-107, DCH-519 and DCS-78 recorded good root growth (volume, dry weight) followed by DPC-9, ICS-164 and ICH-66. ICH-66, ICS-164, DCS-78 and DCH-519 recorded significantly higher TDM at 90 DAS. SCMR was significantly higher in DCS-107, DCH-519 and ICS-164. Thus, among the studied genotypes, the male parents DCS-78, DCS-107, ICS-164 and hybrids DCH-519 and ICH-66 recorded good root growth and TDM.

Screening castor parental lines for drought tolerance

A set of 59 parental lines were screened for drought tolerance during late *rabi* 2018 by imposing drought stress from 45 DAS till harvest. Crop growth parameters *viz.,* plant height, node number, stem girth and branch production reduced after 70 days in stress. Effective spike length (ESL), capsule number, spike weight and seed weight of primary and secondary spikes were also reduced under drought stress.

Effect of drought stress on growth and seed yield in castor parental lines

Character	Treatment	
	Control	Stress
Plant height (cm)	63.3	42.7
Node number	11	10
Stem girth (mm)	21.8	16.8
Secondary branches	3	1
Tertiary branches	1	0
Primary spike data (per plant)		
Effective spike length (cm)	32.6	24.3
Capsule number	43	33
Spike weight (g)	68.2	43.0
Seed weight (g)	39.9	23.9
Secondary spike data (per plant)		
Spike number	1	0
Effective spike length (cm)	12.3	4.4
Capsule number	12	6
Spike weight (g)	27.8	8.8
Seed weight (g)	34.6	4.9
Total seed weight (g)	74.5	28.9

As there was water scarcity, even control plots were irrigated with minimal water and at prolonged intervals which affected the crop growth even in irrigated plots. Drought intensity was very high (intensity index = 0.612), which resulted in an average seed yield reduction of 58%, under drought stress. Among the studied genotypes, 16 parental lines (DCS-9, DCS-104, DCS-105, DCS-106, DCS-110, DCS-119, DPC-9, DPC-16, DPC-18, DPC-23, DPC-28, ICS-121, ICS-127, ICS-133, ICS-134, ICS-322) with 31-51 g/plant seed yield in stress, with <51% reduction in seed yield with drought stress and with <1.0 drought susceptibility index (DSI) were selected for further studies.

Sunflower

Field evaluation of identified salt tolerant lines at Machilipatnam and Gangavathi

Based on preliminary laboratory screening for salinity tolerance with a large set of genotypes, 21 lines were identified as salt tolerant. These 21 lines were evaluated at Gangavathi (8-10 dS/m) and 19 at Machilipatnam (11.2 dS/m) for their performance under saline conditions. Based on plant growth and survival, CSFH-12205, CO-2, KBSH-44, COSF-1A, DRSH-1, and 103 A were found tolerant at Gangavathi and CSFH-12205, CO-2, KBSH-44, COSF-6A and COSF-7A were found tolerant at Machilipatnam, while EC-623011, 11 A and P-152 R were found susceptible at both the places. There was a good correlation between the lab and field study. Salt sensitive genotypes from the lab study showed very poor growth even under field conditions and *vice versa* which indicated that lab studies could be used to screen a large number of sunflower genotypes for identification and selection of genotypes for salinity tolerance. The identified salinity tolerant lines will be studied further for trait expression.

11 A (sensitive)

P-152R (sensitive)

CSFH-12205 (tolerant)

DRSH-1 (tolerant)

Reaction of sunflower genotypes to salinity stress

Evaluation of R x R gene pool progenies for drought tolerance

A set of 15 restorer gene pool progenies that were found drought tolerant in the previous year were evaluated in the field by subjecting the crop to stress from 30 DAS. However, the crop received 7.2 mm rainfall at 60 DAS. Among the traits, leaf area index was the most affected followed by seed weight due to stress. The crop experienced moderate drought intensity of 0.30. RGP-46-P3 and RGP-60-P1 recorded low drought susceptibility index and good seed yield under stress (>10 g/plant) whereas RGP-21-P6 recorded good seed yield under stress and were found promising for drought breeding. DRSH-1 hybrid with low DS1, lower increase in leaf temperature and higher seed yield showed its ability to withstand drought stress as well in addition to salinity.

Effect of drought on seed weight, test weight, LAI and leaf temperature of R x R gene pool progenies

Sl. No.	Genotype	Seed weight (g/plant)			Test weight (g)			LAI			Leaf temperature (°C)		
		Control	Stress	DSI	Control	Stress	% reduction	Control	Stress	% reduction	Control	Stress	% increase
1	RGP 21-P-6	19.5	12.0	1.4	3.1	2.7	14	2.8	1.2	58	20.5	24.2	18
2	RGP 32-P-1	10.5	4.5	2.1	2.7	2.4	12	1.7	0.9	48	22.2	25.7	16
3	RGP 33-P-5	6.6	5.6	0.5	2.8	2.7	3	2.4	1.0	59	20.7	23.5	13
4	RGP 50-P-1	14.4	7.5	1.8	3.2	2.4	26	2.6	1.0	60	20.6	23.8	16
5	RGP 60-P-2	20.9	9.2	2.1	3.7	2.8	25	2.3	1.1	51	22.0	25.3	15
6	RGP 61-P-1	11.8	9.1	0.8	2.7	2.1	23	2.4	1.3	45	20.8	24.3	17
7	RGP 61-P-2	10.6	8.2	0.8	2.6	2.4	9	2.6	1.5	44	20.5	25.0	22
8	RGP 95-P-1	12.1	7.7	1.3	1.7	1.7	3	2.2	1.3	41	21.2	23.8	12
9	DRSH-1	27.8	26.3	0.2	4.3	4.5	-5	3.8	1.3	64	21.5	24.0	12
10	298-R	18.6	14.4	0.8	4.0	3.0	23	2.4	0.9	63	20.7	24.4	18
11	RGP 21-P-2	14.8	10.1	1.2	2.7	3.2	-18	2.6	1.6	39	20.9	24.7	18
12	RGP 21-P-8	6.5	6.3	0.1	2.7	2.6	5	3.0	2.0	33	21.9	24.0	10
13	RGP 60-P-2	6.8	5.5	0.7	3.1	2.7	14	3.2	1.4	55	21.2	24.9	18
14	RGP 46-P-3	16.3	15.0	0.3	4.6	3.5	25	2.7	1.4	47	20.3	24.7	22
15	RGP 60-P-1	11.1	10.1	0.4	4.3	3.5	18	3.6	2.0	44	21.4	25.5	19
	Mean	13.9	10.1	1.0	3.2	2.8	11.9	2.7	1.3	50	21.1	24.5	16.3
CD (0.05)	Stress levels	1.6			0.2			0.7			2.6		
	Genotypes	2.6			0.4			0.7			0.8		
	Interaction	3.7			0.6			NS			2.7		

Other traits

Head diameter (cm)			Plant height (cm)			Stem girth (mm)			Leaf temperature (°C) 65 DAS			SCMR			Days to flowering			Days to maturity			RWC		
C	S	% R	C	S	% R	C	S	% R	C	S	% R	C	S	% R	C	S	% R	C	S	% R	C	S	% R
10.7	9.9	8	123	102	17	19.5	15.6	20	22.7	23.9	-6	41.3	42.2	-2	72	71	1	98	96	2	75	66	11

C – Control, S – Stress, % R – Percent reduction under stress, SCMR - SPAD chlorophyll meter reading, RWC - Relative water content

Sesame

Screening and identification of potential sources of tolerance to abiotic stress and improved physiological efficiency

Eighty two selected lines of sesame from Indian core set were screened for the traits associated with drought tolerance. Drought was monitored by using sensors (Proximal, Soil Sence) and drought stress was maintained from post-anthesis stage to physiological maturity of the crop. A total of 22 traits were recorded that include, morpho-physiological, biochemical and yield traits under both conditions. The leaf weight, total biomass, number of capsules, capsule weight, seed weight per capsule and seed weight were reduced under drought conditions compared to irrigated conditions. Plants showed vulner*ab*ility to intermittent drought affecting dry matter partitioning and reproductive process which ultimately was reflected on seed yield. The genotypes IC-96240, IC-20445, IC-132176, IC-204622, IC-132171, JCSDT-112, JCSDT-116 and IC-205368 showed high seed yield and capsule number under both stress and irrigated conditions. The oil content varied from 38 to 52% among the core set accessions. These identified genotypes will be screened further for their seed yield, stress tolerance index responses under both drought and irrigated conditions to identify source material with traits associated for intermittent drought tolerance. Pollen viability in terms of reproductive success under drought condition was also tested in selected accessions of core set. Wrinkled and partially viable pollen were observed under stress condition while under irrigated conditions, 100% pollen viability was found in the tested accessions.

To understand the root architecture, the root traits at successive soil depths and their relationship with the seed yield *vis-a-vis* aerial biomass and yield, experiments were conducted in root structures (1.2 x 2 x 30 m^3) using high yielding selected germplasm accessions from the core collection (IC-204300, IC-205471, IC-43036, IC-132300, IC-132186, IC-205649, IC-204090, IC-204622 and IC-132171) and selected varieties adapted to dry environment (RT-346, RT-135, Swetha til and JCSDT-26) along with checks (TKG-22 and GT-10). The results indicated that the root depth (RD) varied from 40 to 80 cm/plant; the genotype IC-205649 recorded the highest RD and the lowest was recorded in IC-132300. The root volume and root length density (RLD) also varied from 0.29 to 0.47 cm/cm^3 and the maximum root volume in terms of more lateral and profuse root system was found in JCSDT-26, IC-204090 and IC-204622 as compared to other genotypes and national checks. A positive relationship (R^2: 0.34) between seed yield and RLD and with shoot growth (R^2: 0.42) indicated that the genotypes with profuse lateral root system can explore more water and nutrients from soil profile contributing to higher seed yield. Genotypes JCSDT-26, IC-204090 and IC-204622 with potential root traits can be the targets for location specific variety development in sesame breeding program.

Soil moisture, temperature and atmospheric temperature and RH monitoring sensor in sesame field

IC-204445, a land race from Maharashtra with good capsule production (under moisture stress)

Quantification of plant water uptake gravimetrically after mulching soil surface with low density polythene-mulch

Distribution of roots in IC-204622 under stress conditions (left side); Scanning roots using Win-Rhizo software (above)

Screening of selected sesame genotypes for physiological efficiency

One hundred and six sesame genotypes were screened under natural condition for physiological efficiency during *kharif* 2018. Water use efficiency and photosynthetic efficiency were assessed by indirectly measuring canopy temperature and chlorophyll contents using infrared gas analyzer and SPAD meter, respectively.

Across 106 genotypes, the leaf temperature ranged from 29°C (G-Til-2) to 33.9°C (IS-475) and the SPAD values ranged from 29.5 (S-1678-1, Savithri) to 54.9 G-Til-2).

Best Management Practices

Best Management Practices (BMPs) is the term used to describe practices which have been proven to provide optimum production potential, input efficiency and environmental protection for specific site. The actual genetic potential of the newer cultivars can be realized only when the agro-ecological optimum conditions are provided through best management practices (BMPs). Performance of new castor hybrids (ICH-66; DCH-538) were evaluated in comparison with DCH-519 and DCH-177 in large plots (0.6 acres) under best management practices and are discussed.

Performance of new castor hybrids under best management practices in large plots

Performance of new hybrids of castor *viz.*, ICH-66 and ICH-538 along with released hybrids DCH-519 and DCH-177 was evaluated under best management practices (BMPs) (seed treatment with *Trichoderma*; *Azotobacter* and PSB bio-fertilizers; sowing at wider spacing 120 x 45 cm and intercultivation through power weeders/tractors; soil test based fertilizer application) in large plots of about 0.6 acre each under rainfed conditions. Among the hybrids, ICH-66 recorded the highest seed yield (2033 kg/ha) followed by ICH-538 (1874 kg/ha), DCH-519 (1716 kg/ha) and DCH-177 (1241 kg/ha). Cultivation of ICH-66 castor hybrid resulted in highest gross returns (Rs. 93,518/ha); net returns (Rs. 48,936/ha) and profitability (B:C ratio 3.11) followed by ICH-538, DCH-519 and DCH-177.

Performance of new castor hybrids with BMPs in large plots

Hybrid	Seed yield (kg/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
ICH-538	1874	86,204	56,204	2.87
ICH-66	2033	93,518	63,518	3.11
DCH-519	1716	78,936	48,936	2.63
DCH-177	1241	57,086	27,086	1.90

Price of castor seed Rs. 46/kg

Quality and Value Addition

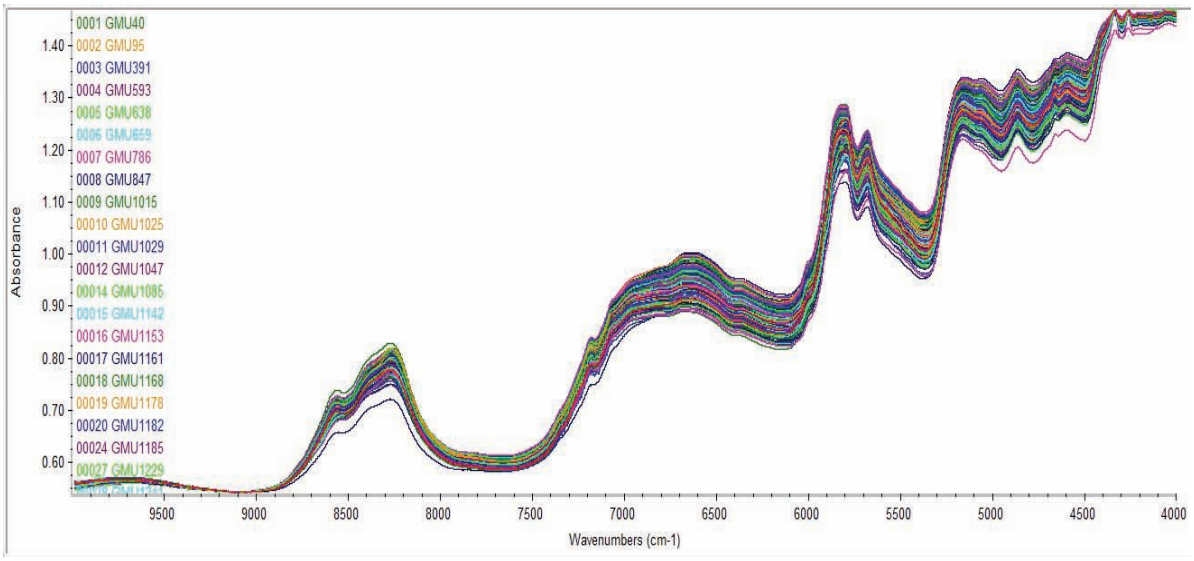
Traditionally kernel oil content is measured by soxhlet method which is time consuming and expensive. An accurate, fast, eco-friendly (without the use of solvent), inexpensive in terms of consumables, and easy to use FT-NIR protocol was developed to measure the oil content of safflower seed kernel. Very small quantity (0.5-1g) is required to estimate the oil content using this method. Apart from oil, safflower is good source of high quality protein. Safflower protein concentrates (SPC), isolates (SPI) and hydrolysates (SPH) were prepared and characterized using different techniques.

Development of FT-NIR protocol for measuring kernel oil content in safflower

A FT-NIR protocol was developed for measuring the oil content of safflower seed kernel. About 240 safflower seed kernels of different genotypes were analysed for oil content by Soxhlet method and FT-NIR spectra for all the samples were generated. A chemometric model was used for analysis in the Thermo FT-NIR (IS-50) system. Spectral range was 4250 to 9999 (cm^{-1}) and path length was multiplicative signal correction. For smoothing of data, Savtzky-Golay filter was applied. Partial Least Squares (PLS) analysis was performed using TQ-Analyst software. The model developed enabled the spectra to be correlated to oil content with high prediction agreement with measurements.

Developing protein hydrolysates from safflower seed cake

Safflower protein concentrates (SPC), isolates (SPI) and hydrolysates (SPH) were prepared from the defatted seeds of safflower. SPC, SPI and SPH were characterized by Fourier-transform infrared spectrometer (FT-IR), Differential scanning calorimeter (DSC) and X-Ray diffraction (XRD). The samples exhibited glass transition temperature below 50°C indicated by first endothermic peak and melting point in the range of 100-115°C based on the sample nature (second endothermic peak). SPI and SPH exhibited one exothermic peak indicating crystalline nature. But SPC exhibited oxidation peak by second exothermic peak at around 205°C i.e., thermal oxidation resulting in instability. All XRD peaks exhibited amorphous nature whereas in the protein isolate and hydrolysate a slight sharpness was observed, which indicates a change in particle nature due to removal of carbohydrate and fibre from the protein concentrate. SPC, SPI and SPH were characterized for water holding capacity, oil holding capacity, foaming capacity and swelling index. SPH were characterized for antimicrobial activity, presence of contaminants and solubility at different pH. SPHs were least soluble between pH 4-5. No antimicrobial activity was detected in the SPH fraction. Human pathogens and fungal contaminants were not detected in the product.



FT-NIR spectra of seed kernels of safflower genotypes (n=240)

Host Plant Resistance

Screening methods

Reliable and uniform mass screening techniques are of primary importance to identify resistant sources against insect pests and diseases. Symptom mapping, damage rating scale and identifying suitable susceptible checks were carried out to develop methods for testing the resistance to the major and emerging insect pests *viz.*, castor thrips (*Scirtothrips dorsalis*), sunflower leafhopper (*Amrasca biguttula biguttula*) and sesame leaf webber and capsule borer (*Antigastra catalaunalis*).

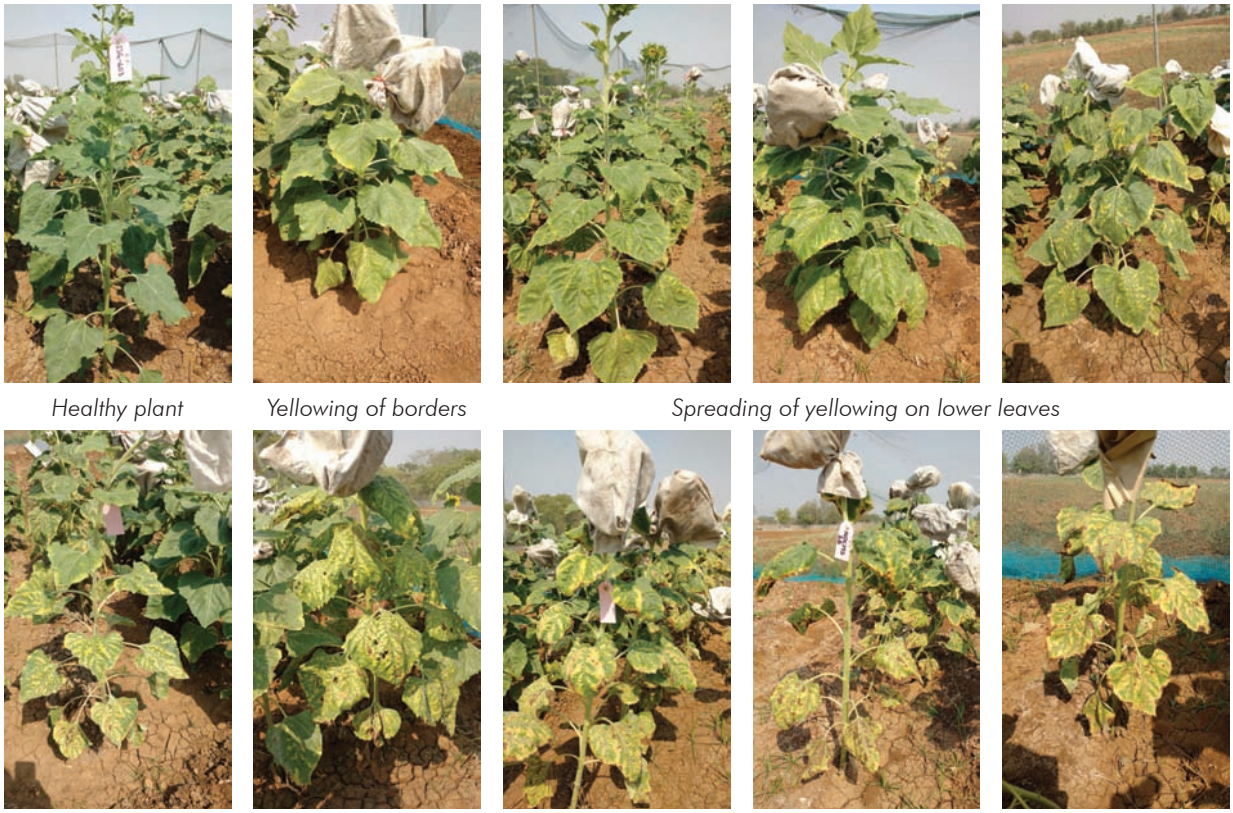
Development of thrips damage rating scale (visual estimation scale) to screen for host plant resistance in castor

Visual symptom based thrips damage was assessed in 13 castor genotypes with different waxy bloom types (zero, single, double and triple bloom types) during *kharif* and *rabi* seasons (2018-19). Thrips caused damage to terminal leaves, floral parts and immature capsules in all the castor genotypes. High thrips infestation on leaves and immature capsules occurred during *rabi* season (18-38 thrips/top leaf and 29-86 thrips/spike) compared to *kharif* season (13-25 thrips/top leaf and 16-63 thrips/spike). Damage symptoms on terminal leaves in all bloom types included wrinkling followed by development of pale yellow or white patches and brown coloured streaks and drying of leaves finally. Damage on floral parts included brown scarification, drying and shedding of flowers without capsule formation. Damage on immature capsules resulted in development of black patches on the outer surface of capsules followed by drying and shedding of immature capsules. Based on damage on terminal leaves and immature capsules, a visual damage scale has been developed to screen castor genotypes against thrips. The scoring of terminal leaf damage was based on a scale of 0-4, where score 0 is for healthy leaf without wrinkling and a score of 4 indicates entire leaf that shows wrinkling and drying. The scoring of immature capsule damage during spike elongation stage was based on a scale of 0-4, where score 0 is for no black patches on capsules and no abscission of capsules in spike and a score of 4 indicates more than 20% capsules drying and shedding in the spike. Based on the mean of leaf and capsule damage symptom scores, a five-degree rating scale was developed to categorize resistance mechanism in castor genotypes against thrips and the scale is described as: 0.0 to 0.5 = Resistant; 0.6 to 1.0 = Moderately Resistant; 1.1 to 2.0 = Moderately Susceptible; 2.1 to 3.0 = Susceptible; 3.1 to 4.0 = Highly Susceptible.

Symptoms of thrips damage on tender leaves, floral parts and immature capsules

Symptom mapping on sunflower due to leafhoppers

The leafhopper screening method in sunflower is based on the natural infestation during *rabi* season. The symptoms caused by leafhopper are yellowing and browning (hopper burn) on leaves. They often mix up with the senescence of the crop. Therefore, it is essential to map the symptoms exclusively caused by leafhoppers. A trial was conducted during *rabi/summer* and symptoms and progress of the symptoms during vegetative and flowering stages was recorded and documented.



Healthy plant *Yellowing of borders* *Spreading of yellowing on lower leaves*

Browning of leaves and spreading of hopper burn *Complete yellowing and browning*

Symptom mapping on sunflower due to leafhoppers

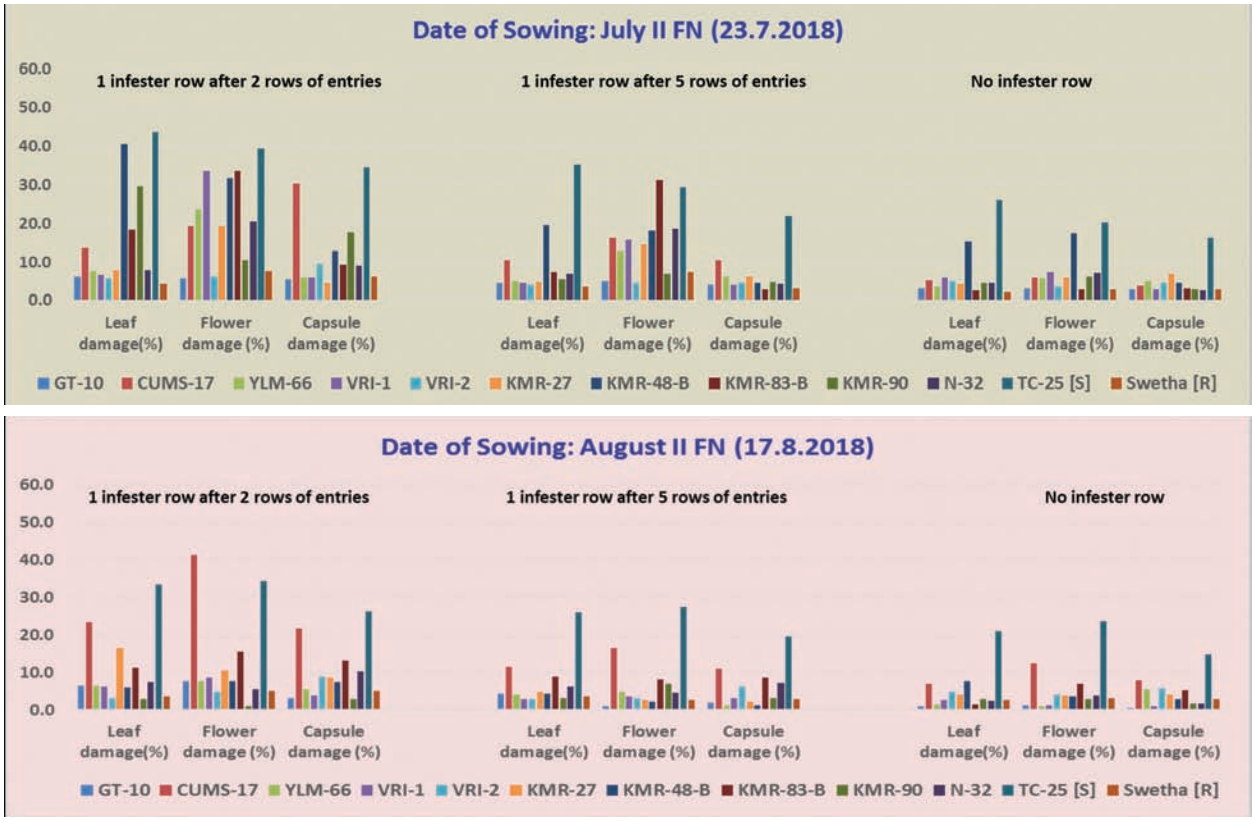
Identification of susceptible check for leafhoppers in sunflower

A susceptible check in any of the screening trial is very essential to measure the reaction of test entries. The variety morden is being used as a susceptible check for screening sunflower entries to leafhoppers. However, it is found that morden is not uniform and inconsistent in its reaction to leafhoppers. A suitable susceptible check needs to be identified to replace morden. Six susceptible lines (DRSF-113, CMS-125A, CMS-2023A, CMS-2023B, NDCMS-2A and NDCMS-2B) were evaluated for leafhopper build up and symptoms during *rabi*/summer season. Build up of leafhoppers was more in both NDCMS-2A/2B and CMS-2023A/B. Susceptible reaction was also the highest in these lines (injury grade of 5.0). Based on growth and reaction, NDCMS-2A/2B were identified as suitable replacement for morden.

Susceptible reaction of NDCMS-2A and 2B to leafhoppers

Development of improved methodology for mass screening of sesame genotypes for resistance to leaf webber and capsule borer (*Antigastra catalaunalis*)

Three screening methods using Prachi as infester row (one infester row after 5 rows of test entries; one infester row after 2 rows of test entries; no infester row) under two sowing dates (July II fortnight and August II fortnight) were evaluated for mass screening for resistance to *Antigastra* of 10 sesame genotypes (GT-10, CUMS-17, YLM-66, VRI-1, VRI-2, KMR-27, KMR-48-B, KMR-83-B, KMR-90 and N-32) along with susceptible (TC-25) and resistant checks (Swetha). In July sown crop, one infester row of Prachi after 2 rows of entries recorded higher leaf damage (43.7%), flower damage (39.3%) and capsule damage (34.7%) as compared to one infester row after 5 rows and without any infester rows (leaf damage of 26.1 to 35.2%, flower damage of 20.3 to 29.4% and capsule damage of 16.3 to 22%). August sown crop recorded significantly low damage (up to 34.3% damage) in all the screening methods as compared to July sown crop (upto 43.7% damage). Among genotypes, GT-10, Swetha and VRI-2 recorded lowest infestation as compared to susceptible check, TC-25. Hence, screening method of adjusting sowing time during July second fortnight and planting of one infester row of Prachi after 2 rows of test entries can be used for mass screening of sesame genotypes for resistance to *Antigastra*.



Improved methodology for mass screening of sesame genotypes for resistance to Antigastra under field conditions

Sources of resistance

Screening for resistance and deciphering the associated mechanism(s) for their utilization in resistance breeding programme against major and emerging pests *viz.*, Fusarium wilt, graymold and sucking pests in castor; leafhopper in sunflower; wilt and aphid in safflower; and root rot, phyllody and *Antigastra* in sesame was carried out for identification of sources of resistance against these pests.

Evaluation of trait specific inbred lines, parental lines and experimental hybrids of castor against wilt under sick plot conditions

Evaluation of 17 trait specific inbred lines, 84 parental lines, 110 experimental hybrids against wilt was undertaken under sick plot. Five inbred lines RG-2800-2, RG-2800-4, RG-2774-1, RG-2774-2 and RG-898-6 recorded <20% wilt incidence while the susceptible check, JI-35 and the resistant check, 48-1 recorded 98.9% and 17% wilt incidence, respectively. Nineteen parental lines DPC-15, M-571, M-574, RG-589, P3-207, 1445-1, 1450-1, 1509-2, 1510-1, 1511-1, 1540-3, 1566-2, 1880-1, 1924-1, 1889-1, JI-226, JI-315, 2015-1 and JI-340 showed highly resistant reaction with <10% wilt incidence while 17 lines showed resistant reaction with <20% wilt incidence with wilt incidence of 95.4% in susceptible check and 14.6% in resistant check.

Forty-seven experimental hybrids ICH-515, ICH-516, ICH-534, ICH-538, ICH-587, ICH-861, ICH-864, ICH-865, ICH-866, ICH-872, ICH-873, ICH-874, ICH-878, ICH-879, ICH-880, ICH-891, ICH-892, ICH-893, ICH-896, ICH-897, ICH-898, ICH-900, ICH-901, ICH-902, ICH-903, ICH-904, ICH-905, ICH-906, ICH-907, ICH-909, ICH-910, ICH-912, ICH-914, ICH-920, K-18-10, K-18-3, M 619 x PMC-55, K-18-14, K-18-15, K-18-16, K-18-24, K-18-26, K-18-28, K-18-30, ICH-382, ICH-353 and ICH-342 recorded <10% wilt incidence with high resistance and 23 experimental hybrids showed resistant reaction with <20% wilt incidence. Wilt incidence of 98% and 14.9% was recorded in the susceptible and resistant checks, respectively.

Promising castor experimental hybrids for wilt disease under sick plot conditions

Wilt reaction of castor genotypes to isolates of *F. oxysporum* f. sp. *ricini*

Six castor genotypes *viz.,* M-574, AP-48, AP-42, RG-2829, RG-3018 and RG-2368 showed resistant reaction to *F. oxysporum* f. sp. *ricini* isolates from Hyderabad, Palem and SK Nagar. Castor genotypes DCS-107 and GC-3 showed resistant reaction to isolates from Hyderabad, SK Nagar and susceptible reaction to Palem isolate. AP-163 showed susceptible reaction to Fusarium isolate from Hyderabad and resistant reaction to Palem and SK Nagar isolates.

Confirmation of resistance to castor wilt disease in germplasm accessions

Thirty four germplasm accessions were evaluated against wilt disease by sick pot method for confirmation of resistance of which seven accessions RG-1922, RG-2661-7-3-5-6, RG-2787-181-12, RG-2787-89-20, RG-2746-1, RG-2976 and RG-3795 recorded <20% wilt incidence. Wilt incidence was 100% in the susceptible check (JI-35) and 11% in the resistant check (48-1).

Identification of sources of resistance to graymold disease in castor

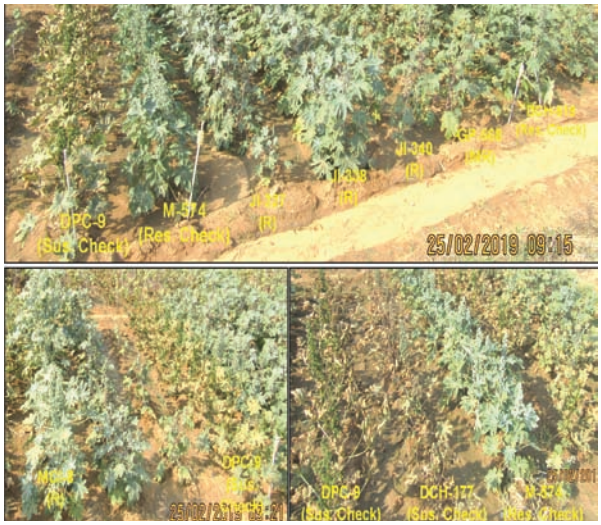
Two castor germplasm lines *viz.,* RG-907 and RG-1963 with moderate resistance to graymold were identified.

RG-1963 *RG-907*

Castor germplasm accessions with moderate resistance to graymold

Identification of sources of resistance in castor parental lines to sucking pests

Twenty six selected castor parental lines along with susceptible and resistant checks were screened for reaction to sucking pests (leafhoppers and thrips) under field conditions using infester row technique. Five castor parental lines *viz.,* MCI-8, JI-226, JI-227, JI-338 and JI-340 recorded low leafhopper infestation (10.6 to 16.6 leafhoppers/3 leaves/plant) and were found resistant to leafhopper (hopper burn grade of 1 on 0-4 scale) while the susceptible checks (DPC-9, DCS-107 and DCH-177) recorded high pest infestation (98.8 to 140.6 leafhoppers/3 leaves/plant) with hopper burn grade 4 on 0-4 scale. Four lines (MCI-8, IPC-34, IPC-35 and P_3-116) were found promising against thrips with very low infestation (<10 thrips/spike) as compared to high infestation of 40.4 thrips/spike in susceptible check, DCS-9.



Hopper burn damage among susceptible and resistant castor genotypes

Identification of sources of resistance to leafhoppers in sunflower

Twenty eight breeding lines were screened for reaction to leafhoppers during *rabi/summer* 2018-19 through sandwich method under natural infestation. Two lines, TSG-403 and TSG-391 were found resistant with an injury grade of 1.0. Eleven lines (HA-124B, CMS-104A, ARM-243A, CMS-11A, ARM-243B, CMS-30A, HA-292A, HA-133B, CMS-30B, HA-89B and HA-133A) were found moderately resistant; 9 lines (HA-259A, CMS-302B, HA-124A, HA-89A, CMS-148A, HA-292B, HA-259B, CMS-302A and HA-112A) were susceptible and one line, CMS-148B was found to be highly susceptible.

Resistant reaction of sunflower genotype, TSG-403 to leafhoppers

Identification of sources of resistance to Fusarium wilt in safflower

Four safflower inbred lines *viz.*, ISF-2471-17, ISF-2413-17, ISF-2258 and ISF 2342 and three germplasm lines GMU-821, GMU-824 and GMU-3740 have been identified as resistant sources against wilt which can be used in breeding programmes aiming at development of resistant varieties and hybrids.

Wilt resistant safflower inbred lines and germplasm accessions

Reaction of safflower sub-core, varieties and high oleic selections to aphids

To identify diverse sources of resistance to aphids, 26 safflower sub-core germplasm lines that were found promising during previous year were screened for their reaction to aphids during *rabi* 2018-19. Five accessions, GMU-5848, GMU-5133, GMU-671, GMU-3256 and GMU-599 were found moderately resistant to aphids (2.3 to 3.0). The susceptible check, CO-1 recorded A.I.I of 5.0 (highly susceptible).

Twenty safflower varieties were evaluated for their reaction to aphids during *rabi* 2018-19. Seven varieties, *viz.,* Manjira, PBNS-12, A-1, SSF-733, SSF-708, SSF-748 and Bhima were found moderately resistant (A.I.I. 2.4 to 3.0) to aphids whereas, variety, Girna showed a resistant reaction to aphids with an A.I.I of 2.0.

Apart from these, 15 high oleic selections were evaluated for their reaction to aphids. Three of these high oleic selections, BC_2F_6-38-9-4-OL, BC_2F_6-38-14-15-OL and BC_2F_6-38-16-12-OL were found resistant to aphids with an A.I.I of 2.0. The susceptible check, CO-1 was found highly susceptible with an A.I.I. of 5.

Resistant reaction of high oleic safflower selections to aphids

Evaluation of sesame germplasm accessions against root rot

Sesame germplasm accessions were screened against root rot through sick pot method. Five accessions *viz.,* IC-500383, IC-500377, EC-107487, EC-132833 and EC-310425 showed <30% root rot incidence, while 24 cultivars showed susceptible reaction (31-50%) and 77 cultivars showed highly susceptible reaction (>51%). Susceptible check, VRI-1 recorded 95.0% root rot incidence.

Evaluation of sesame genotypes to root rot by sick pot method

Confirmation of resistance to root rot in sesame

Twenty nine genotypes which recorded <20% root rot by sick pot method during 2017-18 were tested at Vridhachalam, Tamil Nadu to confirm their resistance to root rot under root rot sick plot conditions during 2018-19. The genotypes S-0448 and IS-24-A recorded <20% root rot while DSK-1-A, B-24, SI-250-A, IC-413248 and IS-245 showed <30% root rot incidence. The local check VRI-1 recorded 62.4% and national check GT-10 recorded 27.8% disease incidence.

Screening of sesame genotypes for phyllody

One hundred and six selected genotypes were screened against phyllody incidence under natural conditions during *kharif* 2018 with Shwetha as susceptible check. None of the genotypes recorded phyllody incidence of 0-20%. Seven genotypes, *viz.,* G-43-p10-p5-p1, NIC-161848-p10-p5-p2, RT-346-p4-p9-p3, RT-351-p10-p3-p2, RT-351-p4-p6-p3, G-TIL-10-p1-p5-p3 and G-TIL-10-p1-p5-p6 recorded 20.1-30% phyllody incidence. Shwetha recorded 50% phyllody incidence.

Effect of date of sowing on phyllody incidence and leafhopper population

Sesame genotypes including germplasm accessions and varieties were sown in four different dates of sowing *viz.,* 3rd week of July, August, November and January. The phyllody incidence and leafhopper population were recorded in the genotypes. Phyllody disease incidence was more in July 3rd week sowing followed by November compared to other sowings. Phyllody

incidence in the entries ranged from 6.3-61.3%; 0.0 - 35.7%; 0.0-62.7% and 0.0 - 46.7% in July, August, November, January sown crops, respectively. Phyllody incidence was <10% in GT-G-30 and it was <20% in Chagatham local, Piyur, RT-346, RJR-170, SL-II and IC-205601 while IC-204158 showed high phyllody incidence of >55% under natural field conditions.

Phyllody and leafhopper incidence in sesame

Incidence of leafhopper was observed in all the dates of sowing and the population ranged from 0.4-3.8, 0.2-3.4, 0.0-2.2 and 0.0-2.6 leafhoppers/3 leaves/plant during July, August, November and January sown crops, respectively. GT-10, GTG-30, RT-346, Kanak, EC-310437 and GRT-8368 recorded low population of 0.0-1.4 leafhoppers/3 leaves/plant, while IC-204161, GP-444, RJR-170, Savithri, Nirmala and Piyur recorded higher population of 0.4-3.8 leafhoppers/3 leaves/plant.

Significant correlation between phyllody incidence and leafhopper population was observed in July sown (r=0.307) and November sown crops (r=0.622) while the correlation was non-significant in August and January sown crops. There was no correlation of weather parameters on phyllody incidence in different dates of sowing.

Screening of sesame genotypes for Antigastra infestation

Screened 106 sesame genotypes along with susceptible (TC-25) and resistant (Shwetha) checks against leaf webber and capsule borer (*Antigastra catalaunalis*) during *kharif* 2018. Observations on leaf, flower and pod damage were recorded from 5 plants in each genotype. Damages assessed on different plant parts were converted to 1 to 9 score. None of the entries recorded a cumulative score of 0-1 (grade 1) classifying as highly resistance. Thirteen genotypes, *viz.*, KIS-398-p4-p10-p6, MT-75-p1-p6-p5, TKG-22-3-p2p6-p4, JLT-408-p5-p3-p9, IS-475-p5-p1-p6, INT-135-115-p4-p3-p7, S-0449-p5-p9-p1, GRT-8368-p7-p6-p1, IS-113-A-p4-p5-p1, G-TIL-2-p5-p9-p1, G-TIL-10-p9-p6-p1, SI-1687-1-p5-p9-p7 and RT-103-p5-p2-p4 recorded a cumulative score of 1.1-2.0 (grade 3) grouping as resistance. Thirty seven and 56 entries showed cumulative scores of 2.1-3.0 (grade 5) and 3.1-5.0 (grade 7) and were categorized as moderately resistant and susceptible, respectively. TC-25 recorded a cumulative score of 5.1-9.0 (grade 9) showing high susceptibility.

Antigastra infestation in sesame

Mechanism of Resistance

Understanding the mechanism of host plant resistance lead to breeding of crop varieties that support lower populations of pests or that have better injury tolerance due to pests. Mechanism of resistance in a castor genotype found promising against lepidopteran defoliators has been evaluated.

Evaluation of mechanism of resistance in castor genotype, ICS-295 against semilooper and tobacco caterpillar

Caged pot and laboratory experiments were conducted to assess the mechanism of resistance in ICS-295 (Ethiopian line) against semilooper (*Achaea janata*) and tobacco caterpillar (*Spodoptera litura*) along with six castor genotypes having different waxy bloom types. A caged pot experiment revealed

that ICS-295 showed antixenosis (non-preference) mechanism of resistance for oviposition to *A. janata* (23.3 and 34.7 eggs) and *S. litura* (1.3 and 4.3 egg-masses) as compared to VP-1 (114.3 and 145.3 eggs by *A. janata*; 14.3 and 13.3 egg-masses by *S. litura*) under free-choice and no-choice tests, respectively. Studies on feeding preference of *A. janata* and *S. litura* larvae using free-choice tests under laboratory conditions revealed lowest larval attraction to ICS-295 (5.0 and 6.7%, respectively) as compared to 23.3-33.3% and 20.0-23.3% attraction to M-574 and VP-1, respectively at 24 hrs after release. Antibiosis mechanism of resistance was observed when the larvae of *A. janata* and *S. litura* were reared on leaves of ICS-295 with significantly prolonged larval and pupal duration and reduced weight of larvae. Larval growth index of *A. janata* and *S. litura* was lowest on ICS-295 (6.21 and 5.21, respectively) as compared to M-574 and VP-1 (7.52 to 7.58 and 6.56 to 6.76, respectively).

Non-preference mechanism of resistance in ICS-295 against semilooper and tobacco caterpillar

Chemical Management

Identification of new chemical molecules with better pesticide properties, lower dosage with selective action is a continuous process for integration in integrated pest and diseases management. In this direction, new fungicides with novel mode of action were evaluated against graymold disease in castor.

New fungicides for management of graymold disease in castor

Among four fungicides *viz.*, propiconazole, carbendazim, fenamidone + mancozeb and pyraclostrobin + fluxapyroxad screened against *Botrytis ricini* in polyhouse, one spray of 0.1% propiconazole was found very effective with 92.2% reduction in graymold severity followed by 0.1% pyraclostrobin + fluxapyroxad spray with a disease reduction of 85.5%.

Propiconazole | *Pyraclostrobin + fluxapyroxad* | *Control*

Effective fungicides identified for management of castor graymold

Bio-agents

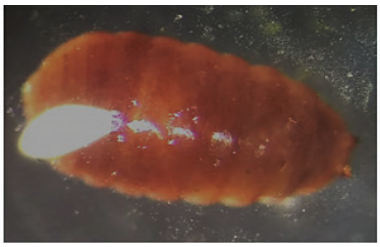
Identification of potential bio-control agents against pests has added a new dimension to IPM strategies. Use of natural bio-agents like *Bacillus thuringiensis* and entomopathogenic nematodes are being considered to be viable alternatives to chemical, particularly for polyphagous pests. Bio-efficacy of entomopathogenic nematodes against polyphagous pests *viz.,* tobacco caterpillar (*S. litura*), leaf miner (*Liriomyza trifolii*) and capsule borer (*Conogethes punctiferalis*) and new isolates against invasive pest *viz.,* fall armyworm (*Spodoptera frugiperda*) was carried out.

Bio-efficacy of entomopathogenic nematodes on *S. litura, L. trifolii* and *C. punctiferalis*

Laboratory bioefficacy studies with entomopathogenic nematodes (EPNs), *Heterorhabditis indica* and *H. bacteriophora* against late instar larvae of *S. litura, L. trifolii* and *C. punctiferalis* revealed that all the insects were highly susceptible to both the tested EPNs. Six different infective juvenile (IJ) concentrations per EPN species *viz.,* 30, 60, 90, 120, 150 and 200 IJs per larva were used in the study. With both the EPNs, IJ concentration of 200 IJs recorded highest larval mortality of 97% and 75% in *S. litura* and *L. trifolii*, respectively. In capsule borer, complete larval mortality was observed with both *H. indica* and *H. bacteriophora* at all the IJ concentrations tested.

S. litura larvae infected with H. bacteriophora

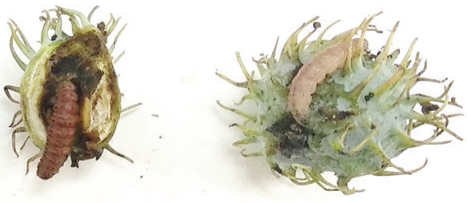
Healthy S. litura larva



H. indica infected larva and pupa of L. trifolii

Healthy L. trifolii larva

Dead capsule borer larva inside capsule

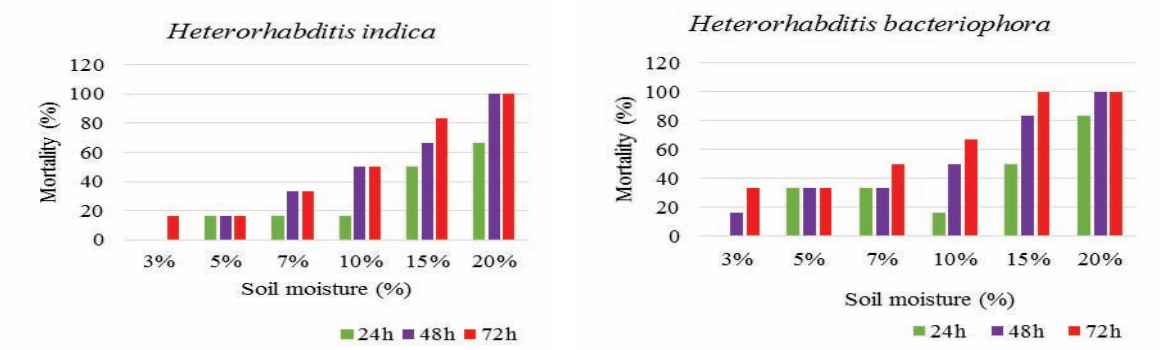


Healthy capsule borer larva

Larvae of S. litura, L. trifolii and C. punctiferalis infected by entomopathogenic nematodes Heterorhabditis spp.

Evaluation of moisture stress tolerance in EPNs

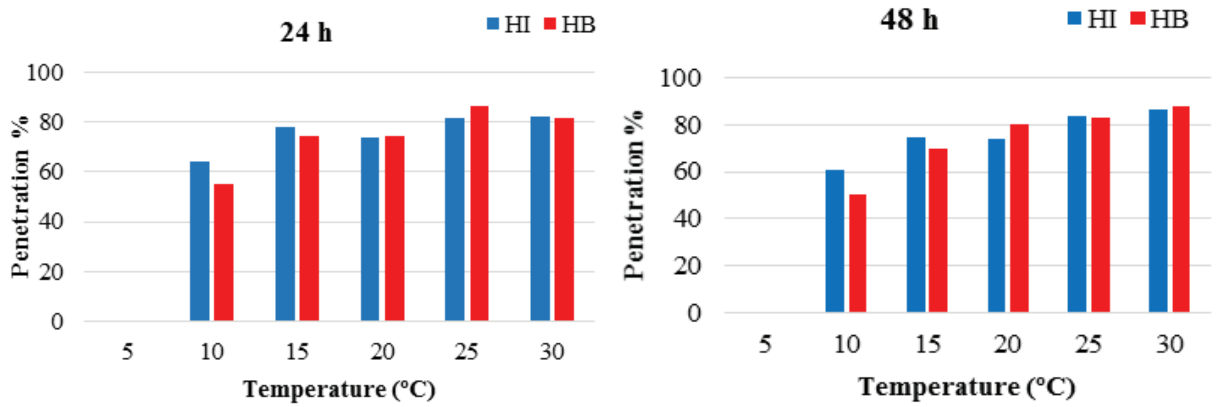
EPNs *viz.*, *H. indica* and *H. bacteriophora* were subjected to different levels of soil moisture (3, 5, 7, 10, 15, and 20%) and checked for their infectivity with greater wax moth, *Galleria mellonella* larvae. The results revealed that a minimum of 15% soil moisture is necessary for survival and infectivity of these EPNs.



Effect of soil moisture on EPNs survival and infectivity

Evaluation of temperature tolerance in EPNs

H. indica and *H. bacteriophora* were tested for their tolerance to different temperatures (5, 10, 15, 20, 25, 30, 35 and 40^{0}C) under laboratory conditions. Low temperature of 5^{0}C as well as higher temperatures of 35^{0}C and 40^{0}C highly influenced the survival and infectivity of both the EPNs. Temperature ranging from 20-30^{0}C was found optimum for infective juvenile (IJ) survival, infectivity and IJ production in both the EPNs.



Effect of temperature on EPNs infectivity

Evaluation of compatibility of EPNs with pesticides

H. indica and *H. bacteriophora* were tested for their compatibility with five pesticides *viz.*, flubendiamide, chlorantraniliprole, profenofos, azadirachtin and Btk. All the pesticides were tested at their recommended doses. The survival and infectivity of both the EPNs was recorded after treating them with pesticides. Profenofos was found to be highly incompatible with *H. bacteriophora* and *H. indica* affecting both survival and infectivity of infective juveniles. Azadirachtin caused reduction in infectivity of both EPNs even though it did not affect the survival. Flubendiamide, chlorantraniliprole and Btk were found safe to both the EPNs.

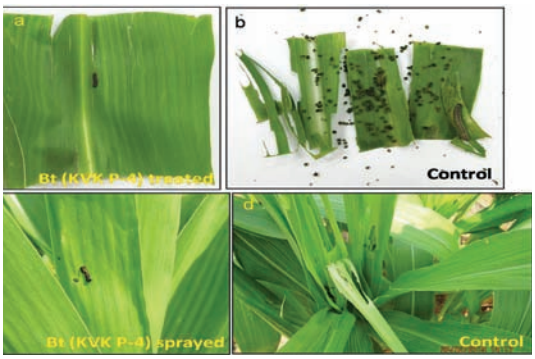
Compatibility of EPN s with different pesticides

Pesticides	Infectivity (%) of *H. bacteriophora*			Infectivity (%) of *H. indica*		
	24 h	48 h	72 h	24 h	48 h	72 h
Chlorantraniliprole	100	90	100	90	70	90
Profenofos	0	0	0	0	0	0
Azadirachtin	33.3	30	10	65	65	50
Bacillus thuringiensis	100	100	100	100	90	100
Flubendiamide	90	90	100	70	100	100
Control	100	100	100	100	100	100

Identification of potent native isolates of *B. thuringiensis* (Bt) and *Nomuraea rileyi* effective against fall armyworm, *S. frugiperda*

A promising isolate KVK-P-4 (DOR Bt-197) of Bt (isolated from soil samples of maize fields in Palem, Mahabubnagar district, Telangana) effective against *S. frugiperda* was identified through laboratory bioassays and pot-culture experiments. Yield of the isolate in mass production through solid state fermentation (SSF) was 24 g/cover (14 x 20", 150 gauge). LC_{50} of the Bt powder was 1.23 mg/ml against 7-days-old *S. frugiperda* larvae 3 days after treatment (DAT) while potency was found to be 71,613 SU/mg using Delfin as the standard.

A promising isolate of the entomopathogenic fungus *N. rileyi* effective against the fall armyworm was isolated. LC_{50} of the isolate was 7.6 x 10^5 conidia/ml against 6-days-old larvae 5 DAT.



Lab bioassays (a-b) and pot culture experiments (c-d) with KVK-P-4 (DOR Bt-197) isolate of Bacillus thuringiensis against S. frugiperda

S. frugiperda larvae infected with N. rileyi

Bio-pesticides

Sustainable pest management demands implemen-tation of tactics that rely upon bio-control agents and their formulations. Various *B. thuringiensis* and *T. harzianum* based biopesticide formulations have been developed and evaluated to mitigate the pest and disease problem in the mandated oilseed crops.

Large scale field evaluation of Bt-127 SC formulation as a component of IPM against major lepidopteran pests of castor

DOR Bt-127 SC formulation was evaluated as a component of IPM for management of lepidopteran pests in castor in farmers' fields at Kanimetta village, Wanaparthy district, Telangana State. The incidence of castor semilooper *A. janata* was lowered by 84.6% in the IPM plot with the first Bt spray (at 46 days after sowing) in contrast to 35.1% in the farmers' practice (FP) where no spray was undertaken. Population of the larval parasitoids was 0.72 and 0.28 per plant in IPM and FP fields, respectively showing that the higher decrease in semilooper population in IPM fields was a combined effect of Bt spray and the larval parasitoid thus, demonstrating safety of the Bt spray to the parasitoid.

Incidence of *S. litura* larvae was lowered by 98.1% with the second Bt spray (at 64 days after sowing) in IPM field and by 96.8% in FP field with acephate spray revealing that effectiveness of Bt formulation was on par with the chemical insecticide acephate. However, population of the larval parasitoid *Apanteles* sp. was higher in IPM field at 1.96 per plant demonstrating safety of the Bt formulation to the larval parasitoid while it was much lower at 0.66 per plant in acephate sprayed FP fields. The net returns in IPM field were Rs.32,500/acre with a CBR of 1:2.61 over net returns of Rs. 14,450/acre with a CBR of 1:1.84 in farmers' practice where acephate was used.

Castor IPM trial at Kanimetta village - spraying of Bt-127 SC and dead larvae of S. litura due to Bt infection

Effectiveness of Bt-127 WDG formulation against *S. litura* in castor

A pot culture experiment was conducted to evaluate the efficacy of DOR Bt-127 67% WDG formulation against 7 and 9 day old larvae of *S. litura*. Among 3 doses evaluated, Bt-127 WDG (67% a.i.) @ 2g/l caused higher mortality of 93.3% and 90.0% against 7 and 9 day old larvae of *S. litura* at 5 days after treatment, respectively. It was found on par with commercial Btk Delfin WG (85% a.i.) @ 1.5 g/l (95.0 and 91.7% mortality against 7 and 9 day old larvae of *S. litura*, respectively).

Shelf-life of Bt-127 suspension concentrate (SC) formulation

Bt-127 SC formulation stored in HDPE bottles at Akola did not show any loss in viability till 21 months period (Log CFU 16.3 ± 0.10/g) from the initial value of Log CFU 16.2 ± 0.14/ml and gave 100% mortality of 7-days-old *S. litura* larvae by 96 hours after treatment.

Shelf-life of Bt-127 WDG formulation

Shelf-life of Bt-127 (67% WDG formulation) (pan agglomeration) at 12 months of storage was Log CFU 16.3 ± 0.10/g and gave 100% mortality of 7-days-old *S. litura* larvae by 96 hours after treatment. Thus, there was no loss in viability of the formulation till 12 months of storage in LDPE covers at room temperature.

Safety and phytotoxicity of Bt-127 SC formulation

Studies on determination of phytotoxicity of Bt-127 SC formulation to sunflower crop in accordance with the registration requirement were carried out. The formulation @ 3.0 ml/l was found safe to the natural enemies *Microplitis maculipennis, Trichogramma chilonis, Cotesia* sp. and *Chrysoperla* sp. in laboratory. Bt-127 SC formulation was field tested on sunflower @ 1.5, 3.0 and 6.0 ml/l. No symptoms of phytotoxicity (hyponasty, epinasty, injury to leaf tip and surface, wilting) were recorded even at double the recommended dose (6 ml/l).

Management of safflower wilt by biopriming with *T. harzianum* Th4d WP

Priming of safflower seeds with *T. harzianum* Th4d WP @ 10 g/l water for 12 h recorded low wilt incidence (20.5%) and significantly high seed yield of 1020 kg/ha. The next best treatment was priming with *T. harzianum* @ 10 g/kg 1 h before sowing recording 25.0% wilt incidence and a seed yield of 950 kg/ha.

Priming with Trichoderma Th4d for 12hr *Pathogen check*

Effect of biopriming of safflower seed with Trichoderma on wilt incidence

Bio-polymers for Seed Health

The tailor-made polymers possess network properties which provide favourable environment to the beneficial microbes which improves long viability under different soil environments and also serve as controlled release systems for regulated release of the agrochemicals. In this context, combined polymer and *Trichoderma* was synthesized and evaluated under *in vitro* and *in vivo* conditions for its efficacy against pathogens in different oilseed crops.

Standardization of polymeric films for seed coating against biotic stresses

Two polymer films were developed for seed coating against biotic stresses. *Trichoderma* was entrapped in pre-polymers and polymeric films were developed and evaluated under pathogenic conditions. Both the polymers (p-1 and p-2) and in combination with *T. harzianum* (Thd) resulted in reduced Macrophomina root rot, *Aspergillus*, Fusarium disease incidence in soybean, safflower, groundnut and castor crops by 30-100% and 50-80% under *in vitro* and *in vivo* conditions, respectively. Based on the pathogen type, significant increase in germination and vigour index by p-1, p-1+Thd, p-2 and p-2+Thd was observed as compared to the pathogen check.

***In vitro* evaluation of polymeric films on pathogen infected seeds in oilseed crops**

Treatment	Groundnut		Castor		Soybean		Safflower	
	Germination (%)	Disease (%)	Germination (%)	Disease (%)	Germination (%)	Disease (%)	Germination (%)	Disease (%)
Untreated	90.0	0.0	96.7	0.0	66.7	0.0	96.0	0.0
Pathogen check	76.7	86.7	73.3	80.0	26.7	96.7	83.0	73.0
Trichoderma	93.3	30.0	86.7	40.0	60.0	80.0	90.0	16.0
Vitavax	93.3	13.3	93.3	23.3	63.3	56.7	96.0	6.0
Polymer 1	83.3	56.7	80.0	50.0	33.3	80.0	93.0	0.0
Polymer 1+ Trichoderma	96.7	26.7	93.3	30.0	66.7	50.0	100.0	0.0
Polymer 2	83.3	40.0	76.7	60.0	33.3	63.3	82.0	0.0
Polymer 2+ Trichoderma	93.3	23.3	90.0	40.0	43.3	66.7	86.0	0.0
CD (p=0.05)	12.6	15.4	10.3	16.8	10.3	12.1	3.6	6.3
SEm (±)	5.8	3.8	3.4	5.6	3.4	4.08	1.2	2.1
CV (%)	7.2	7.5	6.9	8.6	13.1	11.9	2.3	3.2

Efficacy of seed treatment with Trichoderma along with polymeric films in oilseed crops

Efficacy of seed treatment with Trichoderma along with polymeric films in soybean crop

Field evaluation done in soybean coated with the developed polymers exhibited improvement in germination over control. Even under stress conditions (pathogen), increase in enzymatic activity was observed in treatments compared to untreated control. Polymer 1 + *Trichoderma* has resulted in significantly higher seed yield (971 kg/ha) over all other treatments and control (692 kg/ha). Shelf-life of *Trichoderma* was maintained till 24 months without much decrease. Release of *Trichoderma* from films was found to follow Fickian diffusion.

In vivo evaluation of polymeric films on pathogen infected seeds in groundnut and soybean

Treatment	Groundnut		Soybean	
	Germination (%)	Disease (%)	Germination (%)	Disease (%)
Untreated	100.0	0.0	86.7	0.0
Pathogen check	93.3	90.0	83.3	96.7
Trichoderma	96.7	0.0	86.7	23.3
Vitavax	100.0	13.3	93.3	20.0
Polymer 1	86.7	13.3	90.0	43.3
Polymer 1+Trichoderma	96.7	6.7	90.0	23.3
Polymer 2	100.0	13.3	90.0	40.0
Polymer 2+Trichoderma	90.0	16.7	96.7	26.7
CD (p=0.05)	NS	10.3	NS	9.9
SEm (±)	2.8	3.5	4.5	3.3
CV (%)	5.1	13.5	8.8	13.1

Efficacy of seed treatment with Trichoderma along with polymeric films in soybean under field conditions

Evaluation of biopolymer chitosan and *Trichoderma* seed coat formulation in castor and safflower

Coating of castor seed with the biopolymer chitosan + *T. harzianum* Th4d formulation resulted in low Fusarium wilt incidence (40%), increased germination (96.6%) and vigour index (3139) as compared to pathogen check (disease incidence-80%, germination-73.3%, vigour index of 1690).

Safflower seed priming with the biopolymer chitosan + *T. harzianum* Th4d formulation resulted in reduction of Macrophomina root rot incidence by 53.4% and increased germination of 100% over 60% disease incidence and 70% germination in pathogen check.

Treatment with Chitosan +Trichoderma blend

Pathogen check

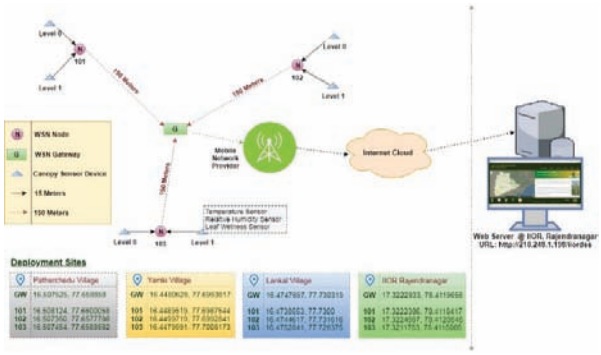
Effect of biopolymer based Trichoderma formulation against safflower root rot

Forecasting of Pests and Diseases

Forecasting of pests and diseases helps farmers in taking timely decision on management. Castor graymold prediction model has been developed and integrated with decision support system (DSS) enabling sending SMS alerts to farmers and the details are presented.

Decision Support System (DSS) developed for graymold prediction and forecasting

A Web based Decision Support System (DSS) has been developed and hosted on IIOR website (url: 218.248.1.198/iiordss) for sending castor graymold alerts and advisories. The DSS receives the real time data on temperature, relative humidity and leaf wetness from the Wireless Sensor Networks (WSN) installed in the castor fields at half-hourly intervals. Thus received data will automatically be utilised for computing the disease severity values based on the weather indices disease prediction model. Further, it will consider various parameters like days after sowing, continuous rainfall spells, stage of the spike and with help of decision rules risk level will be predicted. Accordingly, advisory will be generated and SMS will be sent to registered farmers about the graymold occurrence and its management. As there was no congenial weather for disease development during this season, messages on general cultivation practices were sent to farmers.



WSN deployment sites in farmers field during kharif 2018

Web page of castor graymold DSS

Social Sciences

Impact Assessment of Oilseed Technologies

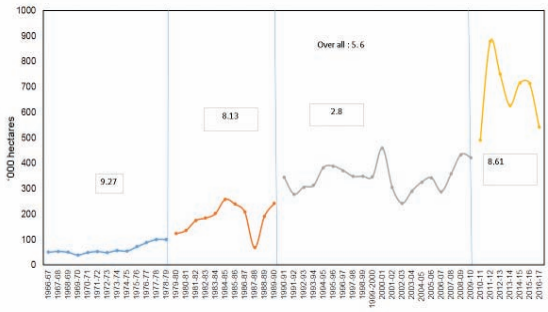
Impact assessment of castor hybrid, GCH-7

The study on impact assessment of GCH-7 in Gujarat revealed that the hybrid GCH-7 covered 2,55,850 ha for Quinqennium ending (QE) 2016 over 2010. The yield advantage was 4.13 q/ha resulting in average additional net returns of Rs.15,624 per ha. The additional yield accrual was 10.56 lakh tonnes for the area covered translating to generation of additional income of Rs. 399.73 crores.

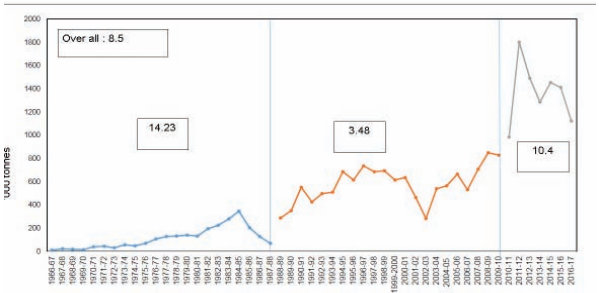
The export earnings from castor oil and its derivatives during the period 1996-97 to 2007-08 was Rs. 9044 crores while the same during the period 2008-09 to 2018-19 was Rs. 44,968 crores. The additional export earnings accrued were Rs. 35,923 crores which was due to the large scale adoption of the hybrid GCH-7. The average TFP during the period 2000-2009 was 1.628 while the same during the period 2010-17 was 2.105. The output indices were higher over the input indices.

Kinked Exponential Growth Rates for castor area, production and yield in Gujarat using Bai-Perron structural break test were computed. For area, three kinks were identified in 1979-80, 1989-90 and at 2010-11. Similarly, two kinks were identified for production and three with respect to yield. Accordingly, growth rates were calculated for each sub period. The study revealed that there was considerable increase in growth rate (8.61) for the sub period (2010-11), that could be attributed to the impact of the new hybrid, GCH-7. Similar finding was evidenced with respect to production as well with a growth rate of 10.4 for the sub period 2010-11 which is again a testimony of large scale adoption and sustenance of the hybrid, GCH-7.

Markov chain analysis employed to study the performance of castor *vis-à-vis* competing crops (rice, wheat, bajra, maize, cotton, arhar, gram and groundnut) for the period 1996-97 to 2017-18 revealed that retention of castor area in the major castor growing districts in Gujarat was to the extent of 89.7 percent clearly indicating the supremacy of the hybrid technology evolved under the NARES.



Kinked Exponential Growth rates of castor area in Gujarat (1966-67 to 2016-17)



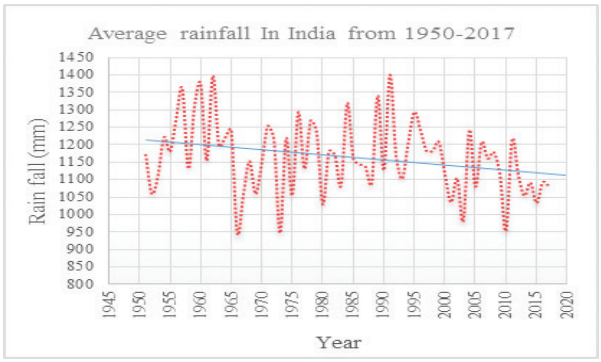
Kinked Exponential Growth rates of castor production in Gujarat (1966-67 to 2016-17)

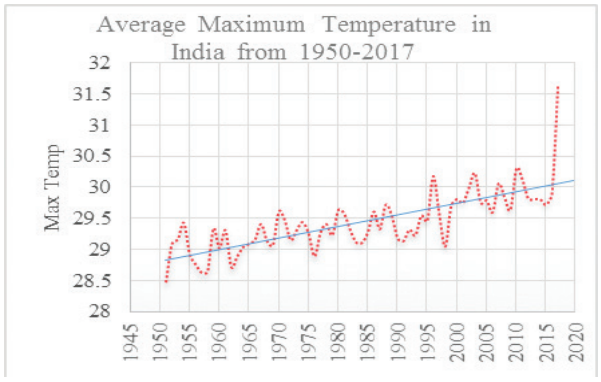
Development of Prediction Models

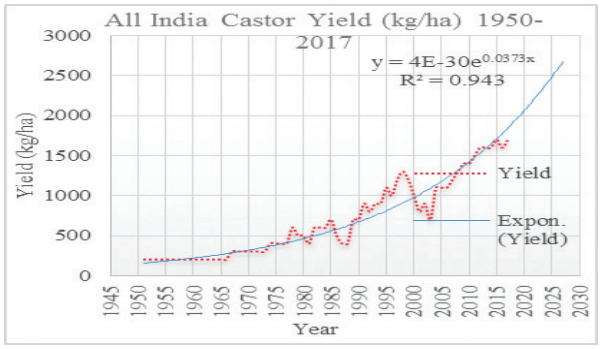
Development of models to predict yield responses to climate change in oilseed crops

During the period under report, the long term time series of weather parameters *viz.*, Max temperature, Min temperature and rainfall from 1950-51 to 2017-18 of all India, month-wise, season-wise were collected and analysed. The trend analysis was carried out by using Mann Kendall test for identifying the presence of increasing or decreasing trend and Sen's slope estimator for calculating the magnitude of trend.

Time series data on total oilseeds (state-wise and district-wise data) revealed significantly decreasing trend with respect to annual and seasonal monsoon rainfall. The average annual mean of maximum temperature across the country showed significant warming trend. The data for castor crop revealed that despite variations in area and production, increasing trends in yields was evidenced from 1950 to 2017.





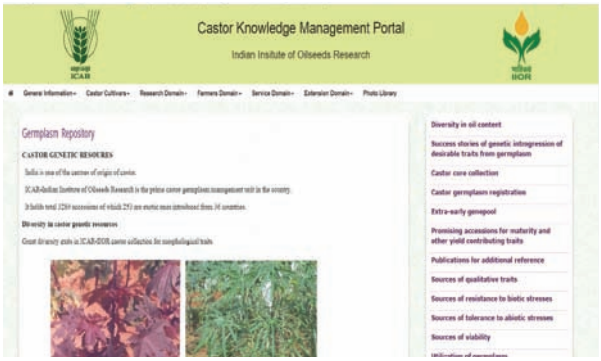


Knowledge Management

Castor knowledge management portal

Castor knowledge management portal is a user-friendly portal exclusively developed and designed as a one stop ready reckoner to access information on germplasm resources, seed production, breeding research, production technologies, pests and diseases, success stories, FAQs, market prices of major APMCs, varieties and hybrids suited for different states, government schemes available for farmers, farm innovations, area, production and productivity statistics.

The entire information was compiled and was categorized into five major domains *viz.*, General domain, Research domain, Extension domain, Farmers' domain and Service domain with sub chapters for each domain. The portal is useful for researchers, academicians, farmers, students, extension workers and NGOs.



Web page of castor knowledge management portal

Demonstrations of Oilseed Technologies

Frontline demonstrations (FLDs) in Oilseeds

FLDs on oilseeds were conducted in 3044 ha during 2018-19 by the oilseed Institutions/ Directorates/ Project Coordinating Units and Indian Institute of Farming Systems Research in various agro-ecological regions of the country. The demonstrations were conducted in 1570 and 1473 ha during *kharif* and *rabi* seasons, respectively. In order to enhance the knowledge of input dealers, extension officers and other extension workers dealing with oilseeds, 39 training programmes on oilseeds technologies were organized. The conduct of FLDs on oilseeds, oilseed based cropping systems and training programmes organized by the oilseeds based institutes are presented.

Frontline demonstrations on oilseeds and training programmes conducted by oilseeds institutes (2018-19)

IIOR/AICRP	Progress						
	Frontline demonstrations (FLDs)					Trainings	
	Approved		Conducted		Total	Approved	Conducted
	Kharif	*Rabi*	*Kharif*	*Rabi*			
ICAR-Indian Institute of Soybean Research, Indore	1100	-	1157	-	1157	5	5
ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur	-	1600	-	1600	1600	10	6
ICAR-Directorate of Groundnut Research, Junagadh	550	300	400	250	650	10	10
Project Coordinator (S&N), Jabalpur	610	200	530	170	700	10	4
Sesame	420	200	370	170	540	10	4
Niger	190	-	160		160	-	-
Project Coordinating Unit (Linseed), Kanpur	750	-	750	-	750	5	4
ICAR-Indian Institute of Farming Systems Research (IIFSR), Modipuram	100	-	100	-	100	5	-
ICAR-Indian Institute of Oilseeds Research, Hyderabad	1060	1540	945	1620	2565	10	10
Castor	750	50	730	50	780	6	4
Sunflower	160	540	65	620	685	4	6
Safflower	-	750		750	750	-	-
Sesame	-	200	-	200	200	-	-
Niger	150	-	150	-	150	-	-
Total	**4170**	**3640**	**3882**	**3640**	**7522**	**55**	**39**

FLDs on castor

In order to showcase the productivity potential and profitability of improved technologies of castor, the demonstrations were conducted in 152 acres in Mahabubnagar and Wanaparthy districts of Telangana State. The technologies demonstrated were castor hybrid DCH-519, optimum spacing, management of graymold, management of semilooper and *Spodoptera*. The details of village-wise productivity potential are presented.

Productivity potential of improved technologies of castor (*kharif* 2018)

District	Village	Area (acres)		Seed yield (kg/ha)		% increase in seed yield
		Laid out	Successfully conducted	IT	FP	
Mahabubnagar	Yankee	20	10	815	750	8.6
	Undekode	20	10	879	775	13.5
	Undhyal	12	10	705	653	8.0
	Patherched	20	11	877	766	14.5
	Kadumur	15	12	1204	1044	15.4
	Lankala	15	9	1039	931	11.6
	Gudigandla	20	15	1020	908	12.3
Wanaparthy	Kanimetta	30	21	888	799	11.2
	Total	152	98*	933	832	12.1

*54 FLDs vitiated due to severe moisture stress during the months of August-November; IT = Improved technology (DCH-519, seed treatment with *Trichoderma*; spacing = 90 cm x 60 cm and management of graymold by prophylactic sprays); FP = Farmers' practice (GCH-4/GCH-7; spacing = 90 cm x 45 cm).

The seed yield improvement ranged from 8.6% in Yankee to 15.4% in Kadumur village with improved technology as compared to farmers' practice.

Profitability of improved technologies of castor (*kharif* 2018)

Village	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	B:C ratio	
	IT	FP	IT	FP		IT	FP
Yankee	12,219	12,375	36,657	33,750	3,063	3.00	2.73
Undekode	13,191	12,788	40,452	35,650	4,399	3.07	2.79
Undhyal	11,139	11,093	31,901	29,363	2,492	2.86	2.65
Patherched	13,159	12,638	40,355	35,232	4,601	3.07	2.79
Kadumur	17,942	17,222	52,983	45,925	6,338	2.95	2.67
Lankala	15,583	13,967	48,828	43,762	3,449	3.13	3.13
Gudigandla	15,300	14,074	46,920	41,768	3,926	3.07	2.97
Kanimetta	13,769	12,781	40,863	36,649	3,226	2.97	2.87
Mean	14,236	13,476	42,897	38,255	3,883	3.01	2.84

CoC = cost of cultivation; GMR = Gross monetary returns; ANR = Additional net returns; B:C ratio = Benefit cost ratio

Highest additional net returns of Rs. 6,338/ha was obtained in Kadumur village with improved technology.


Demonstration of DCH-519 at Kanimetta (Wanaparthy) and Gudigandla (Mahabubnagar)

FLDs on Sunflower

Frontline demonstrations on sunflower were conducted in 60 acres in Hegdoli village, Nizamabad district, Telangana State under rice-fallow, rice-maize, and soybean-fallow cropping systems. The improved technology of using sunflower hybrid DRSH-1, seed treatment with imidacloprid and optimum spacing was demonstrated over 55 acres during *rabi* 2018-19. This has resulted in 18.7% increase in seed yield (1900 kg/ha) as compared to farmers' practice (1600 g/ha) of using private hybrids and closer spacing of 45-30 cm x 30 cm. Demonstrations on foliar application of boron @ 2 ml/l as directed spay at ray floret stage has increased the seed yield by 17.7% as compared to farmers' practice of non-application of boron.

Profitability of improved technologies of sunflower demonstrated during *rabi* 2018-19

Treatment	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	BCR	
	IT	FP	IT	FP		IT	FP
Whole package	26,250	25,000	98,800	83,200	14,350	3.76	3.33
Boron spray	24,500	23,250	94,900	80,600	13,050	3.87	3.47

CoC = cost of cultivation; GMR = Gross monetary returns; ANR = Additional net returns; B:C ratio = Benefit cost ratio

The GMR of Rs.14,350/ha and Rs.13,050/ha was recorded with whole package and boron application, respectively as compared to farmers' practice. The B:C ratio was also higher in IT (3.76 and 3.87) as compared to FP.

Demonstration of DRSH-1 with whole package technology

Demonstration of foliar spray of boron at ray floret stage

Interaction meeting with castor farmers to create awareness on biopesticides in IPM

A farmers' interaction meeting on IPM in Castor was organized at Kanimetta village, Wanaparthy district, Telangana State on February 6, 2019 for farmers and demonstrated the potential of Bt-127 and other biopesticides as components of IPM in management of lepidopteran insect pests of castor. The meeting was organized in association with KVK, Madanapuram. Around 130 farmers, local officials from the Department of Agriculture, KVK, Madanapuram and SDDPA, Wanaparthy attended the meeting.

Interaction meeting at Kanimetta village

Competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana

As part of the farmers' first programme, activities were undertaken in different modules to make the production of oilseeds and other crops of the region more competitive. The achievements made under various modules to improve the livelihoods of the farmers' of four villages of Vikarabad are presented.

NRM Module

- Imparted skill development in soil sampling to 138 households in two villages.

Skill development on soil sampling

- Prepared 149 soil test based soil health cards for major crops (for 12 major, micro and secondary nutrients) covering 354 ha. This intervention resulted in reduced cost of fertilizers by Rs.734/ha. In groundnut, application of gypsum and SSP resulted in better seed filling and pod development. In paddy, INM resulted in reduction of cost incurred towards fertilizer to the extent of Rs. 2153/ha primarily due to reduction in the usage of DAP considering the levels of phosphorus availability in the soil as per the soil health card results.
- Contour cultivation initiated under rainfed ecosystem under undulating topography with customized soil and moisture conservation and package of practices on 40 ha in two villages resulted in yield enhancement of groundnut from 14.72 to 20.13 q/ha.



Interventions on contour cultivation and customized soil and moisture conservation

- In redgram, aforesaid interventions enabled enhanced yields of 5.82 q/ha as against 3.89 q/ha over conventional practice resulting to additional net returns of Rs.5,366/ha over operational costs.
- **Crop residue management:** Green gram crop residue incorporation preceding sowing of castor (*kharif*/late *kharif*/*rabi*) enabled moisture conservation up to 25 days in castor thus enabling effective utilization of moisture besides reduction of two irrigations.
- **Application of tank silt to improve the soil health:** Application of tank silt in chalka soils enabled farmers for better moisture and nutrient utilization in castor crop that enabled them to increase their net additional returns by Rs.4,800-7,250/ha *vis-à-vis* non adopters.


Institute Advisory team monitoring the interventions through NRM

Crops and cropping systems module

The introduction of non-shattering paddy variety, KNM-118, in *kharif* led to productivity enhancement of 20 to 24% over the prevailing cultivar resulting to additional net returns of Rs.10,620/ha.

Technology assemblage in redgram variety TGRD-4 (Hanuma) and castor hybrids (DCH-519/ICH-66) enabled increased net returns of Rs.1,405/ha and Rs.2974/ha, respectively despite hostile drought situations.

Cropping Sequence: Green gram-castor sequence on tribal house-holds in Telangana resulted in providing system returns of Rs. 8,153/ha on rainfed *kharif* eco-system while the same in *rabi* (rainfed) led to system net returns of Rs. 12,626/ha. Under *rabi* irrigated system, the aforesaid cropping system resulted in net returns of Rs. 46,169/ha. The yields of castor was 3.25 q/ha (ANR Rs. 9,025/ha) under *rabi* rainfed situations and 11.9 q/ha (ANR Rs. 37,436/ha) under *rabi* irrigated situations.

Sorghum production technology (Zaid, 2018): Introduction of sorghum (CSH-14) under Zaid in the situations of low water table resulted in productivity of 18.75 q/ha providing additional net returns of Rs. 21,937/ha over operational costs.



Crops and cropping system modules

Horticulture module: Complete technology assemblage of tomato (Arka Rakshak), chilli (Arka Khyathi) and bhendi (Anamika) was taken up. Yield levels of tomato evidenced 17.64% increase over the local variety. The productivity of bhendi was 18.66 q/ha resulting in additional net returns of Rs. 9,973/ha. Chilli productivity increased by 38% over the local cultivar.

Integrated farming system module: Rajasri birds as backyard poultry with complete technology support led to average consumption of eggs per household per week as 3-4 times (10-14 eggs per week). Monthly imputed value of eggs @ Rs. 6/- was Rs. 300-420.

Marketing and value addition

Locally processed tur dal (2 households/4q): Price of naturally processed dal was sold at Rs.85/kg as against sale of primary produce of Rs.48-54/kg.

Paddy to rice (RNR 15048)(1 household/2q): Price of rice was sold at Rs. 40/kg as against sale of paddy @ Rs.17.70/kg.

Partnership and Institution Building

Facilitated in creating FPO "Vikarabad Farmer Producer Organization" sanctioned during 2019 by NABARD through the support of NGO (SWEET) with 498 enrolled members and 218 share capital members.

Backyard poultry for nutritional security and income augmentation

Other Scientific Activities

Agricultural Knowledge Management Unit (AKMU)

Developed the website for Castor Knowledge Management Portals; Mobile Apps For seed production of castor, sesame and safflower; regular updation of the web site through pertinent databases on prices and arrivals of the major APMC's trading IIOR mandate crops, regular uploading of budget releases to ACIRP, FLD and TSP centres, uploading of photographs of important events, press gleanings, tender documents, employment opportunities, etc.

Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell has facilitated the review of the progress of ongoing projects by the Research Advisory Committee (RAC). It has also facilitated the review of experiments carried out under institute and externally funded projects in the field as well as in the Institute Research Council (IRC) meetings. Research Project Proforma (RPP) of 30 institute projects was reviewed as per the IRC recommendations. Five new project proposals (3 institute projects and 2 externally funded projects) were examined. The proposals for thesis projects of seven M.Sc. and five Ph.D. students were processed. The Institute Publication Committee has processed 69 manuscripts (21 research articles, 6 popular articles, 6 book chapters and 36 abstracts/ lecture notes) for publication. The Institute Technology Management Unit (ITMU)/NAIF maintained the database of technologies having commercial potential and IP assets. It has facilitated the hearing on the patent application on 'A process for preparing storable insecticidal formulation using combination of microbials' and submitted response to the First Evaluation Report (FER) with regard to the patent application on 'Production process for improved yield of *Trichoderma* biomass'. Two MoUs were signed with State Agricultural Universities for student research.

AICRP on Oilseeds
(Castor, Sunflower and Safflower)

The significant achievements made under AICRP on Oilseeds (Castor, Sunflower and Safflower) are furnished here under.

CASTOR

During the year, significant progress with regard to varietal and hybrid development was witnessed. One hybrid and two varieties were notified by CVRC for release either all over India or in different states of the country. One state identified variety and one central identified hybrid were submitted to CVRC for notification.

Genotype	Pedigree	Duration for primary spike maturity (days)	Seed yield (kg/ha)	Specific features	Suitable areas for cultivation
GCH-9	SKP-84 x PCS-124	110-120	3820	Wilt and root rot resistant, medium plant stature, profuse branching	All India
Jawahar Castor-4 (JC-4)	SPS-43-3 x JC-6	100-130	2640	Medium maturity, suitable for sole crop under irrigated conditions	Madhya Pradesh
Jawahar Castor-24 (JC-24)	DCS-108 x JC-5	95-110	2745	Early maturing variety suitable for sole and intercropping under rainfed conditions	Madhya Pradesh
Yethapur-1 (Ytp-1) YRCS-1205	TMV-6 x Salem local	115-120	1450	Can be maintained for 3 years (3 kg/plant/year)	Suitable variety for mixed/inter/perennial and sole crop under rainfed conditions of Tamil Nadu
ICH-66	SKP-84 x ICS-164	100-110	1570-3375	Wilt and leafhopper resistant	Suitable for rainfed castor growing areas of Southern India

- Supplied 1201 germplasm accessions for augmentation at Ananthapuramu and Palem, deposited 532 accessions in medium term storage (MTS), supplied 1461 accessions, 62 trait-specific inbred lines and 20 promising germplasm accessions to various AICRP centres.
- Identified 13 early and extra-early inbred lines (83-89 days); six inbred lines with high ricinoleic acid (90-92%) than the checks (88%) in multi-locations.
- A total of 29 new monoecious lines (13 from Junagadh, 14 from SK Nagar, 1 each from Palem and Yethapur) and five new pistillate lines (1 from Junagadh, 2 from Navsari and 2 from Palem) have been developed as potential parents for hybrid development.
- Preliminary yield trial involving 49 new monoecious lines (15 – Junagadh; 34 - SK Nagar) as potential variety revealed that seven inbred lines *viz.,* JI-469, JI-471, JI-478, JI-479, SKI-401, SKI-413 and SKI-416 recorded significantly higher seed yield (12 to 54%) than the check variety, GC-3.

- Out of 216 new hybrids evaluated in preliminary trials at different centres, 17 hybrids were identified with significant yield advantage (10 to 46%) over the best check.
- Among 15 OPVs evaluated for rainfed eco-system, three varieties *viz.,* ICS-241 (66%), ICS-244 (19%) and JI-423 (21%) were promising at Yethapur, Palem and Bhawanipatna centres compared to the checks, DCS-107 (835 kg/ha, 1220 kg/ha) and GC-3 (721 kg/ha), respectively.
- Based on seed and oil yield (>10% over the best checks) and wilt resistance, four hybrids *viz.,* SHB-1027, SHB-1021, ICH-278, ICH-515 and one variety, JI-449 were promoted to AVHT-I of 2019-20.
- SHB-1028 with resistance reaction to graymold (21.8% compared to 100 per cent in susceptible check, DCH-519) and pooled mean seed yield (2527 kg/ha) on par with GCH-8 (2556 kg/ha) was also promoted to AVHT-I.
- A total of 3.85 q breeder seed of varieties and parental lines was produced against the DAC indent of 2.15 q by different centres to meet the demand of seed producers, progressive farmers and researchers.
- Adoption of Best Management Practices (BMPs) in rainfed castor at Palem and Yethapur resulted in significantly higher seed yield (1555 and 1390 kg/ha) as compared to that of farmers' practice. Under irrigated conditions at SK Nagar, performance of castor hybrid grown under best management practices (GCH-8 hybrid; seed treatment with PSB @ 5 ml/kg seeds adopting ideal plant geometry of 150 cm × 120 cm; soil test based nutrient supply; drip irrigation; need based plant protection, harvesting through secateurs) showed 29% higher seed yield (2948 kg/ha) over farmers' practice (GCH-7). Similar trend followed in Junagadh (GCH-9) and DCH-177 hybrid in Bawal and Mandor.
- Castor + pearl millet intercropping system resulted in higher castor equivalent yield (1657 kg/ha), higher Land Equivalent Ratio (1.62) and Area Time Equivalent Ratio (ATER) (1.33) in rainfed Alfisols of Bengaluru.
- A total of 975 frontline demonstrations (FLDs) were conducted during *rabi* 2017-18 and *kharif* 2018 in seven states.
- Under rainfed conditions, seed yield improvement was to the tune of 18% with Improved Technology (IT) (946 kg/ha) as compared to FP (799 kg/ha). The additional net returns (ANR) accrued were Rs. 5193/ha. The B:C ratio was 2.59 and 2.37 with IT and FP, respectively.
- Under irrigated conditions, seed yield improvement was to the tune of 16% with IT (3755 kg/ha) as compared to FP (3229 kg/ha). The ANR accrued were Rs. 21,993/ha. The B:C ratio was 3.86 and 3.37 with IT and FP, respectively.
- Pathogenic variability of isolates of *F. oxysporum* f. sp. *ricini* revealed that AP-42 and AP-56 showed resistant reaction with <20% wilt incidence while the remaining 10 genotypes showed variable reaction for all the three sources of isolates from Hyderabad, Palem and SK Nagar.
- Identified 12 confirmed sources of resistance to wilt, one for graymold and four for root rot.
- Among 30 entries of coordinated trials - SHB-1027, ICH-86 and SHB-1066 were resistant to both wilt and root rot; SHB-1021 moderately resistant to reniform nematode (14.3 egg masses per root) compared to highly susceptible reaction in checks, DCH-177 (>30 egg masses per root); SHB-1028 and ICH-576 moderately resistant to graymold with <25% disease under high disease pressure conditions.
- In integrated management of wilt disease, seed treatment with tebuconazole + trifloxystrobin 0.4 g/kg recorded low wilt incidence (21%) and high seed yield (1032 kg/ha) compared to control (60% and 317 kg/ha) at Palem. Seed treatment with carboxin + thiram 3 g/kg recorded low wilt incidence (37%) and high seed yield (848 kg/ha) at Yethapur compared to control (83% and 414 kg/ha). There were no significant differences among the treatments in wilt incidence at SK Nagar and root rot at Junagadh.
- In on-farm demonstration on management of root rot conducted at research farm, Junagadh, seed treatment and soil application of *T. harzianum* local isolate showed low root rot incidence (5%)

with higher seed yield (3037 kg/ha) compared to control (16% and 2198 kg/ha).

- Identified confirmed sources of resistance to leafhopper with hopper burn grade of 0 to 1 on 0-4 scale as compared to grade 3 to 4 in susceptible checks; germplasm: ICI-RG2661-7-9-1-1; monoecious line: ICS-200; coordinated trial entries: JHB-1061, ICH-538 and ICH-515.
- Identified two confirmed sources of resistance to whitefly (RG-3233 and RG-3428) with grade of 0 to 1 on 0-5 scale in three locations (Yethapur, SK Nagar and IIOR, Hyderabad).
- The newer insecticide buprofezin 25SC (1.5 ml/l) was superior in reducing the whitefly infestation and resulted in higher seed yield at Yethapur (1210 kg/ha) as compared to untreated control (620 kg/ha).
- DOR Bt-127 SC formulation @ 3 ml/l was on par with commercial Btk formulation in reducing the population of semilooper and *S. litura* at Palem. DOR Bt-127 SC formulation treated plot yielded 1346 kg/ha and was on par with commercial Btk (1387 kg/ha).
- Evaluation of compatibility of recommended fungicides and insecticides revealed that carbendazim in combination with novaluron, buprofezin, acetamiprid, flonicamid, dimethoate; carbendazim 12% + mancozeb 63% in combination with acetamiprid, buprofezin, flonicamid, dimethoate and combination of propiconazole with dimethoate showed phytotoxic symptoms.

Major Recommendations

- In Saurashtra region of Gujarat, application of pendimethalin 1 kg/ha (6.7 ml/l) (pre-emergence) + quizalofop ethyl 0.05 kg/ha (2 ml/l) (post-emergence at 25 DAS) + intercultivation followed by hand weeding at 60 DAS resulted in effective weed management along with higher seed yield (4310 kg/ha) and higher profitability (B:C ratio 4.12).
- In irrigated conditions of Haryana, basal application of 40 kg P_2O_5 and seed treatment with PSB (*Pseudomonas* sp.) (20 ml/kg seed) resulted in higher seed yield (4138 kg/ha) and profitability (B:C ratio 3.12).

SUNFLOWER

- Seventy four germplasm accessions and inbreds were identified promising for agro-economic traits at different locations.
- Three powdery mildew resistant lines developed at Raichur centre, *viz.,* RGM-41, RGM-49 and PM-81 which were evaluated for 3-4 years both in field and green house conditions were confirmed for powdery mildew resistance (PDI <10%).
- Based on the passport data, the germplasm catalogue involving 3126 accessions has been published and distributed to the sunflower breeders for effective utilization of promising inbreds and germplasm accessions.
- Open pollinated populations AKSFI-18-8 (1485 kg/ha), AKSFI-18-7 (1470 kg/ha), AKSFI-18-2 (1407 kg/ha), AKSFI-18-1 (1391 kg/ha) and AKSFI-18-5 (1362 kg/ha) at Akola; SS-1319 (1603 kg/ha), SS-1603 (1527 kg/ha), SS-1316 (1502 kg/ha) and SS-1713 (1468 kg/ha) in multilocation trial at Maharashtra were found superior to the checks in terms of seed yield. Coimbatore centre had developed four powdery mildew resistant inbreds (through artificial screening) *viz.,* 32-2-13-1, 32-2-20-1, 32-2-29-1 and 32-3-31-1.
- New experimental hybrids developed at Akola (22), Bengaluru (26), Coimbatore (320), Hisar (48), Latur (39), Ludhiana (74), Nandyal (45), Nimpith (168) and Raichur (196) were evaluated in replicated trials with large plot size.
- Multilocation evaluation of experimental hybrids revealed superiority over the best check hybrids PKVSH-977 (2371 kg/ha) and PKVSH-978 (2315 kg/ha) at Akola; SMLHT-Kh-18-03 (2512 kg/ha), SMLHT-Kh-18-02 (2486 kg/ha) and SMLHT-Kh-18-01 (2206 kg/ha) in Karnataka; HSFH-1194 (2604 kg/ha), HSFH-1594 (2462 kg/ha) and HSFH-1573 (2396 kg/ha) at Hisar; LSFH-1708 (2038 kg/ha) and SVSH-493 (1769 kg/ha) at Latur; PSH-2091 (2622 kg/ha), PSH-2080 (2566 kg/ha), PSH-2594 (2480 kg/ha) and PSH-2593 (2417 kg/ha) at Ludhiana; SH-2551 (2832 kg/ha), SH-2515 (2822 kg/ha) and SH-2384 (3203 kg/ha) at Coimbatore and SMLHT-18-10 (1995 kg/ha), SMLHT-18-14 (1853 kg/ha) and SMLHT-18-2 (1849 kg/ha) at Raichur.

- As part of the prebreeding activity, evaluation of six crosses generated using wild *H. annuus* accessions (ANN-61, ANN-98 and ANN-1114) and RCR-83Br and parental lines at Raichur showed that accessions ANN-61 and ANN-98 resistant to Alternaria leaf spot; sunflower necrosis and leaf curl diseases while ANN-1114 was found to be highly resistant to Alternaria leaf spot. All the six intraspecific crosses showed moderate resistant reaction to Alternaria leaf spot with a score of 5 and resistance to sunflower necrosis disease (range from 3.3 to 7.8%) and leaf curl virus disease (1.5 to 3.0%) under natural field condition.
- KBSH-79, IIOSH-2, PSH-2080, PSH-2091 and BLSFH-15004 were promoted to the next level of testing in *rabi* 2018 and IOSH-15-20, LSFH-1751, BLSFH-15005 and IIOSH-15-10 were promoted to further testing in *kharif* 2019.
- A total of 20 q of breeder seed is expected against an indent of 2.9 q.
- Zero tillage was successful for rice fallow sunflower only in black soils of Nandyal, Andhra Pradesh.
- Efficacy of hydrophilic polymer hydrogel on sunflower production was found in Vertisols of Akola and Latur.
- Ridges and furrow sowing at 60 x 30 cm or Broad bed and furrow - paired row planting at 45 x 40 cm over flat bed sowing was found promising in increasing sunflower yield at Akola, Latur, Nandyal and Raichur. Application of FYM @ 5 t/ha and sowing of sunflower at half way on the ridges at Raichur while flat bed sowing at Nimpith were found promising.
- Sunflower–groundnut (Coimbatore and Bengaluru) and maize-sunflower (Nandyal) were found to be the promising new cropping systems.
- Pendimethalin @ 1.0 kg a.i./ ha as pre-emergence followed by (i) use of power weeder at 30 DAS (Coimbatore) or (ii) Propaquizafop (Agil) @ 62.0 g a.i./ha at 15-20 DAS as post emergence (Akola, Bengaluru and Raichur), or (iii) Quizalofop Ethyl 10 EC @ 37.5 g a.i./ha at 15- 20 DAS (post emergence) (Latur) were effective in effective weed management.
- Good agricultural practices were yielding a minimum of 15% higher yield than farmers' practices across the locations.
- A total of 612 frontline demonstrations were conducted during *rabi*/spring 2017-18 and *kharif* 2018.
- During *rabi* the demonstrations showed that the mean seed yield increased by 16.5% with improved technology ((IT) (1524 kg/ha) as compared to farmers' practice (1308 kg/ha) and in *kharif* the IT (1760 kg/ha) showed 15% increase in mean seed yield as compared to farmers' practice (1483 kg/ha) indicating potential for enhancing the yield of sunflower.
- It is estimated that sunflower production in the country during *rabi*/spring season can be increased to 1.77 lakh t and 2.55 lakh t from 1.34 lakh t by bridging the yield gap I (yield gap between IT and FP) and yield gap II (yield gap between improved technology and state average yield), respectively with the adoption of available improved technologies in the current area under sunflower. During *kharif* sunflower production can be increased from 1.1 lakh t to 1.34 lakh t and 2.38 lakh t, respectively by bridging the yield gaps I and II with the complete adoption of available improved technologies without increasing the area under sunflower.
- Disease survey conducted during the *rabi* 2017-18 and *kharif* 2018-19 indicated low to moderate incidence of all major diseases. Powdery mildew incidence was moderate to high in few locations in Coimbatore and Raichur centres.
- Among the coordinated trial entries (IAHT) screened during *rabi* 2017-18, the entries IIOSH-2, NSFH-36, BLSFH-15004 and NSFH-639 showed low Alternaria severity and NSFH-639 showed minimum lesion length of charcoal rot in artificial screening. Twelve entries were found resistant to downy mildew.
- During *kharif* 2018-19, the IHT entries *viz.*, KBSH-84, CSFH-15026 and IIOSH-15-20 showed low Alternaria severity, the hybrid IIOSH-15-20 recorded lowest necrosis disease incidence (9%). Among AHT entries, LSFH-4951, IIOSH-2, IIOSH-15-10, LSFH-1751 and BLSFH-15005 recorded less Alternaria leaf spot severity. Ten entries of AHT were free from downy mildew.
- Seed treatment with imidacloprid 600 FS @ 5 ml/kg seed + foliar spray with fipronil 5 SC @ 1 ml/l at 30, 45 and 60 DAS was found to be the

most effective in management of viral diseases of sunflower.

- Seed treatment with the plant defense inducer salicylic acid @ 100 ppm + foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing was effective with less incidence of Alternaria leaf spot, necrosis and powdery mildew diseases and highest seed yield and B:C ratio.
- The charcoal rot incidence was minimum in seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed + soil application of Trichoderma viride @ 1.25 kg/ha + P. fluorescens @ 1.25 kg/ha fortified with 250 kg FYM + neem cake @ 250 kg/ha with maximum seed yield and B:C ratio.
- Among combination fungicides, seed treatment with carbendazim 12% + mancozeb 63% WP @ 2 g/kg seed followed by two foliar sprays with zineb 68% + hexaconazole 4% WP @ 0.25 g/l was found to be the most effective in management of Alternaria leaf spot.
- Seed treatment with *Pseudomonas fluorescens* (Pf) @ 10 g/kg seed followed by soil application of Pf 2.5 kg/ha fortified with FYM at the time of sowing + three foliar sprays of Pf @ 30, 45 and 60 DAS was effective in management of Alternaria leaf spot and necrosis diseases with the highest seed yield and B:C ratio.
- On farm validation of two trials concluded during previous season was carried out in farmer`s field. These include: a) Management of Alternaria blight through bioagents and fungicides (at Ludhiana), b) Integrated disease management of important diseases of sunflower (at Akola).
- There was moderate incidence of sucking pests like leafhoppers, whiteflies, thrips during *rabi* season in farmers' fields in Karnataka and Maharashtra.
- Two lines, ARM-240B and CMS-84B from Bengaluru; 11 lines - PM-95, GMU-520, PM-2, PM-3, PM-6, PM-7, PM-40, PM-71, PM-72, PM-73, PM-87 from Raichur; four lines-IC-497575, EC-601935, EC-512709 and EC-512724 from Latur were found resistant to leafhoppers.
- In multilocation evaluation, four entries, *viz.,* AKSFI-33, GPN-219-2, GMU-520 and ID-1079 were found resistant/moderately resistant to leafhoppers. The accessions GMU-4, GMU-339 and GMU-504 were confirmed to be resistant/moderately resistant to leafhoppers. GMU-440 was found to be resistant/moderately resistant to leafhoppers at all the locations. In coordinated trials, among the IHT entries, CSFH-14638, SVSH-498 and LSFH-1751 were found resistant/moderately resistant to leafhoppers at Akola, Latur and Raichur.
- Among IAHT entries, IIOSH-2 (AHT-1) and PSH-2080 (AHT-1) were found moderately resistant/resistant to leafhoppers at Akola, Latur and Raichur.
- Bt-127 SC formulation developed at ICAR-IIOR was found to be at par with other insecticides like, profenofos, chlorantroniprole, dichlorvos and Delfin in reducing *Helicoverpa* and semilooper population at Akola and Latur.
- Diafenthiuron 50 WP @ 1 g/l was the most effective insecticide in reducing the population of whiteflies at Akola, Latur and Raichur.

Major Recommendations

- Application of 100% RDF (80:60:30 NPK kg/ha) along with hydrogel @ 2.5 kg/ha is recommended for higher seed yield and economic returns in Maharashtra.
- Sowing of the hybrid LSFH-171 on ridges and furrows at 60 cm x 30 cm spacing and application of 125% RDF (100: 75: 37.5 NPK kg/ha) is recommended for higher seed yield and economic returns in Maharashtra.
- Incorporation of black gram crop residue, adoption of site-specific target yield of NPK with 5 t FYM/ha and application of *Trichoderma viride* to sunflower + S + limiting micro nutrient B is recommended for higher yield and economic returns in Tamil Nadu.
- Seed priming (carbendazim 2 g/kg seeds + thiamethoxam @ 0.04%) + spray of propiconazole @ 0.1 % + azadirachtin @ 0.15% as soon as disease appears and the 2nd spray 15 days later is recommended for effective management of Alternaria leaf spot and necrosis disease and getting higher seed yield in Maharashtra.
- Seed treatment with Pseudomonas fluorescens @ 10 g/kg seed followed by spray of propiconazole @ 0.1% at 45 days and P. fluorescens @ 1.0% at 60 days after sowing is recommended for effective management of Alternaria leaf spot disease in Punjab.

SAFFLOWER

- Multilocation evaluation of 89 trait-specific germplasm accessions resulted in the confirmation of 44 accessions for further utilization in breeding. GMU 1894 exhibited consistent performance in terms of seed yield at four centres, GMU 7363 and GMU 972 at three centres whereas accessions GMU 1397, GMU 1798, GMU 7351, GMU 880, GMU 884 and GMU 974 recorded high seed yield at two locations. In terms of oil content, GMU 7612 (37.6 to 43.4%), GMU 7618 (38.5 to 41.5%), GMU 7581 (35.6 to 40.6%) and GMU 7590 (35.8 to 40.6%) were consistent for high oil content across six/seven locations.
- Three varieties developed at Indore under national crossing programme recorded 10-11% increase in seed yield (2680-2709 kg/ha) over PBNS-12 (2440 kg/ha).
- One CMS-based hybrid (AKS CMS 2A x GMU 3876) recorded 39.15% higher seed yield than the local check variety, PKV Pink under rainfed conditions at Akola.
- Five CMS-based hybrids recorded 7-13% increase in seed yield (4407-4681 kg/ha) over the hybrid check, DSH-185 (4133 kg/ha) and 16-23% higher seed yield than variety check, A-1 (3796 kg/ha) under rainfed conditions at ICAR-IIOR, Hyderabad. They gave 15-30% higher oil yield (1364-1535 kg/ha) than DSH-185 (1181 kg/ha) and 26-36% higher oil yield than A-1 (1132 kg/ha).
- ICAR-IIOR, Hyderabad developed 86 high oil (35-39.51%) inbred lines from crosses among non-Mexican breeding lines of which 12 inbred lines recorded 11-59% increase in oil yield (883-1263 kg/ha) over A-1 (791 kg/ha) whereas two inbred lines recorded 7-14% increase in seed yield (3236-3437 kg/ha) over A-1 (3023 kg/ha) with 43-59% increase in oil yield.
- In preliminary variety trials at different AICRP centres, 41 test varieties yielded 10-39% (1014-3219 kg/ha) higher seed yield than the best check, A-1/SSF-708/PKV Pink (847-2510 kg/ha).
- In IVT, at national level, none of the test entries could record ≥10% increase in seed and oil yield over the best check, PBNS-12. In Zone-I, SSF-15-65 and ISF-112-15 recorded 13.9 and 12.2% higher oil yield (601 kg/ha and 591 kg/ha), respectively than the best check, PBNS-12 (527 kg/ha). In Zone-II, the varieties, RSS-2016-03 and NARI-125 recorded 16.4 and 10.2% increase in oil yield (1060 kg/ha and 1004 kg/ha) than the best check, PBNS-12 (911 kg/ha). Oil content in RSS-2016-03, NARI-125 and PBNS-12 was 35.4, 36.8 and 31.6%, respectively.
- In IHT, at national level, ISH-401 recorded 13.2% higher seed yield (2413 kg/ha) than the best variety check, A-1 (2131 kg/ha) and 28.8% higher seed yield than the hybrid check, NARI-H-23 (1873 kg/ha). It also recorded 23.5 and 24.3% higher oil yield than the best check variety, PBNS-12 (612 kg/ha) and hybrid check NARI-H-23 (608 kg/ha), respectively. ISH-402 and NARI-H-31 gave 17.1 and 15.7% higher oil yield (717 kg/ha and 708 kg/ha) than PBNS-12 (612 kg/ha) and 17.9 and 16.4% higher oil yield over NARI-H-23 (608 kg/ha).
- In AVT-I, SSF-13-71 recorded 11.5% higher seed yield (2029 kg/ha) than the best check, A-1 (1819 kg/ha) in Zone-I whereas SSF-13-71 and SSF/GMU-2347 gave 13.1% and 12% higher oil yield (589 kg/ha and 583 kg/ha), respectively than A-1 (521 kg/ha. In Zone-II, the non-spiny variety, ISF-1258-15 recorded 14.1% increase in seed yield (2166 kg/ha) than the non-spiny check, NARI-6 (1898 kg/ha).
- In AVT-II, at national level, ISF-764 recorded 12.7% higher seed yield (2224 kg/ha) than the best check, PBNS-12 (1974 kg/ha). It showed 17.5% increase in oil yield (684 kg/ha) than PBNS-12 (582 kg/ha). The variety, SSF-12-40 recorded 17% higher oil yield (681 kg/ha) than PBNS-12 though it gave only 3.5% higher seed yield (2044 kg/ha) over PBNS-12. The high oleic varieties, ISF-1 and ISF-2 recorded 77.46% and 75.44% oleic acid content as against 15.87-16.9% in checks, PBNS-12 and A-1 but could not out yield the checks in terms of seed and oil yield at national level. The non-spiny variety, ISF-763 recorded 18.8% higher seed yield (1621 kg/ha) and 12.8% higher oil yield (494 kg/ha) than NARI-6 (seed yield: 1365 kg/ha; oil yield: 438 kg/ha) at national level.
- A total of 55.57 q breeder seed of 12 varieties was produced against the assigned target of 14.23 q breeder seed.
- Site specific nutrient management in fallow-safflower (STCR equation based fertilizer application + Zn (5 kg/ha) + S (10 kg/ha) enhanced the seed yield over RDF at Akola (37%), Solapur (12%) and Tandur (24%).

- In rice fallow safflower in Chhattisgarh plains, safflower productivity was not affected with intercropping of leafy vegetables *viz.*, coriander and fenugreek (as additive series). Line sowing or broadcasting of fenugreek in safflower recorded additional net returns of Rs. 21,000/ha over sole safflower.
- The demonstrations conducted under rainfed conditions in the traditional states of Karnataka and Maharashtra revealed yield superiority of 23.64 and 34.5% over farmers' practice. For the demonstrations conducted under rainfed conditions across different agro-ecosystems in the country, the yield improvement due to improved technology was 22.10% resulting to additional net returns of Rs. 5,251/ha clearly depicting the superiority of the technologies demonstrated over the farmers' practice with B:C ratios of 2.33 and 2.12 on IT and FP farms. Under irrigated situations in non-traditional states of Chhattisgarh and Uttar Pradesh, the yield increase was 26.9 and 74.8% respectively. For the irrigated ecosystem as a whole, the productivity increased by 58.53% with additional net returns of Rs. 13,478/ha. The B:C ratios recorded on IT and FP farms was 2.42 and 1.97, respectively.

- Potential exists for cluster based area expansion of safflower in select agro-ecological regions of Gujarat, Madhya Pradesh and Telangana. Safflower production at the national level could be improved from the existing level of 0.94 lakh tonnes to 1.21 and 1.73 lakh tonnes, respectively by completely bridging the yield gaps I and II.
- In Uniform Disease Nursery Trial, the entry SAF-1403 was moderately resistant to wilt and recorded highest seed yield at Solapur (856 kg/ha) and Tandur (742 kg/ha) and was identified as the most stable source of resistance to Fusarium wilt disease.
- Seed treatment with *T. harzianum* Th4d SC @ 2 ml/kg and *T. harzianum* Th4d WP @10 g/kg were found to be the most effective recording least incidence of Fusarium wilt, Macrophomina root rot (*Rhizoctonia bataticola*) and Phytophthora seedling blight and recorded highest seed yield at Parbhani centre.
- Seed biopriming with *T. harzianum* @ 10 g/l water for 12 h was found to be the most effective as it recorded significantly least incidence of Phytophthora seedling blight, Fusarium wilt, Macrophomina root rot at Solapur and Tandur centres and Fusarium wilt at IIOR, Hyderabad.
- The entry GMU-1626 was found resistant to aphids, whereas two safflower entries SF-1506 and SAF-1511 were confirmed moderately resistant after two years of multilocation testing.
- Seed treatment with either thiamethoxam 30FS @10 ml/kg or imidacloprid 70WG @ 8 g/kg seed followed by foliar spraying of pymetrozine 50WG @ 300 g/ha or difenthiuron 50WP @ 600 g/ha reduced the aphid population by more than 85% compared to untreated control and resulted in higher yield.

Major Recommendations

- Released DSH-185, the first public sector CMS-based safflower hybrid for all India cultivation.
- Released NARI-96, a spiny safflower variety for Maharashtra, Telangana, Andhra Pradesh, Madhya Pradesh, Chhattisgarh and Rajasthan.
- Application of pre-emergence herbicide Oxyflurofen @ 250 g a.i./ha + two hand hoeings at 25 and 45 DAS was effective in controlling weeds in rice fallow-safflower in Chhattisgarh plains.
- In Chhattisgarh plains rice fallow-safflower, ensure sowing of safflower in November as delayed sowing beyond 1st December drastically reduces seed yield.
- For scarcity zone of Maharashtra, irrigating safflower crop with drip system at 100% of CPE at rosette termination (30-35 DAS), flower initiation (55-60 DAS) and at 50% flowering (72-75 DAS) results in 58% greater seed yield compared to the rainfed crop.
- For effective and economical management of Alternaria leaf spot of safflower and getting higher seed yield, undertake 2 to 3 need based sprays of carbendazim 12% + mancozeb 63% @ 0.2% or iprodione 25% + carbendazim 25% @ 0.2% or mancozeb 75 WP @ 0.25% at 15 days interval starting from first disease appearance in the scarce rainfall zone of Western Maharashtra.

ICAR-IIOR

Annual Report 2018-19

Institutional Activities

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

Extension and Other Activities

I. Tribal Sub-Plan

The Tribal sub-plan programme was implemented in 45 villages of 5 aspirational districts spanning over 4 states *viz.,* Telangana, Andhra Pradesh, Chhattisgarh and Gujarat with the objective of reducing poverty among the scheduled tribe population and creation of productive assets for them. Under this programme, 890 scheduled tribe farmers were benefitted through demonstration of latest released varieties/hybrids of safflower, sesame, niger and castor with improved cultivation practices conducted in association with local NGOs *viz.,* Vikasith Rythu Samkshema Samstha (VRSS), Ekalavya Foundation and REEDS, AICRP (Niger) centre located at Chintapalle, AICRP (Safflower) centre located at IGKVV, Raipur and NAU, Navsari.

Demonstration and field days under Tribal Sub Plan

Organization	State	Aspira-tional districts	Villages	No. of beneficiaries	Crop/Variety/ hybrid demonstrated	Field days
ICAR-IIOR through Ekalavya Foundation, VRSS, REEDS, SANJEEVANI Rural Development, AICRP (Niger) Chintapalle	Telangana and Andhra Pradesh	Adilabad, Vishaka-patnam, Vizia-nagaram	35	820	Niger-KGN-2	Niger: Genjigadda village Chintapalle, Vizag. – November 22, 2018 Anjoda village, Araku, Vizag. – November 23, 2018
					Safflower-PBNS-12	Safflower: Ichodamandal, Adilabad – February 5, 2019
					Sesame-Swetha (Adilabad), YLM-66 (Vizianagaram)	Sesame: Karavavalasa, Salur Mandal, Vizianagaram district – March 18, 2019 Vijapur village Adilabad – March 24, 2019
AICRP (Safflower), IGKVV, Raipur	Chhattis-garh	Rajnand-gaon	3	50	Safflower	-
NAU, Navsari	Gujarat	Narmada	7	20	Castor GCH-7/ GNCH-1	-

Niger field day organized at Araku and Chintapalle

Safflower demonstraions (PBNS-12) in farmers field at Sunkhidi village, Adilabad district

Demonstration plots of summer sesame and distribution of power sprayers at Adilabad

II. North East Hill (NEH) Region Programme

As part of the area expansion of oilseed crops in the NEH region evaluation of the latest released varieties/ hybrids of sunflower and sesame were undertaken. Nine sunflower hybrids were evaluated in three locations of NEH region *viz.*, College of Agriculture Tripura (CAT), Lembucherra, ICAR-RCNEHR, Nagaland and ICAR-RCNEHR, Tripura during *rabi* 2018-19. At CAT, Tripura, the highest yield was recorded in KBSH-74 (2.1 t/ha) which matured in 93 days. The hybrids COSFV-5 and IIOSH-14-2 showed maturity at 105 days and had grown tall. At ICAR-Nagaland centre, the hybrids KBSH-71, KBSH-74, PSH-1962 produced seed yield more than two tonnes per hectare and highest was in KBSH-71 (2.8 t/ha). At ICAR-Tripura centre, the yield of hybrids RSFH-1887, KBSH-78 and IIOSH-14-2 was about 2 t/ha. At this centre, it was noticed that all hybrids were prone to lodging except KBSH-78.

Two field days were organized in the NEH region and details are presented

S.No.	Venue	No. of beneficiaries	Villages	Date	Crop (s) demonstrated
1.	ICAR- RCNEHR, Nagaland centre	30	Jharnapani, Medziphema	February 25, 2019	Sunflower
2.	ICAR-RCNEHR, Tripura centre	70	West Tripura, Dhalai (aspirational district), Khowai and North Tripura	February 27, 2019	Sunflower and Sesame

Field Day at ICAR-Nagaland

Field Day at CAT, Lembucherra

III. Mera Gaon Mera Gaurav (MGMG)

During the year, 79 visits were made by the teams covering 2510 farmers from 40 villages with 55 interface meetings/ghostis conducted in the villages. The institute facilitated conduct of demonstrations on 201 ha with technology support on castor, sesame, paddy, sorghum, green gram, black gram and redgram benefiting 238 farmers. Linkages were established with PJTSAU, ICAR-IIMR, ICAR-DPR, PVNRTVU, Department of Agriculture, Telangana and NGO's. Special events *viz.*, Exposure to oilseeds demonstration plots, conduct of Swachta hi Seva programmes, World soil day, Jai Kisan Jai Vigyan were conducted at IIOR/MGMG villages. The highlights of the various activities are presented.

The Castor Field Day was organised on September 27, 2018 at IIOR Research Farm, Narkhoda wherein farmers were exposed to demonstrations of promising/ new hybrids ICH-66 and ICH-538, popular hybrids DCH-519 and DCH-177, intercropping systems *viz.*, castor + redgram (1:1) and castor + green gram (1:1) with papaya (Taiwan Red Lady) as border crop and demonstration of best management practices were showcased for the benefit of castor growing farmers of Telangana. About 300 farmers from various castor growing districts of Telangana participated in the programme.

MGMG village farmers attending Castor Field Day at IIOR Research Farm, Narkhoda

Swachhta hi Seva programme was organized in Gattepally, Gattepally thanda, Gurudhotla thanda and Rampur thanda (tribal hamlets) during September, 2018 at Vikarabad Mandal to generate awareness and Sramdhan to drive behaviour change with respect to sanitation awareness practices like hand wash, health and hygiene awareness, neighborhood cleaning and compost-pit maintenance.

Swachhta Hi Seva programme in tribal hamlets

On the occasion of World Soil Day on December 5, 2018, celebrations on the theme "Be the Solution to Soil Pollution" were held at IIOR. Around 50 farmers from the MGMG villages were invited for creating awareness on the importance of soil health and integrated nutrient management in sustenance of the soil for future generations. Soil health cards prepared by the institute were distributed to 36 farmers. Renowned soil scientist Dr. Padma Raju, Ex-VC, ANGRAU explained the key interventions for improving soil health.

World Soil Day celebrations at IIOR

Field Interactive sessions on importance of soil health at INM plots at IIOR, Rajendranagar

Field Day on the occasion of Jai Kisan Jai Vigyan was organized on December 22, 2018 at IIOR Research Farm, Rajendranagar. Around 390 farmers from various districts of Andhra Pradesh, Odisha and Telangana participated in the meeting. Newly developed hybrids with best management practices in castor, sunflower, safflower, sesame, niger, groundnut and mustard as well as seed production of castor hybrid DCH 519 were demonstrated.

Field visit and interactive meeting on best management practices in oilseeds

In addition to these, the farmers were motivated to take up cultivation of oilseeds. Other aspects like importance of FPOs, empowering women households through backyard poultry, vermicomposting, awareness on availability of quality seeds, enterprise development programmes on value addition of paddy and pulses were also organized.

IV. National Agricultural Innovation Fund (NAIF) Activities (Component II ABI)

Under this programme, trainings and entrepreneur development programmes (EDP) were organized and the details are presented.

- Conducted EDP on biocontrol agents and value addition of oilseeds organised at Kothakota, Chittoor district, Andhra Pradesh on June 28, 2018 for 48 farmers/prospective entrepreneurs.
- Organised EDP on value addition of oilseeds at Rampur thanda, Vikarabad district, Telangana on September 1, 2018.
- Training on the relevance of Farmers' Producing Organizations (FPO) on value addition was conducted for farmers at Gurudhotla, Vikarabad district, Telangana on December 4, 2018.
- Training on processing of edible oils was organised for four incubates admitted under ABI from March 25-29, 2019.

V. Swachhta hi Seva and Swachhata Pakhwada

Swachhta hi Seva (SHS)-2018, and Swachhta Pakhwada (SP)-2018 activities were conducted under Swachh Bharat Mission from September 15 to October 02, 2018 and December 16-31, 2018. As per the schedule of specific activities listed from ICAR-HRD for celebration of SHS and SP, Swachhta Pledge was administered to all the Scientists/Officers/Staff/ Students of IIOR.

Cleaning drive within campus and surroundings, stock taking of bio-degradable and non bio-degradable waste disposable and sanitation drive was taken up in the villages adopted under farmers first programmes and progress of ongoing swatchta activities was also reviewed. A programme of creating awareness about swachhta among school children was organized at Govt. Primary and High School, Narkhoda village, Rangareddy district (Telangana), folk songs were sung and moral stories about swachhta were narrated and about 350 school students, their teachers and IIOR scientists, administrative, skilled and farm staff participated and made this programme a grand success. Other activity organized included cleaning of streets, drains and back alleys through awareness drive at Narkhoda village. Awareness campaigns for better sanitation practices like use of toilets, hand washing, health and hygiene awareness were organized. The employees and villagers participated with great enthusiasm and cleaned villages and roads.

Swachhata Pakhwada activities

Education and Training

Details of students working for Ph.D. (2018-19)

Name of the student	Title of the thesis	Discipline	University
	Major advisor: **Dr. M. Sujatha**		
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	Osmania University, Hyderabad
	Major advisor: **Dr. V. Dinesh Kumar**		
K. Aravind Kumar	Multigene approaches for necrotrophic fungal tolerance	Biotechnology	University of Hyderabad, Hyderabad
B. Madhu	Development of regeneration and transformation protocols in safflower (*Carthamus tinctorius* L.)	Plant Sciences	University of Hyderabad, Hyderabad
S. Velu Mani	Molecular mechanisms responsible for the biological effects of *Trichoderma* on castor bean (*Ricinus communis* L.) plant health	Plant Sciences	University of Hyderabad, Hyderabad
	Major Advisor: **Dr. M. Santha Lakshmi Prasad**		
K. Sujatha	Study of resistance mechanism and management of Alternaria leaf blight in sunflower	Genetics	Osmania University, Hyderabad
N. Naresh	Diversity analysis of Alternaria leaf blight in sunflower based on morphological, pathogenic and molecular characters	Biotechnology	JNTU, Hyderabad
E. Bharathi	Variability in pathogen population of castor wilt fungus and its management	Microbiology	Osmania University, Hyderabad
	Major advisor: **Dr. S. Senthilvel**		
J. Poornima Kumari	Genetic and molecular analysis of nematode resistance in castor (*Ricinus communis* L.)	Genetics	Osmania University, Hyderabad
Manmode Darpan Mohanrao	Studying allelic relationship and identification of SNP markers linked to specific resistance genes in castor	Genetics and Plant Breeding	PJTSAU, Hyderabad
	Co-Major advisor: **Dr. Ratna Kumar Pasala**		
B.B. Pandey	Studies on traits associated with drought tolerance in sesame	Plant Physiology	IGKVV, Raipur
	Co-Major advisor: **Dr. Lakshmi Prayaga**		
V. Aparna	Studies on thermo tolerance of sunflower	Plant Physiology	IGKVV, Raipur
	Co-Major advisor: **Dr. P. Duraimurugan**		
Borkar Sundar	Studies on bio-ecology and management of storage insect pests of sesame	Agricultural Entomology	JNKVV, Jabalpur

Details of students working for M.Sc. (2018-19)

Name of the student	Title of the thesis	Discipline	University
	Major advisor: **Dr. Lakshmi Prayaga**		
B. Yasaswini	Evaluation of restorer lines of sunflower for drought tolerance	Plant Physiology	PJTSAU, Hyderabad
	Co-Major advisor: **Dr. Ratna Kumar Pasala**		
Ravi Teja, K.N.	Studies on physiological characteristics in sesame (*Sesamum indicum* L.) varieties under rainfed conditions	Plant Physiology	PJTSAU, Hyderabad
G.S. Lakshmi	Characterization and confirmation of elite germplasm of sesame under moisture stress conditions	Plant Physiology	IGKVV, Raipur

Ph.D. Degree awarded

Name of the student	Title of the thesis
	Mapping gene(s) for male fertility restoration (ARG cytoplasm) and resistance to powdery mildew (*Golovinomyces cichoracearum*) in sunflower (*Helianthus annuus* L.). Degree awarded by University of Hyderabad, Hyderabad **Supervisor:** Dr. M. Sujatha Principal Scientist ICAR-IIOR, Hyderabad
K. Prathap Reddy	
	Genetic transformation of safflower (*Carthamus tinctorius* L.) and *Arabidopsis* for increased oil content Degree awarded by Osmania University, Hyderabad **Supervisor:** Dr. V. Dinesh Kumar Principal Scientist ICAR-IIOR, Hyderabad
Ch. Anil Kumar	
	Genetic and molecular analysis of Fusarium wilt resistance in castor (*Ricinus communis* L.) Degree awarded by Osmania University, Hyderabad **Supervisor:** Dr. S. Senthilvel Principal Scientist ICAR-IIOR, Hyderabad
Ranjan Kumar Shaw	
	Development, characterization and evaluation of nanocarrier embedded toxin of *Bacillus thuringiensis* var. *kurstaki* for management of insect pests Degree awarded by Osmania University, Hyderabad **Supervisor:** Dr. P. S. Vimala Devi Principal Scientist ICAR-IIOR, Hyderabad
V. Vineela	

Training programmes for capacity building of stakeholders

1. Scientists

a) Recent Advances in Adaptations and Management Strategies for Sustainable Oilseeds Production under Climate Change Scenario

The ICAR sponsored training programme on "Recent advances in adaptations and management strategies for sustainable oilseeds production under climate change scenario" was conducted at ICAR-IIOR during October 3-12, 2018. Majority of oilseeds grown in rainfed ecosystem are groundnut, sesame, rapeseed, mustard, linseed, sunflower, safflower, soybean and castor. It is to be noted that the production of these oilseeds has always fallen short of our demand due to abiotic stresses especially shortage of rainfall, thermo and photosensitivity, change in pest and diseases due to climatic conditions and there has always been a need to import oil and oilseeds or their products for meeting the demand of our ever-growing population. A total of 19 faculty from SAU's benefitted from lectures delivered by resource persons of ICAR and SAU's and exposure visits including ICRISAT pheonomics, CRIDA climate change facility and IIOR laboratories and experimental farms.

b) Orientation-cum-Training for scientists of AICRP on Oilseeds

The programme for orientation-cum-training for newly joined scientists of AICRP for Sesame, Sunflower, Castor and Safflower was conducted. The duration and number of participants are presented.

Crop	Date	No. of scientists
Sesame	September 27-29, 2018	2
Sunflower	October 29-31, 2018	4
Castor	September 10-12, 2018	4
Castor	February 4-6, 2019	6
Safflower	February 20-22, 2019	5

The scientists were imparted training on various aspects such as management and characterization of genetic resources as well as breeding methods. Techniques for screening against pests, diseases and their management, seed production, agronomy experimentation, physiological aspects, oil content and quality estimation, DUS testing guidelines, PGRC regulations, experimental design and statistical analysis, details of submission of AICRP data in the required format were described by the resource persons from ICAR-IIOR, Hyderabad. The training sessions comprised presentations, interactions, field and laboratory visits.

Visit to safflower and sesame fields

2. Agricultural Department Staff/ Entrepreneurs

a) Model training course on Nutrient and Soil Health Management

A model training course sponsored by Directorate of Extension (DAC&FW), Govt. of India titled "Recent Advances in Nutrient *vis-a-vis* Soil Health Management for Major Oilseed Cropping Systems of India" was conducted at ICAR-IIOR during September 5-12, 2018. Main themes of the training course were: nutrient management approaches and conservation agriculture, soil quality and soil health management, weed management and dryland agriculture, integrated farming systems, organic farming, judicious irrigation and fertigation, demonstration of nutrient analysis, soil test kits and recommendations covering nine oilseed crops. A total of 25 trainees participated from Department of Agriculture of 10 states. The trainees had exposure visits to ICRISAT and bio-fertilizer production laboratory and vermi-composting facilities at Agri Biotech Foundation.

b) Training on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame

The training programme on 'Seed Production Technologies in Castor, Sunflower, Safflower and Sesame' was organised at ICAR-IIOR during January 7-11, 2019. Twenty one participants from SAUs, AICRP, NSC, TSSCA, IIOR, NGOs etc. attended the training. The training included seed to seed aspects starting from basic concepts of crop botany, pollination mechanism, and advances in seed production technologies for varieties, parental lines and hybrid seed production and certification. The knowledge on maintenance breeding, seed production techniques, agronomic management practices, genetic purity testing, seed certification process, post-harvest processing and storage aspects which are critical for successful seed production were imparted. Practical field exposure and hands-on training was provided in all the crops with continuous interaction. Visits to seed testing and certification laboratories and Gubba cold storage facility were organised.

Training on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame; January 7-11, 2019

Visit to Gubba Cold Storage Unit, Hyderabad

c) Training on Mass Production of Entomo-pathogenic and Antagonistic Fungi for Management of Insect Pests and Diseases

A 5 days Hands-on training on isolation, identification, mass production and quality of Entomopathogenic fungus, *Beauveria bassiana* for management of insect pests and antagonistic fungi for management of diseases was organized at ICAR-IIOR during August 7-11, 2018. Three participants from KN BioSciences India Pvt. Ltd., Hyderabad participated in the training.

d) Training on Best Management Practices (BMPs) for Increasing Oilseeds Productivity

Input dealers are the first source of information on agriculture for the farmers. In order to strengthen the information of input dealers a training programme was organized on "Best Management Practices (BMPs) for Increasing Oilseeds Productivity" at ICAR-IIOR on February 14, 2019. Forty input dealers of Mahabubnagar and Wanaparthy districts of Telangana State participated in the training programme.

3. Farmers

a) Training programmes for capacity building of farmers

Name	Venue	Date	No. of beneficiaries
Botrytis management in castor	Lankala and Undhyal, Undekode Gudigandla, Mahabubnagar district Kanimetta, Wanaparthy district, TS	June 26, 2018 July 12, 2018 August 8, 2018	75 50 75
Value addition of oilseeds	Ampally, Vikarabad district, TS	July 4, 2018	23
Suitable hybrids of castor for Mahabubnagar & Wanaparthy districts	Patherched & Yankee, Mahabubnagar district; Gudigandla & Kanimetta, Wanaparthy district; Undhyal & Lankaka, Mahabubnagar district, TS	September 18, 2018 September 28, 2018 October 3, 2018	65 70 70
On-farm training on seed production	Palem, Nagar kurnool district, TS	October 2, 2018	30
Soil test based nutrient application in sunflower	Hegdoli, Nizamabad district, TS	November 2, 2018	50
On-farm training on seed production	Cherukuru, Amangal, TS	November 29, 2018	25
Production technology in oilseed crops for increasing productivity and income	ICAR-IIOR, Hyderabad	November 16, 2018 November 29, 2018 December 13-14, 2018 (6 programmes)	136
Production technology of oilseeds and value addition in oilseeds	ICAR-IIOR, Hyderabad	November 15, 2018 December 11, 2018 December 12, 2018 January 01, 2019 (4 programmes)	134
Technologies for increasing yield of sesame	Imrahimpur, Siddipet district, TS Hegdoli, Nizamabad district, TS	January 10, 2019 March 11, 2019	75 50
Technologies for increasing yield of castor	Patherched, Mahabubnagar district, TS	January 29, 2019	300
Agril Skill Council of India training on Quality seed production	IIOR in collaboration with IIRR, Hyderabad	February 21, 2019	22
Agril Skill Council of India training on Quality seed production	IIOR in collaboration with PJTSAU, Hyderabad	February 25, 2019	25

b) Exposure visits

Field Demonstrations on Oilseed crops and relevant technologies

In order to meet the growing demand of vegetable oils in the country, different oilseed institutes under ICAR/ AICRP developed suitable genotypes and farmer friendly technologies for enhancing the productivity of oilseed crops. It was felt that there was the need to showcase the potential of these new oilseed varieties/ hybrids under best management practices. In this direction, ICAR-Indian Institute of Oilseeds Research (IIOR), Hyderabad conducted "Field Demonstrations of Oilseed Crops" during December 15-30, 2018 at the Research Farm of Rajendranagar. Four varieties of groundnut (K-6, K-9, Kadiri Harithandra and Dharani); four varieties of sesame (Swetha, YLM-66, GT-10, and CUMS-17), four hybrids of sunflower (DRSH-1, IIOSH-2, NDSH-1012 and LSFH-171) and three cultivars of safflower (DSH-185, ISF-764 and PBNS-12), two varieties of niger (JNS-28 and JNS-30), two hybrids of rapeseed-mustard (NRCHB-10 and RH-749) and five released/pipeline hybrids of castor (DCH-519, GCH-7, GCH-8, ICH-66 and ICH-538) were demonstrated by following best management practices. About 500 farmers from 7 districts of four states (Telangana, Andhra Pradesh, Tamil Nadu and Odisha) along with representatives from respective State Department of Agriculture, KVK, ATMA and NGO's participated and benefitted from the event.

Visit of farmers to field demonstrations

c) Field days

i) Castor field day-cum training

In order to revive castor crop in Traditional areas of Telangana, frontline demonstrations of castor were conducted in Mahabubnagar district, Telangana State during *kharif* 2018. A castor field day-cum training was organized on October 4, 2018 at Patherched village, Narwamandal. Around 500 farmers, officials from various organizations, NGOs and scientists of KVK, PJTSAU and ICAR-IIOR and press and media persons participated in the field day. The participants visited the demonstrations fields of farmers *viz.*, Bogganna, Shekar and Nagesh and observed the technologies such as sowing across the slope, hybrids DCH-519 and ICH-66, optimum spacing, need based pest and disease management demonstrated by IIOR scientists. The participants interacted with the scientists and provided the feedback on the technologies demonstrated.

Dr. Vishnuvardhan Reddy addressing farmers during the field day

Farmers participating in the field day

ii) Sunflower field day-cum-interaction meeting

The rice-fallow areas of Telangana State have huge potential for oilseeds cultivation. In order to exploit this potential frontline demonstrations on sunflower were conducted in Nizamabad district of Telangana state. A field day was organized in Hegdoli village, Nizamabad district on March 12, 2019 to create awareness among farmers, staff of agricultural department and KVK and other stakeholders on the profitability of sunflower in rice fallows. The district is one of the potential districts for cultivation of oilseeds (sunflower, safflower and sesame). The Head of Regional Research Station, Rudrur and Scientists of DAATTC and ICAR-IIOR participated in the field day and interacted with the farmers. Local Rythu Samanvaya Samithi members and local leaders also participated in the event. The programme started with the field visits of staff of agricultural department, farmers, scientists and the press followed by interaction with the stakeholders. Around 190 farmers participated and actively interacted with the scientists during the field day.

Farmers sharing their experience of sunflower cultivation in rice fallows

Scientists interacting with farmers

Exhibitions

In order to showcase technologies and facilitate availability of seeds of improved varieties and hybrids to farmers, ICAR-IIOR stall was setup at various expos and melas as presented.

Theme/Area	Place	Date	No. of participants
Agricultural Science Congress Expo	NASC, New Delhi	20.02.2019 to 23.02.2019	Around 500 farmers, staff of agricultural departments and scientists from all over India visited ICAR-IIOR stall
Seed Mela	PJTSAU, Hyderabad	24.05.2018	Around 1000 farmers from various districts of Telangana and Andhra Pradesh visited ICAR-IIOR stall
Seed Mela and Farmers Day	ICAR-IIRR, Hyderabad	03.11.2018	Around 200 farmers, staff of agricultural department and scientists visited ICAR-IIOR stall

Seed Mela at PJTSAU, Hyderabad

Oilseed Seed Mela at IIOR, Hyderabad

Awards and Recognitions

AWARDS

- Dr. P.S. Vimala Devi, Principal Scientist (Agricultural Entomology) has been conferred with Panjabrao Deshmukh Outstanding Women Scientist Award – 2017 during the year 2018 for her pioneering work with various microbial agents and demonstrating their potential for insect pest management which paved the way for their large-scale field use.

Dr. P.S. Vimala Devi receiving the Panjabrao Deshmukh Outstanding Women Scientist Award

- The Rajbhasha Purskar (second prize) has been awarded to ICAR-IIOR for implementation of Official language among central government offices in the Town Official Language Implementation committee meeting held on December 10, 2018 at National Institute of Rural Development and Panchyati Raj, Rajendranagar, Hyderabad.

IIOR Team receiving the Rajbhasha Purskar

- Dr. H.P. Meena, received Best (first) Oral Presentation certificate for the paper "Approaches for genetic enhancement of cultivated sunflower (*Helianthus annuus* L.) for desirable traits" by H.P. Meena, M. Sujatha, M.Y. Dudhe and A. Vishnuvardhan Reddy in the 2nd International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future conducted at Swami Vivekanand Subharti University, Meerut, Uttar Pradesh from October 20-22, 2018.
- Dr. H.P. Meena received the Young Scientist Award during the 2nd International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future held at Swami Vivekanand Subharti University, Meerut, Uttar Pradesh from October 20-22, 2018.
- Dr. H.P. Meena received the Best Scientist Award for the year 2018 from Innovative Research Developers and Publishers (IRDP), Chennai.
- Dr. Jawahar Lal Jatothu received Best Poster Award for the article "Pattern of genotypic diversity in indigenous castor (*Ricinus communis* L.) genotypes" in the National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario held at Junagadh, Gujarat from April 7-9, 2018.
- RULA award for International Innovation and Betterment Excellence has been conferred by the International Journal for Research under Literal Access (IJRULA), UMC and World Research Council to the authors K. Anjani, M.A. Raoof, M. Santha Lakshmi Prasad, P. Duraimurugan, R.D. Prasad, C. Sarada, J. Jawaharlal of the research article "Trait-specific accessions in global castor (*Ricinus communis* L.) germplasm core set for utilization in castor improvement". Industrial Crops and Products, 112: 766-774.

- Dr. P. Duraimurugan received Best Poster Award for the paper entitled "Exploitation of the sex pheromone for monitoring of shoot and capsule borer, *Conogethes punctiferalis* Guenee (Crambidae: Lepidoptera) in castor" (authored by P. Duraimurugan and M. Sampath Kumar) during the 6th Biopesticide International Conference held at Amity University, Raipur, Chhattisgarh, India during March 6-8, 2019.
- Mrs. B. Gayatri and P. Duraimurugan received Best Poster Award for the paper entitled "Bio-efficacy of *Heterorhabditis bacteriophora* (Rhabditida: Heterorhabditidae) against serpentine leafminer, *Liriomyza trifolii* Burgess (Diptera: Agromyzidae) in oilseed crops" (authored by B. Gayatri and P. Duraimurugan) during the First International Conference on Biological Control – Approaches and Applications organized by ICAR-NBAIR at Bengaluru, Karnataka, India during September 27-29, 2018.
- Mrs. Chandrika, K.S.V.P received Best Oral Presentation (First position) award for the presentation on "Sprayable starch granule formulations for Bt against *Spodoptera litura*" in the 6th Biopesticide International Conference (BIOCICON-2019), held at Amity University, Raipur from March 6-8, 2019.

Institutional Best Worker Awards

The Best Worker Award in different categories of IIOR staff were awarded to the following staff on the occasion of IIOR Foundation Day on August 1, 2018.

Name	Category
Dr. P. Lakshmamma, Dr. Lakshmi Prayaga, Dr. K. Alivelu	Best Research Paper (Certificate and cash – ₹ 2000/- each)
Sri P. Sunil Kumar, Sri B.V. Rao	Technical (Certificate and cash – ₹ 1500/- each)
Mrs. C. Lalitha, Sri A. Prem Kumar	Administration (Certificate and cash – ₹ 1500/- each)
Sri A. Rambabu	Skilled Supporting Service (Certificate and cash – ₹ 3000/-)
Mrs. Y. Balamani, Sri M. Krishna, Sri B. Venkataswamy	Temporary Status Labour (Certificate and cash – ₹ 1000/- each)

Recognitions

- Dr. M. Sujatha is a Member of DBT accreditation panel for certification of tissue culture facilities under the NCS-TCP programme.
- Dr. M. Sujatha is nominated as member of the Technical Expert Committee of DBT for Agriculture Biotechnology for a period of 3 years from 2018.
- Dr. M. Sujatha is Board Member of the International Sunflower Association (ISA), Toulouse, France.
- Dr. M. Sujatha was member of the Scientific Committee constituted for the International Symposium on Confection Sunflower Technology and Production at Wuyuan, Inner Mongolia, China from August 8-10, 2018.
- Dr. K. Anjani is appointed as Editorial Board Member of American Journal of Agriculture and Forestry for three years from 2018.
- Dr. K. Anjani is appointed as Editorial Board member of the Journal Probe-Botany from November 2018.
- Dr. N. Mukta, Dr. C. Lavanya and Dr. G.D. Satish Kumar were Panel members for Group discussion on Devising road map for doubling farmers income through climate resilient agricultural technologies at National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario held at ICAR-Directorate of Groundnut Research (DGR), Junagadh on April 9, 2018.
- Dr. P. Kadirvel was appointed as subject expert in the selection committee for the selection/ promotion of faculty members of Department of Genetics & Plant Breeding, Annamalai University, Tamil Nadu on February 17, 2019.

- Dr. H.P. Meena co-chaired the session V and conducted the proceedings during the 2nd International Conference organized from October 20-22, 2018 at Meerut, Uttar Pradesh.
- Dr. J. Jawahar Lal is nominated as Editorial Board Member of Journal of International Academic Research for Multidisciplinary.
- Dr. P.S. Vimala Devi is a member of the Local Project Advisory Committee (LPAC) of DST for reviewing an ongoing project at NAARM, Hyderabad on "Agricultural Research and Development Infrastructure in Andhra Pradesh and Telangana".
- Dr. M. Santha Lakshmi Prasad received "Fellow of Indian Society of Oilseeds Research" for the outstanding contribution in the field of oilseeds research and development in India.
- Dr. P. Duraimurugan has been recognized as Editorial Board Member, Journal of Food, Agriculture and Environment, WFL Publisher (Science and Technology), Finland.
- Dr. P. Duraimurugan is a DBT Nominee in the Institutional Biosafety Committee (IBSC) of M/s. Seed Works International Pvt. Ltd., Medchal Mandal, Telangana.
- Dr. P. Duraimurugan has been recognized as External Examiner for evaluation of the Ph.D. and M. Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore.
- Dr. P. Duraimurugan has been recognized as an Associate Editor, Editorial Board, Journal of Oilseeds Research, Indian Society of Oilseeds Research, ICAR-IIOR, Hyderabad.
- Dr. H.H. Kumaraswamy is recognized as Editorial Member for International Journal of Agricultural Sciences, Published by Bioinfo Publications.
- Dr. H.H. Kumaraswamy is an external expert in the Institutional Biosafety Committee (IBSC) of M/s Seed Works International Pvt. Ltd., Medchal Mandal, Telangana.
- Dr K. Ramesh served as member of the Zonal Project monitoring committee for the ICAR-CRIDA projects undertaken by Krishi Vigyan Kendras of Andhra Pradesh as DDG (NRM) nominee of ICAR. Visited and reviewed the project work undertaken by the KVKs along with other members of the ZPMC.
- Dr. Ratna Kumar Pasala was conferred Associate Fellow-2018 by Telangana Academy of Sciences.
- Dr. Ratna Kumar Pasala received Elsevier Reviewer Recognition-2018 by Agricultural Water Management, and Regional Studies in Marine Sciences, Elsevier, The Netherlands.
- Dr. Ratna Kumar Pasala is Member Editor of the Journal of Functional and Environmental Botany -2018 (ISSN: 2231-1742).
- Dr. C. Sarada received "Fellow of Indian Society of Oilseeds Research" for the outstanding contribution in the field of oilseeds research and development in India.
- Dr. C. Sarada was nominated as an expert member in the selection committee for the promotion under CAS of UGC 2006 scales for faculty members of Ag. Statistics, APAU, Andhra Pradesh on June 18, 2018.
- Dr. K. Alivelu received "Fellow of Indian Society of Oilseeds Research" for the outstanding ontribution in the field of oilseeds research and development in India.

T.V. Talk

Name	Programme	Date
Dr. G. Suresh	Tips for attaining higher yields in Sunflower (in Telugu) telecasted from 10TV channel	December 16, 2018

Intellectual Property Rights

Technology licensing under NAIF (Component I ITMU)

Licensing of *Trichoderma harzianum* Th4d 20% SC formulation to M/s Shri Ram Solvent Extractions Pvt. Ltd, Jaspur (U.S. Nagar), Uttaranchal.

Additional data for the process for multiplication and production of DOR Bt-1 WP 0.5% formulation to M/s Multiplex Biotech Pvt. Ltd, Bengaluru, Karnataka.

On-Going Research Projects

Institute

Sl. No.	Project No.	Project title	Investigators
1	101-5 (IXX12584)	Exploitation of inter and intraspecific genetic resources for development of agronomically superior inbred lines and populations in sunflower	M. Sujatha H.P. Meena M.Y. Dudhe H.D. Pushpa Lakshmi Prayaga S. Chander Rao P.S. Srinivas K. Alivelu A. Vishnuvardhan Reddy
2	102-7 (IXX12633)	Exploitation of safflower genetic resources for development of superior breeding lines with high oil yield and adaptation to stresses	P. Kadirvel N. Mukta Md. A. Aziz Qureshi R.D. Prasad P.S. Srinivas Praduman Yadav
3	102-8 (IXX12568)	Development of parental lines with high oil yield and wilt resistance in safflower	K. Anjani R.D. Prasad
4	102-9 (IXX12571)	Development of genetic and genomic resources and identification of genes/markers for agronomic traits in safflower	B. Usha Kiran V. Dinesh Kumar P. Kadirvel
5	103-12 (IXX12565)	Exploitation of plant genetic resources for development of superior inbred lines in castor	K. Anjani M. Santha Lakshmi Prasad P. Duraimurugan Praduman Yadav P. Lakshmamma J. Jawahar Lal
6	103-13 (IXX12629)	Diversification of pistillate base and development of superior parental lines in castor	T. Manjunatha C. Lavanya S. Senthilvel P. Lakshmamma
7	103-14 (IXX13518)	Development of genomic resources and tools for applications in castor breeding	S. Senthilvel R.D. Prasad M. Santha Lakshmi Prasad B. Gayatri
8	103-15 (IXX13580)	Optimization of regeneration and transformation protocols to realize grey mold resistant transgenic castor (*Ricinus communis* L.)	V. Dinesh Kumar M. Sujatha B. Usha Kiran H.H. Kumaraswamy Rohini Sreevathsa (NRCPB, IARI, New Delhi)
9	104-12 (IXX12625)	Development of agroecological, situation specific, cropping system oriented technologies for different oilseed crops	S.N. Sudhakara Babu Md. A. Aziz Qureshi K. Alivelu

Sl. No.	Project No.	Project title	Investigators
10	104-13 (IXX12569)	Assessing safflower based cropping systems productivity and resource use efficiency under different land configurations, crop geometry and IPNM in different Vertisol types and rainfall patterns	P. Padmavathi I.Y.L.N. Murthy P. Ratna Kumar K. Alivelu
11	104-14 (IXX13048)	Synthesis and evaluation of polymers for seed health and productivity of oilseed crops	K.S.V.P. Chandrika Praduman Yadav R.D. Prasad S.N. SudhakaraBabu P. Padmavathi Lakshmi Prayaga P. Ratna Kumar Anupama Singh (IARI, New Delhi) Tushar Jana (UoH, Hyderabad)
12	104-15 (IXX13052)	Screening and identification of potential sources of tolerance to abiotic stresses and improved physiological efficiency in sesame	P. Ratna Kumar J. Jawahar Lal Praduman Yadav
13	104-16	Development of best management practices for organic soybean-sesame cropping system	K. Ramesh Md. A. Aziz Qureshi Praduman Yadav P. Duraimurugan
14	104-17	Fabrication of Fe and Zn nanosystems as efficient nutrient sources	K.S.V.P. Chandrika Md. A. Aziz Qureshi Praduman Yadav Balaji Gopalan (Chemistry), BITS Pilani, Hyderabad Campus Anupama Singh (Agril. Chemicals), ICAR-IARI, New Delhi
15	104-18	Agronomic interventions for enhancing resource use efficiency in castor based cropping systems	G. Suresh Md. A. Aziz Qureshi
16	105-11 (IXX12567)	Development of water dispersible granular (WDG) formulation of *Bacillus thuringiensis* var. *kurstaki* for management of *Spodoptera litura*	P. S. Vimala Devi P. Duraimurugan K.S.V.P. Chandrika
17	105-12 (IXX12570)	Screening and identification of durable sources of resistance to diseases of castor and deciphering the associated mechanisms	M. Santha Lakshmi Prasad B. Gayatri Praduman Yadav
18	105-13 (IXX12573)	Identification of potential sources of resistance to various biotic stresses and understanding the mechanism of resistance in safflower	P.S. Srinivas R.D. Prasad P. Kadirvel N. Mukta P. Ratna Kumar
19	105-14 (IXX09328)	Screening and identification of dependable sources of resistance to insect pests of castor and deciphering the associated mechanisms	P. Duraimurugan

Sl. No.	Project No.	Project title	Investigators
20	105-15 (IXX13577)	Screening and identification of dependable/ durable sources of resistance to biotic stresses of sesame and deciphering the associated mechanisms	M. Santha Lakshmi Prasad S. Chander Rao P. Duraimurugan H.H. Kumaraswamy
21	105-16 (IXX13582)	Exploiting the bio-efficacy of entomopathogenic nematodes against tobacco caterpillar (*Spodoptera litura*) and serpentine leaf miner (*Liriomyza trifolii*) in oilseed crops	B. Gayatri P. Duraimurugan Sunanda Patil (NIPHM), Hyderabad
22	106-2 (IXX13051)	Production and characterization of protein hydrolysates from safflower seed and validation of their utility in animal nutrition	Praduman Yadav K.S.V.P. Chandrika S.V. Ramana Rao M. Santha Lakshmi Prasad
23	107-16 (IXX12572)	ICT mediated knowledge management and dissemination in different oilseed crops	P. Madhuri G.D. Satish Kumar S.V. Ramana Rao C. Sarada C. Lavanya M. Sujatha N. Mukta Praduman Yadav G. Suresh S.N. Sudhakara Babu P. Padmavathi P. Duraimurugan G. Raghunath
24	107-17 (IXX13053)	On-farm demonstrations of improved technologies and impact assessment of the adoption	S.V. Ramana Rao G.D. Satish Kumar S.N. Sudhakara Babu P. Madhuri
25	107-18 (IXX13581)	Impact assessment of varieties/hybrids of IIOR mandated crops in varied agro-ecological regions of India	S.V. Ramana Rao C. Sarada
26	107-19 (IXX14482)	Development of models to predict yield responses to climate change in oilseed crops	K. Alivelu C. Sarada
27	108-1 (IXX10460)	Development of stable cytoplasmic genetic male sterile system in sesame through wide hybridization	J. Jawahar Lal
28	108-2 (IXX13579)	Exploitation of inter and intra specific genetic resources for development of elite breeding lines in sesame	K.T. Ramya J. Jawahar Lal A.R.G. Ranganatha
29	108-3 (IXX13583)	Development of genetic and genomic resources and identification of gene/marker for different agronomic traits in sesame	H.H. Kumaraswamy M. Santha Lakshmi Prasad P. Duraimurugan P. Ratna Kumar
30	109-1 (IXX13629)	Exploitation of plant genetic resources for development of improved breeding populations in niger [*Guizotia abyssinica* (L. f.) Cass.]	H.D. Pushpa A. Vishnuvardhan Reddy

Externally Funded

Sl. No.	Project title	Investigators	Sponsoring organization	Budget (Rs. in lakhs)
1	Mass production of *Bacillus thuringiensis* (Bt) and *Beauveria bassiana*, formulation as oil based suspension concentrates singly and in combination and field evaluation	P. S. Vimala Devi P. Duraimurugan K.S.V.P. Chandrika	ICAR Network-AMAAS	7.37
2	Development of practicable technologies for field level exploitation of consortia of microbial agents as ameliorators of biotic and abiotic stresses in crops	R.D. Prasad P. Lakshmamma Md. A. Aziz Qureshi K.S.V.P. Chandrika	ICAR Network-AMAAS	7.56
3	Farmers FIRST programme: Competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana	S.V. Ramana Rao Md. A. Aziz Qureshi P. Padmavathi P. Lakshmamma P. Duraimurugan K.T. Ramya T. Manjunatha G.D. Satish Kumar K. Alivelu S.V. Rama Rao (ICAR-PDP) S.T. Veeroji Rao (PVNRTSVU) Gnan Prakash Sarat Chandra Venkata Ramana G. Vidyasagar Reddy	KVK Scheme, Extension Division, ICAR	21.63
4	Seed production in agricultural crops	S.N. Sudhakara Babu C. Lavanya T. Manjunatha H.P. Meena K. Anjani K.T. Ramya	IISS, Mau	11.25
5	Creation of seed hubs of oilseeds for enhancing quality seeds availability of major oilseeds	A. Vishnuvardhan Reddy S.N. Sudhakara Babu T. Manjunatha H.P. Meena K.T. Ramya	DAC-NFSM, GoI	5091.18

Sl. No.	Project title	Investigators	Sponsoring organization	Budget (Rs. in lakhs)
6	Frontline Demonstrations (FLDs) on oilseeds and other activities	G.D. Satish Kumar S.V. Ramana Rao C. Sarada	DAC-NMOOP, GoI	212.00
7	Proactive mitigation of gray mold (*Botryotinia ricini*) disease of castor (*Ricinus communis* L.) crop in Telangana State using dynamical disease forecast	R.D. Prasad C. Sarada	DST-SSTP, GoI	9.00
8	Mapping of QTLs associated with resistance to aphid (*Uroleucon compositae Theobald*) in safflower (*Carthamus tinctorius* L.) using genome-wide SNP markers	P. Kadirvel P.S. Srinivas S. Senthilvel	DST, GoI	9.00
9	Central Sector Scheme For Protection of Plant Varieties and Farmers Rights Authority (Annual)	N. Mukta C. Lavanya M.Y. Dudhe	PPV&FRA, GoI	7.80
10	Developing high oleic safflower genotypes for Indian conditions and development of protocols for marker assisted selection for high oleic traits in safflower	K. Anjani P. Kadirvel Praduman Yadav B. Usha Kiran	MARICO Pvt. Ltd., Mumbai	20.39

Committees

Quinquennial Review Team

Dr. Arvind Kumar	Vice Chancellor Rani Laxmi Bai Central Agril. University Jhansi, U.P.	Chairman
Dr. S.R. Bhat	Principal Scientist (Retd.) NRCPB, Dwarka-110 078 New Delhi	Member
Dr. P.K. Das	Associate Dean Institute of Agricultural Sciences SOA University Bhubaneshwar-510 029, Odisha	Member
Dr. S.J. Kolte	Professor (Plant Pathology) (Retd.) Pune (Maharashtra)	Member
Dr. P. Raghuram	Professor (Ag. Economics) Department of Agri Business Management SV Agricultural College, Tirupati, A.P.	Member
Dr. D.M. Hegde	Former Director (ICAR-IIOR) Bengaluru	Member
Dr. Lakshmi Prayaga	Principal Scientist, ICAR-IIOR Hyderabad	Member Secretary

Research Advisory Committee

Dr. V. Ranga Rao	Former Director (DOR) IIOR, Hyderabad - 500 030	Chairman
Dr. Jitendra Kumar	Dean, Agriculture, G.B. Pant University, Pant Nagar-263 145, Uttarakhand	Member
Dr. D.K. Yadava	ADG, Seeds (Acting), ICAR & Head, SST, IARI, New Delhi	Member
Dr. P. Ananda Kumar	Director (Acting), Retd. & Professor of Emiretus, IIRR, Hyderabad	Member
Dr. Ajay Arora	PS, Division of Plant Physiology, IARI, New Delhi	Member
Dr. B.S. Dwivedi	Head (SS &AC), IARI, New Delhi	Member
Dr.R. Srinivasan	Retd. Professor & PD-NRCPB, ER-28, New Delhi	Member

Dr. K Purna Chandra Rao	Ex-Principal Scientist (VLS), ICRISAT, Hyderabad	Member
Dr. P.K. Chakrabarty	ADG (OP), ICAR, Krishi Bhawan, New Delhi	Member
Shri Ayyagari Bhumayya	Natraj Nagar, Nirmal Adilabad District, Telangana	Member
Dr. Premraj Yadav	Shamshabad, Ranga Reddy District	Member
Dr. A. Vishnuvardhan Reddy	Director, ICAR-IIOR, Rajendranagar, Hyderabad	Member
Dr. V. Dinesh Kumar	Principal Scientist, ICAR-IIOR, Hyderabad	Member Secretary

Institute Management Committee

Dr. A. Vishnuvardhan Reddy	Director ICAR-IIOR, Rajendranagar Hyderabad-500 030	Chairman
ADG(OP)	Indian Council of Agricultural Research Krishi Bhawan New Delhi-110 001	Member
Director of Research	PJTSAU, Hyderabad-500 030	Member
Director of Agriculture	Govt. of Tamil Nadu Chennai	Member
Dr. D.P. Waskar	Director of Research Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani	Member
Shri Ayyagari Bhumayya	H.No.1-2-27/C3 Natraj Nagar Nirmal-504 106 Adilabad District, Telangana	Member (Non official)
Dr. Premraj Yadav	H.No.2/53, Shamshabad Ranga Reddy District, Telangana	Member (Non official)
Dr. Y.G. Prasad	Director ICAR-ATARI, CRIDA Campus Santoshnagar, Hyderabad-500 059	Member
Dr. P. Muthuraman	Principal Scientist ICAR-IIRR, Rajendranagar, Hyderabad-500 030	Member
Dr. Anupama Singh	Head & Principal Scientist (Agril. Chemistry) ICAR-IARI Pusa Campus, New Delhi-110 012	Member
Dr. V. Dinesh Kumar	Principal Scientist ICAR-IIOR, Rajendranagar, Hyderabad-500 030	Member
Finance & Accounts Officer	ICAR-CTRI, Rajahmundry	Member
Shri Shitanshu Kumar	Senior Administrative Officer ICAR-IIOR, Rajendranagar, Hyderabad-500 030	Member Secretary

Important Committees of the Institute

Institute Technology Management Committee (ITMC)	
Dr. A. Vishnuvardhan Reddy, Director	Chairman
Dr. P.S. Vimala Devi, Principal Scientist	Member
Dr. S.N. Sudhakara Babu, Principal Scientist	Member
Dr. V. Dinesh Kumar, Principal Scientist	Member
Dr. B. Dayakara Rao, Principal Scientist, IIMR	Member (External)
Dr. P. Kadirvel, Principal Scientist	Member
Dr. S. Senthilvel, Principal Scientist	Member
Dr. S.V. Ramana Rao, Principal Scientist	Member Secretary
Prioritization, Monitoring and Evaluation Cell	
Dr. S. Senthilvel, Principal Scientist	PME Incharge
Dr. S.V. Ramana Rao, Principal Scientist	Member & IPTM Unit Incharge
Dr. P. Duraimurugan, Senior Scientist	Member
Dr. P. Kadirvel, Principal Scientist	Member
Dr. D. Pati, TIO	Member Secretary
Foreign Deputation Screening Committee	
Dr. P.S. Vimala Devi, Principal Scientist	Chairman
Dr. S.V. Ramana Rao, Principal Scientist	Member
Dr. C. Lavanya, Principal Scientist	Member
Tech. Information Officer, IIOR	Member
Sr. Admn. Officer	Member
Publication Committee	
Dr. M. Sujatha, Principal Scientist	Chairman
Dr. S. Senthilvel, Principal Scientist	Member
Dr. P. Padmavathi, Principal Scientist	Member
Dr. P. Duraimurugan, Senior Scientist	Member
Dr. C. Sarada, Principal Scientist	Member
Institute Germplasm Identification Committee (IGIC)	
Dr. A. Vishnuvardhan Reddy, Director	Chairman
Dr. K. Anjani, Principal Scientist	Member
Dr. P. Kadirvel, Principal Scientist	Member
Dr. R.D. Prasad, Principal Scientist	Member
Dr. P. Duraimurugan, Senior Scientist	Member
Dr. N. Mukta, Principal Scientist	Convener
Official Language Implementation Committee	
Dr. A. Vishnuvardhan Reddy, Director	Chairman
Dr. S.V. Ramana Rao, Principal Scientist	Member
Dr. N. Mukta, Principal Scientist	Member
Dr. Md. A. Aziz Qureshi, Principal Scientist	Member
Dr. P. Kadirvel, Principal Scientist	Member
Sri Shitanshu Kumar, Sr. Admn. Officer	Member
Dr. Praduman Yadav, Scientist	Member
Dr. H.P. Meena, Scientist	Member
Sri K. Srinivasa Rao, Fin. & Acct. Officer	Member
Sri Pradeep Singh, AD (OL)	Member Secretary

Library Advisory Committee	
Dr. P.S. Vimala Devi, Principal Scientist	Chairman
Dr. K. Alivelu, Principal Scientist	Member
Dr. Kadirvel, Principal Scientist	Member
Sri Pradeep Singh, AD (OL)	Member
Sr. Admn. Officer and Fin. & Acct. Officer	Member
Dr. P. Lakshmamma, Principal Scientist	Officer I/c Library
Farm Management Committee	
Dr. S.N. Sudhakara Babu, Principal Scientist	Chairman
Dr. N. Mukta, Principal Scientist	Member
Dr. G. Suresh, Principal Scientist	Member
Dr. P. Duraimurugan, Senior Scientist	Member
Sr. Admn. Officer	Member
Fin. & Acct. Officer	Member
Sri M. Bhaskar Reddy, Head (FOM)	Member Secretary
Estate Management Committee	
Dr. S.N. Sudhakara Babu, Principal Scientist	Chairman
Dr. T. Manjunatha, Scientist	Member
Head (FOM)	Member
Sri G. Balakishan, CTO	Member
Fin. & Acct. Officer	Member
Outside Member from NAARM (Engineer)	Member
Sr. Admn. Officer	Member
TSP activity Committee	
Dr. G. Suresh, Principal Scientist	Chairman
Dr. H.P. Meena, Scientist	Member
Sr. Admn. Officer / Fin. & Acct. Officer	Member
Dr. D. Pati, CTO	Member
ICAR-IIOR-Institute Joint Staff Council	
Official Side	
Dr. A. Vishnuvardhan Reddy, Director (Ex-Officio)	Chairman
Sri Shitanshu Kumar, Sr. Admn. Officer (Ex-Officio)	Member
Sri K. Srinivasa Rao, Fin. & Accounts Officer (Ex-Officio)	Member
Dr. P. Duraimurugan, Scientific Officer	Member
Dr. H.P. Meena, Scientific Officer	Member
Mrs Ch. V. Hari Priya, Technical Officer	Member
Sri G. Balakishan, Technical Officer	Member Secretary
Staff side	
Sri G. Srinivas Yadav, Administrative Category	Member
Sri Rakesh Geeda, Administrative Category	Member
Sri S. Narsimha, Technical Category	Member
Sri E. Ravi Kumar, Technical Category	Member
Sri B. Vishnu, Skilled Support Staff Category	Member
Sri Narasimha, Skilled Support Staff Category	Member

Women Cell	
Dr. P. Lakshmamma, Principal Scientist	Chairman
Dr. G. Suresh, Principal Scientist	Member
Mrs. Ch.V. Haripriya, Chief Tech. Officer (F/F)	Member
Smt. C. Lalitha, PA	Member
Smt. B. Kistamma, SSS	Member
Smt. R. Raji, PS	Member Secretary
Store Purchase Committee	
Dr. P.S. Vimala Devi, Principal Scientist	Chairman
Dr. P.S. Srinivas, Principal Scientist	Member
Ms. K.S.V.P. Chandrika, Scientist	Member
Sr. Admn. Officer and Fin. & Acct. Officer	Member
Local Purchase Committee	
Dr. C. Sarada, Principal Scientist	Chairman
Dr. P. Ratna Kumar, Senior Scientist	Member
Dr. J. Jawahar Lal, Scientist	Member
Sr. Admn. Officer/Nominee	Member
Fin. & Acct. Officer/Nominee	Member
Farm produce, price fixation/sell/dispose committee	
Dr. S.N. Sudhakara Babu, Principal Scientist	Chairman
Dr. P. Duraimurugan, Senior Scientist	Member
Sr. Admn. Officer and Fin. & Acct. Officer	Member
Sri M. Bhaskar Reddy, CTO	Member Secretary
RFS/Revenue Generation	
Dr. V. Dinesh Kumar, Principal Scientist	Chairman
Dr. P. Ratna Kumar, Senior Scientist	Member
Fin. & Acct. Officer	Member
Sri M. Bhaskar Reddy, CTO	Member
Sr. Admn. Officer	Member Secretary
Condemnation Committee	
Dr. M. Sujatha, Principal Scientist	Chairman
Dr. R.D. Prasad, Principal Scientist	Member
Sri P.S. Rao, Sr. Tech. Officer	Member
Sr. Admn. Officer and Fin. & Acct. Officer	Member

Meetings and Events

National Seminar on Road Map of Vegetable Oil Production by 2022

The ICAR-IIOR hosted the National Seminar on "Road Map of Vegetable Oil Production by 2022", organized by Oilseeds Division of Department of Agriculture, Co-operation & Farmers' Welfare (DAC & FW), Government of India during April 28-29, 2018, at the University Auditorium, PJTSAU, Hyderabad. Shri Gajendra Singh Shekhawat Ji, Hon'ble Minister of State for Agriculture and Farmers Welfare, Government of India, inaugurated the event. About 500 participants representing various stake-holder organizations such as State Governments implementing "The Mini Mission-I, II and III", related to centrally-sponsored programmes and schemes in vegetable oil sector; central agencies; ICAR institutes; oilseed industries; progressive farmers; and, senior officials of DAC & FW, GOI attended the two-day-long event. As part of the seminar, an exhibition with stalls by various sectors of vegetable oils; like, equipment manufacturers, processors, marketing agencies, developmental agencies, value chain agencies, etc was also organized to display products and showcase the state-of-the-art technologies and innovations for creating awareness among the stakeholders.

Inauguration of exhibition during the National seminar

Participants of the National seminar

Annual Group Meeting on Sunflower, Castor, Sesame & Niger, 2018

The Annual Group Meeting of Sunflower, Castor, Sesame & Niger was held at ICAR-IIOR, Rajendranagar, Hyderabad during May 17-19, 2018.

Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR presented the research highlights of sunflower and castor. He emphasized the need for development of new CMS lines with high yield potential in sunflower as limited number of CMS lines introduced four decades ago are still being used in the breeding programmes. There is a need for short duration hybrids for diversification of sunflower based cropping systems. Promotion of remunerative intercropping systems is required to bring additional area under sunflower in traditional and non-traditional areas. In castor, there is a need for development of hybrids with high seed yield (3 t/ha) coupled with resistance to the major biotic stresses for cultivation under rainfed cropping situation and all potential growing areas. Focus should be towards breeding short duration hybrids (90-100 days) with ideal plant type amenable for mechanical harvest. Development of climate resilient conservation agricultural practices for castor based cropping systems need attention.

Dr. Rajani Bisen, I/c Project Coordinator (Sesame & Niger) has presented the research highlights of sesame and niger for the year 2017-18. In sesame, major thrust is on development of white bold seeded varieties and organic technology for export promotion, high yielding and stress tolerant varieties for diverse cropping systems and season. In niger, the focus should be on development of high yielding fertilizer responsive varieties and availability of certified/quality seed free of Cuscuta. During the session, the sunflower germplasm catalogue published by IIOR based on characterization of 3126 accessions was released.

Inaugural session of Annual Group Meeting

Institute Research Committee (IRC)

The Institute Research Committee (IRC) meeting was conducted under the Chairmanship of Dr. A. Vishnuvardhan Reddy, Director during June 5-8, 12 and 25, 2018 and September 14, 15 and 17, 2018. The results of the research projects undertaken during *kharif* 2017 and *rabi* 2017-18 were reviewed and the technical programme for *kharif* 2018 and *rabi* 2018-19 was discussed and finalized.

Session during IRC meeting

ICAR-IIOR Foundation Day

ICAR - Indian Institute of Oilseeds Research (IIOR), Rajendranagar, Hyderabad celebrated its 41st Foundation Day on 1st August, 2018. The Foundation Day lecture on "Coconut, Palm and Olive Oil: International Scenario, Market and Way Forward" was delivered by Dr. N.K. Krishna Kumar, Regional Director, Bioversity International-India office, New Delhi and former DDG (Hort.), ICAR. Enumerating the important steps for increasing the vegetable oil production, Dr. Kumar has suggested that increased MSP for oilseed crops, assured irrigation, availability and access to better hybrids, micro nutrient application, processing, VCO as olive oil replacement, use of rice bran oil and revisiting the support for basic and strategic research are essential and these will help in bridging the gap between domestic supply and demand and thereby reduce imports. Guests of Honor, Dr. V. Praveen Rao, Vice-Chancellor, PJTSAU, Hyderabad, Dr. V. Ranga Rao, Former Director, IIOR; Dr. E.A. Siddiq, Former DDG (CS); Directors of other ICAR institutes in Hyderabad and PJTSAU senior officials were present on this occasion.

Foundation day celebrations

Annual Group Meeting on Safflower and Linseed, 2018

The Annual Group Meeting on Safflower and Linseed was held at Birsa Agricultural University, Ranchi, Jharkhand during August 10-12, 2018. The inaugural session was chaired by Dr. P. Kaushal, Hon'ble Vice-Chancellor, Birsa Agricultural University, Kanke. The Director of Research, Dr. D.N. Singh in his welcome address provided an overall scenario of agriculture in the state of Jharkhand and urged the need for diversification though introducing oilseeds in rice fallow systems towards increasing the farmers' income. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR in his presentation on the research highlights of safflower provided a wrap up on the performance of oilseeds in the country. He opined that appropriate areas are to be identified for increasing the area and production of safflower and linseed. The Chairman, Dr. P. Kaushal, Hon'ble Vice-Chancellor, BAU, urged the group to have a focused approach for increasing the coverage under safflower and linseed and tailored technology assemblage for the respective AESR need to be developed/ disseminated considering the vintage value of safflower and linseed. On the germplasm front, he suggested for evaluating the material and identify the worthy germplasm to be taken up in the breeding programmes so that the outputs and outcomes would lead to doubling of farmers income. He suggested that short duration varieties may be identified/ developed for rice fallow system.

Inaugural session of Annual Group Meeting on Safflower and Linseed, 2018

Institute Management Committee (IMC)

The 42nd meeting of the Institute Management Committee was held on November 19, 2018 under the Chairmanship of Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. Dr. Jagadeeshwar, Director of Research, PJTSAU, Hyderabad; Shri Ayyagari Bhumayya, Nirmal, Adilabad District - Member (Non-Official), Dr. P. Muthuraman, Principal Scientist, ICAR-IIRR, Hyderabad, Dr. Y.G. Prasad, Director, ICAR-

ATARI, Hyderabad attended the meeting. The Member Secretary apprised the committee about the action taken report on the proceedings of the preceding IMC meeting and presented the Agenda of 42nd IMC meeting of IIOR.

Meeting of Institute Management Committee

Research Advisory Committee (RAC) Meeting

Dr. A. Vishnuvardhan Reddy, Director, IIOR welcomed the Chairman and Members of RAC followed by presentation on the Action Taken Report on the recommendations of 31st RAC meeting. Strategies adopted by the institute to address the researchable issues, significant achievements made under each of the research projects were presented by the Heads of each section and discussed during the interaction sessions. RAC members were also appraised of the extension activities taken up by the institute to popularize the technologies developed in the mandate crops and visited the experimental fields of IIOR at Rajendranagar as well as Narkhoda to oversee the field experiments and screening/ phenotyping facilities at these research farms and had in depth interaction with the concerned scientists on their on-going research projects. Expressing happiness with the compliance of the recommendations of the previous two RAC meetings including the re-organization/restructuring of all on-going research projects of the institute on a multi-disciplinary mission mode programme basis, RAC placed on records the satisfaction with the implementation of research programmes in tune with the mandate of the institute. RAC also expressed that farm planning, maintenance and execution, overall tempo of research activities as well as its external visibility on multiple fronts in the form of massive seed production program of its mandate oilseed crops, large scale on-farm demonstrations and other extension programmes adopted by the institute were impressive. Research Advisory Committee made recommendations to further improve the research outputs and deliverables.

Field visit of Research Advisory Committee

Quinquennial Review Team (2012-13 to 2016-17)

The QRT under the Chairmanship of Dr. Arvind Kumar had a total of 9 meetings with different stakeholders to review the progress of research made during the quinquennium at IIOR and the AICRP centres of castor, sunflower, safflower, sesame & niger and linseed. QRT reviewed in depth the progress of research, coordination and technology transfer by IIOR, Project coordinating units of sesame & niger and linseed and all AICRP centres of castor, sunflower, safflower, sesame, niger and linseed. The team was provided with background information on progress made during 2012-17. The team also participated in the annual workshops of all these crops at IIOR, Hyderabad; Ranchi and interacted with the scientists. QRT also visited various centres and interacted with concerned Vice-Chancellors and scientists during their presentations of scientific achievements. Based on materials submitted and interactions with heads of the institutions, scientists, recommendations were given to further strengthen the research, coordination, infrastructure facilities for meeting the future challenges of oilseed production in the country.

QRT Meeting

Agricultural Education Day

The Agricultural Education Day was organised on December 3, 2018 at ICAR – Indian Institute of Oilseeds Research, Hyderabad. Students of higher secondary (Class 9 and 10) and intermediate (Class 11 and 12) attended the programme. A total of 1150 students from 15 schools and colleges visited the institute. Visits to crop cafeteria field demonstrations on oilseed crops, laboratories and oilseeds museum were organized to enthuse the children towards choosing a career in agricultural sciences.

Visit of school children to crop demonstrations and museum

International Women's Day

The International Women's day was celebrated at ICAR-IIOR on March 8, 2019. Apart from focusing on women-centric developments, this day also emphasizes on the importance of gender equality. On this occasion, a lecture on campaign theme of this year's women's day "Balance for Better'' was delivered by Ms. G. Jayalakshmi, IAS, Director General, NIPHM. The session was chaired by Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. Ms. Jayalakshmi emphasized the importance of women empowerment and explained about achieving the balance in gender in every aspect of life for a better nation. To achieve this, change should start first at home and aspects like mutual respect, encouragement in professional growth, equal sharing of household responsibilities, bringing up children to make them responsible citizens deserve due attention. Dr. A. Vishnuvardhan Reddy stated about the equal opportunities given to women in this Institute in various institutional activities.

International Women's Day celebrations

International Yoga Day

The International Yoga Day was celebrated on June 21, 2018. In the morning session, under the instructions of Yoga Guru Shri Ajit Singh all the staff of IIOR performed various Yoga Asanas as per combined protocol CYP provided by Ministry of Ayush, Govt. of India. In the afternoon session, a special lecture was delivered by Smt. Pavitra, Yoga Guru from Yoga Hub, Attapur, Hyderabad. She explained the importance of Yoga in daily life. She also elaborated the Astanga Yoga and beautifully explained Yam, Niyam Asan, Pranayam, Pratyahar, Dharana, Dhyan and Samadhi and various Asanas. She enlightened the staff members about various Sushma Yoga Asanas, which were demonstrated by her associate and could be performed in the leisure/breaks during working time.

International Yoga Day celebrations

Human Resource Development

Annual Training Plan Implementation

The details of trainings attended by different categories of ICAR-IIOR staff along with physical/ financial targets and achievements are presented.

a) Scientific staff

S. No.	Name of employee	Designation	Discipline/Section	Name of training programme attended
1	Dr. M.Y. Dudhe	Scientist	Crop improvement	Next generation sequencing data analysis, Tel-hai college, Israel, August 12-16, 2018
2	Dr. G. Suresh	Principal Scientist	Crop production	MDP Leadership development at NAARM, Hyderabad, December 18-29, 2018

b) Technical staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Sri T. Veeraiah	Technical officer F/F	Seed section	Pesticide application techniques and safety measures at NIPHM, Hyderabad, July 16-20, 2018
2	Sri Surender Prasad Shukla	Technical officer	Workshop/ establish-ment	Soft skills and personality development for technical staff, NAARM, Hyderabad, September 18-27, 2018
3	Sri V. Sambasiva Rao	Asst. Chief Tech. Officer	Library	Advances in application of ICT in libraries of NARES to support in education and research, PJTSAU, Hyderabad, September 10-30, 2018
4	Sri M. Indrasena Reddy	Technical Assistant -T3 (Tractor Driver)	Farm	Automobile maintenance, road safety, behavioural skills, ICAR-CIAE, Bhopal, January 16-22, 2019
5	Sri G.Y. Prabhakar	Technical officer - T5	Farm	Farm management, ICAR-IIFSR, Modipuram, February 13-19, 2019
6	Sri G. Pardhasaradhi	Sr. Technical Assistant - T4 (Driver)	Driver	Automobile Maintenance, ICAR-CIAE, Bhopal, February 19-25, 2019

c) Administrative staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Sri P.R.V.P. Rao	Assistant	Admin/Care taker hostel	Hospitality management, ICAR-NAARM, April 20-25, 2018
2	Mrs. C. Lalitha	Personal Assistant	Administration	Enhancing efficiency and behavioural skills of stenographers of ICAR, NAARM, Hyderabad, June 21-26, 2018
3	Sri P. Srinivasa Rao	Personal Assistant	Administration	Enhancing efficiency and behavioural skills of stenographers of ICAR, NAARM, Hyderabad, June 21-26, 2018
4	Sri G. S. Yadav	Personal Assistant	Administration	Enhancing efficiency and behavioural skills of stenographers of ICAR, NAARM, Hyderabad, June 21-26, 2018
5	Sri Shitanshu Kumar	SAO	Administration	MDP administrative and financial management, NAARM, Hyderabad, December 19-22, 2018

Physical targets and achievements

S. No.	Category	Total No. of emplo-yees	No. of trainings planned for each category during 2018-19 as per ATP	No. of employees undergone training during April-Sept 2018	No. of employees undergone training during Oct 2018-March 2019	Total No. of employees undergone training during April 2018 to March 2019	% realization of trainings planned during 2018-19
1	2	3	4	5	6	7=5+6	7/4 x 100=8
1	Scientist	40	9	1	1	2	22.2
2	Technical	35	7	3	2	5	71.4
3	Administra-tive & Finance	24	9	4	1	5	55.6
4	SSS	19	0	0	0	0	-
Total		**118**	**25**	**8**	**4**	**12**	**48**

Financial targets and achievements

S. No.	RE 2018-19 for HRD (Rs in lakhs)	Actual Expenditure up to 31 March, 2019 for HRD	% Utilization of allotted budget
1	2	3	3*100/2=4
	17206	17206	100

Other trainings attended

Name	Training Programme	Venue	Date
Dr. N. Mukta Dr. P. Padmavathi	Training cum Workshop on Plant Biosecurity	NIPHM, Hyderabad	August 30-31, 2018
Dr. H.H. Kumaraswamy	Seventh training workshop for Institutional Biosafety Officers focusing on "Confined Field Trials (CFT) of transgenic crops, during events selection as well as during testing of bioefficacy, performance studies and field levels trials".	ICAR-NRCPB, New Delhi	December 10-11, 2018
Dr. K. Ramesh	DST training on "Integrated Nutrient Management and Nutrient Budgeting through Advance Models to Improve Crop Productivity".	ICAR-CS&WCRI, Ooty	October 22-26, 2018
Dr. K. Anjani	Analysis of Experimental Data Using R	ICAR-NAARM, Hyderabad	February 21-26, 2019

Participation in Conferences/Seminars/Symposium/Workshops/Meetings

a) National

Name	Programme	Venue	Date
Dr. S.N. Sudhakara Babu	164th RCGM meeting of DBT	DBT, New Delhi	April 3, 2018
Dr. A. Vishnuvardhan Reddy, Dr. N. Mukta, Dr. G.D. Satish Kumar, Dr. K. Ramesh, Dr. Lakshmi Prayaga, Dr. T. Manjunatha, Dr. Jawahar Lal, Dr. Praduman Yadav, Dr. P. Ratna Kumar, Dr. C. Lavanya	National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario	ICAR-Directorate of Groundnut Research, Junagadh	April 7-9, 2018
Dr. H.P. Meena	Sunflower and Niger field day under the programme Area expansion for oilseed crops in NEH regions	Tripura and Arunachal Pradesh	April 9-12, 2018
Dr. P. Lakshmamma	Farm innovators meet	ATARI Zone X, CRIDA, Hyderabad	April 14, 2018
Dr. P. Lakshmamma Dr. Lakshmi Prayaga Dr. M.A. Qureshi	Regional consultation on Climate smart agricultural policies, strategies and agriculture development programs towards climate change adaptation and mitigation	ICAR-NAARM, Hyderabad	April 17, 2018
Dr. M. Santha Lakshmi Prasad Dr. P.S. Srinivas Dr. P.S. Vimala Devi	Brainstorming Session on Emerging Plant Protection Technologies: Opportunities and Challenges	NIPHM, Hyderabad.	April 20, 2018

Name	Programme	Venue	Date
Dr. A. Vishnuvardhan Reddy and all Scientists of ICAR-IIOR	National Seminar on Road Map of Vegetable Oil Production by 2022	PJTSAU, Hyderabad	April 28-29, 2018
Dr. H.H. Kumaraswamy	Workshop on Right to Information for PIOs	Institute of Secretariat Training and Management (ISTM), Old JNU Campus, New Delhi	May 7-9, 2018
Dr. S.N. Sudhakara Babu	Annual 33rd meeting of National Seed Project	PAJANCOA, Karaikal	May 9-11, 2018
Dr. S.N. Sudhakara Babu	165th RCGM meeting of DBT	DBT, New Delhi	May 22, 2018
Dr. P.S. Vimala Devi Dr. P. Duraimurugan	International Day for Biological Diversity	PJTSAU, Hyderabad	May 22, 2018
Dr. R.D. Prasad	National workshop on Problems and Prospects for Commercia-lization of Trichoderma	NASC, New Delhi	May 24, 2018
Dr. P.S. Vimala Devi Dr. R.D. Prasad	National Workshop on Microbe based Technologies for Soil Health and Plant Nutrition	NASC, New Delhi	May 25, 2018
Dr. S.V. Ramana Rao	National review meeting on the action plan for farmers FIRST programme	ICAR- IISWC, Dehradun	May 25, 2018
Dr. N. Mukta	13th Review meeting of DUS test centres: *kharif* crops 2018	NASC, New Delhi	May 31, 2018
Dr. G.D. Satish Kumar	Annual Action plan workshop of KVKs of Telangana	ATARI, Zone X, Hyderabad	May 31 to June 1, 2018
Dr. A. Vishnuvardhan Reddy Dr. P. Lakshmamma Dr. C. Sarada, Dr. K. Alivelu	Consultation Meeting on Doubling Farmer's income in Telangana and adjoining areas	ICAR-CRIDA, Hyderabad	July 3, 2018
Dr. S.N. Sudhakara Babu	166th RCGM meeting of DBT	DBT, New Delhi	July 3, 2018
Dr. G. Suresh	Action Plan Workshop on Cluster FLDs on Pulses and Oilseeds	ATARI, Hyderabad and ICAR-IIOR, Hyderabad	July 24, 2018
Dr. N. Mukta	Workshop on Networking and Collaborative Research and Educational Activities of Scientific Institutes in Hyderabad	Telangana State Forest College & Research Institute, Mulugu	July 25, 2018
Dr. V. Dinesh Kumar Dr. P. Ratna Kumar	National Workshop on Regulatory Mechanisms, Transgenic technology & Applications in Plants (RMTTAP)	Acharya Nagarjuna University, Guntur	August 2-3, 2018
Dr. S.V. Ramana Rao	National Review meeting on ABI	NASC, New Delhi	August 28, 2018

Name	Programme	Venue	Date
Dr. P.S. Vimala Devi	Local Project Advisory Committee (LPAC) meeting of DST	ICAR-NAARM, Hyderabad	August 30, 2018
Dr. N. Mukta Dr. P. Padmavathi	Training cum Workshop on Plant Biosecurity	NIPHM, Hyerabad	August 30-31, 2018
Sri G. Raghunath	Re-Engineering of Agril. Libraries and Engineering Technologies	Bihar Veterinary Science University, Patna	September 4-5, 2018
Sri V. Sambasiva Rao	Advances in Application of ICT in Libraries of NARES to Support Education & Research	PJTSAU, Hyderabad	September 10-30, 2018
Dr. V. Dinesh Kumar	National Seminar on Applications of Bioinformatics in Agricultural Research and Education	ICAR-NAARM, Hyderabad	September 14-23, 2018
Dr. N. Mukta	14th Review meeting of DUS test centres for Rabi crops 2018	NASC, New Delhi	October 4, 2018
Dr. S.N. Sudhakara Babu	168th RCGM meeting of DBT	DBT, New Delhi	October 9, 2018
Dr. P. Padmavathi	Meeting on Mahila Kisan Divas and Technology Day	KVK, ICAR-CRIDA Hyderabad	October 15, 2018
Dr. S.V. Ramana Rao	Agri start-up conclave	NASC, New Delhi	October 15-16, 2018
Dr. P. Duraimurugan	Start-up and Entrepreneurship Conclave, Unleashing Potentials in Agriculture for Young Agripreneures (UPAYA)	NASC, New Delhi	October 16-17, 2018
Dr. S.N. Sudhakara Babu Sri N. Prabhakara Rao	Workshop on post harvest technologies for better seed quality	TSSCOA & DAC, Hyderabad	October 30-31, 2018
Dr. S.N. Sudhakara Babu	169th RCGM meeting of DBT	DBT, New Delhi	November 20, 2018
Dr. S.V. Ramana Rao	Meeting of RKVY-RAFTAR	DAC&FW, Krishi Bhavan, New Delhi	November 22, 2018
Dr. P.S. Vimala Devi	Brainstorming meeting on Fall Army Worm (FAW)	PJTSAU, Hyderabad	November 27, 2018
Dr. K. Alivelu Dr. C. Sarada Dr. P.S. Vimala Devi	Krishi Kala Ustav II	ICAR-NAARM	November 27 to December 2, 2018
Dr. P.S. Srinivas	National Symposium on Entomology 2018 Advances and Challenges	PJTSAU, Hyderabad	December 10-12, 2018
Dr. S.V. Ramana Rao	National meeting for increasing oilseeds production under the proposed National Mission on Vegetable oils	DAC&FW, Krishi Bhawan, New Delhi	December 22, 2018

Name	Programme	Venue	Date
Dr. H.H. Kumaraswamy	Seminar on Sustainability of Small Farmer in the changing of Agricultural Scenario	PJTSAU, Hyderabad	December 22, 2018
Dr. S.N. Sudhakara Babu	170th RCGM meeting of DBT	DBT, New Delhi	January 8, 2019
Dr. N. Mukta	XXXIX Meeting of Plant Germplasm Registration Committee (PGRC)	ICAR-NBPGR, New Delhi	January 28, 2019
Dr. P.S. Vimala Devi	Annual Conference of Vice Chancellors of Agricultural Universities and Directors of ICAR Institutes	NASC, New Delhi	January 30, 2019 to February 1, 2019
Sri G. Raghunath	National level capacity building workshop for Libraries of SAUs	PJTSAU, Hyderabad	February 5-9, 2019
Dr. S.V. Ramana Rao	Kharif price policy meeting	CACP, New Delhi	February 7, 2019
Dr. P.S. Srinivas	International Symposium on Edible Alliums: Challenges and Opportunities	ICAR-DOGR, Rajgurunagar, Pune	February 9-12, 2019
Dr. N. Mukta Dr. P. Padmavathi	Brain storming session for online course in Plant Bio-security under MOOCs Platform	NIPHM, Hyderabad	February 13, 2019
Dr. G.D. Satish Kumar	Agricultural Science Congress	IARI and NAAS, New Delhi	February 20-23, 2019
Dr. G. Suresh Dr. P. Duraimurugan	Kisan Samman Nidhi Programme	ICAR-IIRR, Hyderabad	February 24, 2019
Dr. M. Santha Lakshmi Prasad	National Symposium on Recent Challenges and Opportunities in Sustainable Plant Health Management	BHU, Varanasi	February 26-28, 2019
Dr. S.V. Ramana Rao	Workshop on Impact Assessment of project interventions	ICAR-NRRI, Cuttack	March 2, 2019
Dr. C. Sarada	Databases on oilseeds research for KRISHI Portal in User's Workshop on ICAR KRISHI Geoportal – A Digital Platform for Sustainable Agriculture	ICAR-NBSS&LUP, Nagpur	March 7-8, 2019
Dr. G. Suresh	Interaction Meeting of Scientists and farmers with Shri Gajendra Singh Shekhawat, Hon'ble Union Minister of State for Agriculture & Farmers' Welfare	ICAR-NAARM, Hyderabad	March 9, 2019
Dr. Lakshmi Prayaga Dr. S. Senthivel	Workshop on preparation of EFC/ SFC proposals	ISTM, New Delhi	March 11-13, 2019

Name	Programme	Venue	Date
Dr. Praduman Yadav	National conference on POSHAN Abhiyan organized by Ministry of Women and Child Development	The Ashok Hotel, New Delhi	March 15, 2019
Dr. G.D. Satish Kumar	State Level Interaction Workshop for Stakeholders of Castor	CCSHAU, Hisar	March 15-16, 2019
Dr. S.N. Sudhakara Babu	171st RCGM meeting of DBT	DBT, New Delhi	March 29, 2019

b) International

Name	Programme	Venue	Date
Dr. M. Sujatha	International Symposium on Confection Sunflower Technology & Production	Wuyuan, Inner Mongolia, China	August 8-10, 2018
Dr. Mangesh Y. Dudhe	Workshop on Next-Generation Sequencing and Data Analysis	Tel-Hai College, Kiryat Shmona, Israel	August 12-16, 2018
Dr. K.T. Ramya	International sesame industry conference	Pingyu, China	August 24-27, 2018
Dr. C. Lavanya	International Symposium on Plant Mutation Breeding and Biotechnology organized by FAO/ IAEA	Vienna, Austria	August 27-31, 2018
Mrs. B. Gayatri	First International Conference on Biological Control – Approaches & Applications	ICAR-NBAIR, Bengaluru	September 27-29, 2018
Dr. H.P. Meena	2nd International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future organized by Agricultural Technology Development Society (ATDS)	Swami Vivekanand Subharti University, Meerut	October 20-22, 2018
Dr. C. Sarada	International Conference on Research Frontiers on Precision Agriculture organized by AFITA/ WCCCA, 2018	IIT, Mumbai	November 24-26, 2018
Dr. P. Lakshmamma Dr. Lakshmi Prayaga Dr. P. Ratna Kumar Dr. Praduman Yadav	4th International Physiology Congress	CSIR-NBRI, Lucknow	December 2-5, 2018
Dr. M. Jagadeswaran	2nd International Workshop on Advanced R&R-QR	ICRISAT, Hyderabad	December 3-7, 2018
Dr. P. Duraimurugan Mrs. K.S.V.P. Chandrika Mrs. G. Varsha Mrs. V. Vineela	6th Biopesticide International Conference (BIOCICON-2019)	Amity University, Raipur	March 6-8, 2019

हिन्दी गतिविधियाँ

राजभाषा पखवाडा समारोह

भारतीय तिलहन अनुसंधान संस्थान में हिन्दी पखवाडे काआयोजन 14-28 सितंबर, 2018 तक किया गया। पखवाडे के दौरान पाँच प्रतियोगिताओं स्मरण, एक मिनट, चुटकुले, सामान्य ज्ञान और पुस्तक पठन का आयोजन किया गया। सभी प्रतियोगिताओं में संस्थान के वैज्ञानिक, अधिकारी एवं कर्मचारियों उत्साह और उमंग से भाग लिया। पखवाडे के दौरान एक कार्यशाला का आयोजन भी किया गया जिसमें श्री. कमालुद्दीन, प्राध्यापक, हिन्दी शिक्षण योजना ने कार्यालयीन हिन्दी के बारे में विस्तार से जानकारी दी।

पखवाडे का समापन समारोह 9 अक्तूबर, 2018 को संपन्न हुआ। समापन समारोह का आरंभ श्री. शीतांशु कुमार, वरिष्ठ प्रशासनिक अधिकारी के स्वागत भाषण से हुआ। उन्होंने प्रभारी निदेशक डॉ. ए.आर.जी. रंगनाथा तथा उपस्थित सभी वैज्ञानिक, अधिकारी व कर्मचारियों का स्वागत करते हुए पखवाडे के सफल आयोजन के लिए बधाई दी।

राजभाषा कार्यान्वयन समिति की उपाध्यक्ष डॉ. एन. मुक्ता ने राजभाषा की प्रगति रिपोर्ट प्रस्तुत की। उन्होंने बताया कि वर्ष के दौरान नियमानुसार प्रत्येक तिमाही में कार्यशाला का आयोजन नियमित रुप से किया गया। प्रत्येक तिमाही में राजभाषा कार्यान्वयन समिति की बैठक का आयोजन किया गया तथा इसमें लिए गए निर्णयों को कार्यान्वित किया। वर्ष के दौरान हमने पारंगत तथा प्रबोध की कक्षाएँ क्रमशः जनवरी और जून माह में चलाई। जिसमें संस्थान के अतिरिक्त नार्म, हैदराबाद के अधिकारियों तथा कर्मचारियों ने भाग लिया। पखवाडे के दौरान नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के अधिकारियों/कर्मचारियों के लिए निबंध प्रतियोगिता का आयोजन हमारे संस्थान में किया गया।

डॉ. रंगनाथा, प्रभारी निदेशक ने अपने अध्यक्षीय संबोधन में संस्थान में हिन्दी की प्रगति पर संतोष व्यक्त करते हुए हिन्दी अनुभाग को इसके लिए बधाई दी और आशा व्यक्त की इसके कार्यान्वयन में उत्तरोत्तर प्रगति होती रहेगी। इसके पश्चात आपने पखवाडे के दौरान आयोजित प्रतियोगिताओं के विजेताओं में पुरस्कार वितरित किए इसके अतिरिक्त राजभाषा विभाग की प्रोत्साहन योजना के अंतर्गत हिन्दी में सर्वाधिक कार्य करने वाले अधिकारी / कर्मचारी को नगद पुरस्कार से सम्मानित किया गया।

श्री. प्रदीप सिंह, सहायक निदेशक (राजभाषा) के धन्यवाद ज्ञापन से समारोह का समापन हुआ।

प्रबोध पाठ्यक्रम का आयोजन

जून माह के दौरान तिलहन अनुसंधान संस्थान तथा नार्म के एसएसएस कर्मचारियों के लिए प्रबोध पाठ्यक्रम का आयोजन संस्थान में किया गया। इस पाठ्यक्रम में कर्मचारियों को हिन्दी भाषा का अक्षर ज्ञान, छोटे-छोटे वाक्य बनाना सिखाया गया। बीस कार्यदिवस की कक्षाओं के पश्चात इसकी परीक्षा का आयोजन हिन्दी शिक्षण योजना के कवाडीगुडा स्थित कार्यालय में किया गया। इस पाठ्यक्रम का संचालन श्री. जयशंकर प्रसाद तिवारी, सहायक निदेशक, हिन्दी शिक्षण योजना ने किया।

नराकास सदस्य कार्यालयों के लिए कार्यशाला आयोजन

नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के स्टॉफ सदस्यों के लिए अर्ध दिवसीय कार्यशाला का आयोजन 05 फरवरी, 2019 को राष्ट्रीय कृषि अनुसंधान प्रबंध अकादमी में किया गया। डॉ. आर. वी. एस. राव, प्रधान वैज्ञानिक, नार्म ने आधुनिक कार्यालयीन जीवनशैली में कार्यकुशलता एवं सक्षमता निर्माण पर पॉवर पाईंट प्रस्तुति दी।उन्होंने अत्याधित प्रभावी लोगों की सात प्रभावशाली आदतों पर तैयार छोटी-छोटी क्लिपिंग दिखाते हुए आधुनिक जीवन के लिए आवश्यक स्फूर्ति, प्रेरणा, समय का महत्व, सकारात्मक भावना आदि विषयों पर प्रकाश डाला। इसमें नगरद्वय में स्थित केंद्रीय सरकार के विभिन्न कार्यालयों से लगभग 35 अधिकारियों व कर्मचारियों ने भाग लिया।

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Wackchure, G.C., Minhas, P.S., Ratna Kumar, P., Choudhary, R.L., Meena, K.K., Rane, J. and Singh N.P. 2019. Bio-regulators - a useful tool to enhance crop yield, productivity and quality for resilient agriculture. Technical Article. ICAR-NISAM, Baramati.

Presentations in Conference/Symposia/Trainings

Name of the presenter	Title	Place	Date
Mrs. B. Gayatri	Bio-efficacy of *Heterorhabditis bacteriophora* (Rhabditida: Heterorhabditidae) against serpentine leafminer, *Liriomyza trifolii* Burgess (Diptera: Agromyzidae) in oilseed crops in Ist International Conference on Biological Control – Approaches and Applications.	ICAR-NBAIR, Bengaluru, Karnataka	September 27-29, 2018
Dr. C. Lavanya	Development of diverse parental lines in castor through single seed descent method, in National Conference on Enhancing productivity of oilseeds in changing climate scenario.	ICAR-DGR, Junagadh	April 7-9, 2018
	Development of leafhopper and wilt resistant pistillate line in castor through mutation breeding, International Symposium on Plant Mutation Breeding and Biotechnology.	Vienna, Austria	August 27-31, 2018
Dr. G.D. Satish Kumar	Leveraging ICTs for knowledge transfer to farmers National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario.	ICAR-DGR, Junagadh	April 7-9, 2018
	Prospects and potential of castor cultivation in Haryana.	CCSHAU, Hisar	March 15-16, 2018
Mrs. G. Varsha	A strategic seed coating approach using biopolymer + *Trichoderma* in management of Fusarium wilt in Castor bean and Aspergillus collar rot in Groundnut, in 6th Biopesticide International Conference.	Amity University, Raipur, Chhattisgarh	March 6-8, 2019

Name of the presenter	Title	Place	Date
Dr. H.P. Meena	Approaches for genetic enhancement of cultivated sunflower (*Helianthus annuus* L.) for desirable traits in 2nd International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future.	Swami Vivekananda Subharti University, Meerut, U.P.	October 20-22, 2018
	Parental seed production and hybrid seed production in sunflower in Training programme on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame.	ICAR-IIOR, Hyderabad	January 7-11, 2019
Dr. K. Anjani	Breeding strategies for oilseeds in climate change scenario in ICAR short course on Recent advances in adaptation and management strategies for sustainable oilseeds production under climate change scenario.	ICAR-IIOR, Hyderabad	October 3-12, 2018
	Varietal seed production and hybrid seed production in safflower in Training programme on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame.	ICAR-IIOR, Hyderabad	January 7-11, 2019
Mrs. K.S.V.P. Chandrika	Sprayable starch granule formulation of *Bacillus thuringiensis* against *S. litura*" in 6th Biopesticide International Conference.	Amity University, Raipur, Chhattisgarh	March 6-8, 2019
Dr. K.T. Ramya	Sesame breeding and Production in India: Challenges and Opportunities in the International Conference on International Sesame Industry Conference.	Pingyu County, Henan Province, China	August 24-27, 2018
	Seed production in Sesame in Training programme on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame.	ICAR-IIOR, Hyderabad	January 7-11, 2019
Dr. M. Santha Lakshmi Prasad	Oilseed diseases and their integrated management to trainees of NIPHM from PHM / PGDPHM-Kerala.	ICAR-IIOR, Hyderabad	June 23, 2018
	Identification of resistant sources in germplasm accessions against castor wilt disease in National Symposium on Recent Challenges and Opportunities in Sustainable Plant Health Management.	IAS, BHU, Varanasi	February 26-28, 2019
Dr. M. Sujatha	Declining sunflower area & production in India – an analysis in Brainstorming session organized on 19th May 2019 during the Annual Sunflower Workers Group meeting.	ICAR-IIOR, Hyderabad	May 17-19, 2018
	Breeding strategies for incorporation of resistance to major diseases on sunflower (*Helianthus annuus* L.) in India. International Symposium on Confection Sunflower Technology and Production.	Wuyuan, Inner Mongolia, China	August 8-10, 2018
	Prebreeding and genetic enhancement of cultivated sunflower (*Helianthus annuus* L.). International Symposium on Confection Sunflower Technology and Production.	Wuyuan, Inner Mongolia, China	August 8-10, 2018

Name of the presenter	Title	Place	Date
Dr. N. Mukta	Identification of efficient safflower germplasm accessions under moisture stress conditions in National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario.	ICAR-DGR, Junagadh	April 7-9, 2018
	Constraints in safflower production and way forward at Annual Group Meeting for Safflower and Linseed.	BAU, Ranchi	August 10-12, 2018
Dr. P. Duraimurugan	Integrated Pest Management in Gingelly (ICM in Gingelly Crops under the SSEPERS-ATMA programme, State Department of Agriculture, Tamil Nadu).	ICAR-IIOR, Hyderabad	July 25, 2018
	Pest Management Strategies in Oilseeds in the Climate Change Scenario, in the ICAR Short Course on Recent Advances in Adaptation and Management Strategies for Sustainable Oilseeds Production under Climate Change Scenario.	ICAR-IIOR, Hyderabad	October 3-12, 2018
	Integrated Pest Management in Oilseed Crops in Training Programme on Sesamum, Groundnut and other annual Oilseed Crops.	ICAR-IIOR, Hyderabad	December 11-13, 2018
	Integrated Pest Management in Oilseed Crops in Training Programme on Seed production technologies in castor, sunflower, safflower and sesame.	ICAR-IIOR, Hyderabad	January 7-11, 2019
	Insect Pests of Oilseed Crops and their Management in Off-campus PGDPHM programme organized by NIPHM, Hyderabad to the Agricultural Officers of Department of Agriculture, Kerala.	ICAR-IIOR, Hyderabad	June 23, 2018
	Large scale field evaluation of Bt-127 SC formulation as a component of IPM in soybean and castor in 6th Biopesticide International Conference.	Amity University, Raipur, Chhattisgarh	March 6-8, 2019
	Exploitation of the sex pheromone for monitoring of shoot and capsule borer, *Conogethes punctiferalis* Guenee (Crambidae: Lepidoptera) in castor in 6th Biopesticide International Conference.	Amity University, Raipur, Chhattisgarh	March 6-8, 2019
Dr. P.S. Srinivas	IPM in oilseed crops in training programme on Best Management Practices for increasing oilseed production.	ICAR-IIOR, Hyderabad	February 14, 2019
Dr. P.S. Vimala Devi	Production techniques, quality control and constraints of entomopathogenic fungi in training programme on Production protocols of parasitoids and EPFs.	NIPHM, Hyderabad	December 19-21, 2018

Name of the presenter	Title	Place	Date
Dr. R.D. Prasad	Critical Issues in Research and Commercialization of *Trichoderma* in Workshop on Problems and Prospects for Commercialization of *Trichoderma*.	NASC, New Delhi	May 24, 2018
Dr. S.V. Ramana Rao	Value addition of oilseeds to farmers from Odisha under ATMA Programme.	ICAR-IIOR, Hyderabad	December 23, 2018
	Business opportunities in oilseeds to the participants under Training Programme on Entrepreneurial Skill Development.	NAARM, Hyderabad	March 2, 2018 and March 26, 2018
Dr. T. Manjunatha	Parental seed production and hybrid seed production in Castor in Training programme on Seed Production Technologies in Castor, Sunflower, Safflower and Sesame.	ICAR-IIOR, Hyderabad	January 7-11, 2019
Dr. V. Dinesh Kumar	Post transcriptional gene silencing: Basic concepts and applications at the National Workshop on Regulatory Mechanisms, Transgenic technology and Applications in Plants (RMTTAP).	Acharya Nagarjuna University, Guntur	August 3, 2018
	RNAseq and its applications at the National Seminar on Applications of Bioinformatics in Agricultural Research and Education.	NAARM, Hyderabad	September 28, 2018
	Biotechnology: Tool to aid in coping with Climate change to the participants of ICAR short course on Recent advances in adaptation and management strategies for sustainable oilseeds production under climate change scenario.	ICAR-IIOR, Hyderabad	October 11, 2018
Mrs. V. Vineela	Identification of virulent isolates of *Bacillus thuringiensis* var. *kurstaki* effective at high temperature for management of lepidopteran pests in 6th Biopesticide International Conference.	Amity University, Raipur, Chhattisgarh	March 6-8, 2019

Infrastructure Development

Library and Documentation

The Library and Documentation unit continued to collect, store, organize and disseminate information on all aspects of crop improvement, crop production, crop protection and utilization of oilseed crops. An amount of Rs. 9.55 lakhs was spent during the period under report to acquire 46 books and for subscription to 51 Indian periodicals and 6 foreign periodicals, 2 databases *viz.,* India Patent and India Agri. Stat. A total of 70 publications were received *on gratis*, besides newsletters and annual reports from different organizations. New records of books were added to the computerized library catalogue database. The KOHA Integrated Library Management Software has been in operation at IIOR. Four issues of "IIOR Newsletter" and 280 electronic article delivery though e-mails have been brought out and circulated to all scientists working in AICRP (Sunflower, Safflower, Castor and Sesame & Niger) centres across different states and IIOR. Literature searches have been carried out in the mandate crops using in-house database, CROP CD, AGRIS on CD, AGRICOLA. The online database Indiagristat.com (Agriculture) has been subscribed for the year 2018-19.

Civil Works

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

Works/Repairs
Renovation of Plant Breeding Laboratory (Old Pathology and Biotech Labs)
Minor Repairs of Farm Building Complex at Narkhoda Farm
Repairs and Extension of Committee Room at IIOR, Rajendranagar
Repairs to civil structure of Old Glass House at Rajendranagar
Minor Repairs of Main Building, Annex Building and Seed Stores

Visitors

- Dr. P.V. Vara Prasad, Professor, Kansas State University, USA visited ICAR-IIOR on July 27, 2018 and delivered a lecture on "Impact of Climate Change Factors on Yield and Quality of Oilseed Crops.

- During the year under report, about 2820 farmers from Andhra Pradesh, Tamil Nadu, Karnataka, Telangana, Maharashtra and Odisha and nearly 3000 students from SAUs, Colleges and Schools belonging to Telangana, Andhra Pradesh, Tamil Nadu, Maharashtra, Kerala, Gujarat and Karnataka visited this Institute and interacted with the scientists.

Promotions/Transfers/Appointments/ Superannuations

Promotions

Name	From	To	Date
Sri Y. Rama Govinda Reddy	Sr. Technical Officer (T-6)	Asst. Chief Technical Officer (T-7/8) (Field/Farm)	01.01.2014
Mrs. Ch. V. Haripriya	Sr. Technical Officer (T-6)	Asst. Chief Technical Officer (T-7/8) (Field/Farm)	01.01.2011
Dr. G. Annapurna	Sr. Technical Officer (T-6) (Press & Editorial)	Asst. Chief Technical Officer (T-7/8) (Press & Editorial)	29.06.2016
Mrs. Ch. V. Haripriya	Asstt. Chief Technical Officer (T-7/8) (Field/Farm)	Chief Tech. Officer (T-9) (Field/Farm)	01.01.2018
Sri B.V. Rao	Sr. Tech. Officer (T-6) (Photography)	Asst. Chief Technical Officer (T-7/8) (Photography)	01.07.2018
Sri B.V. Noble	Sr. Tech. Officer (T-6) (Photography)	Asst. Chief Technical Officer (T-7/8) (Photography)	01.07.2018
Sri G. Srinivasa Rao	Assistant	Asst. Admn. Officer	31.08.2018
Dr. Kadirvel Palachamy	Sr. Scientist (Genetics)	Principal Scientist (Genetics)	01.08.2017
Dr. Mangesh Y. Dudhe	Scientist (Plant Breeding)	Sr. Scientist (Plant Breeding)	26.06.2017
Dr. T. Manjunatha	Scientist (Plant Breeding)	Sr. Scientist (Plant Breeding)	21.04.2018

Transfer

Name	Post	From	To	Date
Dr. Sujatha, T.P.	Scientist (Biotechnology)	ICAR-IIOR Hyderabad	ICAR-Indian Instt. Agrl. Biotechnology, Ranchi	28.6.2018 (AN)

Appointment

Name	Designation	Date
Sri Demudu Naidu Panchada	Technical Assistant (T-3)	16.03.2019 (FN)

Superannuations

Name	Post	Date
Sri B. Narasimha	Skilled Supporting Staff	30.04.2018
Dr. H. Basappa	Principal Scientist (Ag. Entomology)	30.06.2018
Sri S. Shamdas	Assistant Administrative Officer	31.07.2018
Dr. I.Y.L.N. Murthy	Principal Scientist	30.09.2018
Sri L. Krupakar	Technical Officer	31.10.2018
Sri G. Chandraiah	Private Secretary	30.11.2018
Dr. S. Chander Rao	Principal Scientist (Plant Pathology)	31.12.2018
Dr. Durgamadhab Pati	Technical Information Officer	31.01.2019
Dr. A.R.G. Ranganatha	Principal Scientist (Plant Breeding)	31.01.2019
Sri B.V. Noble	Assistant Chief Technical Officer	28.02.2019
Sri G. Rajamouli	Skilled Supporting Staff	31.03.2019

Personnel
(as on March 31, 2019)

Dr. A. Vishnuvardhan Reddy	Director

Director's Cell

Sri P. Srinivasa Rao	Personal Assistant
Sri G. Srinivas Yadav	Personal Assistant

Research Section

Crop Improvement

Dr. M. Sujatha (Genetics & Cytogenetics)	Head & Principal Scientist
Dr. K. Anjani (Plant Breeding)	Principal Scientist
Dr. V. Dinesh Kumar (Biotechnology)	Principal Scientist
Dr. N. Mukta (Economic Botany)	Principal Scientist
Dr. C. Lavanya (Plant Breeding)	Principal Scientist
Dr. Senthilvel Senapathy (Plant Breeding)	Principal Scientist
Dr. Kadirvel Palchamy (Genetics)	Principal Scientist
Sri H.H. Kumaraswamy (Biotechnology)	Scientist
Dr. Mangesh Y. Dudhe (Plant Breeding)	Scientist
Mrs. B. Usha Kiran (Biotechnology)	Scientist
Dr. J. Jawaharlal (Plant Breeding)	Scientist
Dr. H.P. Meena (Plant Breeding)	Scientist
Dr. T. Manjunatha (Plant Breeding)	Senior Scientist
Dr. K.T. Ramya (Genetics and Plant Breeding)	Scientist
Mrs. H.D. Pushpa (Genetics and Plant Breeding)	Scientist
Sri K. Sayendra	Technical Officer (F/F)
Sri P. Gopinadhen	Technical Officer (F/F)
Sri P. Sunil Kumar	Technical Officer (Lab. Tech.)
Sri G. Srinivasa Rao	Sr. Tech. Assistant (F/F)
Mrs. P. Mary	Technician T-1
Sri J. Narasimha	Technician T-1

Crop Production

Dr. G. Suresh (Agronomy)	Head & Principal Scientist
Dr. P. Padmavathi (Agronomy)	Principal Scientist
Dr. P. Lakshmamma (Plant Physiology)	Principal Scientist
Dr. Lakshmi Prayaga (Plant Physiology)	Principal Scientist
Dr. Md. A. Aziz Qureshi (Soil Science)	Principal Scientist
Dr. K. Ramesh (Agronomy)	Principal Scientist
Dr. Ratna Kumar Pasala (Plant Physiology)	Senior Scientist
Dr. Praduman Yadav (Biochemistry)	Scientist
Mrs. K.S.V.P. Chandrika (Agricultural Chemicals)	Scientist

Mrs. Ch.V. Haripriya	Chief Tech. Officer (F/F)
Sri P. Ashok	Tech. Officer (T-5)
Sri S. Narsimha	Tech. Officer (T-5)

Crop Protection

Dr. P.S. Vimala Devi (Agricultural Entomology)	Head & Principal Scientist
Dr. R.D. Prasad (Plant Pathology)	Principal Scientist
Dr. M. Santhalakshmi Prasad (Plant Pathology)	Principal Scientist
Dr. P. Satya Srinivas (Agricultural Entomology)	Principal Scientist
Dr. P. Duraimurugan (Agricultural Entomology)	Senior Scientist
Mrs. B. Gayatri (Nematology)	Scientist
Sri Ch. Anjaiah	Sr. Technician (F/F)
Sri S. Saida Reddy	Technician (F/F)

Social Sciences

Dr. S.V. Ramana Rao (Agricultural Economics)	Head & Principal Scientist
Dr. C. Sarada (Agricultural Statistics)	Principal Scientist
Dr. G.D. Satish Kumar (Agricultural Extension)	Principal Scientist
Dr. K. Alivelu (Agricultural Statistics)	Principal Scientist
Mrs. P. Madhuri (Computer Applications)	Scientist

Seed Section

Dr. S.N. Sudhakara Babu (Agronomy)	Head & Principal Scientist
Sri T. Veeraiah	Sr. Technical Asst. T4 (F/F)

Support Services

AKMU Cell

Sri P. Srinivasa Rao	Senior Technical Officer (Engg. & Workshop)

Library & Documentation

Sri G. Raghunath	Asst. Chief Tech. Officer
Sri V. Sambasiva Rao	Asst. Chief Tech. Officer

Art & Photography

Sri B.V. Rao	Asst. Chief Tech. Officer

Technical Coordination Cell

Mrs. R. Raji	Personal Assistant

Farm Section

Sri M. Bhaskar Reddy	Head (FOM) & Chief Technical Officer (F/F)
Sri G. Balakishan	ACTO (F/F)
Sri Y. Rama Govinda Reddy	Asst. Chief Tech. Officer (F/F)

Sri M. Panduranga Rao	Technical Officer (F/F)
Sri G.Y. Prabhakar	Tech. Officer (T-5)
Sri C. Prabhudas	DMO
Sri Surender Prasad	Technical Officer (Workshop)
Sri A. Srinivasa Raju	Tech. Asst. (AC Mechanic) T3
Sri N. Vasanth	Tech. Asst. (Workshop) T3
Sri K. Srinivas	Tech. Asst. (Workshop) T3
Sri Demudu Naidu Panchada	Tech. Assistant T3
Sri M. Indrasena Reddy	Tech. Asst. (Tractor driver) T3
Sri Y. Venkateshwar Rao	Tech. Asst. (Tractor driver) T3
Sri T. Bichanna	UDC

Administration

Sri Shitanshu Kumar	Sr. Administrative Officer
Sri Pradeep Singh	Assistant Director (OL)
Sri G. Srinivasa Rao	Asst. Admn. Officer
Dr. G. Annapurna	ACTO (Press & Edi.)
Mrs. C. Lalitha	Personal Assistant
Mrs. R.A. Nalini	Assistant
Sri P.R. Varaprasada Rao	Assistant
Sri E.V.R.K. Nagendra Prasad	Assistant
Sri B. Giri	UDC
Mrs. P. Swapna	LDC

Stores

Sri Rakesh Geeda	Assistant
Sri G.B. Nagendra Prasad	UDC
Mrs. G. Maheshwari	LDC

Drivers

Sri V. Yadagiri Swamy	Sr. Tech. Asst. Driver, T4
Sri G. Ramulu	Tech. Asst. Driver, T-I-3
Sri G. Pardhasaradhi	Sr. Tech. Asst. Driver, T4
Sri E. Ravi Kumar	Tech. Asst. Driver, T3

Audit & Accounts

Sri K. Srinivasa Rao	Finance & Accounts Officer
Sri A. Prem Kumar	Jr. Accounts Officer
Sri G. Raghava Kiran Kumar	Stenographer
Mrs. S. Swarupa Rani	Assistant
Mrs. B. Gyaneshwari	UDC

Skilled Supporting Staff

Sri G. Mallesh	SSS
Sri D. Narasimha	SSS
Sri M. Venkatesh	SSS
Sri A. Rambabu	SSS
Sri M. Ramulu	SSS
Sri P. Krishna	SSS
Sri D. Balaiah	SSS
Mrs. B. Kistamma	SSS
Sri K. Sanjeeva	SSS
Sri B. Vishnu	SSS
Mrs. G. Bharathamma	SSS
Sri Narsimha	SSS
Sri B. Gyaneshwar	SSS
Sri P. Srinivas	SSS
Mrs. K. Kalavathi	SSS
Mrs. A. Lalitha	SSS
Mrs. K. Suseela	SSS

भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान
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