ICAR-IIOR
Annual Report

वार्षिक प्रतिवेदन
Annual Report
2020

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

ICAR-IIOR Annual Report

Citation
ICAR-IIOR, Annual Report 2020
ICAR-Indian Institute of Oilseeds Research, Hyderabad.

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Published by
Director
ICAR-Indian Institute of Oilseeds Research
Rajendranagar, Hyderabad-500 030
Telangana, India.

Designed & Printed at
Balajiscan Private Limited
11-2-1145, Beside Matas Temple,
Opp: Subhan Bakery, Nampally,
Hyderabad, Telangana – 500 001, INDIA.
Tel: 23303424/25, 9848032644
Press: 9248007736/37

Preface

It gives me immense pleasure to present the ICAR-IIOR Annual Report 2020 with highlights on significant achievements made under research, extension and training programmes conducted during 2020. The year recorded overall excess rainfall of 26.3% over long term average. As against the previous year, area and production of oilseed crops in the country evidenced an increase of eight and six per cent, respectively.

During the year, in spite of the disturbance in functioning due to the COVID-19 pandemic, many significant achievements were made. These include the identification of the safflower hybrid ISH-402 for all India cultivation under rainfed and irrigated conditions and registration of the castor parental line M-574 with Plant Varieties Registry, PPV&FRA under extant (VCK) category. Among the technologies assessed, two SNP markers were validated for prediction of the wilt resistance phenotype in castor, two genomic regions putatively associated with tolerance to safflower aphid, and allele associated with high oil content in safflower were identified. A novel process of preparing protein hydrolysates from deoiled safflower cake was standardized and proved promising as protein source. The other salient achievements include: effectiveness of DOR Bt-127 SC formulation against major lepidopteran pests of sunflower, castor and groundnut under multilocation field testing; development of in vivo method to study the mechanism of resistance to leafhopper in castor; transmission of phytoplasma causing phyllody in sesame through grafting, dodder and leafhopper; confirmation of sources of resistance to major pests and diseases in castor (leafhopper, whitefly, wilt), sunflower (leafhopper) and safflower (wilt and aphid); development of bio-polymer based seed coating to improve efficacy of bio-agents and improve seed health during germination; development of conservation agriculture practices for castor based cropping systems; cropping system oriented resource-use efficient technologies in safflower; resource use efficiency in emerging oilseeds based cropping systems and model to predict yield responses to climate change in castor. Two National mission network projects on harnessing genetic resources for improvement of safflower and niger through biotechnological tools funded by DBT have been initiated. Another important development is the shifting of PC Unit for AICRP (Linseed) to IIOR, Hyderabad.

As a major step towards facilitating availability of improved varieties and hybrids to the farmers, a total of 22780 q seeds were produced on-farm as well as through farmer participatory mode. The 'Oilseeds Seed Hub' on nine oilseed crops sponsored by Department of Agriculture Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India is being coordinated by ICAR-IIOR, Hyderabad with the participation of 32 centres.

For effective outreach of IIOR technologies to the farmers, farmer-centric programmes were conducted - a total of 9115 Front Line Demonstrations (FLDs) were conducted across nine oilseed crops; 63 trainings and entrepreneurship development programmes were organized on oilseeds technologies, seed production, organic farming, non-chemical oil expelling, and mass production of microbial pesticides; promising hybrids of sunflower and varieties of sesame were evaluated in North Eastern Hill states to identify suitable genotypes for promoting area expansion and crop diversification in non-traditional areas; distribution of soil health cards to farmers was also carried out. Under Mera Gaon Mera Gaurav (MGMG), tribal sub-plan (TSP), SC-Sub plan, Farmers First programmes, the farmers were periodically updated about various agricultural practices/technologies to enhance their income levels besides providing incentives such as seeds, other inputs and facilitating linkages with ICAR institutes, SAUs, Department of Agriculture and NGO's. In addition, a National Seminar on 'Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security' was organized on February 7-8, 2020 under the aegis of Indian Society of Oilseeds Research (ISOR) by involving all the stakeholders.

I place on record my sincere gratitude and reverence to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. T.R. Sharma, DDG (CS), ICAR; Dr. Sanjeev Gupta, ADG (O&P), Dr. S.K. Jha, former ADG (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 Research Advisory Committee for the critical assessment and guidance in improving the research programmes of the institute. My sincere thanks to all the Heads of Sections, Drs. V. Dinesh Kumar, S.N. Sudhakara Babu, R.D. Prasad, S.V. Ramana Rao, Shri. Shitanshu Kumar, SAO, Shri. K. Srinivasa Rao, FAO, Dr. A.L. Rathnakumar, Officer I/c PME Cell and Dr. P. Ratna Kumar, I/c TIO for their inputs in compiling the information of their respective sections. I appreciate the efforts of Dr. N. Mukta, the team of editors of the IIOR Annual Report and other staff members of the Institute for their contribution in bringing out the publication. The contribution of Smt. C. Lalitha, PS for secretarial assistance and Shri. Pradeep Singh, Assistant Director (OL) for translation of the Annual Report in Hindi is gratefully acknowledged.

Hyderabad
March 15, 2021

(M. Sujatha)
Director (A)

Contents

ICAR-IIOR

Annual Report 2020

Executive Summary

Executive Summary

Major Achievements (2020)

Hybrid identified for release

- Safflower hybrid ISH-402, has been identified by Varietal Identification Committee for All India cultivation.

Registration with Plant Varieties Registry

- Castor parental line M-574 was registered with Plant Varieties Registry, PPV&FRA under extant (VCK) category.

Technologies developed / assessed

- Two SNP markers (Rc_30146-1103419 and Rc_28694-84511) were validated for prediction of the wilt resistance phenotype in castor with >90% accuracy.
- Two genomic regions (*QUc-Ct3.1* and *QUc-Ct5.1*) putatively associated with tolerance to safflower aphid and explaining 40% of the variability were identified.
- Allele of *CtDGAT-1* associated with high oil content in safflower was identified.
- DOR Bt-127 SC formulation was found effective against major lepidopteran pests of sunflower, castor and groundnut based on multilocation field testing.
- A novel process of preparing safflower protein hydrolysates from deoiled cake was standardized and proved promising as protein source in wistar rat diet.
- Safflower knowledge management portal was developed for the benefit of safflower researchers, academicians, farmers and extension workers.

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 882 accessions were rejuvenated and conserved in IIOR genebank.
- Two extra-early (<100 days to first picking) inbred lines ICI-EE-GP-73-2 and ICI-RG187-3-2-3-5 with 26-27% higher seed yield, biotic stress resistant inbred lines ICI-RG2661-7-5-2 (leafhopper resistant) and ICI-RG-2746-1 (wilt and root rot resistant) with 16-19% higher seed yield than the check were identified as superior lines.
- The lines ICI-RG-2800-1 to ICI-RG-2800-8 and ICI-RG-2774-1 to ICI-RG-2774-3 were confirmed for resistant reaction to capsule borer.

Sunflower

- A total of 268 sunflower accessions from USDA were multiplied and deposited in the long-term storage (LTS) at NBPGR, New Delhi.

Safflower

- A total of 630 rejuvenated accessions were conserved under medium term storage.
- Nine germplasm accessions *viz.*, GMU-7882, GMU-2709, GMU-7869, GMU-7887, GMU-7880, GMU-7871, GMU-3074, GMU-7907 and GMU-7922 were identified for high seed yield ranging from 14.8-21 g/plant compared to 13.3-14.2 g/plant in the checks PBNS-12 and A-1 whereas two accessions (GMU-7898, GMU-

7899) were confirmed for early flowering (63-68 days to 50% flowering) compared to the normal duration check (77-82 days to 50% flowering).

Sesame

- Out of 1787 accessions raised for evaluation, 320 diverse accessions were identified for higher seed yield and phenotypic traits.

Niger

- A total of 1823 accessions including landraces and exotic germplasm were augmented to the collection.
- Seventeen accessions were identified for higher seed yield per plant (>4 g).

Linseed

- A total of 2885 accessions are being multiplied and evaluated at three locations *viz.*, Raipur, Ranchi and Raichur.
- A set of 202 diverse accessions and being characterization and evaluated at ICAR-IIOR, Hyderabad.

Pre-breeding

- In sunflower, seven pre-bred lines (PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014 and PB-1019) derived from *H. argophyllus* exhibited resistance to leafhopper with Mean Susceptibility Index (MSI) of 1.0.
- In safflower, selections were made for wilt resistance, higher seed yield and oil content from different generations of interspecific crosses.

Parental lines-Development, Characterization and Evaluation

Castor

- Two pistillate lines IPC-38 (0.92 to 0.98) and IPC-39 (0.93 to 0.98) with higher pistillate (P) index upto five spike orders were identified.
- Pistillate line, IPC-30 expressed stable and the best pistillate character (0.37 ISFs) than the check SKP-84 (0.94 ISFs), in multilocation evaluation.
- Four male lines *viz.*, ICS-373, ICS-415, ICS-364 and ICS-396 were identified for better seed yield compared to the varietal check, 48-1 and the best male line, DCS-78.
- Five pistillate lines (IPC-31, IPC-44, IPC-39, IPC-38, JP-86) and four male lines (ICS-125, DCS-112, DCS-89, 48-1) were identified as best combiners for seed yield.
- Three lines [ICS-341 (0%), ICS-355 (0%) and ICS-353 (4.6%) and] isolated from advanced generation of six bi-parental crosses were identified for wilt resistance in comparison with susceptible check, JI-35 (100%).

Sunflower

- Promising CMS lines for oil content (CMS-70B, HA-89B, CMS-302B), high test weight (CMS-67B, ARM-249B, NDCMS-2B) and earliness (CMS-338B, CMS-67B, CMS-850B, CMS-48B) were identified.
- CMS lines COSF-7A, CMS-38A, CMS-234A and ARM-243A and testers RGP-225, RGP-223, RGP-233, RGP-21-P_2-S_2, RGP-50-P_1-S_4 and RGP-58-P_4-S_2 were identified as good general combiners for yield and yield contributing traits.
- Sixteen newly developed restorer gene pool inbreds were found resistant to downy mildew based on two years of screening in downy mildew sick plot at Latur.
- Four newly developed restorer gene pool inbreds (RGP-46-P_2, RGP-50-P_2S_1, RGP-49-P_4, RGP-21-P_2S_2) and four F_1 hybrids showed resistant reaction to powdery mildew with PDI value <10%.

Safflower

- Three wilt resistant inbred lines *viz.*, ISF-2342, ISF-2413-17 and ISF-2471-17, developed using wilt resistance linked SSR markers, exhibited resistance reaction in sick plots at multilocations and validated the effectiveness of marker assisted selection.
- Inbred line ISF-1703-2-1-2016, identified for *Alternaria* tolerance at ICAR-IIOR, Hyderabad was further validated at Solapur and Parbhani for the trait.

Varietal Development

Safflower

- Two non-spiny varieties, ISF-763 and ISF-1258-15 and a spiny variety, ISF-112-15 completed

AVT-II and ready to be proposed to Varietal Identification Committee for identification and release.

- Three varieties *viz.*, ISF-87-15 (high oil 40%), ISF-116 (wilt resistant) and ISF-849-sel-16 were promoted to AVT-II , while one variety, ISF-123-sel-15 was promoted to AVT-1 and three varieties *viz.*, ISF-2342 (interspecific and wilt resistant), ISF-300 (developed from NCP gene pool) and ISF-867 (short duration) were nominated for IVT.

Sesame

- F_2 population of multiparent cross (HT-1 X RT-351)/(GT-2 X TKG-22)//(HIMA X TSS-6)/(RAJESHWARI X E-8) exhibited wide variability for flower initiation (26-58 days), leaf colour and pattern, capsule size (2.5-4.5 cm), and number (54-152) during late *kharif*.
- Inheritance studies for conspicuous purple flower lip colour (observed in wild species) and multicapsules/axil showed 13:3 and 11:5 ratio, respectively in F_2 generation of the cross IC-205776 x EC118591, respectively.
- Four entries *viz.*, SEL-S-2019-1013, SEL-S-2019-1017, SEL-S-2019-1018 and SEL-S-2019-1019 showed <20% root rot incidence and were identified as promising lines for root rot tolerance.

Hybrid Development

Castor

- Three hybrids ICH-368, ICH-901 and ICH-941 recorded a yield advantage of 17.9 to 26.4% over the best check, ICH-66 (1753 kg/ha).
- Two short duration (85-90 days to primary spike maturity) hybrids *viz.*, ICH-440 (IPC-15 x ICS-345), ICH-1146 (IPC-39 x DCS-89) of and two normal duration (with >90-110 days primary spike maturity) hybrids *viz.*, ICH-239, ICH-277 were nominated to IVHT-Short duration and IVHT-Normal duration, respectively.
- Two promising hybrids *viz.*, ICH-278 (DPC-25 x ICS-164), resistant to wilt and leafhopper and ICH-515 (SKP-84 x RG-566) resistant to wilt, root rot and moderately resistant to gray mold entered AHT-II while one promising variety ICS-164 was promoted to AVT-I.

Sunflower

- Two entries, IIOSH-413 and IIOSH-566 were nominated for *rabi* 2020 initial hybrid trial (IHT) and one entry IIOSH-15-20 was nominated for *kharif* 2020 AHT-II under AICRP.

Safflower

- ISH-400 was promoted to AHT-II; ISH-423 was promoted to AHT-1 and three hybrids *viz.*, ISH-413, ISH-417 and ISH-419 were nominated to IHT.
- The hybrid, ISH-401, with seed yield of 19.57 q/ha and 32.38 q/ha under rainfed and irrigated conditions, respectively is ready for proposing to VIC for all India release.

Molecular Breeding and Biotechnology

Castor

- Allelism tests indicated that wilt resistance in RG-1149, RG-1673 and 48-1 is controlled by recessive genes that are allelic. Among the resistant sources carrying dominant genes, wilt resistance loci in RG-1354 and RG-2685 were allelic while loci in whereas RG-2874 and RG-999 were non-allelic.
- The linkage of two SNP markers (RC-30146-1103419 & RC-28694-84511) with wilt resistance in castor was validated using an independent segregating population. The markers could predict the phenotype with >90% accuracy.
- Pre-inoculation medium with 0.3 mg/L TDZ, regeneration media RM30 or RM26 or RM 149, shoot elongation medium of MS+ 0.2 mg/L BAP and rooting medium of MS+1mg/L IBA were the ideal combinations for *in vitro* regeneration in castor.

Safflower

- SSR linkage map with 242 markers was developed using F_6-RIL population (237 lines) of CO-1 and EC-523368-2 cross and two genomic

regions (*QUc-Ct3.1* and *QUc-Ct5.1*) putatively associated with tolerance to safflower aphid explaining 40% of the variability were identified.

- A SNP map with 49 markers using F_8-RILs (280) of CO-1 and EC-523368-2 cross was developed.
- Allele mining of *CtOleosin4* gene identified single nucleotide change at 77 bp in the CDS region leading to an amino acid change in the protein from methionine (M) to lysine (K) in high and low oil lines.

Sesame

- Among the 200 microsatellite markers, 67 markers amplified, of which 43 produced discernible bands showing polymorphism with polymorphic information content (PIC) ranging from 0.18 to 0.53 when tested in a set of 24 Indian sesame genotypes.
- Standard molecular analysis revealed that the phytoplasma isolate of IIOR showed very high similarity (99.92%) with *Candidatus Phytoplasma aurantifolia* isolate OS-KACh-AB and the isolate belonged to 16Sr group II, subgroup D (GenBank accession: Y10097).
- The sequence analysis showed that mature SAP54 from ICAR-IIOR was identical to the SAP54 reported by Delhi University.
- Two genes encoding proteins, *RNF5* (E3 ubiquitin-protein ligase RNF5 LOC105167488) and *NPY4* (BTB/POZ domain-containing protein NPY4 LOC105158596), that are known to interact with SAP54 effector molecule of Phytoplasma, were isolated and are being used to develop the rBiFC vectors.

DUS Testing

- DUS testing of safflower was completed for one new candidate for first year and one VCK entry along with two reference entries each.
- In castor, DUS testing of one farmer's variety along with two reference varieties was completed.

Seed Production

- A total of 555.69 q of breeder, foundation, certified and TL seed of castor, sunflower, sesame and safflower were produced.
- Under seed hub programme 22,780 q of seed of nine oilseed crops were produced by 32 centres.

Crop Production

Conservation Agriculture

- Conventional tillage and castor + groundnut intercropping system recorded highest castor equivalent yield (3153 kg/ha) and rain water use efficiency (4.91 kg/ha/mm) under conservation agriculture practices in shallow Alfisols under rainfed conditions.

Cropping Systems Research

- Preceding legume crops *viz.*, greengram and soybean or fallow did not affect safflower productivity with highest value being recorded with supplemental nutrition under soybean-safflower cropping system with higher safflower equivalent yield (2510 kg/ha) and rain water use efficiency (3.2 kg/mm of rainfall).

Resource Use Efficiency

- In maize: castor cropping system under long term fertilizer management in Alfisols, highest yields of maize (5.29 t/ha) and castor (2.15 t/ha) were recorded with integrated nutrient management (NPK+FYM/Crop residues). NPK+crop residue-NPK followed by NPK+B-NPK recorded higher NUE for maize yield: 11.99 kg/kg nutrient(s) followed by 10.41 kg/kg nutrient(s) and NUE for castor yield 5.43 kg/kg nutrient(s) followed by 4.71 kg/kg nutrient(s).
- Sesame productivity was lowest (240 kg/ha) under zero tillage under paddy fallow situations across soil types. Supplemental fertilization (50 to 100% RDF) increased sesame productivity.
- The Fe and Zn citrate nanomaterials were characterized for physico-chemical properties using FTIR, XRD, SEM, TEM, TGA. The initial plant uptake of the synthesized nutrients was proved in soybean..

Abiotic Stress Tolerance

- Three castor parental lines, DCS-104, DCS-106, DPC-18, were identified as drought tolerant with

≤30% reduction in total seed yield and ≤0.70 Drought Susceptibility Index (DSI).

- In sesame, the genotype IC-204966 was identified for tolerance to drought with higher growth and productivity under moisture stress.
- AKSF-6-3B was identified as heat tolerant sunflower inbred with low reduction in yield (3%), no change in HI with 3°C rise in temperature during crop growth period against the mean yield reduction of 22%.

Value Addition

- In the trials with Wistar rats, safflower SPH (seed protein hydrolysate) increased the body weight and indicated that SPH could replace the expensive casein hydrolysate in the diet.
- Safflower meal diet was competitive and superior over soybean meal in improving body weight and health of chicken.

Crop Protection

Host Plant Resistance

- Experiments with *in vivo* cage method revealed that the resistant genotypes of castor exhibited antixenosis mechanism of resistance for oviposition and tolerance to hopper burn damage.
- Based on the screening with isolates of *F. oxysporum* f.sp. *ricini* from Hyderabad, Palem and S.K. Nagar, castor genotypes AP-33, AP-125, DCS-107, AP-163/AP-48, RG-3105/AP-56, RG-2836/RG-3467/ICS-144, ICS-125 and JI-35 were selected as differential lines.
- Eight castor inbred lines *viz.*, ICI-RG-2661-7-3-5-6, ICI-RG-2787-89-20, ICI-RG-2787-152-9, ICI-RG-3425-5, ICI-RG-2746-1, ICI-RG-2774-2, ICI-RG-898-6 and RG-2034 were identified as resistant to wilt disease.
- Seven castor parental lines *viz.*, ICS-200, ICS-216, ICS-217, DPC-18, DPC-27, IPC-34 and IPC-36 were confirmed for resistant reaction to leafhopper while four parental lines *viz.*, IPC-30, IPC-31, IPC-46 and MCI-8 were promising against both leafhopper (hopper burn grade of 1 compared to 4 in susceptible check, DPC-9 on 0-4 scale) and thrips (<15 thrips compared to 46.8 thrips/spike in susceptible check, DCS-9).
- Studies on influence of wax content in pericarp of castor capsules on gray mold severity revealed that genotypes with low quantities of wax content on capsules (0.17 to 0.69 µg/mg) recorded low disease severity (1.3-4.2%) as compared to high waxy bloom genotypes (higher wax content of >1.50 µg/mg with 40 to 95% disease severity).
- In sunflower, a susceptible check to leafhoppers, NDCMS-2B has been identified to replace the existing inconsistent susceptible check, Morden.
- Among 18 inter-specific derivatives of *Helianthus annuus* x *H. argophyllus* screened for their reaction to leafhoppers, seven progenies *viz.*, PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014 and PB-1019 were resistant to leafhoppers with mean scale index (MSI) of 1.0. The accession, TSG-391 was confirmed resistant to leafhoppers with MSI of 1.2.
- In safflower, 40 breeding lines and germplasm lines were evaluated for their reaction to aphids. Seven accessions, GMU-7911, GMU-7915, GMU-7916, GMU-7918, GMU-7919, GMU-7920 and GMU-7921 were found moderately tolerant to aphids (A.I.I. 2.3-2.6).
- Transmission studies for sesame phyllody disease indicated that phyllody phytoplasma co uld be transmitted through grafting, dodde r and leafhopper but not with sap abrasion a nd sap injection methods. Transmission was co nfirmed through nested PCR.

Biopesticides

- As per registration guidelines of CIBRC, LC_{50} value of DOR Bt-127 suspension concentrate (SC) formulation against *Spodoptera litura* was determined to be 1.79 µl/ml at 96 hours after treatment.
- Shelf-life of water dispersible granule (WDG) formulation of DOR Bt-127 was tested for viability

for a period of 24 months. Log *cfu* value of Bt spores in Bt WDG formulation did not show any decrease till 12 months of storage and the value showed insignificant decrease by 24 months.

Biopolymers and Bioagents

- A bench scale protocol was standardized for preparation of polymeric film solutions by physico-chemical cross linking and film by solvent-casting method using water soluble polymers. Crosslinked biopolymers were synthesized using cellulose and chitosan as backbone based on its film forming ability.
- Coating of safflower seed with biopolymer chitosan + *Trichoderma harzianum* Th4d formulation @ 10 ml/kg seed resulted in low incidence of wilt (5.5%) and root rot (2%) compared to untreated control (wilt incidence-16.9%; root rot-15%) and recorded higher seed yield (850 kg/ha as against 425 kg/ha in control).
- Groundnut seed coating with biopolymer chitosan + *T. harzianum* Th4d @ 10 ml/kg significantly improved seed germination (76.7% compared to 66.2% in untreated control) and recorded low root rot incidence (4.3%) and higher pod yield (3193 kg/ha compared to 2398 kg/ha in untreated control).
- Seed treatment with biopolymer cellulose + *T. harzianum* Th4d and chitosan + *T. harzianum* Th4d @ 10 ml/kg in soybean resulted in significantly higher seed yield (1234 to 1346 kg/ha) as compared to untreated control (1121 to 1256 kg/ha) under field conditions at Nandyal and Raichur.

Social Sciences

- Prediction models were developed for predicting castor yield based on weather parameters - this applicability of the model was demonstrated with over 90% accuracy of predicting the yields of castor based on weather parameters.
- Impact assessment of castor hybrids in Gujarat state was carried out. The monetization of GCH-7 revealed substantial economic benefit across major castor growing districts of Gujarat (Rs.28,701 crores for the period 2008-09 to 2017-18) across the districts of Banaskanta, Mehasana, Kucchh, Patan, Surendernagar, Sabarkanta, Ahmedabad and Vadodara.
- As an outreach programme, oilseed technologies were demonstrated through 9115 FLDs and CFLDs in all the oilseed crops.
- Under the umbrella programme of competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana, interventions on contour cultivation/ ridge and furrow method enhanced yield by 24% providing additional net returns of Rs.11,493/ha while technology assemblage in cropping systems module across various crops provided additional net returns ranging from Rs. 6,754/ha to Rs. 29,138/ha.
- As a part of secondary agriculture towards doubling of farmers income, pilots on marketing and value addition resulted in accrual of additional returns of Rs.2,245/q in rice and Rs.5,362/q in tur dal thus indicating the potential of upscaling value addition through cluster approach/ FPO's

ICAR-IIOR

Annual Report 2020

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 was 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 technological 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 December 31, 2020

Category	Sanctioned	Filled	Vacant
Scientific	43*	38	5
Technical	46	27	19
Administrative	29	20	9
Skilled supporting	18	17	1
Total	**136**	**102**	**34**

*including one RMP

Financial Statement

Allocation and Expenditure

Head of Account	Allocation (Rs. in lakhs) 2020-21			Expenditure (Rs. in lakhs)*		
	IIOR Uni-fied Budget	AICRPO (OS + S&N + LIN)	TOTAL	IIOR Uni-fied Budget	AICRPO (OS + S&N+ LIN)	TOTuAL
A. GRANT IN AID – CAPITAL						
Works	76.00	0.00	76.00	0.00	0.00	0.00
Equipment	7.00	0.00	7.00		0.00	0.00
Information & Technology			0.00	0.09		0.09
Library	10.00		10.00			0.00
Vehicle & Vessels			0.00			0.00
Furniture	7.00		7.00	0.29		0.29
SC-SP	30.00		30.00	7.37		7.37
B. GRANT IN AID – SALARIES						
Establishment Charges	1795.16	1808.30	3603.46	1349.09	1155.45	2504.54
Wages	370.00		370.00	277.33		277.33
Overtime Allowance	0		0.00	0.00		0.00
Pension	230		230.00	144.14		144.14
C. GRANT IN AID – GENERAL						
TA	20.00	56.37	76.37	5.67	25.17	30.84
Res. & Operational Expenses	260.00	269.63	529.63	199.31	136.56	335.87
Administrative Expenses	242.00		242	86.69		86.69
Miscellaneous Expenses	8.00		8.00	0.22		0.22
N.E.H (General)	20.00	25.00	45.00	8.66	9.03	17.69
N.E.H.(Salaries)		64.43		0.00	44.41	44.41
TRIBAL SUB-PLAN - General	31.00	60.00	91.00	13.08	15.91	28.99
TRIBAL SUB-PLAN - Capital	0.00	3.60		0.00	0.00	0.00
SC - SP	150.00		150.00	20.32	0.00	20.32
TOTAL	**3256.16**	**2287.33**	**5475.46**	**2112.26**	**1386.53**	**3498.79**

*upto December 31, 2020

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	0.00	0.00
Grants for Salaries	1054.10	675.79	373.27	257.39	380.93	222.27
Grants for General	155.00	81.51	85.00	39.34	86.00	40.88
TSP – General	20.00	5.41	20.00	5.29	20.00	5.21
TSP - Capital					3.60	0.00
NEH (Salaries)					64.43	44.41
NEH (General)	10.0	2.68	5.0	1.32	10.00	5.03
Total	**1239.10**	**765.39**	**483.27**	**303.34**	**564.96**	**317.80**

w.e.f., April to December, 2020

Resource Generation

Particulars	Amount (in lakhs)
Sale of Farm Produce	0.54
Sale of Old Vehicles & Machine Tools	0.00
Sale of IIOR Publications & Tender forms etc.	0.00
Rent (Hostel)	0.35
License Fee (Quarters)	1.38
Interest earned on loans & Advances	0.93
Leave Salary & Pension Contribution	0.00
Analytical testing charges	7.35
Interest earned on STDR	0.00
Receipts from service rendered/Sale of tech.	0.00
Unspent balance of grants	0.00
Training	0.00
Miscellaneous receipts	2.06
Total	**12.61**

Funds received for Externally Sponsored Projects

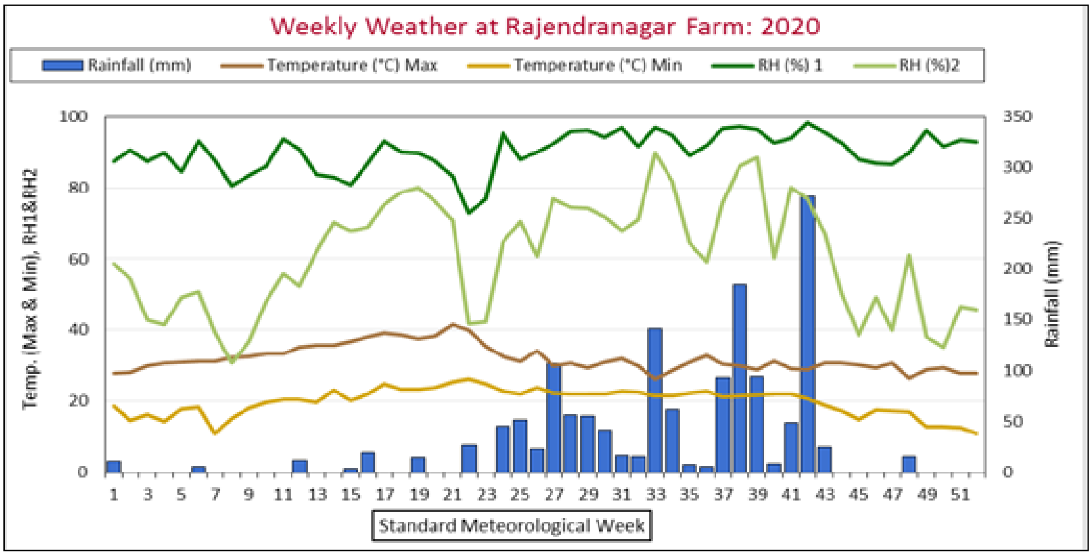
Particulars	Fund	
	Receipt/ Opening balance	Expenditure
DBT Projects	382.67	186.97
DUS Projects	23.50	5.58
DBAC Projects	324.49	228.21
Intl. Collaboration	10.51	10.51
Other Deposit Schemes	122.57	12.81
Total	**863.74**	**444.08**

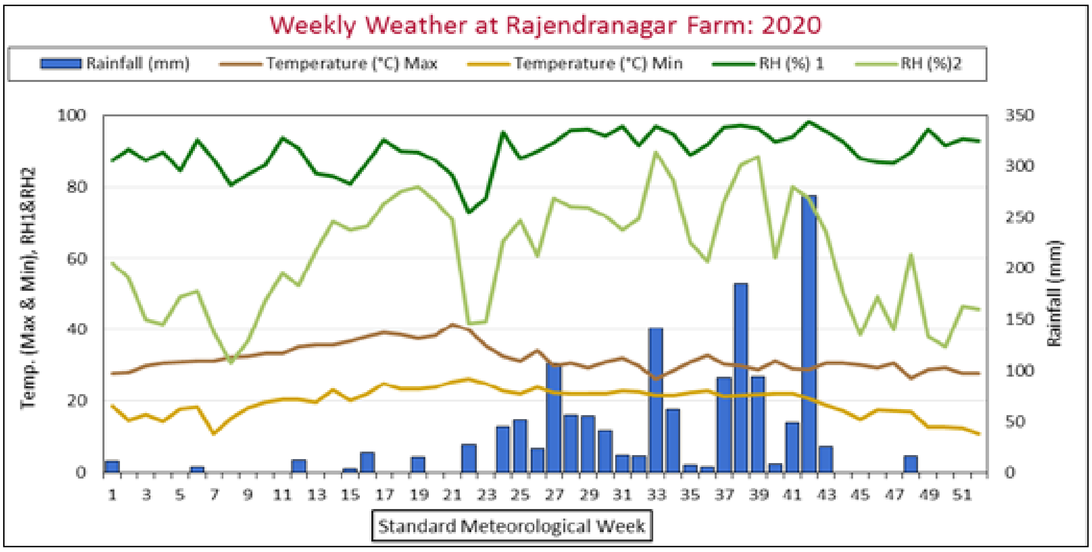
ICAR-IIOR

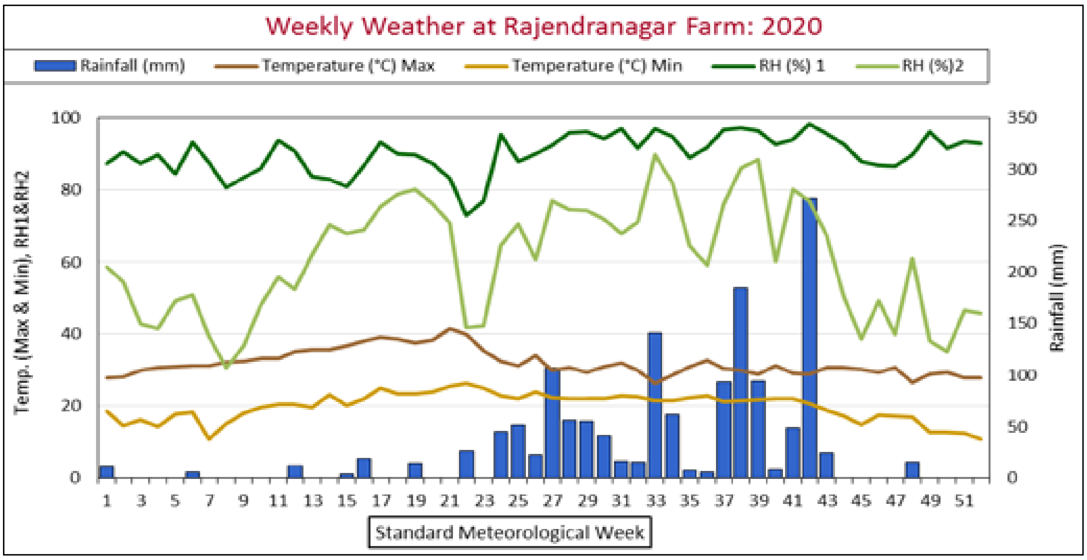
Annual Report 2020

Research Achievements

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


Weekly Weather at Rajendranagar Farm: 2020
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%)2
Temp. (Max & Min), RH1&RH2
Rainfall (mm)
Standard Meteorological Week


Weekly Weather at Rajendranagar Farm: 2020
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%)2
Temp. (Max & Min), RH1&RH2
Rainfall (mm)
Standard Meteorological Week


Weekly Weather at Rajendranagar Farm: 2020
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%)2
Temp. (Max & Min), RH1&RH2
Rainfall (mm)
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 mandate crops namely castor, sunflower, safflower, sesame, niger and linseed for crop improvement research 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, emphasis has been on the identification of trait specific germplasm lines conferring resistance to biotic and abiotic stresses, yield enhancing traits and oil content.

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 centres. The institute also owns the responsibility of rejuvenating the working germplasm periodically and depositing the material with NBPGR for long term storage. The activities carried out by germplasm units are summarized here.

Castor

Fifty four trait specific inbred lines derived from germplasm and 246 germplasm accessions were multiplied through self-pollination at ICAR-IIOR. Rejuvenation of 882 accessions was undertaken and the fresh seeds of these accessions were deposited with the gene bank of ICAR-IIOR. A total of 746 accessions and 13 trait-specific inbred lines were supplied to AICRP centres for testing against biotic stresses like wilt, root rot, grey mold, leafhopper, whitefly and thrips.

Multilocation yield evaluation of trait-specific inbred lines derived from germplasm

Fourteen trait specific inbred lines comprising four early, one high ricinoleic type, one root rot resistant, one leafhopper and root rot resistant, one wilt and leafhopper resistant, two wilt resistant, two wilt and root rot resistant, two leafhopper resistant and 17 capsule borer tolerant were evaluated along with two check varieties, DCS-9 and GC-3 in a randomized block design with two replications at Palem, Hyderabad (rainfed) and S.K. Nagar (irrigated). The net plot size of the experiment was 8.64 sq.m and 17.28 sq.m. with a spacing of 90 x 60 cm and 120 x 90 cm under rainfed and irrigated conditions, respectively.

Early inbred lines: Four -early (<100 days to first picking) inbred lines *viz.,* ICI-EE-GP-63-15, ICI-EE-GP-73-2, ICI-EE-GP-73-14 and ICI-RG187-3-2-3-5 recorded 37-39 days to flowering across all locations and 88-93 days to maturity compared to the early maturing check, DCS-9 (45 and 104 days). All the four extra-early inbred lines gave higher seed yield (541-643 kg/ha) than DCS-9 at 150 DAS. Two inbred lines *viz.*, ICI-EE-GP-73-2 and ICI-RG187-3-2-3-5 with 27% (1965 kg/ha) and 26% (1943 kg/ha) higher seed yield than the early check, DCS-9 (1547 kg/ha) after four pickings could act as good genetic sources of early maturity coupled with high yield for further utilization in breeding programmes.

Biotic stress resistant inbred lines: Nine biotic stress resistant inbred lines were at par with checks (DCS-9 and GC-3) with respect to days to flowering and maturity. The leafhopper resistant inbred line, ICI-RG2661-7-5-2 gave 16% higher total seed yield (2549 kg/ha) than the best check, GC-3 (2195 kg/ha) while the wilt and root rot resistant inbred line, ICI-RG-2746-1 gave 19% higher total seed yield (1840 kg/ha) than the check, DCS-9 (1547 kg/ha), while the other biotic stress resistant inbred lines were not comparable with checks for seed yield.

The lines ICI-RG-2800-1 to ICI-RG-2800-8 and ICI-RG-2774-1 to ICI-RG-2774-3 confirmed resistant reaction to capsule borer for three consecutive years when evaluated through the infester row method and through artificial release of capsule borer moths under net-confined condition for one year. They were evaluated for seed yield and yield components.

Reaction of inbred lines to capsule borer for three years and performance for seed yield at three locations

Inbred lines	Capsule damage (%)					Total seed yield (kg/ha)			
	Open field conditions using infester row method				Net confined conditions	Irrigated	Rainfed		Overall mean
	2019-20	2018-19	2017-18	Mean	2017-18	S.K. Nagar	Palem	ICAR-IIOR	
ICI-RG-2800-1	8.2 (16.6)	5.8 (13.9)	2.7 (9.5)	5.6	4.4 (12.1)	2663	1975	1233	1957
ICI-RG-2800-2	7.6 (16.0)	5.6 (13.7)	3.9 (11.3)	5.7	4.2 (11.9)	NT	NT	NT	NT
ICI-RG-2800-3	4.7 (12.4)	9.3 (17.7)	3.8 (11.2)	5.9	5.5 (13.6)	2212	2146	1143	1834
ICI-RG-2800-4	5.9 (14.0)	8.2 (16.6)	0.6 (4.3)	4.9	2.0 (8.0)	1820	1459	691	1323
ICI-RG-2800-5	8.2 (16.6)	8.8 (17.3)	1.2 (6.3)	6.1	5.8 (13.9)	1549	491	1133	1058
ICI-RG-2800-6	8.4 (16.8)	6.4 (14.7)	3.4 (10.6)	6.1	4.6 (12.4)	2935	1616	1476	2009
ICI-RG-2800-7	9.1 (17.6)	8.0 (16.4)	2.6 (9.3)	6.6	3.5 (10.7)	1691	841	1026	1186
ICI-RG-2800-8	7.0 (15.0)	7.0 (15.3)	5.2 (13.2)	6.4	3.2 (10.3)	1480	854	1229	1188
ICI-RG-2774-1	6.5 (14.8)	3.8 (11.3)	6.1 (14.3)	5.5	4.9 (12.7)	2805	1833	2008	2215
ICI-RG-2774-2	6.9 (15.2)	7.8 (16.2)	5.2 (13.2)	6.6	5.7 (13.8)	2594	1300	1403	1766
ICI-RG-2774-3	8.3 (16.7)	7.9 (16.3)	5.9 (14.0)	7.4	6.5 (14.8)	2014	763	860	1212
ICI-RG-898-1	12.4 (20.3)	12.7 (20.8)	8.5 (16.9)	11.2	3.6 (10.9)	2361	902	1495	1586
ICI-RG-898-2	11.3 (19.6)	8.1 (16.6)	6.3 (14.5)	8.6	12.5 (20.7)	2201	938	1125	1421
ICI-RG-898-3	9.4 (17.8)	8.0 (16.4)	3.9 (11.4)	7.1	2.9 (9.8)	1791	1100	1116	1336
ICI-RG-898-4	11.3 (19.6)	8.8 (17.2)	4.5 (12.2)	8.2	6.0 (14.2)	1615	828	1245	1229
ICI-RG-898-5	17.0 (24.3)	6.3 (14.5)	1.8 (7.7)	8.4	3.8 (11.2)	1503	972	2302	1592
ICI-RG-898-6	16.9 (24.2)	8.0 (16.4)	11.1 (19.4)	12.0	5.8 (13.9)	2402	1813	1858	2024
48-1 (RC)#	8.1 (16.5)	5.3 (13.3)	6.8 (15.1)	6.7	7.4 (15.7)	2869	1296	1812	1992
DCS-9 (SC)@	88.7 (70.4)	84.5 (66.8)	47.2 (43.4)	73.5	54.7 (47.7)	3103	2289	2324	2572
CD (P=0.05)	4.5	1.9	2.6	-	1.7	689	485	480	

Figures in parentheses are arcsine transformed values; RC - Resistant check; SC- Susceptible check; Resistant: 0-10%; Moderately resistant: >10-20%; Moderately susceptible: >20-40%; Susceptible: >40%

Net plot size for seed yield evaluation- irrigated: 17.28 sq.m; rainfed: 8.64 sq.m

#Check for seed yield: DCS-9; @ Check for seed yield: GC-3; NT – not tested

High ricinoleic acid inbred line

The high ricinoleic acid type inbred line, ICI-RG-226-29-2-2 flowered (DF: 42) and matured (DM: 98) earlier than both the checks with 9% higher total seed yield (1679 kg/ha) than DCS-9 (1547 kg/ha) after four pickings. Ricinoleic acid content (92 %) was higher than DCS-9 (89%) and GC-3 (87%) and stable across the locations under both rainfed and irrigated conditions.

Sunflower

A total of 3400 genetic resources are available in the IIOR gene bank. Major emphasis during the year was on multiplication and deposition of the sunflower accessions in medium term storage (MTS) facility of IIOR. Seven hundred sixty accessions were multiplied and 106 accessions including genetic stocks, were supplied to different researchers as per their requirement. A total of 268 sunflower accessions from USDA were multiplied and deposited in the long-term storage (LTS) at NBPGR, New Delhi.

Evaluation of pre-bred lines

Three hundred forty eight pre-bred lines received through USDA, USA during 2018 under the International Collaborative Project with University of British Columbia were raised during *rabi* 2019 in augmented block design with five checks received with the pre-bred lines and 2 national checks. Phenotypic data on yield and yield related traits were collected for the identification of better performing pre-bred lines for high yield potential. Good variability was noticed among pre-bred lines for days to maturity (89-126), plant height (65-184 cm), head diameter (4.5-19.5 cm), 100-seed weight (1.3-8.3 g), seed yield/plant (1.2-74g) and oil content (28.6-42%).

A total 49 pre-bred lines with oil content >37% were utilized in crossing with two CMS sources (ARM-243A and CMS-17A). Out of the pre-bred lines, six restored complete fertility under the ARM-243A background whereas 22 pre-bred lines restored complete fertility under the background of CMS-17A. The best performing crosses (ARM-243A×PI-686532, ARM-243A×PI-686556, ARM-243A×PI-686592) were identified for seed yield ranging from 28 to 30 g/plant and oil content of 37-39%.

Safflower

A total of 7022 safflower germplasm accessions are conserved in the Medium-Term Storage (MTS) Module at IIOR, Hyderabad. Viability testing was undertaken for 1109 accessions after six years of conservation and 66.2% of the accessions recorded >85% germination. Sowing was taken up for 1648 accessions for rejuvenation and 290 promising accessions for multiplication during *rabi*, 2020-21. Seeds of 630 freshly multiplied accessions were conserved under MTS. A total of 538 samples of 403 accessions were supplied to indenters for utilization in breeding, screening against Alternaria, wilt, aphid and moisture stress tolerance at multilocations.

Evaluation of promising germplasm

A trial comprising of 27 accessions and five checks (A-1, PBNS-12, NARI-57, Bhima, JSI-99) was conducted (plot size: 3 rows x 5 m) with two replications. Nine germplasm accessions *viz.*, GMU-7882, GMU-2709, GMU-7869, GMU-7887, GMU-7880, GMU-7871, GMU-3074, GMU-7907 and GMU-7922 were identified for high seed yield ranging from 14.8-21.0 g/plant compared to 13.3-14.2 g/plant in the checks PBNS-12 and A-1. The accessions GMU-7898 and GMU-7899 were confirmed for early flowering (63 days and 68 days to 50% flowering) compared to 77-82 days in normal duration checks and 59 days for 50% flowering in early duration check (JSI-99).

Sesame

Out of 1787 accessions raised in an augmented block design, 320 diverse accessions were selected based on traits *viz.*, plant height, distance to first capsule forming node, branching pattern, capsule/leaf axil, capsule morphology (length, width, shape, tip), and number of capsules/plant. Of these, 27 promising accessions were selected based on plant type, vigour and growth, number of capsules/leaf axis and capsule morphology for assessing the photosynthetic efficiency and dry matter accumulation at crown growth period (65-70 days). Dry matter accumulation in these plant types will be compared with dry matter accumulation at harvest for identification of physiologically efficient types for use as donors in crossing programme.

Two wild accessions from TNAU-Vridhachalam and 29 released varieties of sesame from different states were collected and multiplied in *kharif* 2020. One hundred and eighty six diverse and elite accessions were also collected from NBPGR for further multiplication, characterization and evaluation in summer 2021.

Three local collections *viz.*, Latur local (Maharashtra), Kurvaguda local (Telangana) and Ayyarmalai local Tamil Nadu) were collected and evaluated. Single plants were selected based on high capsule number and seed yield.

Growth and yield attributes of local collections of sesame during Summer-2020

Characters	Latur local	Kurvaguda local	Ayyarmalai local	GT 10 (check-1)	Swetha til (check-2)
Days to flower initiation	35	42	35	30	35
Days to flower cessation	74	86	75	65	78
Plant height (cm)	124	145	100	113	146
Number of primary branches	6	8	6	6	6
Number of secondary branches	8	10	8	8	4
Number of capsules/plant	76	113	64	72	82
Capsule length (cm)	3.2	3.0	2.4	2.5	3.5
Seed yield (g)/plant	14.6	12.5	8.2	5.1	8.6
Test weight (g)	3.5	3.2	2.8	3.16	3.36
Oil content (%)	48.6	46.2	46.5	43.6	47.6

Niger

A total of 1823 accessions were received from ICAR-NBPGR, New Delhi for seed multiplication, characterization and evaluation. Fifteen accessions from USDA ARS, WRPIS, Washington State University, USA and five popular varieties from Ethiopia *viz.*, Ginchi, Shambu-1, Kuyu, Fogera and Estete were augmented. Six farmer's varieties were collected from different regions of Araku valley of Andhra Pradesh, Dharwad and Hassan districts of Karnataka.

A total of 150 accessions were received from PC Unit, Jabalpur were evaluated along with two checks *viz.*, JNS-9 and IGPN 2004-1 for major agronomic traits and promising trait specific accessions were identified for future use in breeding programmes.

Promising niger germplasm accessions identified

Major agronomic traits	Promising germplasm accessions
Early plant type (38-47 days to 50% flowering)	JN-19, JN-20, JN-23, JN-29 and JN-137 (Checks: JNS-9: 49 days; IGPN 2004-1: 52 days)
Number of branches per plant (>7)	JN-11, JN-12, JN-14, JN-18, JN-20, JN-22, JN-37, JN-96, JN-103, JN-118 and JN-124 Checks: JNS-9 (7); IGPN 2004-1 (7)
Number of heads per plant (>34)	JN-14, JN-18, JN-36, JN-96, JN-104, JN-106, JN-107, JN-116, JN-118, JN-138 (Checks: JNS-9: 29; IGPN 2004-1: 32)
Number of seeds per head (≥18)	JN-7, JN-25, JN-93, JN-95, JN-96, JN-101, JN-103, JN-109, JN-110 (Checks: JNS-9: 15; IGPN 2004-1: 16)
High seed yield/plant (>4 g)	JN-1, JN-19, JN-25, JN-107, JN-108, JN-109, JN-110, JN-111, JN-112, JN-113, JN-116, JN-120, JN-122, JN-127, JN-128, JN-129, JN-133 (Checks: JNS-9: 3.6 g; IGPN 2004-1: 3.9 g)

Linseed

A total of 2885 accessions of linseed germplasm were obtained from PC Unit, Kanpur and three sets of these accessions were grown during November 2020 at IGKVV, Raipur; BAU, Ranchi and UAS, Raichur for evaluation and large scale seed multiplication for distribution to linseed scientists.

A set of 202 diverse accessions of linseed including three high α-linolenic acid types (Shekhar, T-397, PCL-55) and one variety containing low (<4%) α-linolenic acid, TL-99 were sown during November 2020 for characterization, evaluation and effecting crosses at ICAR-IIOR, Hyderabad.

Pre-breeding

Pre-breeding activities utilizing the wild species have been carried out in sunflower and safflower. In sunflower, the major emphasis is for widening the genetic base for yield related traits, drought tolerance and resistance to powdery mildew, downy mildew and leafhopper by utilizing the diploid, compatible and annual wild species. In safflower, emphasis has been to utilize wild species to transfer Alternaria leaf spot and Fusarium wilt resistance. The results obtained under these activities are summarized.

Sunflower

Generation advancement of pre-bred material from BC_2F_3 to BC_2F_4 generation

A total of 350 BC_2F_3 families derived from different wild species (wild *H. annuus, H. debilis* and *H. praecox)* were advanced to BC_2F_4 generation through selfing during *kharif* 2020. Quantitative data could not be obtained due to poor expression of crop and severe incidence of Alternaria caused by continuous rain during crop growth. However, wide variability was observed for morphological traits like days to flowering, plant height, leaf shape, leaf colour, head diameter, etc.

Supply of pre-bred material to different AICRP centres

During the year 2020, a total of 145 BC_2F_4 families derived using different accessions of diploid annual compatible species including *Helianthus argophyllus*, *H. debilis, H. petiolaris* and wild *H. annuus* combinations were supplied to five AICRP centres for characterization, evaluation and utilization in breeding programme.

S. No.	Centre	No. of progenies	Wild species used
1	Tornala	20	*H. argophyllus*
2	Hisar	30	*H. debilis*
3	Coimbatore	45	*H. petiolaris* and *H. debilis*
4	Latur	25	Wild *H. annuus*
5	Raichur	25	*H. petiolaris*

Safflower

Development of inbred lines derived from interspecific crosses

Several selections made from F_4 generation of [*C. tinctorius* x (*C. tinctorius* x *C. oxyacantha*)], F_1 of [(*C. tinctorius* x *C. oxyacantha*) *C. tinctorius*) x (*C. tinctorius* x *C. palaestinus*)], F_2 generation of [(*C. oxyacantha* x *C. palaestinus*) *C. tinctorius*], BC_2-F_2 of [(*C. tinctorius* x *C. oxyacantha*) *C. tinctorius*] and BC_1F_1 of [(*C. tinctorius* x *C. palaestinus) C. tinctorius*] were advanced to the next generation. Selections were made based on phenotypic resemblance to cultivated species coupled with high seed yield, oil content and 100-seed weight.

a. **F_4 generation of [*C. tinctorius* x (*C. tinctorius* x *C. oxyacantha*)]:**

   Thirteen promising selections made out of 119 selections were advanced to the next generation. Among these promising selections, seed yield ranged between 31.3 and 41 g/plant, 100-seed weight varied between 3.8 and 5.2 g, while the oil content ranged between 30.1 and 33.9%. The male parent for making the initial cross had been selected for wilt resistance in wilt sick plot from F_1-F_6 generations which was also confirmed using SSR markers specific to wilt resistance in *C. oxyacantha* (IP-16).

b. **F_1 of [(*C. tinctorius* x *C. oxyacantha*) *C. tinctorius*) x (*C. tinctorius* x *C. palaestinus*)]:** Two best performing selections made from this F_1

cross were advanced to the next generation. The F_7 generation of (A-1 x IP-16) and F_5 generation of (A-1 x PI-235663-2) used in this cross had been selected for wilt resistance from F_1 to F_7/F_5 generations using SSR markers linked to *C. oxyacantha* and *C. palaestinus* specific wilt resistance loci and validated in wilt sick plot.

c. **F_2 generation of [(*C. oxyacantha x C. palaestinus*) *C. tinctorius*]:** A total of 51 selections were made from the F_2 generation of [(*C. oxyacantha* x *C. palaestinus*) *C. tinctorius*], of which 23 selections possessing high oil content ranging from 35-39.34% and high seed yield/plant ranging from 30.1 to 44 g and 100-seed weight ranging from 4.6 to 5.6 g were advanced to the next generation. These selections had bold white seeds with moderately thin hull.

d. **BC_2F_2 of (*C. tinctorius* x *C. oxyacantha*) *C. tinctorius*:** Of the nine selections made in BC_2F_2 of (*C. tinctorius* x *C. oxyacantha*) *C. tinctorius*, three were advanced to the next generation. Range for seed yield varied between 33.7 and 48.2 g/plant.

e. **BC_1F_1 of [(*C. tinctorius* x *C. palaestinus*) *C. tinctorius*]:** Four selections from this cross were advanced to the next generation and the seed yield ranged from 11.5 to 33.4 g/plant.

Parental Lines- Development, Characterization and Evaluation

IIOR being the coordinating and nodal agency of the AICRP on mandate crops, plays a pivotal role in developing parental lines using germplasm available and the phenotyping facilities developed at the institute, and then supplying the enhanced breeding lines to the co-operating centres. In castor and sunflower, where predominantly hybrids are cultivated, parental line development has been an important activity. Emphasis has been given to develop parental lines with additional ancillary traits like resistance to stresses and suitable for different agro-ecological situations. In castor, new pistillate as well as new male (monoecious) line development 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, gray mold 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, resistance to downy mildew, tolerance to moisture stress and salinity, and high oil content. This activity has also been initiated in niger. Results obtained under different activities carried out during the year are presented.

Castor

Pistillate line development: Genetic variability for pistillate character is created through different approaches like gene pool and recombination breeding using single, double and multiple crosses followed by selection and generation advancement.

Genepool: After the first cycle of random mating in isolation of the genepool involving four pistillate lines *viz*., DPC-9, SKP-84, JP-86 and Rb-1854, 99 single plant progeny rows involving nearly 980 plants were grown in *kharif* 2020. Genetic variation for morphological characters *viz*., dwarf plant types along with condensed nodes, cup shaped leaves (70%) and pistillate (56%) expression up to quaternary and pentenary spike orders were predominant than normal plant type and monoecious expression. Red stem color was predominant (84%) followed by mahogany (11%) and green (4%) stem color. Segregation for bloom was skewed towards double bloom (80%) followed by triple (10%), single (8%) and zero bloom (<1%). In addition, single seed (open pollinated and random mated) each collected from 99 plants grown in isolation was used to raise a single seed descent (SSD) derived population and grown in *kharif* 2020. Node number varied from 9 to 19 while 12 dwarf and two normal plant type single plant pistillate selections were made for generation advancement.

Recombination breeding: Two multiple crosses involving eight parents each are in different stages of selection for generating diverse recombinants.

Parents involved in multiple crosses

Multiple cross	Parents involved	
	Double cross-I	Double cross-II
Multiple cross I	(DPC 25 x Rb 13-1854) x (CNES-1 x NES-6)	(DPC-21 x DCS-106) x (JP-77-1 x DPC-21)
Multiple cross II	(DPC-16 xM-571) x (SL x DPC-25)	(DPC-23x DPC-21) x (DPC-9 x DPC-14)

In the F_2 population (300 plants) of a cross involving DPC-23 (pistillate) and DPC-21 (pistillate), 80 single plant selections of desirable traits and pistillate expression up to 6th order were selected and sown in *rabi* 2020-21. Node number of selections varied from as low as 5 to 16 while the frequency of plants with low node number ($\leq$10) was higher (60) compared to high (>10) node number (20).

Selection and generation advancement continued in three back crosses *viz.*, BC_1F_2 [(CNES-1 x FC-8) x CNES-1, (CNES-1 x PMC-36) x CNES-1 and (M-619 x FC-8) x M-619]; 5 F_3 progenies [Rb 13-1854 x DPC-25, CNES-1 x NES-6, DPC-21 x DCS-106, JP-77-1 x DPC-21 and DPC-25 x Rb13-1854] for pistillate plants with very less ISF, longer spike and good branching ability.

Evaluation of new pistillate lines for agronomic characters and sex expression: Seven new pistillate lines were evaluated along with three checks, DPC-9, M-574 and SKP-84 for their sex expression, agro-morphological characters, seed yield, and yield components for the last two years. Sex expression was calculated as an index or ratio of number of plants showing either pistillate (P), interspersed staminate flowers (ISF), monoecious or sex reversion (R) to the total number of plants observed at each spike order. Two pistillate lines *viz.*, IPC-38 (0.92 to 0.98) and IPC-39 (0.93 to 0.98) had higher pistillate index throughout the five spike orders. Pooled means over two years for nine characters indicated node number up to primary spike varied from 10.8 to 16.4 with longer primary spikes of 42-55 cm while the seed yield (140-189 g/plant), hundred seed weight (26.4-31.7 g) and oil content (45.6-47.2%) in new pistillate lines were on par with the checks (148 g/plant, 29.8 g, 47%). Pistillate line, IPC-39 with higher P index was also identified as a good general combiner for low node number, primary spike length, total seed yield and oil content.

Pooled means of agro-morphological characters and pistillate index of new and pistillate lines over two years (2017-18 and 2018-19)

Genotype	Plant height up to primary spike (cm)	Number of nodes up to primary spike	Days to 50% flow-ering of primary	Primary spike length (cm)	Number of capsules per primary spike	100-seed weight (g)	Total seed yield (g/plant)	Oil content (%)	Mean pistillate index#
IPC-33	58	12.0	47.8	52	95	30.5	178*	46.5	0.86
IPC-34	62	11.2	44.9	55	118	28.3	155	45.7	0.58
IPC-35	52	11.2	44.6	42	75	26.0	189**	45.6	0.79
IPC-36	56	11.0	43.8	45	88	30.1	144	47.6	0.88
IPC-37	58	12.0	48.0	43	67	31.7	174*	47.4	0.91
IPC-38	58	16.4	65.5	51	83	26.4	140	46.1	0.94
IPC-39	52	10.8	43.0	45	93	32.8	160	47.2	0.96
DPC-9 (C)	53	12.7	50.8	43	77	28.5	135	47.0	0.78
M-574 (C)	49	14.8	59.3	51	82	29.8	146	46.7	0.90
SKP-84 (C)	64	16.9	67.5	58	100	29.7	121	47.7	0.70
General mean	56	12.9	51.5	48.6	88	29.4	154	46.8	
C*D (P=0.05)	20.12	1.9	7.5	18.54	15.9	7.5	48.1	2.9	

#over five spike orders-primary, secondary, tertiary, quaternary, pentenery

**: Significant over check SKP-84 **: Significant over SKP-84 and DPC-9*

Multilocation evaluation of new pistillate lines: Three new pistillate lines *viz.*, DPC-22, IPC-30 and IPC-31 were evaluated along with three checks (DPC-9, SKP-84 and M-574) in an RBD with 3 replications of 2 rows each (10 plants in each row) for sex expression (pistillateness) and agro-morphological traits in four locations *viz.*, Hyderabad, Bengaluru, S.K. Nagar and Junagadh centres, during 2019-20 season. All the lines expressed pistillateness without reversion in any order of the spikes during the trial duration. IPC-30 expressed stable and the best pistillate character (0.37 ISFs) than the best check SKP-84 (0.94 ISFs).

DPC-22 *IPC-30* *IPC-31*

Spike characters of new pistillate lines

Monoecious line development

Gene pools for non-spiny male lines: Two crosses *viz.*, JI-315 crossed with mixed pollen of 48-1, DCS-89, CI-2, ICS-164, DCS-123 and DCS-106 crossed with mixed pollen of CI-2, RG-566, 48-1, DCS-89, ICS-164, DCS-123, DPC-18 were made involving nine non-spiny, elite male lines with good combining ability and wilt resistance for developing a genepool under random mating in isolation.

Bi-parental crosses for introgression of wilt resistance and diversification: Thirty six F_1s were generated using germplasm lines RG-1354, RG-2874, RG-2944 carrying dominant wilt resistance and male lines with good combining ability, ICS-156, ICS-159, ICS-169, ICS-171, ICS-177, ICS-182, ICS-185, ICS-186, ICS-210, ICS-216, and ICS-217 for introgression of wilt resistance and diversification of male lines.

Breeding for gray mold resistance

Three cycles of random mating among the inter-crossed progenies of 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) led to selection and advancement of 89 individual plants based on desirable agronomic traits to S_2 generation during *kharif* 2018-19. The S_2 families (20 plants/family) raised in the experimental field during *kharif* 2019-20 were exposed to severe incidence of gray mold disease during October 2020 as shown in the picture. Under the natural epiphytotic condition, 33 individual plants of genepool and 29 F_5 progenies derived from crosses involving moderately resistant lines *viz.*, RG-558-1, RG-193, ICS-341, ICS-345, ICS-323, ICS-324 and ICS-325 with low disease severity (<10%) were selected and advanced by selfing.

Promising single plant selection in the field Gray mold disease incidence in the field during October-2020

Wilt resistant monoecious lines

Ten new inbred lines *viz*., ICS-341, ICS-346, ICS-348, ICS-349, ICS-350, ICS-351, ICS-353, ICS-354, ICS-355 and ICS-356 were isolated from advanced generations of six bi-parental crosses (JC-12 × 48-1, M-574 × RG-2326, M-574 × RG-2473, M-574 × RG-193, SKP-84 × ICS-357, SKP-84 × RG-193). Five lines [ICS-341 (0%), ICS-348 (13%), ICS-349 (18.2%), ICS-353 (4.6%) and ICS-355 (0%)] were identified as wilt resistant lines in the permanent wilt sick plot of IIOR, Rajendranagar during *kharif* 2019-20 in comparison with susceptible check, JI-35 (100%).

Genetic characterization of wilt resistant sources

An attempt was made to elucidate the inheritance pattern of wilt resistance in different resistant castor lines *viz*., RG-1149, RG-1354, RG-2874, RG-2685, RG-1673, 48-1 and RG-999. These resistant lines were crossed with susceptible line JI-35. The F_1, F_2 and backcross populations of the crosses were grown in sick plot for evaluation of wilt resistance during *kharif* 2019-20. The reaction of F_1s indicated that wilt resistance in 48-1, RG-1149 and RG-1673 inherited as recessive whereas wilt resistance was dominant in RG-1354, RG-2874, RG-2685 and RG-999.

The disease reaction of segregating populations to Fusarium infection at 150 DAS was scored. The segregation of resistance and susceptibility in F_2 populations of 48-1 × JI-35 and RG-1673 × JI-35 indicated that resistance in 48-1 and RG-1673 inherits as monogenic recessive. However, the segregation in backcross population [(RG-1673 × JI-35) × RG-1673] fits into di-genic ratio. The wilt resistance in RG-1149 inherited as di-genic recessive as per the segregation in F_2 and backcrosses of RG-1149 × JI-35. The segregation of wilt resistance in the F_2 and backcross populations of RG-1354 × JI-35, RG-2874 × JI-35, RG-2685 × JI-35 and RG-999 × JI-35 showed that wilt resistance in RG-1354, RG-2874, RG-2685 and RG-999 is controlled by single dominant locus.

Reaction of segregating populations to Fusarium wilt infection in sick plot

Cross	Gene ration	Segregation for wilt resistance					Ratio (R:S)	X^2	Gene action
		No. of plants	Observed		Expected				
			R	S	R	S			
48-1 × JI-35	F_2	62	19	43	15.5	46.5	(1:3)	1.05	Monogenic recessive
(48-1 × JI-35) × JI-35	BC_1F_1	24	1	23	0	24	(0:1)	-	Recessive
RG-1149 × JI-35	F_2	149	57	92	65.2	83.8	(7:9)	1.83	Di-genic recessive
(RG-1149 × JI-35) × RG-1149	BC_1F_1	74	62	12	55.5	18.5	(3:1)	3.05	Di-genic recessive
(RG-1149 × JI-35) × JI-35	BC_1F_1	20	2	18	0	20	(0:1)	-	Recessive
RG-1673 × JI-35	F_2	156	49	107	39	117	(1:3)	3.42	Monogenic recessive
(RG-1673 × JI-35) × RG-1673	BC_1F_1	74	60	14	55.5	18.5	(3:1)	1.46	Di-genic recessive
(RG-1673 × JI-35) × JI-35	BC_1F_1	20	1	19	0	20	(0:1)	-	Recessive
RG-1354 × JI-35	F_2	152	124	28	114	38	(3:1)	3.51	Monogenic dominant
(RG-1354 × JI-35) × JI-35	BC_1F_1	76	45	31	38	38	(1:1)	2.58	Monogenic dominant
RG-2874 × JI-35	F_2	160	130	30	120	40	(3:1)	3.33	Monogenic dominant
(RG-2874 × JI-35) × JI-35	BC_1F_1	80	37	43	40	40	(1:1)	0.45	Monogenic dominant
RG-2685 × JI-35	F_2	157	124	33	117.75	39.25	(3:1)	1.33	Monogenic dominant
(RG-2685 × JI-35) × JI-35	BC_1F_1	44	28	16	22	22	(1:1)	3.27	Monogenic dominant
(RG-2685 × JI-35) × RG-2685	BC_1F_1	76	76	0	76	0	(1:0)	-	Dominant
(RG-999 × JI-35)	F_2	111	82	29	83.25	27.75	(3:1)	0.08	Monogenic dominant

Allelic relationship of wilt resistance genes in germplasm sources

The germplasm accessions *viz.*, RG-1149, RG-1673 and 48-1 carry recessive genes for wilt resistance, whereas RG-1354, RG-2874, RG-2685 and RG-999 carry dominant genes for wilt resistance. To study the allelic relationship of wilt resistance loci in different germplasm sources, the F_2 populations *viz.*, RG-1149 × 48-1, RG-1149 × RG-1673, 48-1 × RG-1673, RG-1354 × RG-2874, RG-1354 × RG-2685, RG-2685 × RG-2874, RG-1354 × RG-999 and RG-2874 × RG-999 were generated. Out of these populations, the F_2 population of RG-1354 × RG-2874 was screened against wilt in sick plot during *kharif* 2017-18 and *kharif* 2018-19. Results indicated that wilt resistance loci in RG-2874 and RG-1354 are non-allelic.

During 2019-20, the F_1s and F_2 populations of remaining seven crosses were raised in the wilt sick plot of IIOR and reaction of F_1 and F_2 plants to Fusarium infection was observed up to 150 days after sowing. The F_1s of all the crosses were resistant. The reaction of F_2 populations is presented in the table given below. There was no segregation for susceptibility in the F_2 populations of RG-1149 × 48-1, RG-1149 × RG-1673, 48-1 × RG-1673 and RG-1354 × RG-

2685. Based on the results, it was inferred that wilt resistance loci in RG-1149, 48-1 and RG-1673 are allelic. Similarly, wilt resistance loci in RG-1354 and RG-2685 are allelic. The F_2 populations of RG-2685 × RG-2874, RG-1354 × RG-999 and RG-2874 × RG-999 segregated in 15:1 ratio for resistance and susceptibility underpinning that the wilt resistant locus in RG-2685 is non-allelic to RG-2874 and the wilt resistant locus in RG-999 is non-allelic to RG-1354 and RG-2874.

Reaction of F_2s of resistant × resistant crosses to Fusarium wilt infection (2019-20)

Cross	Segregation for wilt resistance					Ratio (R:S)	X^2	Allelic relationship
	Total plants	Observed*		Expected*				
		R	S	R	S			
RG-1149 × 48-1	221	221	0	221	0	1:0	-	Allelic
RG-1149 × RG-1673	196	196	0	196	0	1:0	-	Allelic
48-1 × RG-1673	196	191	5	196	0	1:0	-	Allelic
RG-2874 × RG-1354#	180	171	9	168.8	11.3	15:1	0.48	Non allelic
RG-1354 × RG-2685	185	185	0	185	0	1:0	-	Allelic
RG-2685 × RG-2874	226	218	8	211.9	14.1	15:1	2.82	Non allelic
RG-1354 × RG-999	220	211	9	206.25	13.75	15:1	1.75	Non allelic
RG-2874 × RG-999	216	208	8	202.5	13.5	15:1	2.39	Non allelic

#screening in *kharif*-2018; * R – resistant; S - susceptible

Evaluation of new male lines for seed yield and yield components

Fifty eight new male lines (ICS-359 to ICS-416) were evaluated along with four checks *viz.*, DCS-9, DCS-78, DCS-107, 48-1 in an ARBD in *kharif* 2019-20 for seed yield and yield components. Among eight promising male lines, four male lines *viz.*, ICS-373, ICS-415, ICS-364 and ICS-396 recorded significantly higher seed yield than the best varietal check, 48-1 and best male line, DCS-78. ICS-364 was promising for total and effective primary spike length and 100-seed weight while ICS-366 which was significantly shorter than DCS-78 and a good source for generation of short statured hybrids.

Promising male lines for seed yield and yield components in castor (2019-20)

Entry	Plant height up to primary spike (cm)	No. of nodes upto primary spike	Total primary spike length (cm)	Effective primary spike length (cm)	No. of capsules / primary spike	100-seed weight (g)	Seed yield (g/plant)	Oil content (%)
ICS-373	107	17.8	44	42	57	25.4	496**	44.5
ICS-415	103	13.6	42	42	36	20.4	309**	45.4
ICS-364	84	16.8	54**	54**	58	34.0*	199*	40.3
ICS-396	76*	18.8	37	37	52	21.4	197*	38.8
ICS-365	85	15.8	32	30	43	28.4	186	45.2
ICS-406	87	16.0	46	46	37	27.4	186	45.2
ICS-366	63*	18.8	51**	51**	72	23.8	185	41.1
ICS-378	87	15.8	33	33	61	27.8	181	46.0
48-1 (C)	120	16.9	36	36	63	28.2	173	44.6
DCS-78 (C)	67	13.0	39	38	50	25.2	102	45.5
CD (P=0.05)	22.2	1.9	11	11.3	23.4	3.4	87	2.6

**significantly above best check: 48-1; * male line: DCS-78

Assessing the combining ability of new inbred lines

Combining ability analysis (line x tester) of four sets indicated five pistillate lines (IPC-31, IPC-44, IPC-39, IPC-38, JP-86) and four male lines (ICS-125, DCS-112, DCS-89, 48-1) as best combiners for seed yield while five crosses were promising with significant *sca* effects. IPC-39 was the best general combiner for short plant height, early flowering, total primary spike length, total seed yield and hundred seed weight while IPC-38 was a good combiner for node number, total and effective primary spike length, number of capsules and oil content. Among the testers, DCS-112 was the best general combiner for majority of the traits except for oil content followed by DCS-89 for early flowering, low node number, total seed yield and oil content.

Best parental lines with *gca* effects and promising hybrids in line x tester analysis of four sets

Trials	Pistillate lines	Male lines	Best parental lines with significant *gca* effects	Best crosses with significant *sca* effects
Set-I	DPC-22, DPC-25, IPC-30, IPC-31 and JP-86	ICS-310, ICS-312 and ICS-313	IPC-31 and JP-86	Nil
Set-II	DPC-22, DPC-25, IPC-42 and IPC-44	ICS-125 and ICS-127	IPC-44 and ICS-125	DPC-25 x ICS-127, IPC-42 x ICS-127, IPC-44 x ICS-125
Set-III	IPC-38 IPC-39	DCS-78, DCS-89, DCS-94, DCS-102, DCS-104, DCS-105, DCS-107, DCS-110, DCS-112, DCS-118, DCS-119 and 48-1	IPC-39, IPC-38 DCS-112, DCS-89 48-1	IPC-39 x DCS-89 IPC-38 x DCS-94
Set-IV	M-574 SKP-84 DPC-21	ICS-127, ICS-128, ICS-134, ICS-139, ICS-141	M-574 ICS-141	Nil

Maintenance of pistillate lines, monoecious lines and farmer's collections

A total of 43 pistillate lines and 140 male lines have been maintained in *rabi* 2019-20. Additionally, 160 farmers' collections of castor were also maintained

Sunflower

During the year 2020, CMS and R lines obtained from USDA–USA were supplied to Bengaluru (3 B lines and 1 R line), Bhubaneshwar (10 A/B, 10 R lines), Nimpith (10 A/B, 15 R lines), Latur (20 newly developed R lines for downy mildew screening) and Hisar (20 A/B and 10 R lines) centres. Newly developed restorer gene pool inbreds were supplied to Hisar (45 R lines), Tornala (45 R lines) and Latur (45 R lines) for strengthening the hybrid breeding programme.

Evaluation of maintainer lines: Characterization and evaluation of all available CMS lines at a single location is very important to identify trait specific CMS lines for further utilization in heterosis breeding programme. In this context, a total of 146 maintainer lines developed so far by AICRP centres and ICAR-IIOR, Hyderabad were evaluated for yield and yield contributing traits in augmented block design along with three checks *viz.*, CMS-17B, CMS-234B and ARM-243B during *rabi* 2019-20. Three CMS lines namely CMS-70B, HA-89B and CMS-302B were found promising for oil content (38-38.9%). Three lines CMS-67B, ARM-249B and NDCMS-2B were better for high test weight (7.4-8.2 g) while four maintainer lines, CMS-338B, CMS-67B, CMS-850B and CMS-48B were promising for earliness (40-53 days to 50% flowering).

Promising trait specific CMS lines in sunflower

S. No.	CMS B lines	Days to 50% flowering	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Oil Content (%)	Volume Weight (g/ 100 ml)	Seed yield (g/plant)
High oil content (%)								
1	CMS-70B (Ludhiana)	58	107	11.0	6.4	38.6	53	25.0
2	CMS-70B (Raichur)	57	103	11.4	6.0	38.9	53	22.0
3	HA-89B	61	108	14.6	5.9	38.9	42	23.0
4	CMS-302B (Coimbatore)	55	101	6.0	5.8	38.0	44	13.0
High test weight (g)								
1	CMS-17B (Bengaluru)	60	106	12.6	9.1	27.8	44	30.0
2	CMS-67B (Ludhiana)	52	95	12	8.2	34.3	42	27.0
3	ARM-249B (Raichur)	60	130	12.8	8.1	33.1	34	12.0
4	NDCMS-2B (Bengaluru)	53	82	8.8	7.4	32.4	35	19.0
5	CMS-70B (Ludhiana)	58	107	11.2	6.4	38.6	53	25.0
6	CMS-850B (Bengaluru)	55	90	6.0	6.1	34.5	50	10.0
7	CMS-3102B (Bengaluru)	62	135	14.0	6.4	35.0	48	13.0
8	CMS-42B (Ludhiana)	55	92	10.8	5.4	35.9	47	23.3
Early flowering								
1	CMS-338B (Bengaluru)	40	50	2.2	3.6	28.0	40	2.8
2	CMS-67B (Ludhiana)	52	95	12.0	8.2	34.3	42	27.0
3	CMS-850B (Akola)	52	85	9.0	5.1	34.1	42	8.0
4	CMS-48B (Ludhiana)	53	80	8.4	5.0	31.7	35	13.5
Checks								
1	CMS-17B (Bengaluru)	60	106	12.6	9.1	27.8	44	30.0
2	CMS-234B	55	108	11.6	3.6	24.1	35	6.2
3	ARM-243B	65	149	13.0	5.9	32.1	36	23.0
	Mean	58.1	103.3	11.4	5.8	32.4	37.8	15.9
	SD	4.3	26.0	2.5	1.3	3.3	5.2	9.3
	CV (%)	7.4	25.2	22.0	22.6	10.3	13.7	58.3

Assessing the combining ability of parents: Two sets of experiments were carried out to assess the *gca* and *sca* effects of newly developed restorer lines. In Set-I, a total of 10 newly developed drought tolerant restorer lines were tested for their combining ability using five CMS lines *viz.*, ARM-248A, COSF-6A, COSF-7A, CMS-38A and FMS-852A. Among the evaluated testers, RGP-225 was a good combiner for days to 50% flowering, days to maturity, plant height, stem girth, seed yield/plant and oil content. RGP-223 was good general combiner for days to 50% flowering, days to maturity, plant height, head diameter and 100 seed weight while RGP-233 was a good general combiner for number of leaves/plant, autogamy (%) and seed yield/plant. Among lines, COSF-7A was good general combiner for days to 50% flowering, days to maturity, plant height, volume weight and oil content. CMS-38A was a good general combiner for number of leaves/plant, 100-seed weight, autogamy (%) and seed yield/plant.

Among hybrids, 3 combinations, FMS-852A x RGP-222, ARM-248Ax RGP-184, and CMS-38A x RGP-157 were the best specific combiners for days to 50% flowering and days to maturity. Four combinations *viz.*, CMS-38A x RGP-222, CMS-38A x RGP-173, ARM-248A x RGP-233 and COSF-7A x RGP-157 were best specific combiners for seed yield/plant while FMS-852A x RGP-223, ARM-248A x RGP-184, COSF-6A x RGP-233 and ARM-248A x 298R were best specific combiners for oil content. Based on the *gca* and *sca* analyses, general and specific combiners that showed significant differences were identified and these could be used in hybrid breeding programme or CMS conversion programmes.

In Set-II, ten restorer lines were tested for their combining ability using five CMS lines *viz.*, CMS-234A, CMS-335A, ARM-243A, HA-430A and CMS-1010A. Among the evaluated lines, CMS-234A was found to be a good combiner for days to 50% flowering, days to maturity, plant height and 100 seed weight while ARM-243A was a good general combiner for days to 50% flowering, days to maturity, 100-seed weight, volume weight and seed yield/plant. Among testers, RGP-21-P_2-S_2 and RGP-50-P_1-S_4 were found to be best combiners for days to 50% flowering, days to maturity and plant height. For seed yield/plant, PM-81 and RGP-58-P_4-S_2 were good general combiners while RHA-6D1 and RGP-50-P_1-S_4 were for oil content.

Among hybrids, 5 combinations, CMS-335A x RGP-30-P_3-S_1, CMS-335A x RGP-49-P_4, HA-430A x RGP-49-P_4, CMS-1010A x RGP-50-P_2-S_1 and CMS-335A x RGP-58-P_4-S_2 were identified as good specific combinations for seed yield/plant while CMS-335A x RGP-50-P_1-S_4, CMS-234A x RHA-6D1, ARM-243A x RGP-21-P_2-S_2 and CMS-234A x PM-81 were good combinations for oil content.

Good general and specific combiners for seed yield and its attributes in sunflower

Character	Set-I		Set-II	
	Best general combiners	Best specific combiners	Best general combiners	Best specific combiners
Days to 50% flowering	COSF-7A, FMS-852A, RGP-225, RGP-190, RGP-223	FMS-852A x RGP-222, ARM-248A x RGP-184, CMS-38A x RGP-157	CMS-234A, ARM-243A, RGP-21-P_2-S_2, RGP-50-P_1-S_4, RGP-30-P_3-S_1	CMS-234A x RGP-50-P_1-S_4, ARM-243A x RGP-49-P_4, ARM-243A x RGP-58-P_4-S_2, CMS-1010A x PM-81
Days to maturity	COSF-7A, FMS-852A, RGP-225, RGP-190, RGP-223	FMS-852A x RGP-222, ARM-248A x RGP-184, COSF-6A x 298R, COSF-7A x RGP-118, COSF-7A x RGP-173	CMS-234A, ARM-243A, RGP-21-P_2-S_2, RGP-50-P_1-S_4, RGP-30-P_3-S_1	CMS-234A x RGP-50-P_1-S_4, ARM-243A x RGP-49-P_4, ARM-243A x RGP-58-P_4-S_2, CMS-1010A x PM-81
Plant height (cm)	COSF-6A, COSF-7A, RGP-225, RGP-223	FMS-852A x RGP-190, FMS-852A x 298R, COSF-6A x RGP-190, COSF-7A x RGP-184	CMS-234A, HA-430A, RGP-50-P_1-S_4, RGP-21-P_2-S_2	ARM-243A x RGP-50-P_2-S_1, ARM-243A x RGP-49-P_4, HA-430A x RGP-46-P_2
Head diameter (cm)	FMS-852A, RGP-157, RGP-184, RGP-190, RGP-233	FMS-852A x RGP-184, COSF-7A x 298R, ARM-248A x RGP-157	CMS-1010A, PM-81	ARM-243A x PM-81, CMS-335A x RGP-49-P_4
Number of leaves per plant	CMS-38A, RGP-222, RGP-157, RGP-233	None	-	-
Stem girth (cm)	ARM-248A, RGP-225	FMS-852A x RGP-184, COSF-7A x RGP-190, CMS-38A x RGP-225	-	-

Character	Set-I		Set-II	
	Best general combiners	Best specific combiners	Best general combiners	Best specific combiners
100-seed weight (g)	CMS-38A, RGP-223	CMS-38A x RGP- 222	CMS-234A, ARM-243A, RGP-58-P_4-S_2, PM-81, RHA-6D-1	CMS-335A x RGP-49-P_4, CMS-335A x RGP-46-P_2, HA-430A x RGP-30-P_3-S_1, ARM-243A x PM-81
Volume weight (g/100 ml)	COSF-7A, RGP-222	ARM-248A x RGP-118	ARM-243A, RGP-46-P_2, RGP-50-P_2-S_1	CMS-1010A x RGP-49-P_4
Autogamy (%)	COSF-6A, CMS-38A, RGP-184 , RGP- 190, RGP-233	COSF-7A x RGP-118, FMS-852A x RGP-222, ARM-248A x RGP-118	-	-
Seed yield per plant (g)	CMS-38A, RGP-225, RGP-233	CMS-38A x RGP-222, CMS-38A x RGP-173, ARM-248A x RGP-233, COSF-7A x RGP-157	ARM-243A, RGP-58-P_4-S_2, PM-81	CMS-335A x RGP-30-P_3-S_1, CMS-335A x RGP-49-P_4, HA-430A x RGP-49-P_4, CMS-1010A x RGP-50-P_2-S_1, CMS-335A x RGP-58-P_4-S_2
Oil content (%)	COSF-6A, COSF-7A, RGP-225, 298R	FMS-852A x RGP-223, ARM-248A x RGP-184, COSF-6A x RGP-233, ARM-248A x 298R	RHA-6D1, RGP-50-P_1-S_4	CMS-335A x RGP-50-P_1-S_4, CMS-234A x RHA-6D1, ARM-243A x RGP-21-P_2-S_2, CMS-234A x PM-81

Screening of newly developed restorer lines against downy mildew: A total of 20 newly developed promising restorer inbreds were screened for downy mildew reaction under downy mildew sick plot at Latur, Maharashtra over two years during *rabi* 2019-20 and *kharif* 2020. Seventeen inbreds *viz.,* RGP-125, RGP-134, RGP-137, RGP-147, RGP-151, RGP-154, TSG-350, RGP-172, RGP-178, RGP-184, RGP-189, RGP-191, RGP-195, RGP-201, RGP-223, RGP-238 and RGP-303 were completely free (resistant) from downy mildew. Downy mildew incidence was 0% in resistant genotypes and 20-30% in susceptible genotypes while it was 80% in susceptible check Morden. Identified downy mildew resistant lines will be utilized for development of downy mildew resistant heterotic hybrids at ICAR-IIOR, Hyderabad and sunflower AICRP centres.

Identification of powdery mildew resistant inbreds and hybrids: Fifty F_1 hybrids along with their parents (15), PM-81 as resistant check and CMS-2023 as susceptible check were scored for powdery mildew at 45, 60, 75 and 90 days after sowing and the score was converted into percentage disease index (PDI). The line RGP-46-P_2 (4.20%) followed by RGP-50-P_2S_1 (7.30%), RGP-49-P_4 (7.97%) and RGP-21-P_2S_2 (8.47%) showed lower incidence of the disease while the incidence was 7.63% and 67.30% in resistant and susceptible checks, respectively. Among the hybrids, lowest powdery mildew incidence was exhibited by CMS-335A x RGP-50-P2S1 (4.80%) followed by CMS-335A x RGP-46-P_2 (4.93%), HA-430A x PM-81 (7.17%) and CMS-1010A x RGP-50-P_2S_1 (9.40%). Identified parental lines could be utilized for development of PM resistant gene pool or development of powdery mildew resistant hybrids.

RGP-46-P_2 *RGP-50-P_2S_1* *CMS-335A x RGP-46-P_2* *CMS-335A x RGP-50-P_2S_1*

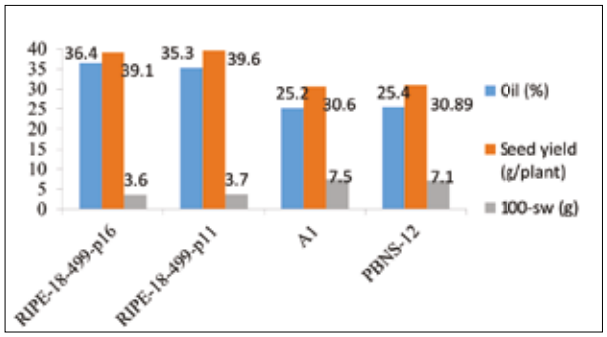
Reaction of powdery mildew at 90 DAS in inbreds and hybrids

Safflower

Development of inbred lines from recurrent introgressive population enrichment (RIPE) programme

1st cycle RIPE (1C-RIPE): Of the 74 S_4-IC-RIPE selections, 13 selections with high seed yield and oil content were advanced to S_5 generation. Among the advanced selections, the oil content (%), seed yield (g/plant) and 100-seed weight (g) ranged between 37.6 and 40.8, 21 and 39.4 and 4.1 and 4.9, while check variety A-1 had 25.3, 30.6, 7.5 and the check variety PBNS-12 had 25.4, 30.8 and 7.1, respectively.

2nd cycle RIPE (2C-RIPE) populations: Of the 19 S_3-2C-RIPE selections, two selections with high seed yield and oil content were advanced to S_4 generation.



High oil-high yielding S_3-2C-RIPE selections

3rd cycle RIPE (3C-RIPE) populations: Of the 335 RIPE selections, 87 selections with high seed yield and oil content were advanced to S_4 generation. Out of 36 S_2-3C-RIPE selections, 20 selections giving higher oil content, seed yield and 100-seed weight were selected for advancing them to further generations.

Among the advanced selections, the oil content (%), seed yield (g/plant) and 100-seed weight (g) ranged between 39.09 and 41.93, 20 and 48.5, 3.8 and 6 while check variety A-1 had 25.25, 30.6 and 7.5 and the check variety PBNS-12 had 25.4, 30.8 and 7.1, respectively.

4th cycle RIPE (4C-RIPE) population: Out of a total of 300 selections in S_1 generation of selections from 4th cycle RIPE population, 87 selections were retained based on oil content, seed yield and 100-seed weight, of which further 55 were identified as the best selections and were advanced to next generation. Among the 55 identified S_1-4C-RIPE selections, the oil content (%), seed yield (g/plant) and 100-seed weight (g) ranged between 35 and 41.99, 22.9 and 56.5, 4 and 5.8, while check variety A-1 had 25.25, 30.6 and 7.5 and the check variety PBNS-12 had 25.4, 30.8 and 7.1, respectively.

Among the 87 best S_1-4C-RIPE selections, 13 possessed high oil content and early maturity (DF: 69-70 days). Among the advanced selections, the oil content (%), seed yield (g/plant) and 100 seed weight (g) ranged between 37.52 and 41.84, 24.4 and 39.8 and 3.6 and 6, while check variety A-1 had 25.2, 30.6 and 7.5 and the check variety PBNS-12 had 25.4, 30.8 and 7.1 respectively. Two early maturing genotypes (RIPE-18-971 and RIPE-18-1192 are shown in the figure.

RIPE-18-971

RIPE-18-1192

Early maturing high oil selections from S_1-4C- RIPE

Multilocation confirmation of wilt and Alternaria resistance in interspecific inbred lines

Three wilt resistant inbred lines *viz.*, ISF-2342, ISF-2413-17 and ISF-2471-17 developed from the cross (A-1 x *C. palaestinus*) developed using wilt resistance linked SSR markers were screened against Fusarium wilt in three wilt sick plots at Solapur, Tandur and IIOR. They exhibited resistant reaction to wilt at all the three locations confirming and validating the effectiveness of marker-assisted selection for wilt resistance in interspecific derivatives. The wilt resistant variety, ISF-2342 has been nominated to IVT during 2020-21.

Field view of ISF-2342

The inbred line ISF-1703-2-1-2016 (derived from *C. tinctorius* x *C. palaestinus* cross) which was identified for Alternaria tolerance at IIOR was confirmed for the trait during screening at Solapur and Parbhani (22.7% and 23% Alternaria severity compared to 94.1% and 84% in susceptible check, respectively).

Wilt resistant inbred lines/varieties

Two inbred lines *viz.*, DSF-4 and ISF-116 showing wilt resistance reaction when screened at Solapur and Tandur during 2018-19 in wilt sick pots have further been confirmed for the resistance reaction during 2019-20 in wilt sick pots when screened using the location specific isolates at Tandur, Solapur and IIOR.

Niger

Development of gene pool through random mating

Fourteen elite lines were selected and allowed for first cycle of random mating during *kharif* 2019. Second cycle of random mating was allowed during *kharif* 2020 and seeds from 500 individual plants were harvested.

Generation of poly-cross cycle I

Genotypes IGPN-1108, IGPN-8004, IGPN-16-31 and JNS-206 with higher seed yield/plant (>6 g), genotypes 89-25, JN-17, IGP-272, ONS-107 with >30 capitula/plant, and genotypes NPR-19, NPR-22 with >20 seeds/capitula were selected for making the poly-cross. A total of 10 poly-cross sets involving three parents each were developed under individual nets as listed.

1.	IGPN 1108 X IGPN 8004 X IGPN16-31
2.	IGPN 8004 X IGPN16-31 X JNS206
3.	IGPN16-31 X JNS206 X 89-25
4.	JNS206 X 89-25 X JN-17
5.	89-25 X JN-17 X IGP-272
6.	JN-17 X IGP-272 X ONS-107
7.	IGP-272 X ONS-107 X NPR-19
8.	ONS-107 X NPR-19 X NPR-22
9.	NPR-19 X NPR-22 X IGPN 1108
10.	NPR-22 X IGPN 1108 X IGPN 8004

Development of new crosses

In order to develop recombinant breeding material for high yield and other yield related traits, new crosses were initiated using ten elite genotypes *viz.*, JNC-1, JNC-6, JNC-28, JNC-30, JNS-9, JNS-28, IGPN-2004-1, BNS-10, DEOMALI and UTKAL NIGER-150.

Development of poly cross

Use of gibberellic acid to induce sterility in female lines for crossing

Varietal Development

In safflower and sesame, predominantly the focus has been on 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. In sesame, concerted efforts have been made to develop elite breeding lines from the variability available and also to create additional variability by effecting multi-parent crosses. Progress made under different activities are presented briefly.

Safflower

Varieties under testing

Three varieties *viz.*, ISF-2342 (interspecific), ISF-300 (developed from NCP gene pool) and ISF-867 (short duration) are in IVT during 2020-21. One variety, ISF-123-sel-15 is being tested in AVT-1 during 2020-21. Three safflower varieties *viz.*, ISF-87-15 (high oil 40%), ISF-116 (wilt resistant) and ISF-849-sel-16 were promoted to AVT-II during 2020-21. Two non-spiny varieties *viz.*, ISF-763 and ISF-1258-15 and a spiny variety, ISF-112-15, have completed AVT-II and shall be proposed to Varietal Identification Committee.

Development of short duration varieties

The short duration variety, ISF-867 developed from [(Nira x *C. oxyacantha*) x Nira] has been evaluated for four consecutive years. It recorded marginally higher seed yield (4%) than normal duration check and matured 14 days earlier than A-1.

A-1 *ISF-867*

ISF-867 flowering earlier than check A-1

Performance of ISF-867 across 4 years

Variety	DF	DM	100-seed weight (g)	Seed yield (kg/ha)				
				2019-20	2018-19	2017-18	2016-17	Mean
ISF-867	75	118	4.5	3167	2760	1659	2313	2475 (4%)
JSI-99 (SD-C)	61	106	6.2	328	153	770	408	415
A-1 (ND-C)	88	132	7.5	2653	2440	2252	2179	2381

SD-C: short duration check; ND-C: normal duration check; figures in parenthesis indicate percent increase over A-1

Sesame

The multi-parent cross of (HT-1 x RT-351)/(GT-2 x TKG-22)//(HIMA x TSS-6)/(RAJESHWARI x E-8) was forwarded to develop multi-parent advance generation intercross lines (MAGIC lines). In F_2, 1960 plants were raised. Single capsule per plant was harvested from each F_2 plant. One capsule per dibble will be used to rise F_3 generation. Phyllody disease was the major concern while raising F_1 and also F_2 generations. Capsules from phyllody free plants were only harvested to advance the generation. This population exhibited wide variability for flower initiation (26-58 days), leaf colour and pattern, capsule size (2.5-4.5 cm), and number (54-152) during late *kharif*.

Hybridization between released varieties and a few stable landraces was attempted in four-way crossing pattern. A large F_2 population of 4 four-way crosses was raised. Significant variation for branching pattern, flower colour, capsule number, orientation, size and pubescence were observed in the cross (IC-96227 x IC-96160) x (Rajeshwari x VRI-3). Similarly, variation for days to maturity, capsule size, leaf orientation and area were observed for (Phule til x RT-351) x (IC-500472 x IC-96227). Selections were made for good plant types with >80 capsules/plant along with convergent branching pattern with 4-6 primary branches and no secondary branches, bigger capsules, lower internodal length, bigger leaf area and plants with partially uniform maturity.

Inheritance pattern of purple lip colour and multicapsules

Segregating population of a cross IC-205776 x EC-118591 was scored for flower lip colour and multicapsules /axil. Female parent IC-205776 is characterized by pink colour flowers with distinct purple colour lip similar to wild type *S. mulayanum*, single flowers per node and produced single capsules per node with brown seed. Male parent EC118591 is characterized by white flowers with white lip and multiple flowers per node (6 flowers) producing multicapsules at nodes with brown seed. The population showed variation for flower and flower lip colour, number of capsules per node and capsule hairiness. The seed yield ranged between 6-24 g/plant. Single capsule from each plant was harvested without operating selection. The ratio of white lip flower to pink and purple lip flowers (wild type) did best fit with 13:3 (χ^2 =1.24; p=0.26 at 1 df) while the ratio of multiple flowers per node and single flower per node did best fit with 11:5 ratio (χ2 =1.49; p=0.23 at 1 df).

Different types of flower colours, arrangements at axil and capsule number per axil observed in parents and segregating plants in sesame

(a) Female parent (IC-205776)- Single flower at axil with pink corolla and conspicuous purple colour on lower lip of corolla (b) Single capsule at axil (c) Male parent (EC-118591)- multiple flower at axil with white corolla and lower lip (d) Multiple capsule at axil (e) Segregating plant in F_2 with multiple flower at axil having conspicuous purple colour on lower lip of corolla (f) Multiple capsule/axil

Evaluation of entries for phyllody and *Macrophomina* root rot

Thirty two advance breeding lines selected previously for better seed yield and oil content were evaluated for phyllody and root rot of which six advance breeding lines were identified with tolerance to either phyllody and root rot. None of the entries were free from phyllody, one entry SEL-S-2019-1016 showed 14.1% incidence at 80 days after sowing. Similarly, four entries SEL-S-2019-1013, SEL-S-2019-1017, SEL-S-2019-1018 and SEL-S-2019-1019 were tolerant to root rot.

Advance breeding lines identified with tolerance to phyllody and root rot

Entries	Phyllody incidence (%)				Root rot (%)
	50 DAS	60 DAS	70 DAS	80 DAS	
SEL-S-2019-1009	5.3	9.9	18.0	25.1	28.5
SEL-S-2019-1013	9.0	26.3	36.7	36.7	17.5
SEL-S-2019-1016	3.7	3.7	9.3	14.1	23.7
SEL-S-2019-1017	11.3	16.6	22.3	29.5	18.8
SEL-S-2019-1018	1.3	9.2	16.4	33.6	16.5
SEL-S-2019-1019	2.8	5.1	8.6	20.4	15.6
Swetha Til	3.0	7.2	14.3	15.8	NT
GT-G-30	0	0	0	16.9	NT
GT-10 (R check for phyllody and root rot)	0	0	0	9.8	25.5
RJR-170 (S check for phyllody)	24.7	42.5	57	67.9	NT
VRI-1 (Susceptible check for root rot)	NT	NT	NT	NT	84.5

DAS: Days after sowing; NT: Not tested; R: Resistant; S: Susceptible

Selections in advance generations of F_5 and F_6

Advance generation lines of 2 crosses NIRMALA x S-0479 (11 families) and NIRMALA x JHA-1610-2 (14 families) at F_5 generations were evaluated during *kharif* season. Uniform lines performing superior over checks were identified.

Elite lines selected from cross NIRMALA x S-0479 and NIRMALA x JHA-1610-2 at F_5 generation

S. No.	Entry	Days for flower initiation	Plant height (cm)	No. of primary branches	Number of capsules / plant	Seed yield (g/plot)*	Oil content (%)
1.	NIRMALA x S-0479 (F_5-5)-W	35	124	6	63	256	45.3
2.	NIRMALA x S-0479 (F_5-20)32-LB	35	113	4	75	252	46
3.	NIRMALA x S-0479 (F_5-27)-LB	33	96	4	84	265	47
4.	NIRMALA x JHA-1610-2 (F_5-14)-W	35	75	4	58	245	48
5.	NIRMALA x JHA-1610-2 (F_5-15)-LB	33	73	4	63	236	49
6.	NIRMALA x JHA-1610-2 (F_5-16)-W	34	82	4	68	276	48
7.	NIRMALA x JHA-1610-2 (F_5-21)-W	32	75	4	67	253	45
8.	NIRMALA x JHA-1610-2 (F_5-36)-LB	32	85	4	69	274	45
	Swetha til (check)-W	33	134	6	42	181	46
	GT-10 (check)-B	30	113	8	71	241	46

Note: Lines selected were bold seeded; W-white seed; LB-Light brown seed; B-black; *Plot size: 3.6 m^2

Advance sesame breeding lines selected for high seed yield/plot (g/3.6 sq m), high oil content, and high test weight

Fifty two F_6 entries from 4 crosses *viz.*, RT-346 x S-0449 (12 families), SI-349 x DS-5 (15 families), N-32 x RT-127 (11 families) and IS-846-A x VRI-3 (14 families) were evaluated during summer season in augmented design. Lines performing better for either seed yield, oil content or test weight over the checks were selected. There was no variation for maturity, plant height, seed yield and oil content, while capsule number and test weight differed significantly. One entry SI-349 x DS-5-F6-7 (white seed) exhibited highest yield of 955 kg/ha albeit with lower oil content (43%).

Mean values of yield parameters in stable F_6 entries

Treatment	Plant stand	Days for flower initiation	Plant height (cm)	No. of capsules / plant	Seed yield (g/ plot)*	Test weight (g)	Oil content (%)
IS-846-A x VRI-3-F6-19-LB	35	40.2	134.8	67.7	196.8	3.5	50.6
IS-846-A x VRI-3-F6-5-W	35	40.2	145.8	68.7	162.3	3.2	51.2
RT-346 x S-0449-F6-15-W	33	42.2	170.3	84.2	203.3	3.5	43.7
SI-349 x DS-5-F6-5-W	35	44.2	146.3	67.7	220.3	3.4	42.1
SI-349 x DS-5-F6-7-W	37	41.2	146.3	67.7	344.3	3.2	43.8
Swetha til (check)-W	35	43.4	141.2	58.6	196.4	3.4	47.5
GT-10 (check)	35	40	110.4	89.8	179.2	3.2	43.6
Mean (N=52)		40.8±1	143.4±8.4	62.1±3.1	164±16.9	3.2±.03	46.2±1.12
CD (P=0.05)		NS	NS	8.53	NS	0.09	NS

W-white seed; LB-Light brown seed; *Plot size: 3.6 m^2

Preliminary yield trials of stable lines

Preliminary yield trials of 44 uniform entries from different crosses selected for yield, oil content, better plant architecture were conducted in RBD with two replications (plot size 3.6 m^2) during *kharif* and summer for their performance. Eight entries superior over local check during *kharif* were identified.

Elite lines identified as superior over local check during *kharif* 2020

Entries	No. of branches	No. of capsules/ plant	Capsule length (cm)	Plant to 50% flower initiation	Plant height (cm)	Seed yield (kg/ha)	Seed yield (g/plot)*	Test weight (g)
PYT-41	4.9	56.5	3.0	39.5	85.6	505.5	273.0	3.6
PYT-26	3.7	72.8	2.7	38.5	87.2	498.1	269.0	3.3
PYT-28	4.4	76.8	2.8	38.5	94.5	443.5	239.5	3.5
PYT-39	4.2	45.0	3.1	39.0	77.5	442.5	239.0	3.3
PYT-21	4.1	78.5	2.2	39.5	97.8	441.6	238.5	3.5
PYT-37	4.2	39.0	2.5	39.0	74.7	439.8	237.5	3.5
PYT-12	4.0	103.0	4.1	40.5	151.0	438.8	237.0	3.4
PYT-32	3.9	62.3	2.6	38.5	81.2	425.9	230.0	3.2
GT-10	8.0	71.5	2.5	41.0	113.0	447.2	241.5	3.1
Swetha til	6.0	42.5	3.0	42.5	134.0	336.1	181.5	3.5
TKG-22	4.0	34.5	3.3	39.5	95.0	274.0	148.0	3.7
General Mean	4.4	58.3	2.7	39.4	93.6	318.8	172.2	3.0
CV (%)	9.55	29.28	5.2	2.19	10.9	10.11	10.11	6.9
SE(d)	0.42	17.0	0.14	0.86	10.2	32.2	17.4	0.21
LSD at 5%	0.85	34.3	0.29	1.73	20.6	64.8	35.0	0.42

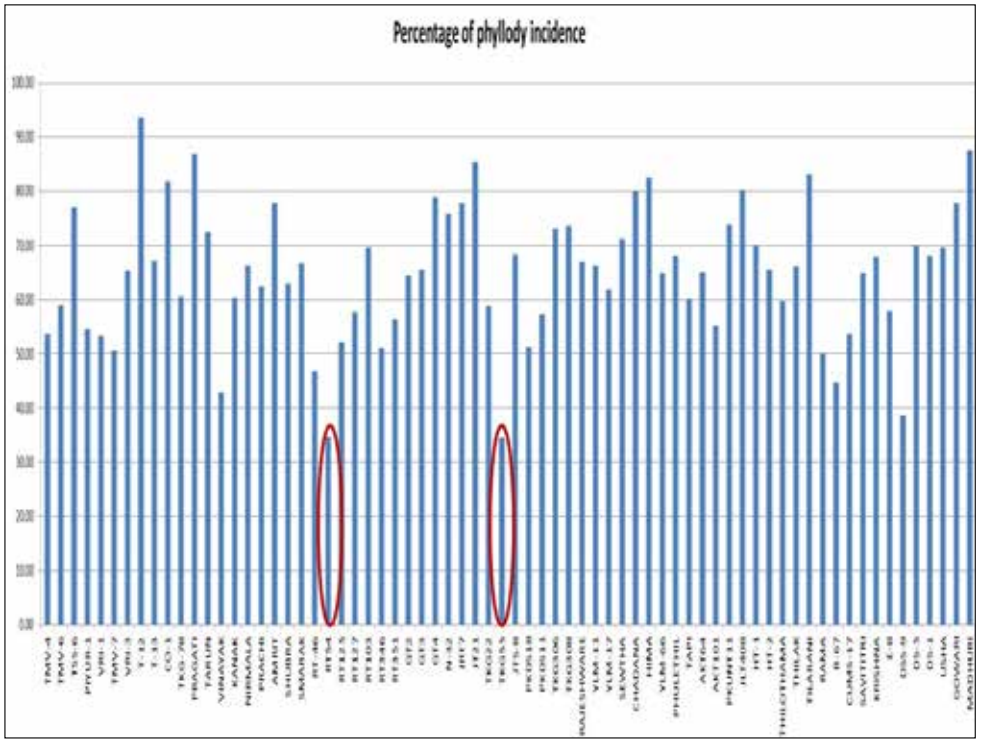
*Plot size: 5.4 m^2

Evaluation of released varieties

Seventy two released varieties were evaluated in RBD with three replications (plot size 5.4 m^2) and screened for phyllody. DSS-9, CUMS-17 and DS-1 were the best performing varieties. Phyllody incidence in these varieties is represented in figure.

Performance of released varieties during *kharif* 2020

Varieties	Days to flowering	Days to maturity	No. of capsules/ plant	Primary branches /plant	Plant height (cm)	Sec. branches/ plant	Seed yield (g /plant)	Seed yield (kg/ha)	Oil content (%)
DSS-9	36	81	110	5	142.7	5	8.9	492.3	48
CUMS-17	36	79	129	6	104.0	11	8.0	445.2	48
DS-1	40	76	106	4	134.3	8	7.0	426.2	46
RT-127	30	71	104	2	95.0	4	6.8	396.7	50
GT-10	39	80	109	4	180.0	4	6.4	373.4	46
DS-5	41	81	88	3	191.0	4	6.3	351.9	50
Shubra	32	79	86	3	151.3	4	6.0	315.3	48
Swetha til	33	72	87	2	87.7	5	5.8	268.7	48
TMV-6	39	80	150	9	138.7	3	5.5	257.8	46
TSS-6	36	75	83	4	143.0	5	5.2	230.7	48
General Mean	36.1	75.6	76.5	4.6	116.5	4.6	8.3	164.9	
p-Value	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	
CV (%)	1.37	0.98	16.6	9.7	6.48	18.17	22.16	15.9	
SE(d)	0.40	0.60	10.37	0.37	6.17	0.68	2.04	30.34	
LSD at 5%	0.80	1.20	20.50	0.72	12.19	1.35	4.03	69.32	



Phyllody reaction among released sesame varieties

Hybrid Development

Castor

Generation of new hybrids: One hundred and sixty two new hybrids were generated by hand pollination using the following pistillate and male lines.

Female (pistillate) lines	Male lines
IPC-38, IPC-46 DPC-15, DPC-21, DPC-22, DPC-25, M-571, SKP-84, IPC-41, IPC-46, JP-86, JP-96, DPC-16, M-574, DPC-19, VP-1, DPC-23	ICS-348, ICS-350, ICS-355, K-18-92, K18-93, K-18-94, K18-99, K-18-101, K-18-104, K-18-106, K-18-119, K-18-129, K-18-134, JI-315, 2412-1, 1932-1, ICS-299, ICS-310, ICS-164, ICS-313, ICS-312, ICS-174, ICS-316, 48-1, DCS-9, 48-1, DCS-78, DCS-89, DCS-102, DCS-105, DCS-106, DCS-107, DCS-108, DCS-109, DCS-110, DCS-118, DCS-119, DCS-121, DCS-123, DCS-94, DCS-112, DCS-104, ICS-128, ICS-134, ICS-130, ICS-145, ICS-149, ICS-144, Kranthi

Confirmatory yield trial of promising experimental hybrids

In a confirmatory replicated yield trial of promising experimental hybrids in RBD of four rowed plots each, during *kharif* 2019-20 under rainfed conditions, three hybrids ICH-368, ICH-901 and ICH-941 were superior to the best check, ICH-66 (1753 kg/ha) with yield advantage of 17.9-26.4%.

Performance of promising hybrids in confirmatory yield trial

Entry	NN	DF	PH (cm)	TPSL (cm)	EPSL (cm)	NSP	SW (g)	SY (kg/ha)	OC (%)
ICH-368	15	52	147.8	40.3	39.2	11	34.0	2216[a]	45.1
ICH-901	15	50	175.1	37.1	37.0	7	32.5	2151[b]	45.7
ICH-941	13	52	130.1	43.0	41.2	8	31.9	2067[b]	45.9
ICH-66	16	52	144.0	38.1	38.1	7	33.7	1753[b]	45.0
GCH-8	14	52	142.5	45.2	40.9	7	31.7	1677[b]	45.2
CD (P=0.05)	0.9	1.9	23.3	7.4	7.1	2.3	1.1	491.3	1.1
CV (%)	4.2	2.3	9.7	11.1	11.4	16.5	2.1	17.8	1.4

NN-No. of nodes; DF-Days to 50% flowering; PH-Plant height; TPSL-Total primary spike length; EPSL-Effective productive spike length; NSP-No. of spikes per plant; SW-100-seed weight; SY-Seed yield; OC-Oil content. Means followed by different alphabets varied significantly at P=0.05.

Preliminary evaluation of castor hybrids in *kharif*, 2019-20

A total of 167 hybrids were evaluated in four sets along with 50 parents and two or three checks, DCH-177, ICH-66 and GCH-8. Each entry was raised in a single row in a randomized block design with three replications at spacing of 90 x 60 cm under rainfed conditions.

Promising hybrids in four sets of preliminary evaluation trials

S. No.	Entry	NN	DF	PH (cm)	TPSL (cm)	EPS L(cm)	SW (g)	SYPP (g)	OC (%)	CD (P=0.05)
	Set-I									
1	ICH-1050	13	47	62	48	46	37	163*	42.8	36.0
2	ICH-1040	13	44	67	42	38	36	148	43.5	
	GCH-8 (check)	12	47	58	42	41	35	111	43.2	
	Set-II									
3	ICH-1194	15	54	91	39	39	26	234	46.0	55.2
4	ICH-1200	15	51	70	39	39	33	220	46.0	
	GCH-8 (check)	14	52	94	54	53	32	189	46.6	
	Set-III									
5	ICH-983	14		108	38	38	29	207	45.7	26.6
6	ICH-990	18		148	45	45	34	195	45.6	
	ICH-66 (check)	14		125	48	44	34	144	46.7	
	Set-IV									
7	ICH-887	13		134	42	39	32	411	46.6	33.0
8	ICH-950	10		61	47	45	26	285	46.0	
	ICH-66 (check)	14		97	51	48	30	195		

NN-No. of nodes; PH-Plant height up to primary spike; TSPL/ESPL-Total/Effective primary spike length; SW-100-seed weight; SY-Seed yield; OC-Oil content

Entries in co-ordinated multilocation trials

Based on the preliminary and confirmatory yield trials conducted at IIOR, two short duration hybrids ICH-440 (IPC-15 x ICS-345), ICH-1146 (IPC-39 x DCS-89) of 85-90 days to primary spike maturity and two normal duration hybrids ICH-239, ICH-277 with >90-110 days primary spike maturity were nominated to IVHT-SD and IVHT-Normal duration respectively. Promising genotypes in pipeline include two hybrids ICH-278 (DPC-25 x ICS-164), ICH-515 (SKP-84 x RG-566) in AHT-II and ICS-164 castor variety in AVT-I that are in advanced stages of evaluation. ICH-515 is resistant to wilt, root rot and moderately resistant to gray mold while ICH-278 is resistant to wilt and leafhopper.

Sunflower

Synthesis of new experimental hybrids during *kharif* 2020

A total of 70 new experimental hybrids were generated during late *kharif* 2020 using 6 promising CMS lines ARM-248A, CMS-1001A, COSF-6A, COSF-7A, CMS-1006A and CMS-1010A and newly developed restorer gene pool inbreds.

Evaluation of sunflower hybrids for yield and yield contributing traits

A total of 315 new experimental hybrids along with three checks (DRSH-1, KBSH-44 and IISOH-15-20 (included in AHT-II trial during *kharif* 2020) were evaluated for yield and yield contributing traits in augmented block design during *rabi* 2019-20 at ICAR-IIOR, Hyderabad. Many promising hybrids were identified for different traits.

Promising sunflower hybrids identified

Hybrid	DF	PH	HD	SY	SW	VW	OC
HA-228A x RGP-46-P_3	57	154	14.6	66.7	7.0	43.5	35.1
CMS-2023A x RGP-21-P_4-S_{1-3}	62	153	15.4	50.7	6.9	44.4	35.6
HA-228A x IR-6	58	143	14.2	52.2	6.8	48.2	35.1
CMS-1005A x RGP-117	57	142	12.2	48.6	6.2	46.5	37.4
CMS-1006A x RGP-117	61	147	14.0	47.6	6.4	46.1	37.9
CMS-1006A x RGP-21-P_4-S_1	60	129	12.6	45.8	6.5	46.6	38.6
CMS-1010A x RGP-117	62	160	14.4	50.7	6.7	44.7	37.2
HA-303A x RGP-46-P_3	62	128	12.2	52.4	6.2	44.4	36.1
HA-303A x RGP-30-P_1-S_1	61	123	12.0	61.2	6.7	45.3	36.4
HA-303A x TSG-260	56	133	15.0	54.6	6.5	46.0	37.1
ARM-243A x RGP-11-$_P$1	65	171	16.4	54.9	6.8	46.9	37.7
ARM-243A x GP6-79	64	176	15.8	54.2	6.4	47.1	37.3
ARM-243A x PS-2056	65	170	15.6	54.3	6.2	47.3	37.7
ARM-243A x CSFI-13022	63	167	16.4	56.4	7.0	44.9	36.9
IIOSH-15-20 ©	67	165	17.4	57.8	6.8	45.1	36.9
KBSH-44 ©	63	164	14.8	37.8	8.2	48.8	30.9
DRSH-1 ©	62	163	13.8	40.4	6.2	45.6	36.8
Mean	57.2	136.2	12.6	31.2	5.4	43.5	34.6
CD (P= 0.05)	1.9	2.0	1.4	2.3	1.1	2.1	1.3
CV (%)	9.3	6.4	3.8	12.6	3.1	4.6	6.4

DF-Days to 50% flowering; PH-Plant height (cm); HD-Head diameter (cm); SY-Seed yield per plant (g); SW-100-seed weight; VW-Volume weight (g/100 ml); OC-Oil content (%)

CMS-1006A x RGP-117 *ARM-243A x RGP-11-P_1* HA-228A x IR-6 *HA-228A x RGP-46-P_3*

Promising sunflower hybrids

Evaluation of hybrids developed by ICAR-IIOR in other locations

Experimental hybrids newly developed at ICAR-IIOR, Hyderabad were supplied to sunflower AICRP centres *viz.*, Ludhiana (150), Bhubaneswar (24) Nimpith (38 in Set-I, 51 in Set-II and 50 in Set-III), Tornala (30 in Set-I and 40 in Set-II), Latur (35) and Nandyal (40) for identification of best experimental hybrids for their states. The performance of the material at Nimpith, Bhubaneswar and Ludhiana is described, data from other centres is under compilation and analysis.

Of 56 hybrids evaluated in RBD with two replications at Nimpith during spring 2019, six were promising with significantly higher seed yield than the best check. Highest seed yield 2165 kg/ha was reported in hybrid

IIOSH-1219 followed by IIOSH-1346 (1984 kg/ha), IIOSH-1280 (1970 kg/ha), IIOSH-1325 (1792 kg/ha), IIOSH-1208 (1790 kg/ha) and IIOSH-1286 (1776 kg/ha) compared to best check KBSH-44 (1735 kg/ha).

At Bhubaneswar, among the 24 hybrids evaluated in RBD with two replications (plot size: 2 rows of 4.5 m length), highest plot yield was recorded in entry IIOSH-1336 (1332 g) followed by IIOSH-1329 (1301 g) compared to checks DRSH-1 (1057 g) and KBSH-44 (1100 g). More than 38.0% oil content was recorded in 11 hybrids and the highest oil content (42.27%) was observed in IIOSH-1326 followed by IOSH-1315 (40.95%), IIOSH-1316 (40.92%), IIOSH-1325 (40.27%) and IIOSH-1310 (40.11%) compared to best check DRSH-1 (38.26%).

At Ludhiana, the experimental hybrids (150) were evaluated in augmented block design (plot size: 3.0 x 1.2 m^2) along with two checks DRSH-1 and KSFH-7032 and 14 hybrids recorded seed yield >3000 kg/ha. Highest seed yield and oil yield of 3744 kg/ha and 1621 kg/ha, respectively were observed in IIOSH-1257 with 43.3% oil content followed by IIOSH-1336 (3597 kg/ha and 1504 kg/ha), IIOSH-1344 (3389 kg/ha and 1406 kg/ha), IIOSH-1341 (3364 kg/ha and 1406 kg/ha) and IIOSH-1346 (3347 kg/ha and 1439 kg/ha) compared to national check DRSH-1 (1633 kg/ha and 673 kg/ha) and best private sector hybrid KSFH-7032 (2444 kg/ha and 980 kg/ha).

The promising hybrids will be resynthesized and re-evaluated for yield and yield contributing traits to identify best heterotic hybrids for the states of West Bengal, Odisha and Punjab.

Seed multiplied and nomination of entries for coordinated trials: Sufficient quantity of seeds of five entries *viz*., IIOSH-15-10, IIOSH-15-20, IIOSH-460, IIOSH-413 and IIOSH-566 were produced during *rabi* and late *rabi* 2019-20 for coordinated trials (IHT and AHT). Two entries (IIOSH-413 and IIOSH-566) were nominated during *rabi* 2020 for initial hybrid trial (IHT) and IIOSH-460 and IIOSH-15-20 for IHT and AHT-II trial, respectively during *kharif* 2020.

Average performance of sunflower hybrid IIOSH-15-10 over three years in coordinated trials: Entry IIOSH-15-10 WAS evaluated during the years 2017, 2018 and 2019 during *kharif* season for yield and yield contributing traits in IHT, AHT-I and AHT-II trials. This entry gave average 6.3% and 22.4% higher seed yield and 6.9% and 7.7% higher oil yield over the check hybrids, KBSH-44 and DRSH-1, respectively in AICRP trials.

Performance of IIOSH-15-10 across three years compared to checks

Entry	Overall seed yield (kg/ha)			Overall mean	Seed yield superiority (%)	Overall oil yield (kg/ha)			Overall mean	Oil yield superiority (%)
	IHT	AHT- I	AHT-II			IHT	AHT-I	AHT-II		
IIOSH-15-10	1760	2050	1934	1915	-	391	704	632	576	-
KBSH-44 (NC)	1625	1902	1880	1802	6.3	359	636	621	539	6.9
DRSH-1 (NC)	1490	1619	1586	1565	22.4	375	621	608	535	7.7
CD (P=0.05)	80.6	107.0	84.7				48.0	-		
CV (%)	11.4	11.4	10.9				13.4	-		

Performance of IIOSH-15-20 in coordinated trials

Average performance of entry IIOSH-15-20 over two years in coordinated trials: The entry IIOSH-15-20 recorded 25.0% and 8.3% higher seed yield and 20.7% and 20.3% higher oil yield over the national check hybrids, DRSH-1 and KBSH-44, respectively in multi-location testing under AICRP. IIOSH-15-20 recorded 0% downy mildew incidence compared to KBSH-44 (30.0%) and DRSH-1 (87.5%). During *kharif* 2019, coordinated entry IIOSH-15-20 (AHT-I) showed tolerant reaction against leafhoppers across the 4 locations. The lowest necrosis disease incidence was recorded on the hybrid IIOSH-15-20 (9%) during *kharif* 2018.

Performance of IIOSH-15-20 across during two years of trials as compared to the checks

Entry	Overall seed yield (kg/ha)		Mean	Seed yield superiority (%)	Overall oil yield (kg/ha)		Mean	Oil yield superiority (%)	Downy mildew incidence (%)		Mean
	IHT	AHT-I			IHT	AHT-I			IHT	AHT-I	
IIOSH-15-20	2411	1987	2199	-	902	720	811	-	0	0	0
KBSH-44 (NC)	2180	1880	2030	8.3	728	621	674	20.3	0.0	60.0	30.0
DRSH-1 (NC)	1932	1586	1759	25.0	736	608	672	20.7	90	85	87.5
CD (P=0.05)	97	84.7			-	-			-	-	
CV (%)	10.8	10.9			-	-			-	-	

Field view of sunflower hybrid IIOSH-15-20

Assessing the standard heterosis of hybrids

A total of 50 F1 hybrids generated using 5 CMS lines and 10 newly developed restorer lines along with 2 national checks *viz.*, DRSH-1 and KBSH-44 were evaluated for standard/economic heterosis. For earliness combinations FMS-852A x RGP-190, COSF-6A x RGP-225, COSF-6A x 298R, COSF-7A x RGP-118, COSF-7A x RGP-173 were promising over both the checks. Two combinations *viz.*, ARM-248A x RGP-233 and CMS-38Ax RGP-173 were the best heterotic combinations for seed yield/plant while four combinations namely COSF-6A x RGP-233, COSF-7A x RGP-225, FMS-852A x RGP-225, COSF-7A x RGP-222 were best combinations for oil content.

Best heterotic combinations for seed yield and its contributing traits

S. No.	Characters	Best heterotic combinations over standard checks			
		Standard heterosis over DRSH-1	Best heterotic combinations	Standard heterosis over KBSH-44	Best heterotic combinations
1.	Days to 50% flowering	-7.03 ** -6.25 ** -5.47 * -5.47 * -5.47 *	FMS-852A x RGP-190 COSF-6A x RGP-225 COSF-6A x 298R COSF-7A x RGP-118 COSF-7A x RGP-173	-9.85 ** -9.09 ** -8.33 ** -8.33 ** -8.33 **	FMS-852A x RGP-190 COS-6A x RGP-225 COS-6A x 298R COSF- 7A x RGP-118 COSF- 7A x RGP-173

S. No.	Characters	Best heterotic combinations over standard checks			
		Standard heterosis over DRSH-1	Best heterotic combinations	Standard heterosis over KBSH-44	Best heterotic combinations
2.	Days to maturity	-4.79 ** -4.26 ** -3.72 * -3.72 * -3.72 *	FMS-852A x RGP-190 COSF- 6A x RGP-225 COSF- 6A x 298R COSF- 7A x RGP-118 COSF- 7A x RGP-173	-6.77 ** -6.25 ** -5.73 ** -5.73 ** -5.73 **	FMS-852A x RGP-190 COSF-6A x RGP-225 COSF- 7A x RGP-118 COSF- 7A x RGP-173 COSF- 7A x RGP-223
3.	Plant height (cm)	-16.46** -16.40** -16.40** -15.29** -14.36**	COSF-7A x RGP-173 COSF-6A x RGP-190 COSF-7A x RGP-225 FMS-852A x RGP-190 COSF-7A x RGP-223	-19.74** -19.69** -19.69** -18.62** -17.72**	COSF-7A x RGP-173 COSF-6A x RGP-190 COSF-7A x RGP-225 FMS-852A x RGP-190 COSF- 7A x RGP-223
4.	Head diameter (cm)	45.27 ** 18.92 ** 18.92 ** 16.89 ** 16.22 **	FMS-852A x RGP-184 ARM-248A x RGP-233 FMS-852A x RGP-190 FMS-852A x RGP-225 ARM-248A x RGP-157	41.45 ** 15.79 ** 15.79 ** 13.82 ** 13.16 **	FMS-852A x RGP-184 ARM-248A x RGP-233 FMS-852A x RGP-190 FMS-852A x RGP-225 ARM-248A x RGP-157
5.	Volume weight (g/100 ml)	-	-	21.84 ** 19.88 ** 18.53 ** 18.40 **	COSF-7A x RGP-222 FMS-852A x RGP-222 COSF-6A x 298R COSF-6A x RGP-222
6.	Seed yield per plant (g)	57.61 ** 54.71 ** 32.74 ** 29.26 * 28.26 *	ARM-248A x RGP-233 CMS-38A x RGP-173 COSF-6A x RGP-233 CMS-38Ax RGP-190 COSF-7A x RGP-157	31.29 ** 28.87 **	ARM-248A x RGP-233 CMS-38Ax RGP-173
7.	Oil content (%)	6.30* 5.79* 5.70* 5.59 *	COSF-6A x RGP-233 COSF-7A x RGP-225 FMS-852A x RGP-225 COSF-7A x RGP-222	26.14** 25.53 ** 25.43** 25.29 ** 24.21 **	COSF-6A x RGP-233 COSF-7A x RGP-225 FMS-852A x RGP-225 COSF-7A x RGP-222 COSF-7A x 298R

*indicates significance at CD (@5%) and ** indicates significance at CD (@1%

Safflower

Evaluation of newly developed hybrids

During this year, the hybrid ISH-402, with seed yield of 20.3 q/ha and 31.84 q/ha under rainfed and irrigated conditions, respectively was identified by Varietal Identification Committee for all India cultivation after its evaluation under the AICRP system. The hybrid, ISH-401, with seed yield of 19.57 q/ha and 32.38 q/ha under rainfed and irrigated conditions has completed three years of evaluation under AICRP system and is ready for proposing to VIC for all India release. Apart from the high yielding ability, this hybrid is also moderately resistant to wilt and Alternaria leaf spot.

ISH-402

Other hybrids developed at IIOR are in different stages of evaluation under AICRP system; ISH-423 has been promoted from IHT to AHT-1; ISH-400 has been promoted to AHT-II and three hybrids *viz.*, ISH-413, ISH-417 and ISH-419 have been nominated to IHT during 2020-21. The hybrid, ISH-423 in AHT-I has exhibited moderate resistance against Fusarium wilt in wilt sick plots at Tandur, Solapur and IIOR when tested in IHT.

Molecular Breeding and Biotechnology

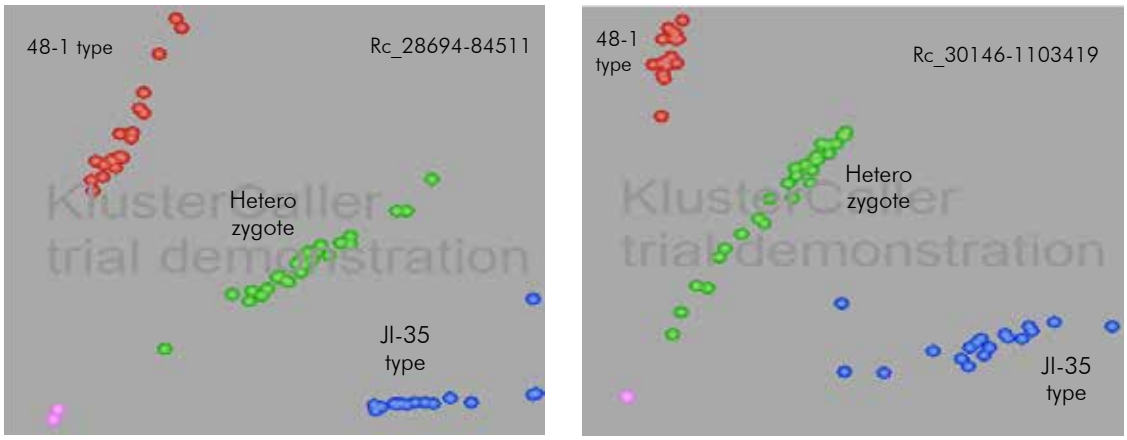
Castor

Validation of SNP markers associated with wilt resistance

The putative QTL on LG-4 linked to wilt resistance identified using the RILs of JC-12 × 48-1 was validated in the F_2 population derived by crossing resistant line 48-1 and the susceptible line JI-35. A total of 60 F_2 plants of 48-1 × JI-35 were evaluated for wilt resistance by raising the plants in the permanent wilt sick plot of ICAR-IIOR and scoring their reaction at 150 DAS.

Phenotyping of F_2 population in wilt sick plot

The DNA was extracted from the leaves collected from the seedlings grown in the sick plot before they succumbed to the wilt. Two polymorphic markers *viz.*, Rc_30146-1103419 and Rc_28694-84511, which were physically nearer to the marker (Rc_30146-1221543) linked to the QTL were used to genotype the F_2 plants through KASP assay.



Genotyping of F_2 population using SNP markers

As wilt resistance in 48-1 inherits as single recessive locus in JI-35 background, co-segregation analysis was carried out as per single recessive gene model. The results of co-segregation analysis for two polymorphic markers are presented in the table given below.

Co-segregation of genotype and phenotype for SNP marker Rc_28694-84511

Allele	No. of individuals	Expected phenotype	Observed phenotype	
			Resistant	Susceptible
48-1	19	Resistant	16	3
Heterozygous	25	Susceptible	0	25
JI-35	16	Susceptible	2	14

Co-segregation of genotype and phenotype for SNP marker Rc_30146-1103419

Allele	No. of individuals	Expected phenotype	Observed phenotype	
			Resistant	Susceptible
48-1	16	Resistant	14	2
Heterozygous	27	Susceptible	3	24
JI-35	17	Susceptible	1	16

The comparison of genotypic and phenotypic data indicated co-segregations of SNP markers with the observed phenotype. These markers could predict the resistance phenotype with >90% accuracy.

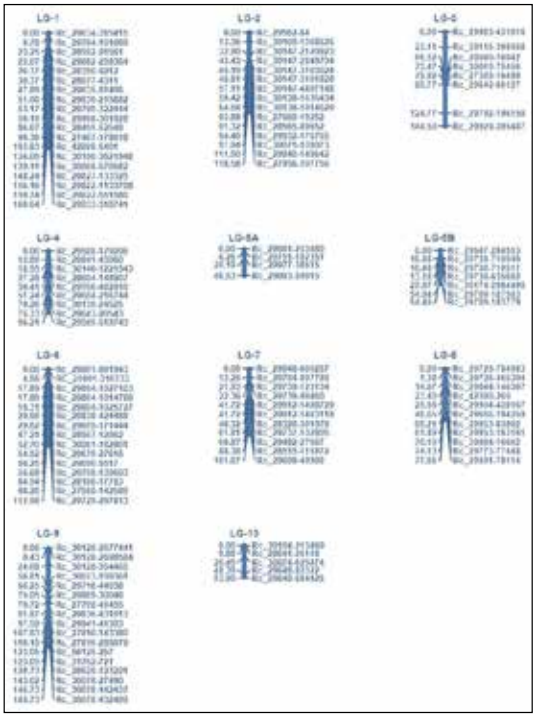
During the reporting period, five additional F_2 populations (RG-1149 × JI-35, RG-2685 × JI-35, RG-1354 × JI-35, RG-2874 × JI-35 and RG-1673 × JI-35) were also phenotyped by raising them in the sick plot. The genotyping of these populations is in progress.

Towards development of near isogenic lines (NILS) carrying different wilt resistance genes

Attempts are being made to generate a series of near isogenic lines carrying different wilt resistance genes in a single genetic background as a useful genetic resource for studying genetic, pathological and molecular aspects of wilt resistance in castor. The wilt resistance genes in three different sources *viz.*, 48-1, RG-999 and RG-1673 are being transferred into a susceptible line, JI-35 through backcrossing. During the reporting period, BC_3F_1 families of JI-35 × RG-999 and BC_2F_1 families of JI-35 × RG-1673 were generated for further backcrossing.

Identification of QTLs linked to gray mold resistance in RG-1963

To identify QTLs linked to gray mold resistance in germplasm line RG-1963, a set of 119 F_2 individuals of the cross JC-12 × RG-1963 was genotyped using 120 SNP markers selected from across 10 linkage groups of castor. The genotyping was done through KASP assays. A linkage map was constructed using ICIM software. The markers were assigned to linkage groups at the logarithm of the odds (LOD) threshold of >5. Markers within each linkage group were ordered with the help of algorithm called 'Record'. Map distances between markers were calculated using the Haldane mapping function.



Linkage map of JC-12 × RG-1963

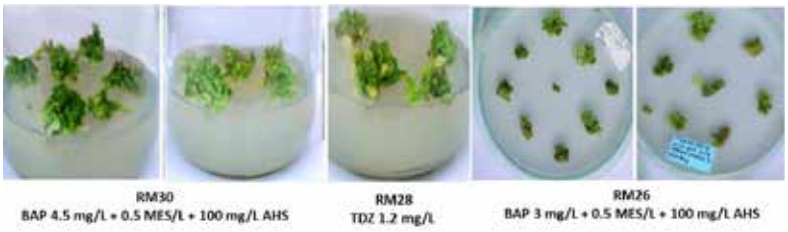
The linkage map and the phenotypic data (disease severity) of the F_2 population were subjected to QTL analysis using QTL Cartographer V2.5. No significant QTL could be identified for gray mold resistance at LOD threshold of 2.

Validation of QTL linked to gray mold resistance in 48-1

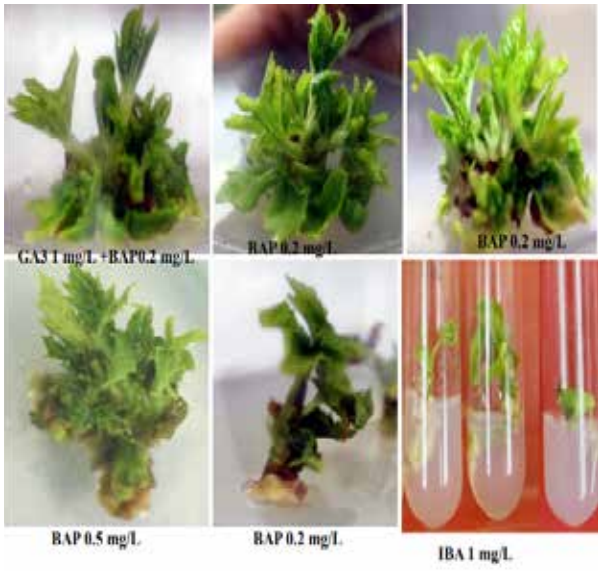
In our earlier project, a major QTL for gray mold resistance was identified on LG-9 linked to SNP marker Rc_29941-41303 using an RIL population of JC-12 × 48-1. In the RILs, expression of gray mold resistance was confounded by the presence/absence of spine on capsules. Therefore, it was proposed to validate the putative QTL in a population in which spininess of capsules does not segregate. The F_2 population of DPC-15 × 48-1 was chosen for this purpose. A total of 37 F_2 plants of DPC-15 × 48-1 was evaluated for resistance to gray mold under field condition with artificial inoculation during *kharif* 2019-20. All the F_2 plants had non-spiny capsules but wide variation was observed for disease reaction. The disease severity ranged from 10-80% in the F_2 population. The parental polymorphism survey was done using 10 SNP markers spanning the QTL region. However, none of the markers was polymorphic between the parents. Therefore, generation of a new population was initiated. A non-spiny line IPC-46 was crossed with ICS-324. ICS-324 is a resistant inbred line derived by crossing two moderately resistant lines *viz.*, DPC-9 and 48-1. The F_1 will be advanced to F_2 during 2021 and used for validation of putative QTL mapped in 48-1 or identification of novel QTLs.

Optimization of tissue culture protocol in castor

An optimized, reliable and repeatable tissue culture protocol was developed. Different media combinations (totaling130) with cytokinins (BAP, 2-iP, kinetin, zeatin, TDZ) singly or in combination with auxins (IBA, IAA and NAA), were tested for direct shoot proliferation activity. Of these, 9 combinations gave promising results using MS media supplemented with different concentrations of plant growth regulators such as BAP, 2-iP, TDZ, IBA. Initially, the embryo axis derived hypocotyls were pre-incubated for 10-12 days in 0.3 mg/L TDZ before inoculation. Direct regeneration of the shoots was observed with optimum results on MS media supplemented with RM6 (1 mg/L 2iP + 0.5 mg/L KN+ 0.5 mg/L TDZ + 0.5 mg/L IBA) RM7 (1 mg/L BAP + 1 mg/L 2-iP +0.5 mg/L TDZ+ 0.5 mg/L IAA), RM23 (6 mg/L BAP + 1 mg/L IAA +0.5 g/L $AgNO_3$), RM26 (3 mg/L BAP + 0.5 g/L MES), RM28 (1.2 mg/L TDZ), RM30 media (4.5 mg/L BAP + 0.5 g/L MES + 100 mg/L AHS), RM99 (5 mg/L 2iP + 0.5 g/L MES), RM149 (5 mg/L BAP + 0.5 mg/L IBA + 0.5 g/L MES) and RM150 (3 mg/L BAP + 0.5 mg/L IBA + 0.5 g/L MES) after 30 days of inoculation. The explants were sub-cultured after 15-20 days on to the same media. To maintain pH of the media, 0.5 g/L MES was added to the media. Although it gave the highest number of shoots per explant, RM 28 media (1.2 mg/L TDZ) induced hyperhydricity and shoot elongation was difficult. The media combinations RM30, RM 26, RM 149 and RM 150 gave highest number of shoots/explant. The better shoot elongation was observed with 0.2 mg/L BAP and 1g/L GA_3. Plants rooted well on MS medium supplemented with 1 mg/L IBA. Highest plantlet regeneration (98.9%) was observed on regeneration media RM30 and RM 149 whereas maximum shoot elongation was observed in BAP 0.2 mg/L and 1mg/L GA_3 and root induction were observed with IBA 1mg/L. Hence, it was concluded that pre-inoculation medium with 0.3 mg/L TDZ, regeneration media RM30 orRM26 or RM 149, shoot elongation medium of MS+ 0.2 mg/L BAP and rooting medium of MS+1mg/L IBA were the ideal combinations for *in vitro* regeneration in castor.



Multiple shoot induction on different media of castor



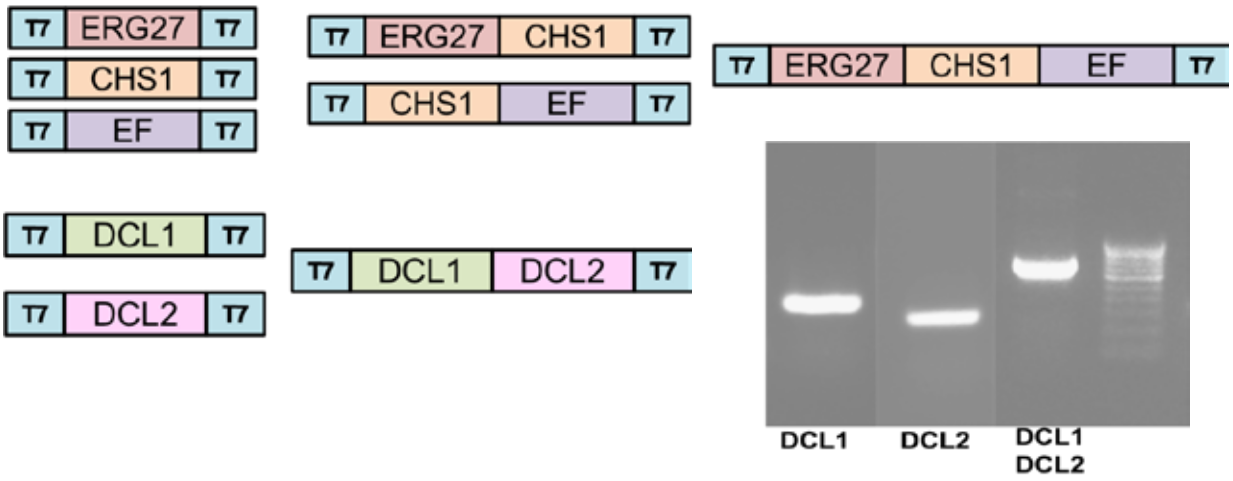
Shoot elongation and root induction of castor

***In planta* transformation**: PCR based screening of progeny of T_3 plants of *in planta* transformed castor plants in the green house for the presence of transgene(s), identified 43 plants positive for *EBP1* transgene.

Studies on spray induced gene silencing of *Botryotinia ricini* genes

The RNAi pathway has emerged as a powerful tool to contain plant pests including fungal pathogens. Use of the lethal RNAi signals (siRNAs) against the genes of importance for survival and virulence are known to restrict proliferation of the fungus and thus reduce the impact of the disease. These siRNA signals could be generated *in planta*, a strategy known as 'host-induced gene silencing' (HIGS) and involves development of transgenic plants producing the siRNAs against the selected fungal genes. In the second strategy, known as 'spray-induced gene silencing' (SIGS), the lethal siRNAs are guided into the fungal pathogens exogenously. SIGS targeted against essential genes such as *DCL1, DCL2, EF, ERG27* and *CHS1* has been exploited to protect crop plants from *Botrytis cinerea* and other fungal pathogens. It has been hypothesized that SIGS could be used against *Botryotinia ricini* by targeting its essential genes either singly or in combinations. Based on this premise, studies were initiated to determine the effect of SIGS to control grey mold in castor.

Fragments of the five selected genes, *ERG27*, *CHS1*, *EF2, DCL1* and *DCL2,* were amplified from *B. ricini* using the primers designed based on *B. cinerea* gene sequences. The primers contained T7 promoters on the 5' side to enable *in vitro* transcription to produce double stranded RNA (dsRNA) and the siRNA. Primers were also designed for overlapping PCRs so that fused transcripts of different combinations of the chosen genes could be produced *in vitro*. Totally, 9 different PCR products with different combinations of the chosen genes, as shown in the figure below, were obtained through primer overlap PCR and these were cloned and sequenced. Sequence analyses revealed substantial changes in the gene sequences compared to sequences from *B. cinerea*. The PCR product containing T7 promoters at both ends will be used for *in vitro* transcription using the MEGAscript RNAi Kit. Alternatively, the gene fragments from TA vector will be cloned in pL4440 vector, which contains a double and convergent T7 promoter to produce dsRNA.



Combinations of amplified gene fragments for producing siRNAs through *in vitro* transcription

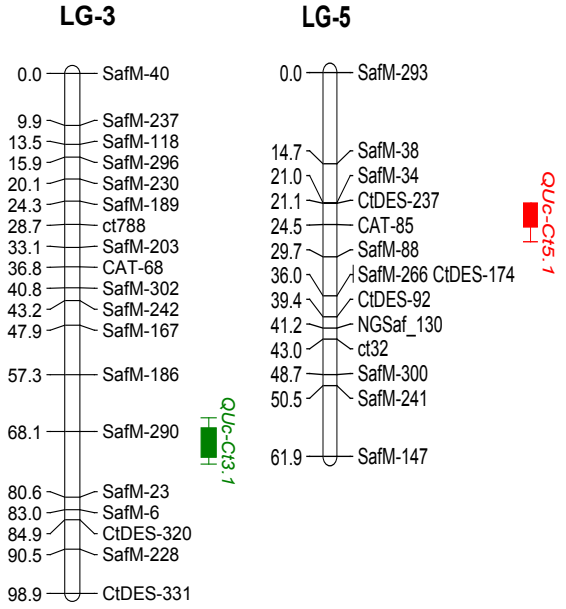
Gel picture showing the confirmation of cloning DCL gene fragments separately and in combination in pTZ57R/T vector

ERG27: Ergosterol synthase; *CHS1*: Chitinase synthase; *EF*: Elongation factor; *DCL1*: Dicer like 1; *DCL2*: Dicer like 2; T7: T7 promoter sequence

Safflower

Detection of putative QTLs associated with tolerance to aphid using SSR markers

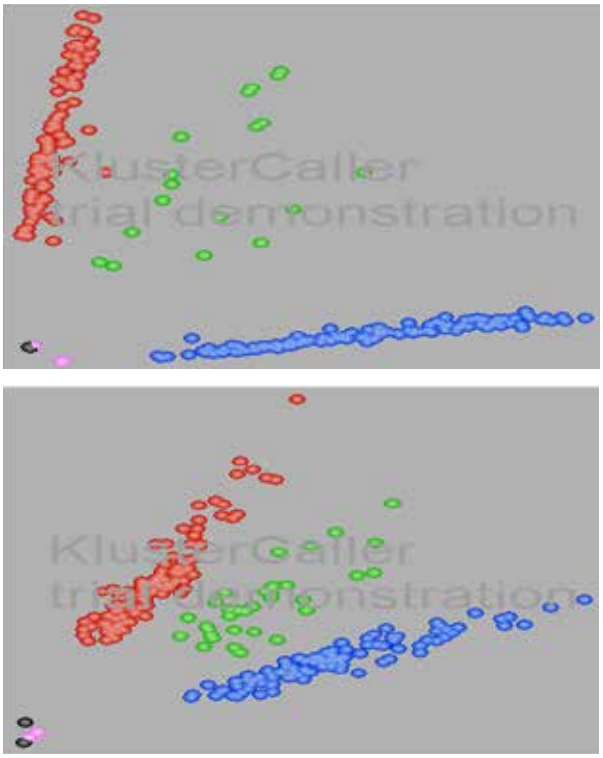
Genetic linkage map of the F_6-RIL population (237 lines) of the cross: CO-1 x EC-523368-2 was developed with 242 SSR markers. A QTL analysis was performed using the SSR data and phenotypic data (tolerance to aphid based on days-to-wilt as the parameter) of the F_6-RIL population through composite interval mapping approach. The QTL analysis revealed two genomic regions: *QUc-Ct3.1* and *QUc-Ct5.1*, putatively associated with tolerance to aphid. *QUc-Ct3.1*, a major QTL, located on linkage group 3 with the closest marker SafM-290 (LOD = 18.3, R^2 = 31.5%). *QUc-Ct5.1*, a minor QTL, located on LG-5 with the closest marker CtDES-237 (LOD = 7.0, R^2 = 9.1%). This is the first report and a significant lead towards discovering genes for tolerance to safflower aphids.



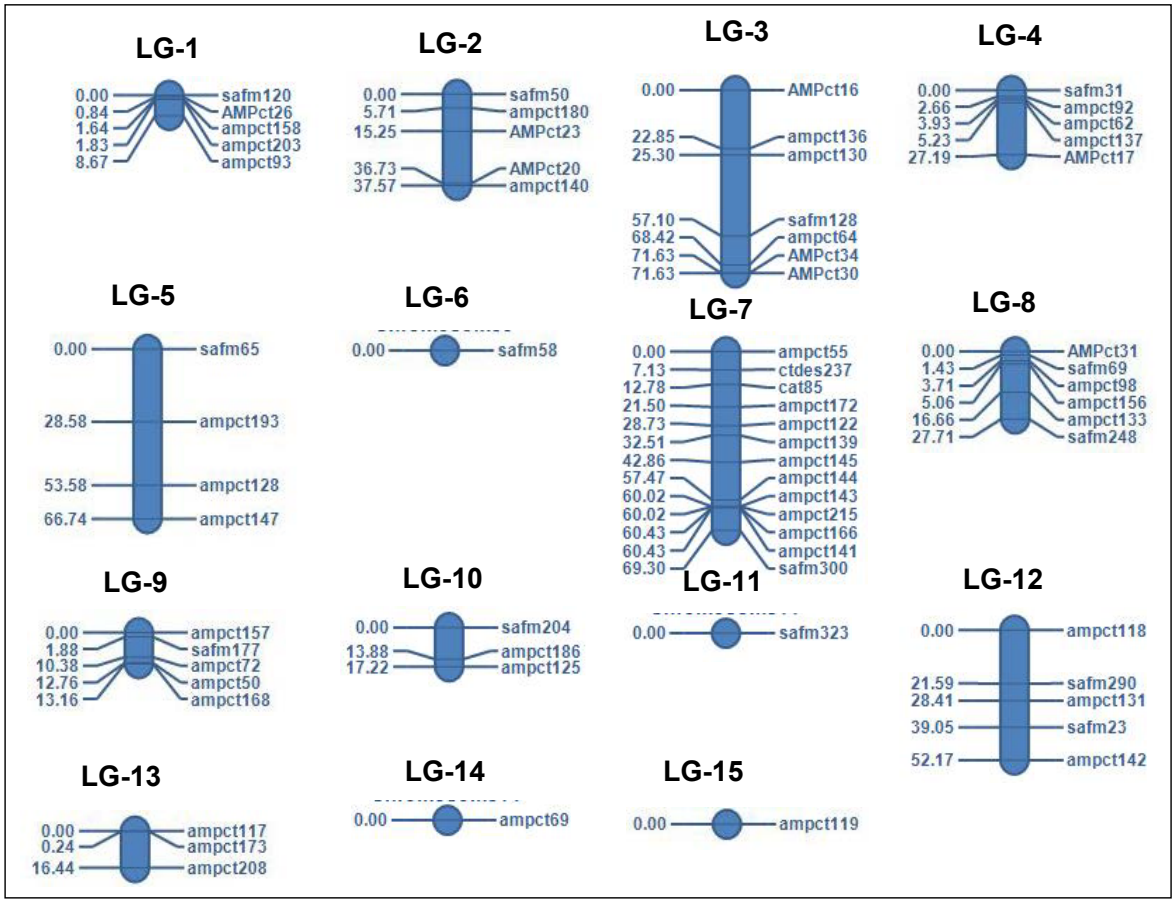
Linkage map positions of the putative QTLs associated with tolerance to aphid

Construction of skeleton linkage map with SNP markers

SNPs between the safflower parental genotypes, CO-1 and EC-523368-2 were identified using their whole genome assemblies (obtained based on the paired end sequences with read length of 150 nucleotides in Illumina Hiseq 2000 platform). Kompetitive Allele Specific PCR (KASP) assays were designed for SNP genotyping. Genotypic data of 280 F_8-RILs of the cross: CO-1 x EC-523368-2 with 49 SNP loci were generated. Linkage analysis produced 11 groups and four unlinked loci. Development of high density SNP linkage map of safflower is in progress.



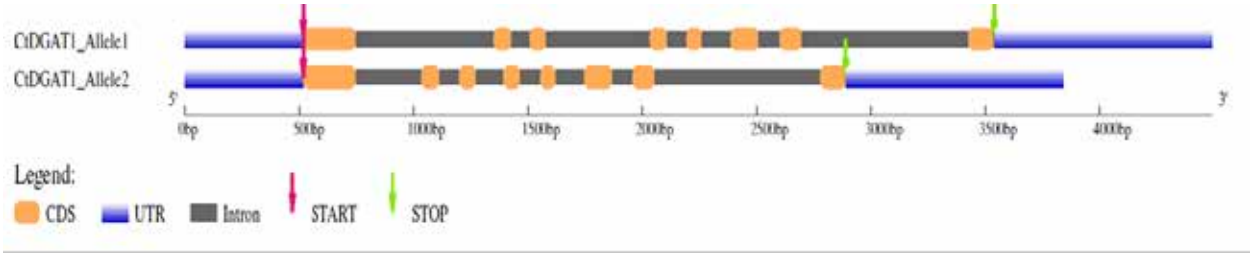
Genotyping of F_8-RIL population with SNP markers



Skeleton linkage map of F_8-RIL population with SNP markers

Candidate gene based allele mining for oil content in safflower

Candidate genes associated with glycerol lipid metabolism, fatty acid biosynthesis, and fatty acid elongation were identified from genome sequencing data. A few of these genes, known to have effect on oil content in different oilseed crops, were selected to study the variability at sequence level across a panel of 40 genotypes that differed in seed oil content (23 to 48%). Primers were designed for amplification of the selected genes and the obtained amplicons were sequenced. Initially, genes *Ctacc*D (Acetyl CoA carboxylase D), *CtFAD2-1, CtFAD2-2, CtFAD2-10* (Oleate desaturases), *CtGAPDH* (Glyceraldehyde3-Phosphate Dehydrogenase), Oleosin 1, 2, 3, 4, 5, 6, 7, 8 genes, *CtDGAT-1, CtDGAT-2, CtDGAT-3* (Diacyl glycerol acyl transferases), *CtFATA* and *CtFATB* (Fatty acyl thioesterases), *CtGPAT* (glycerol-3-phosphate acyltransferase), *CtPDAT* (Phospho-diacyl glycerol acyl transferase) were sequenced and subjected to detailed analysis. Out of, 20 genes studied, five genes (*CtDGAT1, CtDGAT2, CtPDAT, CtFATB and CtOleosin4*) showed nucleotide variation between the set of 20 low and 20 high oil content lines. Sequence analysis clearly indicated two haplotypes for each of these five genes. Two of the genes, *CtDGAT-1* and *CtFATB* showed substantial size variability in gene length whereas only subtle changes in sequences were observed in the other three genes. Allele specific primers were designed for *CtDGAT-1* and *CtFATB* genes. The germplasm mapping panel comprising 192 accessions which had been developed and phenotyped for yield and yield related traits across four locations, was screened to understand the distribution of the two haplotypes. The two alleles detected in *CtDAGT-1* are represented in the figure below. Strong association with one of the alleles of *CtDGAT-1* and oil content was observed with an R^2 value of 0.76 in the germplasm mapping panel.



Structure of two alleles of CtDGAT-1 gene in safflower

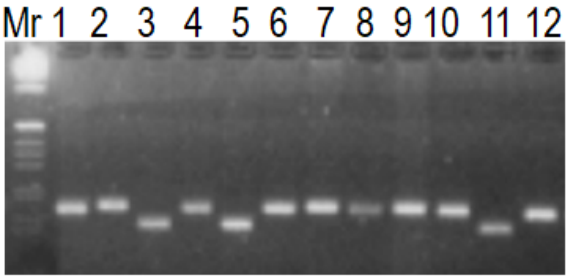
Allele mining of *CtOleosin4* gene identified single nucleotide change at 77 bp in the CDS region leading to an amino acid change in the protein from methionine (M) to lysine (K) in high and low oil lines. Distribution of the haplotypes for *CtOleosin4* is represented in the figure. For oleosin 4 gene, KASP assay can be designed for further screening in the germplasm mapping panel.

Alignment of CDS sequence of Ct- oleosin4 of 20 low and high oil content safflower lines

Sesame

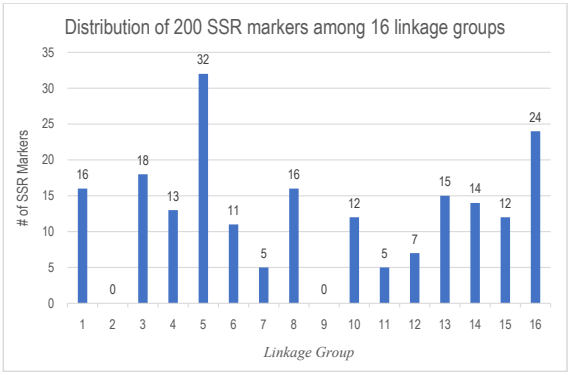
Genomic and genetic resources in Indian sesame

Genomic and genetic resources are the pre-requisites for exploiting the potential of genomics-assisted crop improvement in sesame. Towards this end an additional set of 200 microsatellite markers were optimized for PCR-amplification and were tested for their amplifiability in a set of 24 Indian sesame genotypes. Among 200 markers, 67 amplified and 43 produced discernible bands showing polymorphism with polymorphic information content (PIC) ranging from 0.18 to 0.53.



Polymorphism of marker SIM510 among 12 Indian sesame genotypes: TKG-22, JLT-408, S-0449, NIC-3181, Swetha, RT-103, G-43, GTIL-10, IS-446, HT-2, TMV, and NIC-1646

Further, these 200 SSR markers were assigned to linkage groups based on *in silico* analysis of the sesame genome sequence information. This information is useful for selection of markers belonging to a particular linkage group to build consensus linkage map based on meta-analysis of the previously analyzed markers as well as those publicly available in the publications and databases.



Delineating the effector biology of phytoplasma causing phyllody

The effector molecules secreted by Phytoplasma in the host cell play a key role in the genetic reprogramming of the host plant leading to the peculiar symptoms such

as phyllody resulting in drastic yield losses. SAP54 has been identified as one such effector molecule leading to phyllody symptoms in different crops and it has been shown that SAP54 homologs are found in different phytoplasma strains. Characterization of the ortholog of SAP54 in phyllody causing phytoplasma in sesame and identification of its interacting partners in phyllody affected sesame plant will enable in finding out the key molecules of the host plant that are required for manifestation of phyllody symptoms. This will provide insights into the role of SAP54 in manipulating or deciding the fate of the meristematic cells in the shoot apical meristem from flowering to vegetative phase and in turn developing the peculiar disease symptoms. Interaction studies of effector molecule with interacting partners in sesame will be a step towards delineating the mechanism and identification of the important key molecules involved in phyllody development in sesame and help in identifying the critical vulnerable points that can form the basis for developing control strategies for the disease.

Characterization of phytoplasma strain infecting sesame at IIOR

In sesame, earlier reports have indicated that phyllody causing phytoplasma belongs to distinct subgroups 16SrII-A, II-C, and II-D in diverse agro-climatic zones covering different sesame growing states. To identify the strain of phytoplasma in Hyderabad, standard nested PCR was conducted using the universal primers and the genomic DNA isolated from the midrib and veins of phyllody infected sesame plants. The 16SrDNA fragment of 1.2Kb obtained was cloned and sequenced. The conserved sequence was analysed for sequence homology by NCBI BLASTn and *in-silico* virtual RFLP analysis, was carried out using the online tool (https://plantpathology.ba.ars.usda.gov/phytoplasma.html) to identify the subgroup. The analyses revealed that the isolate (P-IIOR) showed very high similarity with *Candidatus Phytoplasma aurantifolia* isolate OS-KACh-AB with 99.92% identity. Virtual RFLP analysis revealed that the query 16S rDNA F2nR2 fragment was identical (similarity coefficient 1.00) to the reference pattern of 16Sr group II, subgroup D (GenBank accession: Y10097).

Isolation of SAP54 from the phyllody affected sesame plants at IIOR

The mature SAP54 fragment (devoid of the signal peptide sequence) of 276 bases was amplified from the gDNA of infected sesame plants (cv. Swetha) taken from ICAR-IIOR, Rajendranagar research farm and cloned. Three positive clones were sequenced using both M13 forward and reverse primers. The sequence analysis showed that mature SAP54 from ICAR-IIOR was identical to the SAP54 reported by Delhi University even though they had isolated it from the strain that showed similarity to *Candidatus Phytoplasma asteris* and belonged to 16SrI-B group.

Isolation of genes encoding interacting proteins RNF5 and NPY4 from phyllody affected sesame plants

Preliminary work reported from Delhi University using Y2H system has identified RNF5 and NPY4 as putative interacting protein partners of SAP54. To establish their interaction *in planta*, rBiFC (ratiometric bimolecular fluorescent complementation) technique will be followed. In rBiFC procedure, the effector protein (EP) and interacting proteins (IP) will be fused to the split fluorescent protein such as YFP (yellow fluorescent protein) as two independent expression units within the same T-DNA. Once this construct is expressed in a plant cell, if the candidate EP and IP interact, then the two split parts of the YFP (fused to EP and IP) will complement each other and the fluorescence is detected in the cell. Based on this principle, to develop the appropriate rBiFC vectors, genes encoding two IPs, *RNF5* (E3 ubiquitin-protein ligase RNF5 LOC105167488) of 679 bp and *NPY4* (BTB/POZ domain-containing protein NPY4 (LOC105158596) of 1.9 Kb were isolated from the genomic DNA of phyllody affected sesame plants using gene specific primers. These sequences have been confirmed as well as further modified to have the versions without stop codon to facilitate the N and C- terminus fusion to the YFP in rBiFC vector.

Phloem specific expression of SAP54 in model plants *Nicotiana benthamiana* and *Catharanthus roseus*

Isolation of phloem specific promoter AtSUC2 from the gDNA of *Arabidopsis thaliana* has been completed and confirmed by sequencing. The promoter will be

cloned upstream of *SAP54* in a plant binary vector pCAMBIA 1305.2 to assess the localized phloem specific expression of SAP54 in *N. benthamiana* and *C. roseus* for the subsequent studies on manifestation of phyllody symptoms in these model plants.

DUS testing and Registration

Under the Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority, DUS testing trials were conducted for safflower during *rabi* 2019-20 and castor in *kharif* 2020.

DUS testing of safflower was undertaken for one new candidate for first year and one VCK entry along with two reference entries each during *rabi* 2019-20 and data was recorded for 26 DUS traits. Nine reference entries of safflower and the candidates were maintained and multiplied.

In castor, DUS testing of one farmer's variety was undertaken along with two reference varieties and data was recorded for 30 DUS traits during *kharif* 2020. Seed multiplication of two fresh farmer's varieties received from PPV&FRA, New Delhi was undertaken. During *rabi* 2019-20, 11 reference varieties of castor were maintained and multiplied.

A new project on 'Development of Distinctiveness, Uniformity and Stability (DUS) testing guidelines for niger [*Guizotia abyssinica* (L.f.) Cass.]' was sanctioned by PPV&FRA, New Delhi and work was initiated. Fourteen niger varieties were sown for multiplication and characterization of seed traits.

Registration: Castor parental line M-574 was registered with Plant Varieties Registry, PPV&FRA under extant (VCK) category. It was assigned the Registration no. 143 of 2020 dated June 8, 2020 and the period of protection is upto June 7, 2035.

Seed Production

Maintenance breeding (Nucleus seed, Breeder seed and Foundation seed production)

In castor, nucleus seed was produced for SKP-84 (0.5 kg), ICS-164 (1 kg) and DPC-9 (2 kg). Nucleus seed was produced for ARM-243-A (1 kg), ARM-243-B (0.3 kg) and RHA-6D-1 (0.4 kg) in sunflower. In safflower, nucleus seed was produced for ISF-1 (1.1 kg), ISF-764 (2.1 kg), A-133-1A (5 kg), B-133-1B (3 kg), 1705-p22 (3 kg) and NARI-96 (1 kg).

Breeder, certified and TL seed production

A total of 555.69 q of breeder, certified and TL seed of castor, sunflower, sesame and safflower were produced.

Seed production of different oilseed crops at ICAR-IIOR

Crop	Variety/ Hybrid/ Parent	Seed Production(q)
Castor	ICH-66 (Hybrid) (CS)	177*
	DCH-519 (Hybrid) (in stock)	154
	SKP-84 (Female Parent of ICH-66)	1.1
	ICS-164 (Male Parent of ICH-66)	0.6
	DPC-9 (Female Parent of DCH-177)	1.1
	DCS-107 (V) (BS)	1.5
	Total	**335.3**
Sunflower	DRSH-1(Hybrid) (TL)	7.1
	ARM 243 A	0.42
	ARM 243 B	0.45
	RHA 6D-1	0.55
	DRSF-108 (V) (BS)	0.14
	Total	**8.66**

Crop	Variety/ Hybrid/ Parent	Seed Production(q)
Sesame	GT-10 (V) (TL)	0.4
	Swetha (V) (TL)	6.2
	CUMS-17 (V) (TL)	0.91
	YLM-66 (V) (TL)	1.1
	Total	**8.61**
Safflower	ISF-764 (V) (CS & TL)	190*
	ISF-764 (V) (BS)	7.0
	DSH-185 (Hybrid) (TL)	0.76
	CMS 133-1A	0.72
	CMS 133-1B	0.3
	1705-P22 (R line)	0.7
	NARI-96 (V) (BS)	3.07
	NARI-57 (V) (BS)	0.57
	Total	**203.12**
	Grand Total	**555.69**

*Participatory seed production under Oilseeds Seed hub; CS: Certified seed; TL: Truthfully Labelled; BS: Breeder Seed

Oilseeds Seed Hub

During the year 2019-20, a total of 22,780 q of certified quality seed was produced of nine annual oilseed crops across 32 seed hubs against a target of 36,065 q. Progress of all the seed hub centres was reviewed at the Review meeting conducted at RA KVK, Nimpith and chaired by JS (Oilseeds), DACFW and attended by ADG (OP), ICAR and all participating centre seed officers. Issues pertaining to increasing SRR and VRR for achieving higher domestic oilseeds production and problems related to seed lifting, pricing, subsidy as well as insufficient revolving fund for groundnut and soybean were discussed.

Crop Production

Conservation Agriculture

Conservation agriculture (CA) is a farming system that promotes minimum soil disturbance, maintenance of soil cover (crop residues or cover crops) and diversification of plant species. It enhances biodiversity and natural processes above and below ground which contribute to increased water and nutrient use efficiency, improved and sustained crop production, and higher carbon sequestration. CA can be seen as a new way forward for conserving resources and enhancing oilseed productivity. The CA practices are being evaluated for castor-based cropping systems in shallow Alfisols under rainfed conditions.

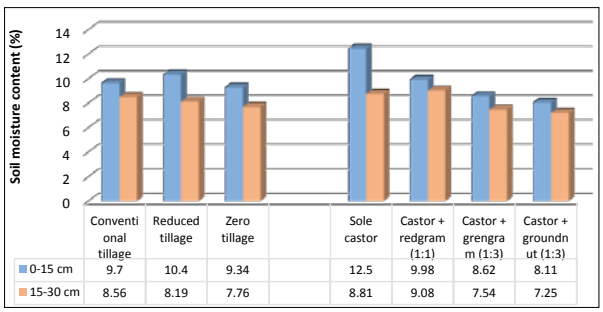
Development of conservation agricultural practices for castor-based cropping systems

Conservation agriculture (CA) practices (tillage and intercropping systems) were evaluated in fixed plot in castor-based cropping systems in shallow Alfisols under rainfed conditions. The cropping system experienced early season drought and excess rain at maturity, affecting normal crop growth and yield of castor and intercrops (greengram, redgram and groundnut).

During the second year of experimentation, tillage practices did not show significant influence on growth, yield attributes and seed yield of castor. The performance of castor in terms of plant height, number of branches, spike length and 100-seed weight differed significantly due to intercropping systems. Performance of sole castor was superior in terms of plant height (92.9 cm) and 100-seed weight (24.7 g) and the lowest growth attributes were recorded in castor + groundnut (1:3) intercropping system. Sole castor recorded significantly higher yield (1436 kg/ha) followed by castor + greengram (1203 kg/ha); castor + groundnut (1030 kg/ha); and castor + redgram (937 kg/ha) intercropping system. Castor equivalent yield was highest in conventional tillage. Among the cropping systems, highest castor equivalent yield was recorded in castor + groundnut (3153 kg/ha) followed by castor + greengram (2253 kg/ha) and castor + redgram (1355 kg/ha). The interaction effects were not significant. Castor + redgram (1:1) intercropping system recorded highest oil content whereas significantly the highest oil yield (625 kg/ha) was recorded in sole castor. The physiological parameters of mean stomatal conductance was highest in conventional tillage (0.278 μ mol $H_2O/m^2/s$) while higher transpiration rate (1.98 μ mol $H_2O/m^2/s$) and net photosynthesis (μ mol $CO_2/m^2/s$) was found in zero tillage.

Mean soil moisture content (0-30 cm) was relatively higher in reduced tillage systems (9.30%) followed by conventional tillage (9.13%) and the lowest soil moisture content was recorded in zero-tillage system (8.55%). Among intercropping systems; sole castor (recorded highest soil moisture content (10.66%).

The Rainwater use efficiency (RWUE) was the highest in conventional tillage (3.66 kg/ha/mm) followed by reduced and zero tillage practices. Among intercropping systems, significantly the highest RWUE for castor equivalent yield was recorded in castor + groundnut (4.91 kg/ha/mm) followed by castor + greengram (3.10 kg/ha/mm); sole castor (2.30 kg/ha/mm) and castor + redgram (2.05 kg/ha/mm).



Soil moisture (%) (0-30 cm) as influenced by tillage practices in castor based cropping systems

Castor + greengram (1:3) under zero tillage

Performance of castor based intercropping systems as influenced by Conservation Agricultural Practices (2019-20)

Cropping Systems Research

Systems approach to agriculture involving sequential cropping helps in bringing stability to the production through better use of resources, improving soil health, reduced cost of production by utilizing residual fertility and moisture and achieving optimum yields of crops in the system. Short duration legume or cereal or *kharif* fallow preceding safflower are popular in safflower growing regions in Vertisols. Green gram – 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.

Safflower-based cropping systems productivity and resource use efficiency under different land configurations, crop geometry and IPNM under variable rainfall patterns

Soil moisture management for *rabi* safflower grown under receding soil moisture conditions is critical for achieving higher productivity. Under the best land management practice of BBF, safflower-based cropping systems with different leguminous *kharif* crops and different duration varieties of soybean (main plot) were evaluated for the performance of safflower under 2 or 3 rows/BBF and IPNM (sub-plot) to match the resource requirement with productivity in medium deep Vertisols in split plot design.

Safflower productivity was not significantly influenced by the preceding *kharif* crops greengram and soybean varieties (1240 to 1560 kg/ha). Seed yield of safflower sown under zero tilled conditions in 2 or 3 rows/BBF recorded higher seed yield and was at par either with 50% RDF + *Azotobacter* + PSB (1561 to 1520 kg/ha) or 100% RDF + *Azotobacter* + PSB (1499 to 1626 kg/ha). Crop raised without fertilizer recorded significantly the lowest seed yield (1228 to 1245 kg/ha). System productivity in terms of safflower equivalent yield followed the similar trend for response to land configurations and sub-plot treatments.

Performance of safflower in safflower based cropping systems under different plant geometry and fertilizer levels

Treatment for safflower	Safflower yield in cropping systems (CS)			Mean	Mean system SEY (kg/ha)	Mean RWUE (kg SEY/ha mm)
Plant geometry x IPNM (P x I)	Greengram - safflower	Soybean (JS-9305) - safflower	Soybean (JS-335) - safflower			
2 rows per BBF: control	1045	1386	1303	1245	2135	2.7
2 rows per BBF: 50% RDF + *Azotobacter* + PSB	1289	1783	1611	1561	2451	3.1
2 rows per BBF: RDF + *Azotobacter* + PSB	1182	1605	1710	1499	2389	3.0
3 rows per BBF: control	1168	1299	1218	1228	2135	2.7
3 rows per BBF: 50% RDF + *Azotobacter* + PSB	1343	1605	1611	1520	2451	3.1
3 rows per BBF: 50% RDF + *Azotobacter* + PSB	1415	1689	1775	1626	2389	3.0
Mean	**1240**	**1561**	**1538**			
	CS	P x I	Interaction			
S.Em±	112	111	192			
C.D (p≤0.05)	NS	335	NS			

SEY - Safflower Equivalent Yield; RWUE - Rain Water Use Efficiency

***Kharif* crops**: Four rows of greengram and soybean were sown on 13th July on BBF (1.2 m x 0.3 m) under zero tilled conditions. A total of 1350 mm of rainfall was received during the season (June to November 2020). The seed yield of greengram, soybean (short duration variety Basara) and soybean (normal duration variety JS-335) were 450, 1350 and 1200 kg/ha, respectively.

Sowing of kharif crops on undisturbed BBF / zero tilled BBF

Greengram (Var. WGG-42)

Soybean (Var. JS-335)

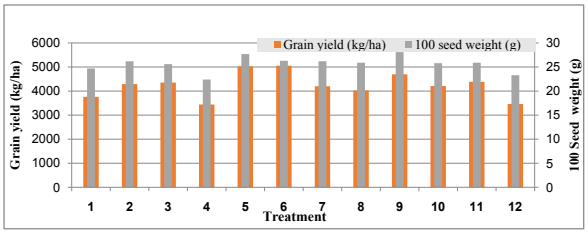
Soybean (Var. JS-9305)

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 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 systems is being developed and evaluated to improve nutrient use efficiency.

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

The fixed plot field experiment with major, secondary and micronutrients in Alfisols on a long-term basis has completed two crop cycles of Maize (*kharif*) – Castor (*rabi*) cropping system. Mean performance of maize showed integrated nutrient management (NPK+FYM), recorded the highest seed yield (5 t/ha) that was marginally superior over 150% recommended NPK to both crops. Further, micronutrient B along with NPK recorded the highest test weight (28.1 g). Similar trend was noticed for fresh fodder and dry stover.

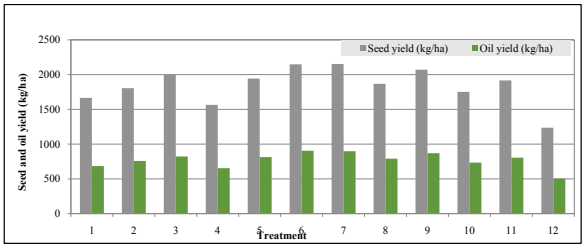


1. N-N; 2. NP – NP; 3. NPK – NPK; 4. 50% NPK; 5. 150% NPK – 150% NPK; 6. NPK + CR - NPK; 7. NPK+FYM 5 t/ha - NPK; 8. NPK+S – NPK; 9. NPK+B -NPK; 10. NPK+Zn - NPK; 11. NPK+S+Zn+B - NPK; 12. Control

Performance of maize under Long term fertility trial in maize - castor cropping system in alfisols (Mean of 2018-19 to 2019-20)

Performance of castor under long term nutrient management in Maize – Castor cropping system in Alfisols

The mean performance of castor crop succeeding maize in *rabi* in maize-castor cropping system indicates that seed yield was higher with use of crop residues (CR) or FYM along with NPK (2.15 t/ha) followed by use of micronutrient B along with NPK (2.1 t/ha). Oil yield varied from 500 to 905 kg/ha.

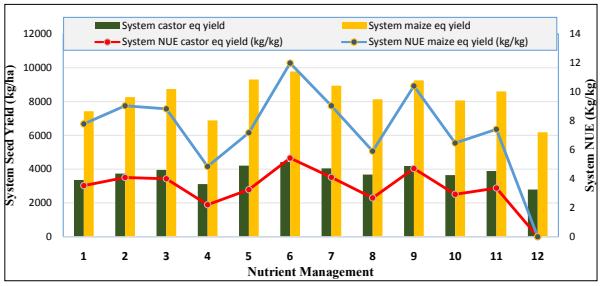


1. N-N; 2. NP – NP; 3. NPK – NPK; 4. 50% NPK; 5. 150% NPK – 150% NPK; 6. NPK + CR - NPK; 7. NPK+FYM 5t/ha - NPK; 8. NPK+S – NPK; 9. NPK+B -NPK; 10. NPK+Zn - NPK; 11. NPK+S+Zn+B - NPK; 12. Control

Mean seed yield of castor due to long term nutrient management in Alfisols (2018-19 to 2019-20)

The system equivalent yields and nutrient use efficiencies for the mean yields of maize and castor for the nutrient management practices on maize – castor cropping system indicate highest equivalent yield of castor (4422 kg/ha) and maize (9780 kg/ha) recorded with NPK + Crop Residue – NPK. The treatment also recorded higher NUE for individual crops (12 and 5.4 for maize and castor, respectively) followed by B application along with NPK.

Soil fertility after *rabi* castor in 2018-19 showed significant variation for pH, soil OC, soil available P and S and soil available Mn and Zn. Soil pH was slightly alkaline (> 8.0) with N alone or control or 50% NPK while with adequate and balanced nutrition, it was neutral. Soil OC was high with NPK+FYM and NPK+Zn-NPK (0.69%). The available soil N and K was low and did not vary significantly. There was significant buildup of soil P in all treatments with P application (range from 27 to 62 kg/ha) compared to 7 to 13 kg/ha without P application and initial status. Soil S was high with 150% NPK to both the crops and in treatments with use of S along with NPK. Similarly, soil Zn was higher in treatments receiving Zn (7 to 9 mg/kg *vs* 1.6-2.6 mg/kg).



1. N-N; 2. NP – NP; 3. NPK – NPK; 4. 50% NPK; 5. 150% NPK – 150% NPK; 6. NPK + CR - NPK; 7. NPK+FYM 5t/ha - NPK; 8. NPK+S – NPK; 9. NPK+B -NPK; 10. NPK+Zn - NPK; 11. NPK+S+Zn+B - NPK; 12. Control

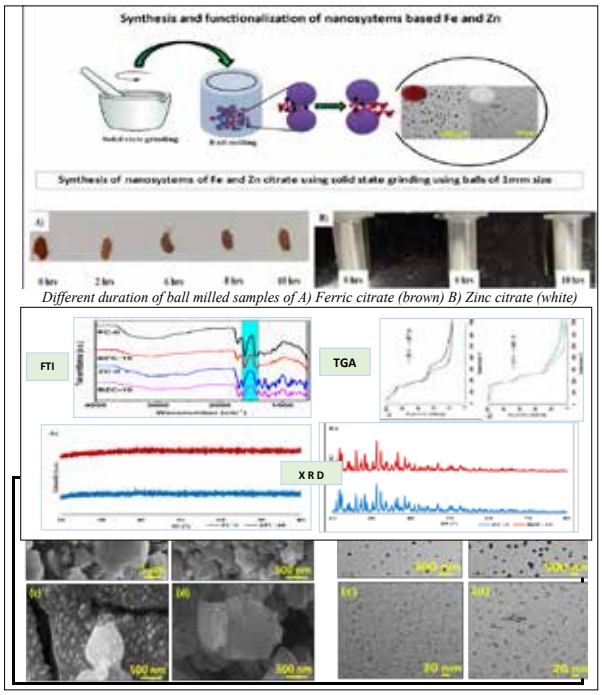
System Equivalent Yield and NUE under Long Term Nutrient managment in maize-castor cropping systems in Alfisols (Mean of 2018-19 to 2019-20)

Fabrication of Fe and Zn nanosystems as efficient nutrient sources

Criticality of micronutrients for balanced nutrition is increasing for realizing high seed yield and achieving higher nutrient use efficiency. The present nutrient use efficiency of micronutrients is a meagre <5%. The new opportunity of developing nanosystems of micronutrients has potential to minimize losses and reactivity leading to lower cost and higher use efficiency.

Synthesis of Fe and Zn nanosystems for soil application

Nanonutrients of Fe and Zn was synthesized using greener techniques like solid-state grinding followed by ball-milling. A series of Fe-citrate and Zn-citrate nanosystems were prepared at different ball milling durations. These nanosystems were characterized by using various techniques: reaction was confirmed through Fourier transform infrared spectroscopy (FTIR), morphological characterization was achieved through scanning electron microscope (SEM) and transmission electron microscope (TEM), and structural characterization was done through X-ray diffraction (XRD) and the thermal properties were assessed using thermogravimetric analysis (TGA). The results demonstrated that the ball mill treatment for different durations influenced the decrease in particle size to result in achieving nano size of the Fe-citrate and Zn-citrates without affecting the crystallinity and thermal stability of the citrates.



Different duration of ball milled samples of A) Ferric citrate (brown) B) Zinc citrate (white)

SEM and TEM images of a) un-ball milled FC; b) Ball milled FC-10 hours; c) un-ball milled ZC-0; d) Ball milled ZC-10 hours samples

The ferric and zinc citrates and respective ball-milled samples (nano material) were assessed for response in soybean in pot culture experiment with white sand. At 15 days after sowing, observation on germination and nutrient uptake was recorded. No toxicity symptoms were observed during the study period. The study proved the mobility and plant uptake of the developed nano systems.

Plant uptake with developed metal citrates in soybean (var. JS-335)

Treatment (Fe nano citrate)	Concentration of Fe µg/ g of dry weight	Treatment (Zn nano citrate)	Concentration of Zn µg/ g of dry weight
Control	295.8^{c}	Control	66.9^{c}
FC 1:1 0 h	493.3^{b}	ZC 1:3 0 h	288.9^{b}
BFC 1:1 2 h	664.1^{ab}	BZC 1:3 2 h	306^{b}
BFC 1:1 4 h	662.9^{ab}	BZC 1:3 4 h	311.2^{b}
BFC 1:1 6 h	789.8^{a}	BZC 1:3 6 h	443.8^{a}
BFC 1:1 8 h	502.7^{b}	BZC 1:3 8 h	353.7^{ab}
BFC 1:1 10 h	534.1^{b}	BZC 1:3 10 h	347.5^{ab}
CD (P=0.05)	173.5	CD (P=0.05)	114.1
CV (%)	13.0	CV (%)	15.9

Mean values with different alphabet superscripts varied significantly as per DMRT
FC = Ferric citrate; BFS = Ball milled ferric citrate; ZC = Zinc citrate; BZC = Ball milled zinc citrate

Developing agro-technology for enhancing sesame productivity under rice-sesame cropping system

Fallow lands after rice with significant residual fertility and moisture provide good opportunity to grow low input requiring sesame during the favorable *rabi*/summer seasons. The performance of sesame succeeding rice varies as per the soil type and crop growing conditions. To assess the performance of sesame after rice under major rice growing regions and soil types, a field experiment was conducted at four locations *viz.*, Hyderabad (TS - Sandy clay loam), Ragolu (AP - Sandy clay loam), Aduturai (TN - Alluvial clay) and Mahisapet (OD - Sandy loam) to find out the optimum tillage and nutrient requirement for rice fallow sesame with tillage management as main factor and nutrient management as sub-factor in a split plot design with three replications.

Across the four centres, zero tillage resulted in significantly lowest yield than other tillage treatments. While at Mahisapet (OD) and Hyderabad (TS) sites registered statistically comparable yields for reduced and conventional tillage, at Ragolu (AP) and Aduturai (TN) sites, conventional tillage and reduced tillage were significantly superior. Across the centres, 100% recommended doses of fertilizers registered the highest yield of sesame, albeit on par with 75% RDF at Mahisapet and Aduturai and 50% RDF at Ragolu (AP).

Effect of tillage and nutrient management on yield (kg/ha) of rice fallow sesame (2019-20)

Treatment	Mahisapet (Odisha)	Ragolu (Andhra Pradesh)	Aduturai (Tamil Nadu)	Hyderabad (Telangana)	Mean
Tillage practices					
A1. Reduced tillage	441^{a}	233^{b}	477^{a}	268^{a}	355
A2: Conventional tillage	462^{a}	458^{a}	408^{b}	307^{a}	409
A3. Zero tillage	349^{b}	179^{c}	334^{c}	97^{b}	240
CD (P=0.05)	65	53	65	41	
Fertilizer management					
B1: Control	322^{b}	247^{b}	366^{b}	90^{d}	256
B2: 25% RDF	353^{b}	281^{b}	390^{b}	146^{c}	292
B3: 50% RDF	379^{b}	287^{ab}	406^{b}	240^{b}	328
B4: 75% RDF	489^{a}	310^{ab}	422^{a}	260^{b}	370
B5: 100% RDF	544^{a}	325^{a}	447^{a}	384^{a}	425
CD (P=0.05)	65	43	27	42	
CV (%)	16	15	14	19	

a) Zero tillage rice fallow sesame at Mahisapet(OD)

b) Rice fallow sesame at Ragolu (AP)

c) Zero tillage rice fallow sesame at Aduturai (TN)

d) Reduced tillage rice fallow sesame at Aduturai (TN)

Abiotic stress tolerance

Abiotic stresses like moisture, temperature and salinity are the limiting factors for oilseeds production under rainfed conditions. Occurrence of drought at sensitive stages severely limits crop yields. Therefore, identification of drought tolerant lines and traits contributing to tolerance is a pre-requisite to breeding for drought tolerance. Towards this direction, castor, sunflower, safflower and sesame genotypes were screened and sources of resistance to drought, salinity and temperature were identified.

Castor

Evaluation of castor parental lines for drought tolerance in field

Sixteen parental lines (10 monoecious, 6 pistillate) along with two checks were evaluated in *rabi* 2019 for their drought tolerance under field conditions by imposing water stress (WS) from 30-90 DAS along with irrigated control in a split plot design with three replications. Moisture stress significantly reduced different crop growth parameters like plant height, stem girth, dry weights of stem, leaf, spike and TDM, effective spike length (ESL), capsule number, spike weight and seed yield of different order spikes. Stress induced a significant increase in bloom content as it is known to reduce cuticular transpiration while RWC was on par with control. Under stress, crop had reduced leaf area and increased leaf thickness resulting in decrease of specific leaf area (SLA) and increase of specific leaf weight (SLW).

Mean total seed yield in water stress reduced up to 50% (67 g/plant) of that under irrigated (control) conditions (134 g/plant). Among the 16 genotypes screened, three genotypes *viz.*, DCS-104, DCS-106, DPC-18 showed ≤30% reduction in total seed yield with ≤0.70 Drought Susceptibility Index (DSI) followed by DPC-9 and DCS-119 which showed ≤40% reduction in total seed yield with ≤0.90 DSI. These selected tolerant genotypes recorded >80 g/plant seed yield under stress except DPC-9 (seed yield of 70.2 g/plant in stress). All the selected genotypes with drought tolerance also showed increased bloom content during stress.

Performance of 16 castor genotypes under water stress

Genotype	Total dry matter (g/plant)		Total seed yield [TSY] (g/plant)		Reduction in TSY under Stress (%)	DSI	Harvest Index (%)	
	Control	Stress	Control	Stress			Control	Stress
Monoecious lines								
DCS-9	294	141	112	41	63.6	1.41	38.1	29.1
DCS-104	321	217	106	86	19.1	0.42	33.0	39.9
DCS-105	408	216	148	72	51.1	1.13	36.5	33.6
DCS-106	331	216	118	82	30.8	0.68	35.9	37.8
DCS-110	303	212	139	67	52.1	1.15	45.9	31.8
DCS-119	420	255	135	82	39.0	0.86	31.9	32.4
ICS-121	315	157	113	35	68.6	1.52	36.4	22.6
ICS-127	387	174	122	47	61.7	1.37	31.4	27.1
ICS-133	384	218	132	72	45.7	1.01	34.2	33.2
ICS-134	500	154	154	37	75.9	1.68	31.2	24.4
Pistillate lines								
DPC-9	373	225	118	70	40.2	0.89	31.6	31.8
DPC-16	328	215	104	56	45.7	1.01	32.1	26.4
DPC-18	339	255	148	108	27	0.60	44.0	42.0
DPC-21	508	222	171	79	53.8	1.19	34.1	35.8
DPC-23	304	105	115	40	65.5	1.45	37.9	37.7
DPC-28	366	157	120	56	52.9	1.17	33.0	37.4
Checks								
48-1	381	244	159	81	49.2	1.09	41.7	32.9
DCH-519	484	231	195	97	50.2	1.11	41.3	42.7
CD (P=0.05)								
Main plots	45.3		2.6				NS	
Sub plots	38.6		19.1				5.2	
Interaction 1	54.5		27.1				7.4	
2	57.0		26.3				7.6	
CV (%) a	19.4		3.2				20.4	
b	11.9		16.6				13.1	

DSI-Drought susceptibility index

Two selected genotypes with good seed yield and low DSI *viz.*, DPC-18 and DCS-119 also recorded >250 g/plant TDM even under water stress. The reduction in harvest index (HI) was non-significant with drought stress. HI of DPC-18 was high (>40%) and on par both under stress and control (42, 44% respectively) indicating its potential use in development of drought tolerant hybrids.

Among the genotypes screened, DPC-21, a pistillate line, produced highest seed yield of primary spike in control (84 g/plant) and primary seed yield on par with other better performing lines (35 g/plant) under stress. It showed less reduction in secondary seed yield also with drought stress (51.2 g/plant in irrigated control, 43.6 g/plant in water stress) but there was no tertiary spike/seed production in stressed plots after relieving stress which under-rated the drought tolerance of this genotype. DPC-18, a selected drought tolerant genotype also recorded good seed yield of primary both in control and stress, but, contrary to DPC-21, it showed good recovery growth with increased tertiary spike/seed production after relieving stress thereby increasing the total seed yield with less percent reduction in stress and also with low DSI and high

HI. Hence, along with three selected genotypes *viz.*, DPC-18, DCS-104, DCS-106 (good recovery growth after relieving stress by production of more tertiaries, drought tolerance with less seed yield reduction and low DSI), DPC-21 also can be used in drought tolerance breeding.

Sunflower

Identification of physiologically efficient lines of sunflower tolerant to temperature stress

Fourteen sunflower lines including 10 CMS lines and four hybrids (DRSH-1, KBSH-44, CO-2 and CSFH-12205) were evaluated for temperature tolerance under field conditions at two different sowing dates, one normal (20.01.2020) and delayed sowing (24.02.2020) to expose the crop to high temperatures. Crop was grown under irrigated conditions without any moisture stress. Mean maximum and minimum temperatures recorded from sowing to flowering in normal sowing were 32.2 °C and 16.4 °C and for February sown crop, they were 35.5 °C and 20.2 °C, respectively. Similarly, the temperature range from sowing to harvest was 36.1 °C and 20.9 °C and 38.3 °C and 23.8 °C during the normal and February sowings, respectively.

Effect of high temperature on different growth parameters

Crop stage	January sowing (Normal)	February sowing (High temperature)
Days to flowering	52	50
Days to harvest	83	75
Plant height (cm)	124	119
Stem girth (mm)	16.0	13.6
No. of leaves	24	27
LAI	2.6	2.3
SCMR	40.6	38.6
Seed yield (g/plant)	18.5	14.6
Harvest Index (HI) (%)	23	24

High temperature stress caused reduction in days to flowering by 2 days and days to maturity by 8 days and reduced seed yield by 22% and increased HI by 5%. All the check hybrids showed ≤ 10% reduction in yield due to high temperature stress. Among the CMS lines, AKSF-6-3B showed tolerance to high temperature with only 2% reduction in yield without change in HI.

Effect of high temperature on seed yield and harvest index

S.No	Inbred	Seed yield (g/ plant)				Harvest Index [HI] (%)		
		January sowing (normal)	February sowing (high temp)	Reduction (%)	Heat tolerance index	January sowing (normal)	February sowing (high temp)	Change (%)
1	AKSF 6-3B	20.8	20.3	2	0.97	27	27	0
2	CMS-17B	21.6	13.3	40	0.37	26	20	-25
3	CMS-107B	19.2	15.1	21	0.73	20	23	15
4	CMS-125B	18.2	9.7	47	0.13	32	31	-2
5	CMS-127B	14.5	11.1	24	0.69	20	23	17
6	CMS-135B	15.4	8.5	45	0.19	22	17	-23
7	CMS-144B	13.0	10.2	22	0.72	22	19	-17
8	CMS-42B	18.6	10.7	43	0.25	27	26	-5
9	CMS-70B	16.0	12.2	24	0.69	23	24	2
10	ARM-243B	15.0	12.5	17	0.79	16	18	12
11	CO-2	16.2	15.8	3	0.97	18	26	41
12	CSFH-12205	19.5	17.6	10	0.89	19	24	22
13	DRSH-1	25.1	23.7	6	0.94	26	32	24
14	KBSH-44	25.3	23.5	7	0.92	25	29	14
	Mean	**18.5**	**14.6**	**22**		**23**	**24**	**5**

Safflower

Screening genotypes for salinity and assessment of biometric parameters for tolerance

Evaluation of genotypes to salinity stress in laboratory using paper towel method

In a confirmatory study during second year, 10 salinity tolerant safflower genotypes along with one susceptible check (SSF-733) was evaluated in laboratory by adopting the paper towel protocol with normal and saline (EC=10 dS/m) water. Growth parameters of the seedlings *viz*., shoot length, shoot weight, root length, root weight, sodium and potassium concentration in shoot and root in response to salinity were recorded after 15 days.

Shoot length and shoot dry weight

Seven genotypes showed less than 10 per cent reduction in shoot length when irrigated with saline water at EC=10 dS/m against control (non-saline water at EC=0 dS/m) with maximum reduction in shoot length in susceptible check SSF-733 (14.0%). Varieties namely PBNS-12 and A-1 also showed better shoot length growth at 10EC salinity compared to susceptible check. However, shoot dry weight of genotypes varied due to salinity levels. Highest reduction of shoot weight (44%) was noticed in susceptible check SSF-733 salinity 10 dS/m while, six genotypes showed less than 11 per cent reduction in shoot weight compared to salinity control.

Shoot sodium (Na) and potassium (K) uptake: The growth of the seedlings in paper towel under salinity situation varied significantly against normal irrigation water and uptake directly affected by the concentration of the sodium and potassium content in the shoot and roots of the genotypes. It was observed that when the seedlings were irrigated with saline water (10 dS/m), the sodium uptake in the shoot also increased irrespective of salinity tolerance (i.e., in all genotypes including susceptible check). However, an interesting observation noticed was that the potassium uptake was high in salinity tolerant genotype. Hence, highest per cent increase in K uptake was noticed in genotype IC-406052 (14.6%) and IC-406143 (12.9%) compared to the susceptible check SSF-733 (-59.2%) against their respective salinity control. Interestingly, least value of shoot Na to K ratio (Na /K) was noticed in tolerant genotype IC-406052 (2.8) indicating the ability of genotype to maintain sufficient amounts of K against the influx of high sodium in the shoot due to salinity in the root zone. However, the values for Na/K ratio did not vary in the safflower genotypes when irrigated with normal water (EC=O).

Performance of promising safflower genotypes under salinity (paper towel method)

Genotype	Shoot length (cm)		Shoot weight (g)		Na uptake Shoot (mg/g dry wt.)		K uptake Shoot (mg/g dry wt.)		Na/K ratio in control (EC 0 ds/m)	Na/K ratio at EC 10 dS/m
	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m		
GMU-6506	29.1	-5.2	0.19	-10.5	2.19	261.0	1.98	-20.9	1.1	5.0
GMU-5075	32.2	-8.6	0.21	-13.3	2.48	155.9	2.25	-42.1	1.1	4.9
GMU-3281	28.6	-5.2	0.16	-6.3	1.87	262.2	1.97	-30.6	1.0	5.0
IC-406143	29.8	-6.4	0.22	-4.5	2.71	236.8	2.53	12.9	1.1	3.2
EC-661173	31.1	-8.7	0.25	-8.0	3.23	218.1	2.90	-23.1	1.1	4.6
IC-406052	31.8	-7.5	0.29	-10.3	3.57	198.1	3.34	14.6	1.1	2.8
IC-338209	29.9	-7.0	0.25	-4.0	3.10	253.8	3.05	-23.7	1.0	4.7
PBNS-12	30.6	-10.8	0.24	-12.5	2.98	216.8	2.47	-31.2	1.2	5.5
A-1	30.4	-11.2	0.22	-27.3	2.71	203.9	2.29	-38.5	1.2	5.8
SSF-733 (Susceptible check)	31.1	-14.1	0.29	-44.8	3.42	163.7	3.22	-59.2	1.1	6.9

C: EC = 0 dS/m; PR: percentage reduction under EC10; PI: percentage increase under EC10

Pot culture study

To study the actual reaction of salinity tolerant genotypes in soil, the genotypes were grown in pots and were irrigated with normal water and saline water (EC=10 dS/m). The following observations were recorded *viz.*, shoot weight, seed yield, and potassium and sodium uptake in the shoots.

Performance of promising safflower genotypes in terms of shoot weight, seed yield, sodium and potassium uptake in shoots at harvest

Genotype	Shoot wt (g)		Seed yield (g/pot)		Na uptake (mg/g)		K uptake (mg/g)		Na/K ratio (at EC 0 dS/m)	Na/K ratio (at EC 10 dS/m)
	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m	Control (EC=0 dS/m)	% change at EC 10 dS/m		
GMU-6506	2.37	-28.3	0.79	-26.6	5.9	270.1	28.0	-38.6	0.21	1.3
GMU-5075	4.9	-67.6	1.24	-54.0	9.3	140.8	69.1	-77.7	0.13	1.5
GMU-3281	5.47	-69.1	0.8	-87.5	11.5	95.7	72.2	-83.4	0.16	1.9
IC-406143	6.13	-71.6	1.35	-65.9	12.3	71.7	71.7	-81.8	0.17	1.6
EC-661173	6.33	-73.9	1.44	-72.9	12.7	68.1	88.6	-87.3	0.14	1.9
IC-406052	5.87	-70.2	1.81	-65.7	10.6	98.8	101.0	-81.3	0.15	1.1
IC-338209	6.87	-77.0	1.06	-54.7	13.7	43.7	98.2	-86.2	0.14	1.5
PBNS-12	6.4	-73.8	1.84	-73.9	10.2	124.8	97.3	-85.1	0.11	1.6
A-1	6.23	-73.0	1.17	-70.1	10.0	166.3	83.5	-83.3	0.12	1.9
SSF-733 (Susceptible check)	5.07	-81.1	1.34	-79.1	9.1	68.3	74.5	-87.8	0.12	1.7

Shoot dry weight and seed yield

The susceptible check SSF-733 showed maximum reduction in shoot dry weight (-81.1%) at EC=10 dS/m against control (0 salinity). The seed yield of genotypes varied due to salinity levels. Highest reduction of seed yield (-79%) was noticed in susceptible check SSF-733 and minimum was recorded in genotype GMU-6506 (-26%) due to salinity.

Shoot sodium (Na) and potassium (K) uptake due to salinity at harvest

In pot culture study, the soil had buffering effect on the salinity of the irrigation water with respect to plant growth. As it was observed that the regular irrigation to genotypes with EC= 0 and 10dS/m till harvest stage did not show any dramatic increase in the sodium uptake in the shoot (as against the high uptake as observed in paper towel study). Although the sodium uptake was high in all the genotypes including susceptible check due saline treatment but minimum percent reduction in potassium uptake was noticed in tolerant genotype GMU-6506 (-38.6%) followed by GMU-5075 and EC-406052 while, susceptible check SSF-733 recorded maximum per cent reduction in potassium uptake (-87.8%). The parameter Na/K ratio in shoot is also important in indicating the salinity tolerance, least value of 1.1 was noticed in genotype IC-406052. However, the values for Na/K ratio did not vary in the safflower genotypes when irrigated with normal water (EC=0). Similar results were also noticed paper towel study in laboratory. Further field level evaluation of these genotypes in natural saline soils for performance up to harvest would help in identifying salinity tolerant lines.

Evaluation of the selected genotypes for salinity tolerance

IC-406052 @ EC=10 dS/m (Saline Tolerant)
SDM: 1.75g
Seed yield/plant: 0.62g
Shoot Na: 1.20%
Shoot K: 1.08%
Shoot Na/K ratio: 1.1

SSF-733 @ EC= 10 dS/m (Susceptible)
SDM: 0.79g
Seed yield/plant: 0.39g
Shoot Na: 1.69%
Shoot K: 0.80%
Shoot Na/K ratio: 2.1

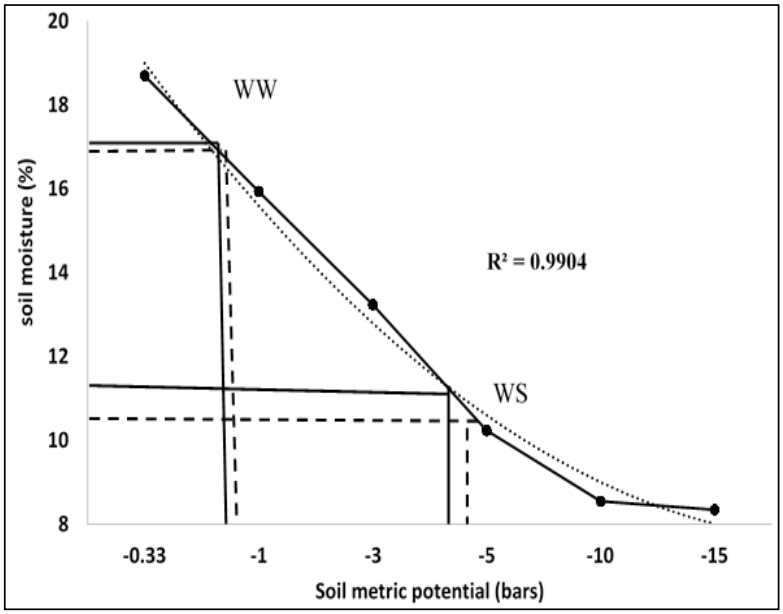
Sesame

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

A field experiment was conducted during late *rabi,* 2019 in shallow Alfisols under irrigated and moisture stress conditions with 25 sesame genotypes, to study the morpho-phenological, physiological and yield and its attributes. Moisture stress was imposed at the flowering stage to physiological maturity and monitored using soil moisture sensors. The sesame genotypes showed significant variation for most of the traits under both irrigated and moisture stress conditions except for days to flower initiation, days to 50% flowering, days to maturity.

Under irrigated conditions, maximum values for plant height, leaf area, stomatal conductance, number of capsules/plant, 1000 seed weight and seed yield were observed in IC-204966; for capsule weight and HI in IC-205471; for intrinsic WUE and capsule length in IC-203962; for RWC in IC-132186; seed number/capsule in IC-132171; low leaf temperature and higher SPAD values in IC-132207; for higher photosynthetic rate in IC-205353 and higher transpiration rate in genotypes IC-132171, IC-132186 and IC-205353; and the number of branches in IC-131500 and oil content in IC-204445.

Under stress conditions, maximum values for plant height, number of branches, RWC, number of capsules/plant, seed yield, HI was observed in genotype IC-204966. Genotype IC-205471 recorded higher capsule weight and total biomass; genotype IC-203962 recorded more number of seed/capsule and capsule length; IC-132186 for higher test weight, transpiration rate, stomatal conductance and oil content; genotype IC-131500 for higher leaf area and iWUE, photosynthetic rate; IC-132207 for low leaf temperature and genotype IC-204445 for higher SPAD value.



Imposed soil moisture in terms of soil metric potential (in bars) under water stress (WS) in comparison with well-watered (WW) conditions

IC-204966 under water stress condition

The genotype IC-204966 had the highest seed weight, capsule number and plant height under both moisture stress and irrigated conditions whereas it expressed high RWC, HI and number of branches under moisture stress condition which is the best indicator for moisture stress tolerance. The genotype IC-131500 had a high intrinsic WUE, leaf area, and photosynthetic rate under moisture stress indicating that the transpired water contributed more towards biomass and seed yield. Therefore, the findings of

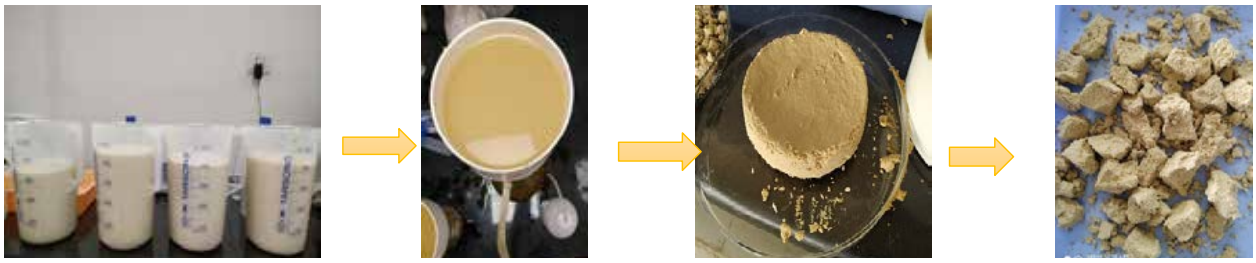
the experiment provided information on the trait-specific genotypes for moisture stress tolerance and a significant relationship between traits and seed yield helped to identify the better-performing genotypes *viz.*, IC-204966, IC-132186, IC-132207, IC-131500, and IC-203962 for traits associated with moisture stress tolerance. Among these identified genotypes, IC-204966 was superior and performed better for most of the traits like seed yield, capsule number, RWC, plant height, HI under both the conditions and had all moisture stress tolerance characteristics.

Quality and Value Addition

Increasing profitability of oilseeds production is critical for competitive and sustainable acreage under oilseeds to meet the production demand. Oilseeds provide valuable by-product cake after extracting primary product - oil. The protein rich oil cake is very useful as feed in dairy and poultry. Value addition of safflower cake as protein sources *viz.*, concentrates, isolates, hydrolysates, in feed as replacement to expensive casein and soya meal. Attempts to prepare novel protein equivalents from safflower meal was made and evaluated.

Production and characterization of protein hydrolysates from safflower seed and validation of their utility in animal nutrition

A novel process was standardized for making protein hydrolysates from safflower meal with respect to parameters such as protease (papain, pepsin, chymotrypsin, alcalase, trypsin, flavourzyme), protease combinations, temperature (5-100 °C), pH (12-1.5), time (5-240 min), acid base concentration and source.



Safflower seed liquid extract → *Vacuum filtration* → *Protein hydrolysates*

Stages in the process of production of protein hydrolysates

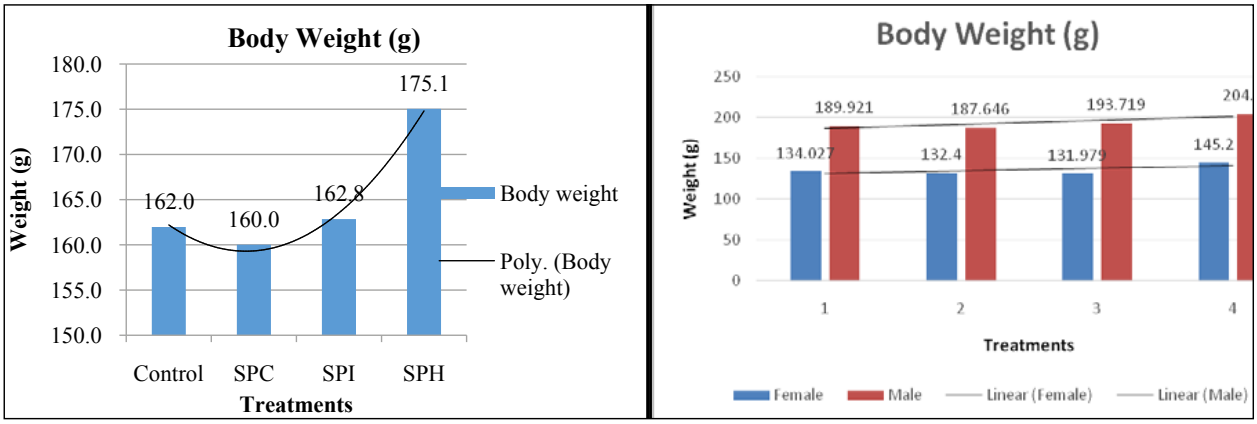
Characterization of protein concentrates, isolates and hydrolysates for all physico-chemical properties were completed using standard protocols. FT-IR characterization for functional groups identification, Differential Scanning Calorimeter (DSC) characterization for thermal properties, X-ray powder diffraction (XRD), SEM and TEM for structural characterization of materials. Further, the three products were characterized for their antioxidant potential, water and oil holding capacity, foaming capacity, swelling index, amino acid composition, presence of contaminants-human pathogens and fungus, and antimicrobial activity.

Efficacy of protein hydrolysates from safflower seed and validation of their utility in nutrition of rats

The experiment was conducted for 15 weeks at National Institute of Nutrition (NIN), Hyderabad. Gradual increase in the feed intake was observed in all the treatments. Rats (both male and female) fed with safflower protein concentrate (SPC), safflower protein isolate (SPI) and safflower protein hydrolysate (SPH) showed significant increase in the body weight. However, higher increase was recorded with SPH diets. Biochemical parameters such as glucose, total cholesterol, triglycerides, HDL, LDL, total protein, albumin, bilirubin, aspartate aminotransferase,

alanine aminotransferase, alkaline phosphatase, creatinine, urea, uric acid, phosphorus, calcium and CPK were recorded. All biochemical parameters were in normal range. All body composition and urine parameters were in normal range. Diet did not show any differences or abnormalities in reproductive performance.

Evaluation of the efficacy of safflower seed protein concentrates (meal) in Vanaraja chicken variety



Effect of safflower protein hydrolysates diet on the body weight of rats

Efficacy of safflower meal was tested in *Vanaraja* variety of chicken during summer at ICAR-Project Directorate on Poultry (ICAR-PDP), Hyderabad. The experiment was conducted with 5 treatments and 11 replications. In each replication, five birds were taken. Different doses of SPC were given to birds (25, 50 75 and 100% replacement of soybean meal; control soybean meal) along with basal diet. Body weight gain, feed intake, food conversation ratio and changes in serum parameters were recorded up to 10 weeks. Significant increase in body weight and decrease in feed intake was observed at 15.9 kg/t dose. Slaughter parameters in all treatments were in normal range.

Effect of safflower seed protein concentrates diet on performance of Vanaraja chicken

Treatment (CP Source)	Week 9 to 10		
	Body weight gain/bird (g)	Feed intake/bird (g)	Feed Conversion Ratio (FCR)
1. SBM 100% (0% SKM)	1531	4696^{ab}	3.068^{a}
2. SKM 25%	1629	4861^{a}	2.985^{ab}
3. SKM 50%	1607	4608^{b}	2.873^{b}
4. SKM 75%	1600	4574^{b}	2.863^{b}
5. SKM 100%	1628	4677^{ab}	2.894^{b}
P - Value	0.19	0.03	0.01
N	11	11	11
SEm±	14.6	30.8	0.02

CP: Crude Protein; SBM: Soybean meal; SKM: Safflower kernel meal
Mean values with different alphabet superscripts varied significantly as per DMRT

Host Plant Resistance

Use of host plant resistance as a key component of integrated pest management (IPM) system has greater potential than any other method for pest management. It is the best option available to minimize the cost of plant protection. Standardization of screening methods and identification of reliable resistance sources are important in the development of pest resistant cultivars. Development of screening method for castor leafhopper, identifying suitable susceptible checks for sunflower leafhopper and symptomatology, etiology and transmission methods of sesame phyllody were carried out to standardize and refine screening protocols against these pests. Sources of resistance to wilt, leafhopper, thrips and capsule borer in castor; leafhopper in sunflower and aphid in safflower were identified and influence of wax content in pericarp of castor capsules on gray mold severity has been evaluated.

Screening methods and mechanism of resistance

Development of an *in vivo* method to study mechanism of resistance to leafhopper in castor

Developed an *in vivo* cage method to study the mechanism of resistance to leafhopper in castor under controlled conditions. Cage method using foldable cage of 215 cm length x 112 cm width x 102 cm height was used to study the antixenosis mechanism of resistance. Potted castor plants (three resistant genotypes *viz*., RG-631, RG-2661, RG-3060 and three susceptible genotypes *viz*., DCS-107, DCH-177, DPC-9 were raised in the cage. At 30 days after sowing, leafhoppers were released and allowed for oviposition. After 7 days, each pot was shifted to individual cages and observation on oviposition was recorded. The results revealed that the resistant genotypes exhibited antixenosis for oviposition (0.8 to 6.8 eggs/leaf in resistant genotypes as compared to 9.3 to 18.8 eggs/leaf in susceptible genotypes).

To study antibiosis and tolerance mechanism of resistance, each potted castor plant of the resistant and susceptible genotypes were grown in individual cages of 120 cm length x 73 cm width x 60 cm height. At 30 days after sowing, leafhoppers were released and allowed for oviposition. Number of eggs laid, nymphal duration, nymphal survival and tolerance of castor genotypes to hopper burn injury was observed. Nymphal duration in resistant genotypes was prolonged (17.6 to 20.3 days) significantly as compared with that on susceptible genotypes (14.2 to 18.0 days). However, nymphal development was unhampered in both resistant and susceptible genotypes. The resistant genotypes recorded hopper burn grade of 0 to 1 (on 0-4 scale) as compared to 3 to 4 in susceptible genotypes.

In vivo method developed to study mechanisms of resistance to leafhopper in castor

Hopper burn injury recorded among resistant and susceptible genotypes under in vivo method

Identification of susceptible check for leafhoppers in sunflower

Reaction of susceptible check is the basis for measuring the reaction of test entries in screening programmes. Since long time, the variety Morden was used as a susceptible check to leafhoppers. However, Morden is not uniform and inconsistent in its reaction to leafhoppers. A suitable susceptible check needs to be identified to replace Morden. During summer 2020, among the six susceptible lines evaluated NDCMS-2B and HA-2023 were highly susceptible. Trial was conducted to confirm the reaction of the susceptible checks. Among the six lines, NDCMS-2B was highly susceptible to leafhoppers. It recorded higher leafhopper population (20.0/plant) than other lines and confirmed the susceptible reaction to leafhoppers for the second year also with an MSI of 4.0. The study showed that the sunflower line, NDCMS-2B can be used as susceptible check in place of Morden in screening for leafhopper resistance.

Reaction of sunflower genotypes to leafhopper

Entry	Leafhoppers/3 leaves/plant at		MSI*	Reaction
	50 DAS	60 DAS		
DRSF-108	5.6	18.9	2.0	MR
DRSF-113	5.4	15.7	2.0	MR
HA-2023 A	5.4	11.0	3.5	S
HA-2023 B	5.2	18.0	3.4	S
NDCMS 2B	8.6	20.0	4.0	HS
CMS-125	4.3	16.3	2.0	MR
Morden	6.5	19.7	3.0	S

MSI- Mean Scale Index 0: Highly resistant; 0.1-1.0: Resistant;
1.1-2.5: Moderately resistant; 2.6-3.5: Susceptible; 3.6-5.0: Highly susceptible

Symptomatology and etiology of sesame phyllody

Symptomatology of sesame phyllody, vector associated and alternate hosts of phyllody was studied in sesame. Various types of symptoms for phyllody disease was observed in sesame plants *viz.*, flowery phyllody, virescence, and proliferation. However, 'virescence' and 'phyllody' were registered more often compared to the floral 'proliferation'. The symptoms of phyllody infected plants of sesame varied depending on the crop stage and infection time. The whole inflorescence was transformed into twisted, reduced leaves tightly arranged at the stem top, with shorter internodes. Among the vectors surveyed, sesame leafhopper, *Orosius albicinctus* Distant was found predominant and transmitted the disease. *Croton* sp., parthenium, periwinkle and sunn hemp were found as alternate hosts of phyllody disease.

Sesame plants showing (a) little leaf symptom, (b) healthy and infected flowers, (c) seed capsule cracking (healthy and infected pods of sesame), and (d) flower virescence symptom

Transmission of phytoplasma causing sesame phyllody

Nature of transmission of sesame phyllody was studied using five methods *i.e.* by using sap abrasion, sap injection, grafting, dodder and leafhopper.

Transmission of sesame phyllody through sap inoculation was carried out by using sap abrasion and sap injection methods. The sap from phyllody infected plants was inoculated onto 20, 25, 30, 35 days old healthy plants of different sesame genotypes *viz.*, E-8, Thilothama, CUMS-17, RJR- 170, Nirmala and IC-204158. All the inoculated plants were kept in insect proof cages and observed for symptom development. However, inoculated plants did not show any disease symptoms in both the methods. The results indicated that the disease was not transmitted through sap abrasion and sap injection methods.

Transmission of sesame phyllody through grafting was conducted using four-week-old healthy sesame plants. The grafting was made with phyllody affected scions on healthy stock and grafted plants were kept in insect proof net cages for development of symptoms. Initially light patches of yellowing was observed, later light crinkling of leaves and stunted growth was observed. The percentage of plants with disease infection was 90% and 60% and took 25.5 and 32.6 days for appearance of the symptoms on CUMS-17 and JCS-1020, respectively.

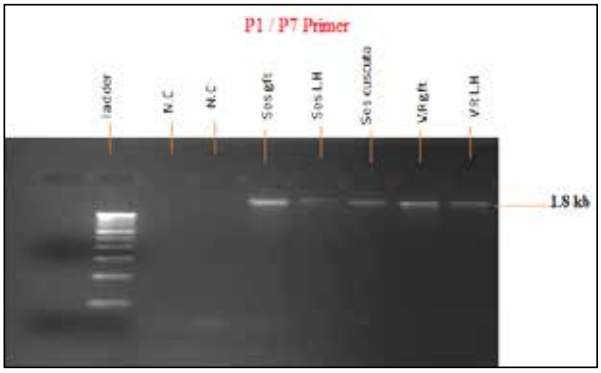
Transmission of phyllody through grafting

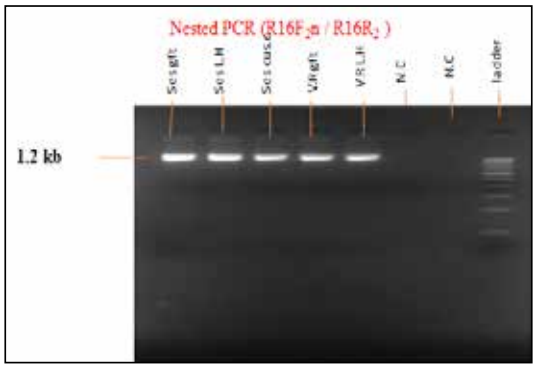
Transmission of sesame phyllody through dodder (*Cuscuta* sp.) was done to four-week-old healthy sesame plants. The dodder strands were established on phyllody infected plants of sesame for 4 weeks and newly formed dodder strands were attached to healthy plants and the plants were regularly observed for development of symptoms. Yellowing and crinkling of leaves was recorded on sesame plants. Percentage of plants with infection was 40% and 20% and had taken 42.5 and 50.0 days for appearance of symptoms on CUMS-17 and JCS-1020, respectively.

Healthy plants of sesame (CUMS-17) and sunn hemp were raised under insect proof cages to study transmission of sesame phyllody through leafhopper. Leafhoppers (*Orosius albicinctus*) were released on phyllody infected sesame plants and given an acquisition feeding period of 15 days under caged conditions. These leafhoppers were released onto the healthy plants raised under cages. After inoculation access period, the leafhoppers were killed with insecticide and the plants were observed for symptom development. Yellowish patches and crinkling of upper leaves were observed on transmitted plants. Percentage of plants with disease symptoms was 38.5% and 54.3% and had taken 60 and 40 days for appearance of symptoms on CUMS-17 and sunn hemp, respectively.

Transmission of phytoplasma through cuscuta

The samples of phytoplasma affected sesame obtained through various modes of transmission *viz.*, grafting, leafhopper and dodder and similarly periwinkle by grafting and leafhopper were confirmed for presence of phytoplasma through nested PCR using universal primer pairs P1/P7 and R16, F2/R 16 R2. PCR products of 1.8 kb were amplified from phyllody infected sesame using universal primer P1/P7 pair but not from healthy samples and a DNA fragment of 1.2 kb was amplified using primers R16F$_2$n/R 16 R2.





Ses gft-sesame grafting; ses LH- sesame leafhopper; Ses cuscuta-sesame cuscuta; VR gft-Vinca rosea grafting; VR.LH-Vinca rosea leafhopper ; Confirmation of sesame samples transmitted through grafting, leafhopper, cuscuta; Vinca rosea samples transmitted through grafting, leafhopper through nested PCR

Mechanisms of Resistance

Influence of wax content in pericarp of castor capsules on gray mold severity

Gray mold is a major disease of castor caused by the pathogen *Botryotinia ricini* which mainly targets the spike and capsules resulting in severe yield losses. Previous observations indicated that with the increase in waxy bloom intensity on capsules (visual) there was an increase in severity of gray mold. Further, to understand the influence of quantity of wax in pericarp of the capsules of different genotypes on disease severity, experiments were carried out.

The quantities of wax extracted from different waxy bloom types using rapid colorimetric method revealed that the disease severity increased with the increase in quantity of wax. The quantity of wax content from visually no or less waxy bloom genotypes *viz.*, DPC-9, RG-1963, ICS-324, ICS-325, RG-1274, RG 3126, RG-61, RG-2465, DCS-107 and ICH-538 was less than 1.50 µg/mg (0.70-1.50 µg/mg) and the genotypes recorded disease severity less than 40% (average disease severity based on detached capsule and spike, polyhouse and field screening). The quantity of wax in high bloom genotypes *viz.*, RG-2944, RG-1645, RG-2717, DCS-9, JC-12, SKI-337, JI-96, JI-226, TMV-5, DCS-118, RG-1289 and DCH-519 was higher than 1.50 µg/mg (1.50-3.00 µg/mg) with disease severity greater than 40% (40-95%) signifying the influence of wax in promoting the disease. Genotypes with no visible waxy bloom on capsules *viz.*, DPC-9, RG-1963, ICS-324 and ICS-325 with low quantities of wax content (0.17 to 0.69 µg/mg), recorded low disease severity. Non-spiny genotypes *viz.*, 48-1 and JI-315 with high bloom and wax quantity of 1.76 and 2.25 µg/mg recorded high average disease severity of 29.5% and 35.7%, respectively. Two genotypes *viz.*, ICS-324 and ICS-325 with no bloom on pericarp but having low quantity of wax (0.17 and 0.37 µg/mg) recorded low disease severity (1.3% and 2.1%) clearly establishing the role of waxy bloom in aiding gray mold infection. Spearman's rank correlation analysis revealed significant positive correlation ($r = >0.5$; $p = <0.01$) between capsule waxy bloom and disease severity.

Sources of Resistance

Castor

Wilt

Twenty trait specific inbred lines of castor were evaluated against wilt disease under sick plot conditions. Among them, ICI-RG-66-2511-3, ICI-RG-66-825-7 and ICI-RG-2719-9 showed resistant reaction to wilt with <20% disease incidence. Wilt incidence varied from 23.2 to 100% in the remaining entries, while susceptible check, JI-35 showed 97.5% and resistant check, 48-1 recorded 6.8% wilt incidence.

Different castor germplasm accessions and inbreds were screened for confirmation of resistance against wilt under glasshouse conditions by sick pot method. Among the entries, ICI-RG-2661-7-3-5-6, ICI-RG-2787-89-20, ICI-RG-2787-152-9, ICI-RG-3425-5, ICI-RG-2746-1, ICI-RG-2774-2, ICI-RG-898-6 and RG-2034 were resistant with <20% wilt incidence. JI-35 (susceptible check) showed 98.6% and 48-1 (resistant check) recorded 16.7% wilt incidence.

RG-3795 ICI-RG-898-6 ICI-RG-2787-89-20 ICI-RG-2787-152-9

Evaluation of trait specific inbred lines of castor against wilt through sick pot method

Wilt reaction of castor genotypes to isolates of *F. oxysporum* f.sp. *ricini* and identification of differential lines for castor wilt disease

About 150 castor genotypes including germplasm accessions, inbred lines, parental lines were screened over 5 years (2015-16 to 2019-20) against isolates of *F. oxysporum* f.sp. *ricini* from Hyderabad, Palem and S.K. Nagar. Among them, 31 genotypes showed resistant reaction; 63 showed susceptibility to all the three isolates while 56 genotypes showed differential reaction to isolates. AP-33 cultivar showed resistant reaction while JI-35 cultivar showed susceptible reaction to Hyderabad, Palem and S.K. Nagar isolates. DCS-107 and GC-3 cultivars showed resistant reaction to Hyderabad, S.K. Nagar isolates and susceptible reaction to Palem isolate. Two genotypes *viz*., RG-3105 and AP-56 recorded resistant reaction to Hyderabad isolate while susceptible reaction to Palem and S.K. Nagar isolates. AP-125 recorded resistant reaction to Hyderabad, Palem isolates and susceptible reaction to S.K. Nagar isolate. Cultivars AP-163 and AP-48 showed susceptible reaction to Hyderabad isolate and resistant reaction to Palem and S.K. Nagar isolates. Five genotypes *viz*., RG-3467, ICS-144, RG-2836, AP-203 and RG-2746 recorded susceptible reaction to Hyderabad, S.K. Nagar isolates while resistant reaction to Palem isolate. Three genotypes *viz*., ICS-125, AP-327 and AP-252 cultivars

RG-3795 ICI-RG-898-6 ICI-RG-2787-89-20 ICI-RG-2787-152-9

Evaluation of trait specific inbred lines of castor against wilt through sick pot method

showed susceptible reaction to Hyderabad, Palem isolates and resistant reaction in S.K. Nagar isolate. Based on above studies, castor genotypes *viz.*, AP-33, AP-125, DCS-107, AP-163/AP-48, RG-3105/AP-56, RG-2836/ RG-3467/ ICS-144, ICS-125 and JI-35 were selected as castor differential lines to study the race pattern /variability of castor wilt pathogen.

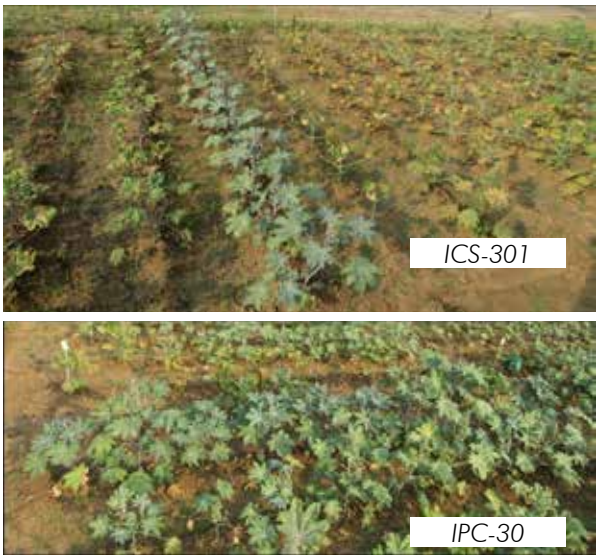
Leafhopper

Among 15 promising parental lines screened against leafhopper, seven parental lines *viz.*, ICS-200, ICS-216, ICS-217, DPC-18, DPC-27, IPC-34 and IPC-36 showed resistant reaction to leafhopper with hopper burn grade of 1 on 0-4 scale, while the susceptible checks recorded hopper burn grade of 4 on 0-4 scale. Eight parental lines *viz.*, ICS-186, ICS-190, ICS-210, DPC-19, DPC-20, IPC-35, IPC-37 and DCS-119 were moderately resistant to leafhopper with hopper burn grade of 2 on 0-4 scale.

Reaction of leafhopper resistant parental line, ICS-200 and susceptible checks

Leafhopper and thrips

Thirty seven castor parental lines along with susceptible and resistant checks were screened for their reaction to sucking pests (leafhopper and thrips) under field conditions using infester row technique. Ten castor parental lines *viz.*, ICS-301, IPC-30, IPC-31, IPC-44, IPC-46, MCI-8, JI-226, JI-227, JI-338 and JI-340 recorded low leafhopper infestation (16.8 to 36.6 leafhoppers/3 leaves/plant) and were resistant to leafhopper (hopper burn grade of 1 on 0-4 scale) while susceptible checks recorded high pest infestation (68.6 to 113.2 leafhoppers/3 leaves/plant) with hopper burn grade 4 on 0-4 scale. Seven parental lines *viz.*, IPC-30, IPC-31, IPC-46, MCI-8, P3-98, P3-116 and P3-90NSP were promising against thrips with very low infestation (<15 thrips/spike) as compared to 46.8 thrips/spike in susceptible check, DCS-9.



Resistant reaction of castor parental lines to leafhopper in comparison with susceptible checks

Capsule borer

Among 15 parental lines screened against capsule borer, the per cent capsule damage ranged from 31.4 (MCI-8) to 56.7% (P3-16). DCS-9 (susceptible check) recorded higher capsule damage of 73.4%, while resistant check, 48-1 recorded 8.7% capsule damage.

Reaction of castor genotypes to capsule borer

Sunflower

Leafhoppers

Eighteen inter-specific derivatives of sunflower (BC_2F_3) derived from crosses involving *H. argophyllus* (accessions ARG-1317 and ARG-1575) were screened for their reaction to leafhoppers during summer, 2020. Seven progenies *viz.*, PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014 and PB-1019 were resistant to leafhoppers with an MSI of 1.0. Another accession, TSG-391 that had

shown resistant reaction in the previous year showed consistent resistant reaction to leafhoppers with an MSI of 1.2, whereas NDCMS 30B and RCR CMS 104 B were found moderately resistant to leafhoppers. Susceptible checks, NDCMS-2B and Morden were highly susceptible and susceptible, respectively.

PB 1005 *PB 1014* *NDCMS-2B (SC)* *PB 1015* *PB 1019*

Resistant reaction of inter-specific derivatives of sunflower to leafhopper

Safflower

Aphids

Nine germplasm and thirty-one breeding lines of safflower were screened for their reaction to aphids during *rabi* 2019 under artificial screening. All the 31 breeding lines were found highly susceptible to aphids with an A.I.I. of 5.0. Seven germplasm accessions, GMU-7911, GMU-7915, GMU-7916, GMU-7918, GMU-7919, GMU-7920 and GMU-7921 were found moderately tolerant with an A.I.I. of 2.3-2.6. Susceptible check, CO-1 recorded the highest injury rating of 5.0 A.I.I.

Tolerant reaction of promising safflower genotypes to aphid

Biopesticides

With the ever increasing awareness of the harmful effects of the chemical pesticides on human life and environment, the immediate need for sustainable and eco-friendly pest management has been felt very strongly providing impetus to research and development of biopesticides. In this context, various *Bacillus thuringiensis* (Bt) based biopesticide formulations were developed. Efficacy of DOR Bt-127 SC formulation against major lepidopteran pests in oilseed crops was evaluated. Also, shelf life of Bt-127 WDG 67% formulation was studied.

Determination of LC_{50} of DOR Bt-127 SC formulation against *Spodoptera litura*

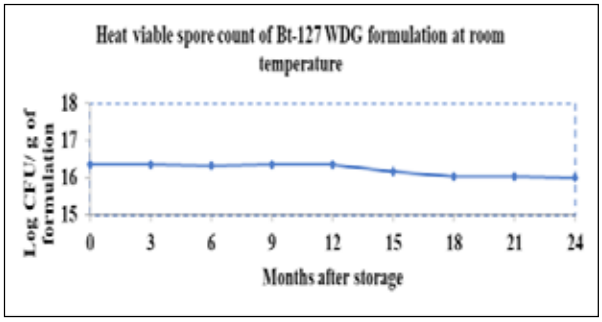
As per registration guidelines of CIB&RC, LC_{50} of DOR Bt-127 Suspension Concentrate (SC) formulation against *Spodoptera litura* larvae (6 day old larvae) was determined at ICAR-Indian Institute of Millets Research, Hyderabad using leaf spray method. Feeding cessation was observed in the larvae within 24 h after feeding in majority of the treatments while larval mortality started from 48 h after treatment in DOR Bt-127 SC formulation. LC_{50} value of DOR Bt-127 SC formulation against *Spodoptera litura* larvae was 1.79 µl/ml at 96 hours after treatment.

Multilocation field testing of DOR Bt-127 SC formulation against lepidopteran pests

Field trials were conducted to evaluate the efficacy of DOR Bt-127 SC formulation against major lepidopteran pests under AICRP on Sunflower (3 locations), Castor (3 locations), Groundnut (3 locations) and Cotton (13 locations). In sunflower, Bt-127 SC @ 3 ml/l was effective against *Helicoverpa armigera* as compared to commercial Btk formulation and efficacy against semilooper and *Spodoptera litura* was on par with commercial Btk formulation. Bt-127 SC @ 3 ml/l was effective against semilooper, *S. litura* and hairy caterpillars in castor. In groundnut, Bt-127 SC @ 3 ml/l was effective against *S. litura*, *H. armigera* and *Aproaerema modicella* and was on par with commercial Btk formulation. Effectiveness of the formulation on non-Bt cotton in North Zone revealed that Bt-127 SC @ 4 ml/l was comparable with chlorantraniliprole @ 0.3 ml/l in reducing spotted bollworm. In Central and South Zones, Bt-127 SC @ 4 ml/l and Brigade-B WP (*Beauveria bassiana*) @ 7 g/l and 5 g/l, respectively were comparable against cotton bollworm complex.

Shelf life of Bt-127 WDG 67% formulation

Shelf life of the formulation was assessed from samples of Water Dispersible Granule (WDG) 67% of DOR Bt-127 stored in LDPE covers at room temperature (30±2 ^{0}C). Viability of Bt spores in Bt WDG formulation was determined for a period of 24 months right from zero day at 3 monthly intervals. Log CFU of Bt spores in Bt WDG formulation was 16.33 at zero day and did not show any decline up to 12 months storage period. The value showed only a slight decline to 16.0 by 24 months. Bioassays against *S. litura* resulted complete mortality upto 18 months and decreased to 86.7% at 24 months of storage.



Shelf-life of WDG formulation at room temperature

Biopolymers and Bioagents

Polymers have proven potential to protect seeds and also act as carriers of chemicals and bioagents used for seed treatment. The matrix forming nature of polymers provide favourable environment to hold beneficial microbes within seeds that leads to physical protection under different soil environments, improves viability and serves as controlled release systems. Attempts were made to synthesize and evaluate biopolymers as seed coating agents for effective delivery of bioagents and nutrients. *Trichoderma* entrapped in developed biopolymers and evaluated for its role on seedling vigour and efficacy against major diseases in different oilseed crops.

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

A bench scale protocol was standardized for preparation of polymeric film solutions by physico-chemical cross linking and film by solvent-casting method using water soluble polymers. Among 560 combinations, 212 combinations were finalized based on scoring on film forming capacity. Two final combinations were identified (cellulose and chitosan), for further experimentation and evaluation.

Management of wilt and root rot incidence in safflower using biopolymer based *Trichoderma* formulations under field conditions

Seed coating with biopolymer based *Trichoderma* formulations along with chemical fungicides were evaluated on seed germination and disease incidence in safflower under field conditions using randomized block design with four replications. Seed coating with biopolymer chitosan + *T. harzianum* Th4d and biopolymer cellulose + *T. harzianum* Th4d liquid

formulation treatments significantly improved seed germination in safflower and recorded low wilt and root rot incidence compared to other treatments. Biopolymer chitosan + *T. harzianum* Th4d treatment recorded significantly low wilt (8.4%) and root rot incidence (4%) compared to fungicide (wilt - 11.2% and root rot - 6%) and untreated control (wilt incidence - 16.9% and root rot - 15%). The seed yield recorded was also high (850 kg/ha) in the same treatment compared to a low seed yield of 425 kg/ha obtained in control.

Effect of biopolymer based *Trichoderma* liquid formulations on germination, seedling vigor index, wilt and root rot incidence in safflower

Treatments	Germination (%)*	Wilt incidence (%)*	Macrophomina root rot incidence (%)*	Seed yield (kg/ha)
Biopolymer cellulose + *T. harzianum* Th4d @ 10 ml/kg seed	75.5 (60.3)	8.4 (16.8)	4.0 (11.5)	796^{ab}
Biopolymer chitosan + *T. harzianum* Th4d @ 10 ml/kg seed	79.0 (62.7)	5.5 (13.5)	2.0 (8.1)	850^{a}
Carboxin 37.5% + Thiram 37.5% DS @ 2 g/kg	74.2 (59.4)	11.2 (19.5)	6.0 (14.1)	725^{c}
T. harzianum Th4d WP @ 10 g/kg	70.1 (56.8)	9.7 (18.1)	5.0 (12.9)	782^{bc}
Control	58.3 (49.7)	16.9 (24.2)	15.0 (22.7)	425^{d}
CV (%)	11.1	15.1	16.3	6.8
CD (P=0.05)	6.6	3.4	2.1	65.0

*Values in the parentheses are angular transformations; Treatments followed by different alphabets differed significantly at P=0.05 by DMRT

Control *Chitosan+ Th4d blend*

Effect of biopolymer based Trichoderma liquid formulation on wilt and root rot incidence in safflower

Management of root/collar rot of groundnut using biopolymer based *Trichoderma* formulations under field conditions

Effect of seed coating with two biopolymer based *Trichoderma* formulations were evaluated against seed germination and biocontrol capacity against root/collar rot of groundnut under field conditions. The trial was conducted in randomized block design with four replications. Seed coating with biopolymer chitosan + *T. harzianum* Th4d and biopolymer cellulose + *T. harzianum* Th4d liquid formulation, carboxin + thiram and *T. harzianum* Th4d WP significantly improved seed germination in groundnut compared to control. Seed coating with biopolymer chitosan + *T. harzianum* Th4d resulted in very low Aspergillus root and collar rot incidence (4.3%) and recorded higher pod yield (3193 kg/ha) compared to all other treatments.

Effect of biopolymer based *Trichoderma* liquid formulations on seed germination, root/collar rot incidence and pod yield in groundnut

Treatments	Germination (%)*	Root rot incidence (%)*	Pod yield (kg/ha)
Biopolymer cellulose + *T. harzianum* Th4d @ 10 ml/kg seed	75.8 (60.5)^{a}	6.7 (15.0)^{ab}	2960^{ab}
Biopolymer chitosan + *T. harzianum* Th4d @ 10 ml/kg seed	76.7 (61.1)^{a}	4.3 (11.9)^{a}	3193^{a}
Carboxin 37.5% + Thiram 37.5% DS @ 2 g/kg	80.0 (63.4)^{a}	7.5 (15.8)^{ab}	2732^{b}
T. harzianum Th4d WP @ 10 g/kg	75.3 (60.2)^{ab}	9.8 (18.2)^{bc}	2795^{b}
Control	66.2 (54.4)^{b}	13.5 (21.5)^{c}	2398^{c}
CV (%)	9.5	4.2	8.0
CD (P=0.05)	6.1	1.1	313

Treatments followed by different alphabets differed significantly at P=0.05 by DMRT

Check Th4dWP Fungicide Cellulose+Th4d Chitosan+Th4d

Effect of biopolymer based Trichoderma liquid formulation on root rot incidence and yield in groundnut

Effect of biopolymer-based seed treatment on disease incidence and yield in groundnut crop under field condition (SRTC, PJTSAU, Hyderabad)

On groundnut crop, seed treatment with chitosan polymer + *T. harzianum* Th4d @ 10 ml/kg seed significantly improved seed yield (2483 kg/ha) under field conditions conducted at SRTC centre, Hyderabad in comparison to control (2105 kg/ha) and the biopolymer based treatment was found at par with fungicidal check (2800 kg/ha). Groundnut seed yield was higher with polymer seed treatment both with *T. harzianum* Th4d and Tebuconazole compared to control.

Effect of biopolymer-based seed treatment on disease incidence and yield in groundnut

Treatments	Seed yield (kg/ha)
T. harzianum Th4d	2319^{cd}
Cellulose polymer + *T. harzianum* Th4d @ 10 ml/kg seed	2386^{bcd}
Chitosan polymer+ *T. harzianum* Th4d @ 10 ml/kg seed	2483^{abcd}
Tebuconazole @ 1 g/kg seed	2800^{abc}
Cellulose polymer + Tebuconazole @ 10 ml/kg seed	2814^{ab}
Chitosan + Tebuconazole @ 10 ml/kg seed	2989^{a}
Chitosan polymer + Tebuconazole @ 10 ml/kg seed	2272^{cd}
Control	2105^{d}
CV (%)	12.3
CD (P=0.05)	539

Treatments followed by different alphabets differed significantly at P=0.05 by DMRT

Field evaluation of biopolymer-based *Trichoderma* (Th4d) through seed coating and its effect on disease incidence and yield in soybean

Field trials were conducted to evaluate the effect of seed coating with biopolymer-based *Trichoderma* formulations in soybean using randomized block design with four replications. Seed treatment with biopolymer cellulose + *T. harzianum* Th4d and chitosan + *T. harzianum* Th4d significantly improved the seed yield of soybean (1345 kg/ha) in field trials conducted at Nandyal and Raichur centres compared to 1256 kg/ha in control treatment. Similarly chitosan or cellulose polymer + Th4d resulted in higher seed yield (1234 to 1284 kg/ha) compared to control (1148 kg/ha) at Nandyal. Among seed borne diseases, yellow vein mosaic virus was observed to less degree at both the centres.

Effect of biopolymer-based seed treatment on disease incidence and yield in soybean

Treatments	Nandyal		Raichur	
	Seed yield (kg/ha)	Yellow mosaic virus disease incidence (%)	Seed yield (kg/ha)	Yellow mosaic virus disease incidence (%)
Chitosan polymer + *T. harzianum* Th4d @ 10 ml/kg seed	1284^{a}	13.5	1345^{a}	4.7^{b}
Cellulose polymer + *T. harzianum* Th4d @ 10 ml/kg seed	1234^{ab}	12.8	1346^{a}	5.6^{b}
Carboxin + thiram @ 2 g/kg	1229^{ab}	11.8	1327^{a}	5.9^{b}
T. harzianum Th4d 1.5% WP @ 10 g/kg seed	1148^{abc}	11.7	1318^{a}	6.2^{ab}
Control	1121^{c}	12.9	1256^{b}	8.1^{a}
CV (%)	7.7	14.7	10.5	20.7
CD (P=0.05)	139	NS	151	1.9

Treatments followed by different alphabets differed significantly at P=0.05 by DMRT

Social Sciences

ICT mediated knowledge management and dissemination in different oilseed crops

Safflower knowledge management portal

A user friendly menu driven Safflower knowledge management portal has been developed to provide detailed information on the crop. The information pertaining to research, production management, pests and diseases, seed production, cultivars, AICRP's, government schemes, package of practices, market prices, contingency plans, FLDs has been compiled and categorised into five major domains *viz.*, General Domain, Research Domain, Farmers Domain, Service Domain and Extension Domain with sub chapters under the respective domains.

The user can access information from any of the domains and can navigate from one screen to another at any point of time. The portal is useful for safflower workers, researchers, academicians, farmers, students, extension workers and NGOs.

A snapshot of the safflower knowledge management portal

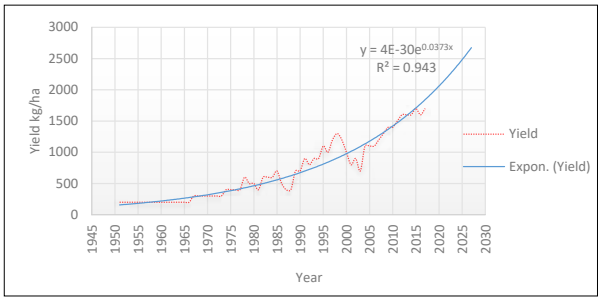
New website for ICAR-IIOR at https://icar-iior.org.in/ created as per the guidelines of Government of India Guidelines for Website (GIGW)

A dynamic and updated website was developed for the institute as per the guidelines of GIGW. The information about the institute, Director, staff (Scientific, technical, administration and accounts) and services like training and consultancies has been provided in detail. The website provides information on the research activities carried out in the institute. Research achievements including those of AICRP are also provided in the website. Detailed information regarding cultivars released in the mandate crops is provided under the technology tab. The details of the events organized at ICAR-IIOR are being uploaded immediately on the website with photographs. Tender documents and job opportunities are uploaded to the website as and when such requirements arise in the institute. Similarly, the financial releases with regard to the AICRPs and FLDs are uploaded regularly. The links to the market databases, mobile applications developed by the institute are provided on the website. For the benefit of IIOR employees, all the essential forms and links to software applications used are provided. The soft copies of annual reports, newsletters published by the Institute are provided under recent publications tab. The website is updated regularly and thus, provides an overall preview of the activities of the institute to the visitors of the website which could be accessed through all the search engines.

A snapshot of the new website of the institute https://icar-iior.org.in/

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

Prediction models have been developed for predicting castor yield data based on weather parameters. Different models like Least Absolute Shrinkage Selector Operator (LASSO), Artificial Neural Networks (ANN) Weather indices and composite weather variable models were fitted to the castor yield data with weather parameters that includes maximum temperature, minimum temperature, rainfall, RH1 and RH2. Time series analysis of castor yield in India showed increasing trend which is an indication of the improving yield over time. The blue line in the figure depicts the trend line for castor yield with R^2 value 0.943. Gujarat covers 60 percent of castor area and yield increased from 1.988 to 2.072 t/ha. Significant positive correlation between yield and weather parameters was indicated. Based on evaluation parameters, Lasso regression model best predicted the castor yield based on weather parameters. The equation that predicts castor yield based on weather parameters is Y = -45.12+ 97.1* Max.Temp + 2.18* Min.Temp + 46.25* RH2+23.7*Rainfall



Impact assessment of varieties/hybrids of IIOR mandated crops in varied agro-ecological regions of India

The monetization of castor hybrid GCH-7 revealed substantial economic benefit across major castor growing districts of Gujarat (Rs. 28,701 crores for the period 2008-09 to 2017-18)

District-wise Monetization of GCH 7 in major districts of Gujarat (Rs. in crores)

Year	Banaskan-tha	Mehsana	Kachchh	Patan	Ahmed-abad	Vadodara	Sabarkan-tha	Surender-nagar
2008-09	139	86	77	50	16	17	69	50.3
2009-10	262	121	81	83	25	26	107	60.1
2010-11	405	279	287	283	81	70	311	237.8
2011-12	1120	462	709	623	179	163	264	384.5
2012-13	738	373	584	305	191	175	263	369.6
2013-14	812	365	623	341	156	242	380	403.6
2014-15	1211	538	599	698	253	169	155	353
2015-16	862	699	690	726	240	163	208	447.1
2016-17	692	507	639	487	226	116	98	210.7
2017-18	1295	615	878	548	325	259	156	189.3
Total	**7536**	**4045**	**5167**	**4144**	**1692**	**1400**	**2011**	**2706**

Analysis of the effect of growing castor in Northern Gujarat

The cropping system, groundnut-potato-summer bajra in Northern Gujarat is gaining prominence and has higher system economic returns over Cost C (Rs. 92,832 /ha) as against Rs. 85,828/ha and Rs. 78,181/ha under greengram-castor sequence and sole castor crop, respectively. This calls for newer research initiatives for enhancing the yield of castor to make it competitive with groundnut-potato-summer bajra system.

Economics of castor based production system in North Gujarat

Cropping system	Cost of Cultivation (Rs/ha)		Farm Harvest Price (Rs./ Q)	By product (Rs./ha)	Gross returns (Rs./ha)	Net Returns (Rs./ha) over	
	Cost A	Cost C 2				Cost A	Cost C 2
Sole castor	39,460	63,551	5,295	3,902	1,41,732	1,02,272	78,181
Greengram-castor	57,928	98,633	9,561	7,470	1,84,461	1,26,533	85,828
Groundnut-pota-to-summer bajra	1,52,784	2,23,157	7,421	21,236	3,15,988	1,63,205	92,832
Fennel	38,386	61,441	7,256	-	1,22,276	83,890	60,685
Isabgul	34,721	54,028	9,867	6,106	1,02,066	67,345	48,039

Source: Department of Agril Economics, C.P.College of Agriculture, SDAU, Dantewada

Cost A: All actual cash and kind expenses incurred in production; Cost C 2: Cost A+ interest on value of owned fixed capital assets (excluding land) + rental value of owned land and rent paid for leased in land + imputed value of family labour

The matrix of crop and yield concentration index for the major castor growing districts in Gujarat suggest that among the high area and low yield index districts such as Ahmadabad, Patan, Surendranagar, Vadodara followed by districts which are classified as medium yield index districts such as Kachchh and Mehasana, efforts should be made to improve the productivity levels to increase the castor production in the state.

Crop and yield concentration index of castor in Gujarat

Yield index	Crop concentration index			
	High	Medium	Low-medium	Low
High	Banaskantha, Gandhinagar	Jamnagar, Morbi	Gir Somnath, Porbandar	Botad, Junagadh
Medium	Kachchh, Mahesana	Aravalli	Rajkot, Tapi	Dohad, Surat
Low-medium	-	Bharuch, Sabarkantha	Amreli, Chhotaudepur, Devbhumi Dwarka, Narmada	Anand
Low	Ahmadabad, Patan, Surendranagar, Vadodara	Kheda	Mahisagar, Panch Mahals	Bhavnagar, Navsari

Demonstration of Oilseed Technologies

Frontline demonstrations (FLD's) on oilseeds

In order to show the productivity potential and profitability of improved technologies, 9510 frontline demonstrations (FLDs) on nine oilseed crops and oilseeds based farming systems were allotted. Out of which, 9220 FLDs were conducted during 2020-21. In order to enhance the knowledge of input dealers, extension officers and other extension workers dealing with oilseed crops, 46 training programmes on oilseeds technologies were organized.

Frontline demonstrations conducted by ICAR-IIOR

One thousand and two hundred frontline demonstrations on castor, sunflower, safflower, sesame and niger were conducted by ICAR-IIOR in collaboration with different NGO's and State Departments of Agriculture (SDA).

Frontline demonstrations conducted by ICAR-IIOR (2020-21)

Crop	Season	No. of FLDs
Castor	*Kharif*	300
	Rabi	50
Sunflower	*Kharif*	50
	Rabi	200
Safflower	*Rabi*	200
Sesame	*Kharif*	25
	Summer	175
Niger	*Kharif*	200
	Total	**1200**

FLDs conducted during *rabi*-summer (2019-20)

Sunflower: Twenty five FLDs on sunflower were conducted during *rabi* 2019-20 in Hegdoli village, Nizamabad in soybean-sunflower and paddy-fallow cropping systems. The crop was harvested in the months of January-February. The seed yield was 18.1% higher in IT (2,480 kg/ha) as compared to FP (2,100 kg/ha). The gross returns in IT were Rs. 1,38,800/ha as compared to FP (Rs.1,17,600/ha). The details of the productivity potential and profitability are presented.

Productivity potential and profitability of component technologies in sunflower

Technology demonstrated	FLDs (No.)	Mean seed yield (kg/ha)		% increase in seed yield over FP	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		ANR (Rs./ha)	BCR	
		FP	IT		FP	IT	FP	IT		FP	IT
Foliar spray of Boron (2% at ray floret stage)	5	1,900	2,300	21.1	24,500	26,000	1,06,400	1,28,800	20,900	4.34	4.95
Management of insect pests*	20	2,150	2,500	16.3	27,000	28,500	1,20,400	1,40,000	18,100	4.46	4.91
Total/Mean	25	2,100	2,480	18.1	26,500	28,000	1,17,600	1,38,880	19,780	4.44	4.96

IT - Improved technology; FP – Farmers' practice *:seed treatment with Imidacloprid 70 WS @ 5 g/kg seed and foliar spray of profenofos 50 EC @ 1 ml/litre

FLD on sulphur application in sunflower in Hegdoli village, Nizamabad district, Telangana State

Stakeholders visits to FLD fields in Hegdoli village, Nizamabad district, Telangana State

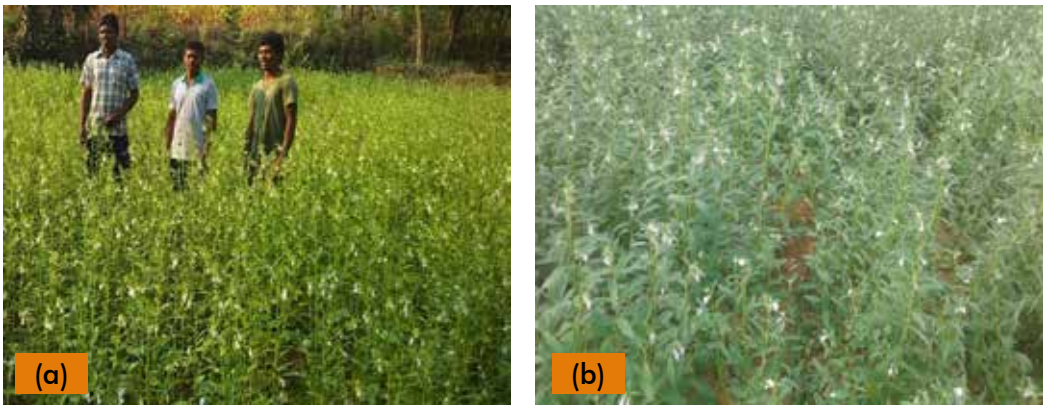
Sesame: A total of 180 FLDs were conducted in Prakasam, Adilabad, Nizamabad and Mahabubnagar districts of Andhra Pradesh and Telangana states in rice fallow and turmeric - fallows in collaboration with District Agricultural Advisory and Transfer of Technology Centre (DAATTC) of State Department of Agriculture, NGOs and KVKs. Eight demonstrations were vitiated due to sever moisture stress in Adilabad.

The seed yield in the demonstrations ranged from 521 kg/ha to 925 kg/ha. The gross returns accrued to farmers ranged from Rs. 33,612/ha to Rs. 68,450/ ha.

Productivity potential of improved technologies of sesame

State/District	Situation	Village	FLDs (No.)	Yield (kg/ha)	CoC (Rs./ha)	GMR (Rs./ha)	NR (Rs./ha)	BCR
Telangana/ Adilabad	Rice-fallows	Gudihathnoor	20	521	13,758	46,905	33,492	3.41
		Seethagondi	10	556	15,660	49,832	34,172	3.18
		Malkapur	7	697	17,537	62,632	45,095	3.57
Mahabubnagar		Lankala	35	575	14,500	40,250	25,750	2.78
Nizamabad	Turmeric-sesame	Padkal	50	925	17,500	68,450	51,000	3.91
Andhra Pradesh/ Prakasam	Rice-fallows	Mundlapadu	50	561	15,734	33,612	17,878	2.13

CoC- Cost of cultivation; GMR- Gross monetary returns; NR- Net returns; BCR- Benefit cost ratio



Demonstration of sesame variety Swetha Til in (a) Mundlapadu village, Prakasam district, Andhra Pradesh and (b) Malkapur village, Adilabad district, Telangana state

Safflower: Demonstrations were conducted in non-traditional areas of Nandyal and Prakasam districts of Andhra Pradesh with the objective of crop diversification and area expansion of safflower. The results indicated that the mean seed yield of safflower in Kurnool district was 1,047 kg/ha (Range: 680-1,320 kg/ha) in safflower plots as against 1,310 kg/ha (Range: 1,050-1,550 kg/ha) of chickpea yield in safflower equivalent. The additional net returns realized due to cultivation of safflower (improved technology) was Rs. 597/ha. The gross monetary returns from safflower and chickpea was Rs. 42,000 and 48,470/ha, while the operational cost of cultivation was Rs. 22,685 and 29,752/ha with safflower and chickpea, respectively. The B: C ratios with IT and FP were 1.85 and 1.57, respectively. The results suggest that the yields of safflower were lower as compared to yields of chickpea in safflower equivalent, but additional net returns accrued were marginally higher with safflower because of lower cost of cultivation of safflower as against chickpea. Thus, in case the safflower productivity is further enhanced, it could be a better competing crop in this area.

In Prakasam district, FLDs were conducted with the newly released variety, ISF-764. The results indicated that the seed yield of safflower in IT plots was 823 kg/ha (Range: 663-1150 kg/ha) as compared to 692 kg/ha in FP plots. The gross monetary returns with IT and FP was Rs. 32,933 and 27,664/ha with operational cost of cultivation of Rs. 14,820/ha each in IT and FP, respectively. Therefore, the average net returns accrued with IT was Rs. 5,269/ha. The B:C ratios were 2.22 and 1.87 with IT and FP, respectively.

Demonstrations conducted by DAATTC centre in Medak district with ISF-764 indicated very low yields of safflower (500 kg/ha) under rice-fallow situation.

Productivity potential and profitability of improved variety of safflower (ISF-764)

Location	FLDs (No.)	Mean seed yield (kg/ha)		% increase in seed yield over FP	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		ANR (Rs./ha)	BCR	
		FP	IT		FP	IT	FP	IT		FP	IT
Prakasam	30	692	823	19.0	14,820	14,820	27,664	32,933	5,269	1.87	2.22
Nandyal	10	1,310*	1,047	-20.1	29,752	22,685	48,470	42,000	597	1.63	1.85
Hulkoti	15	934	1,139	22.0	22,638	24,528	35,492	43,300	5,919	1.57	1.77

IT - Improved technology (ISF-764); FP- Farmers practice (traditional variety); *-Chickpea yield in safflower equivalent; ANR-Additional net returns; BCR- Benefit cost ratio

FLDs conducted during *kharif* 2020-21

Castor: Three hundred FLDs were conducted during *kharif* 2020-21 in traditional castor growing areas of Mahabubnagar and Wanaparthy and districts of Telangana State. The FLDs were conducted on component technologies such as cultivar (ICH-66), management of gray mold disease, management of *Spodoptera* and castor semilooper and optimum spacing. The crop was severely affected due to continuous and heavy rains during the months of August to October and 85 FLDs were vitiated. The seed yield of castor ranged from 600 to 850 kg/ha with improved technologies (IT) whereas, it was 550 to 800 kg/ha with farmers' practices (FP). The sale price of castor seed ranged from Rs.3,500 to 4,700/quintal during the season. Majority of the farmers sold the produce at an average price of Rs.4,200/quintal. The gross monetary returns from castor cultivation ranged from Rs. 25,200/- to 35,700/- with IT as compared to Rs. 23,100 to 32,550/- with FP.

Productivity potential of improved technologies of castor

District	Mandal	Village	FLDs conducted	Vitiated	Technology	Seed yield (kg/ha)		% increase over FP
						IT	FP	
Mahabubnagar	Dewarkadra	Gudigandla	25	15	ICH-66	725	652	11.20
	CC Kunta	Allipur	50	10	ICH-66	700	625	12.00
		Nellikondi	25	-	ICH-66	600	550	9.09
		CC Kunta	30	10	Gray mold management	700	625	12.00
		Undhyal	25	10	Optimum spacing	750	700	7.14
	Narwa	Rampur gate	25	5	ICH-66	650	650	0.00
		Lankala	25	5	Gray mold management	775	700	10.71
		Lakkardoddi	25	10	Management of *Spodoptera* and semilooper	750	700	7.14
	Makthal	Jaklair	25	5		800	725	10.34
	Maddur	Maddur	15	5	ICH-66	800	725	10.34
Wanaparthy	Kothakota	Kanimetta	30	10	Optimum spacing	850	775	9.68

Demonstration of ICH-66 in Allipur village, Mahabubnagar district, Telangana state

Demonstration of optimum spacing in Undhyal village, Mahabubnagar district, Telangana state

Profitability of improved technologies of castor

Village	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	BC ratio	
	IT	FP	IT	FP		IT	FP
Gudigandla	14,500	14,300	30,450	27,384	2,866	2.10	1.91
Allipur	15,500	14,500	29,400	26,250	2,150	1.90	1.81
Nellikondi	14,500	14,300	25,200	23,100	1,900	1.74	1.62
CC Kunta	14,500	15,500	29,400	26,250	4,150	2.03	1.69
Undhyal	14,500	14,300	31,500	29,400	1,900	2.17	2.06
Rampur gate	16,000	16,500	27,300	27,300	500	1.71	1.65
Lankala	15,500	14,000	32,550	29,400	1,650	2.10	2.10
Lakkardoddi	15,000	14,300	31,500	29,400	1,400	2.10	2.06
Jaklair	15,500	14,500	33,600	30,450	2,150	2.17	2.10
Maddur	15,000	14,500	33,600	30,450	2,650	2.24	2.10
Kanimetta	14,500	15,500	35,700	32,550	4,150	2.46	2.10

Niger: Two hundred FLDs on niger were conducted in Ranga Reddy and Vishakapatnam districts of Telangana and Andhra Pradesh, respectively for popularizing the crop and area expansion. Around 80 demonstrations were vitiated due to excess rainfall during the months of September and October in Adilabad. All the demonstrations were conducted with niger variety JNS-28. The crop was sown during the month of September. The crop was affected due to continuous rains in Malkapur village and the yield levels were very low (250 kg/ha). In Manchal, the seed yield recorded was 400 kg/ha. Niger was grown as intercrop in mango orchard utilizing the space between the mango plants, and seed yield was 200 kg/ha was recorded. In Paderu, a predominantly tribal inhabited village, niger was grown on podu lands, where the seed yield recorded was 350 kg/ha.

Popularization of niger crop in Telangana and Andhra Pradesh

State/district	Village	FLDs (no.)	Vitiated	Yield (kg/ha)
Telangana/Adilabad	Malkapur	50	30	250
Ranga Reddy	Manchal	48	20	400
	Chandkhanguda (inter crop in mango)	02	-	200
Andhra Pradesh/ Vishakapatnam	Paderu	50	50	350

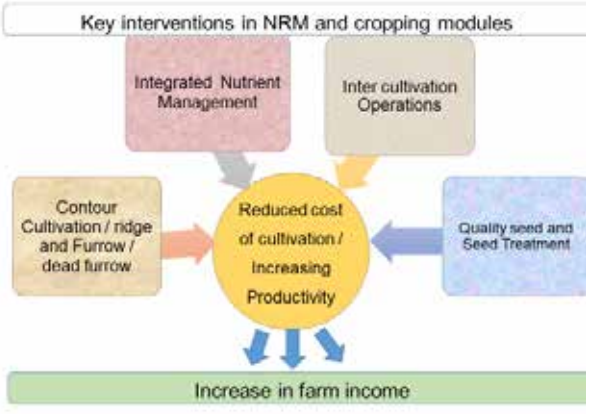
Demonstration of niger variety JNS-28 in hilly slopes of Paderu village, Vishakapatnam district, Andhra Pradesh

Niger as intercrop in mango orchard in Manchal, Ranga Reddy district, Telangana State

Sunflower: Fifty FLDs on sunflower were conducted with DRSH-1 hybrid in Vikarabad district. The crop was severely affected due to heavy rains. Hence, the demonstrations were vitiated.

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

Under the Farmers FIRST programme, activities were undertaken in different modules towards improving the farm level profitability and income.



NRM module

Prepared 220 soil test based soil health cards for major crops (for 12 parameters: major, micro and secondary nutrients) covering 150 households.

In redgram, soil and moisture conservation technologies (contour cultivation/ ridge and furrow method; 39 households, 26 ha) enabled 24% increase in the productivity resulting in additional net returns of Rs.11,493/ha.

Contour cultivation

Ridge and Furrow

Redgram crop with NRM technology(s)

Cropping system module

Technology assemblage (Seed treatment/SSP/Need based plant protection) in greengram-castor cropping sequence realized system net returns of Rs. 29,138 / ha.

Castor production technology (DCH-519 / ICH-66) under *kharif* rainfed situations resulted in productivity of 625 kg/ha providing net returns of Rs. 6,754/ha while under *late kharif/rabi* situations it resulted in productivity of 1075 kg/ha enabling net returns of Rs. 14,288/ha.

Technology assemblage in groundnut (Seed treatment/ Gypsum/SSP/Inter-cultivation/Need based plant protection) under *rabi* situation led to productivity of 1393 kg/ha providing net returns of Rs. 26,377/ha.

Greengram production technology provided net returns of Rs. 9,847/ha with productivity of 403 kg/ha.

The non-shattering paddy cultivar KNM-118 over the local variety resulted in yield enhancement of 14% providing additional net returns of Rs. 13,328/ha.

Monitoring of field crops

Backyard Poultry

Rearing of 380 birds of five week age (Giriraja and Rajasri) for five months by two households enabled a net profit of Rs. 33,000 through sale of the birds.

Marketing and value addition

With the objective towards doubling farmers' income, pilots on marketing and value addition pilots were initiated under the project.

- **Locally processed tur dal**: (**3 households/3 q**): Value addition from redgram to dal enabled additional net returns of Rs. 5,362 / q.
- **Paddy to rice (RNR 15048) (2 households /13 q)**: Processing paddy to rice enabled additional net returns of Rs. 2,245/q.

Other Scientific Activities

Agricultural Knowledge Management Unit (AKMU)

The activities during the period under report include development of a new website for the institute as per the guidelines of GIGW containing information about the institute, Directors, staff (Scientific, technical, administration and accounts), services like trainings, consultancies etc., research achievements including that of AICRP and links to the market databases as well as mobile applications developed by the institute. Uploading of the events organized at ICAR-IIOR with photographs, tender documents, job opportunities, financial releases with regard to the AICRPs, FLDs are undertaken regularly. Regular web conferences were also facilitated under AMKU.

Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell has facilitated the review of the progress of ongoing research and developmental activities by the Research Advisory Committee (RAC). It has also facilitated the review of experiments carried out in the institute and externally funded projects in the of Institute Research Council (IRC) meetings. Two new projects were submitted for external funding. The proposals for thesis projects of nine M.Sc. and 14 Ph.D. students were processed and two students got Ph.D degree awarded. The Institute Publication Committee has processed 80 manuscripts (19 Research articles, 2 Book chapters, 4 popular articles, 9 books and 46 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 transfer of technology (DOR-Bt) to one licensee during the reporting period. A tripartite agreement was done between UAS-B, Invicta Pvt. Ltd and ICAR-IIOR for commercialization of sunflower hybrid KBSH-53. A MoU was signed with State Agricultural University (PJTSAU, Hyderabad) for student research.

AICRP on Oilseeds
(Castor, Sunflower and Safflower)

Significant achievements made under AICRP on Oilseeds are furnished here under.

Castor

- A total of 24 new monoecious lines (12 from Junagadh and 12 from S.K.Nagar) and one pistillate line (JP-108) were isolated from advanced generation at Junagadh.
- In a multilocation evaluation of four pistillate lines, IPC-30 and DPC-22 were confirmed as stable pistillate lines with least number of ISFs and DPC-22 and IPC-31 were confirmed for early flowering.
- Development of monoecious and pistillate genepools at five centres (Junagadh, Mandor, Palem, SK Nagar and Yethapur) through random mating or chain crossing of multiple, wilt resistant elite inbred lines is now either in first or second cycle of random mating or generation advancement during 2019-20.
- A total of 345 new experimental hybrids were generated by different centres for evaluation during 2020-21.
- Out of 500 new hybrids evaluated in preliminary trials at different centres, 24 hybrids were identified with significant yield advantage (7 to 60%) over the best check.
- A total of 28.1 kg nucleus seed of 17 parental lines of released hybrids and varieties was produced by Junagadh, S.K.Nagar, Yethapur and ICAR-IIOR.
- A total of 43.37 q of breeder seed of varieties and parental lines was produced against the total indent of 12.77 q by various centres.
- Adoption of best management practices under irrigated conditions, at Junagadh resulted in 27.6 per cent higher seed yield over farmers practice. Similar trend was observed using GCH-8 hybrid in S.K.Nagar and DCH-177 hybrid in Bawal and Mandor. Under rainfed conditions, adoption of BMPs at Palem and Yethapur resulted in significantly higher seed yield (1715 kg/ha and 1127 kg/ha) as compared to that of farmer's practice.
- Conservation agricultural practices at Mandor (irrigated) resulted in significantly highest castor seed yield (3043 kg/ha) and castor seed equivalent yield (4317 kg/ha). Though sole castor recorded highest seed yield, the highest castor seed equivalent yield (5283 kg/ha) was recorded in castor + groundnut intercropping system. Similar results were reported in Palem under rainfed conditions.
- Field experiments on minimizing the frost damage in castor through chemicals at Bawal, Haryana revealed that spraying of H_2SO_4 (1 litre/ha) and $DMSO_4$ (78 units/ha) were at par and resulted in significantly higher seed yield (3175 and 3154 kg/ha, respectively).
- Studies on high density planting in *rabi* castor for single harvesting by adopting a crop geometry using 90 x 30 cm spacing (37,037 plants/ha) at Palem centre, recorded the highest seed yield (3038 kg/ha) followed by 120 × 45 cm (2777 kg/ha) and 90 × 60 cm (2639 kg/ha), respectively. At Yethapur, significant interaction between castor genotypes and plant densities on seed yield was recorded while ICH-66 recorded highest primary seed yield (625 kg/ha) at a spacing of 90 x 60 cm.
- Evaluation of castor and nutri-cereals intercropping system in rainfed Alfisols at Bengaluru revealed that castor + field bean (2:4) combination resulted in higher castor equivalent yield (1065 kg/ha), higher Land Equivalent Ratio (1.22) and Area Time Equivalent Ratio (0.98).

A total of 773 frontline demonstrations (FLDs), covering an area of 360 ha were conducted. Under rainfed conditions of Andhra Pradesh, Karnataka, Tamil Nadu and Telangana, Improved Technology

(IT) recorded 1115 kg/ha seed yield as compared to 849 kg/ha with Farmer's Practice (FP) and additional net returns accrued were Rs. 9,867/ ha. Under irrigated conditions of Haryana, Gujarat and Rajasthan, IT recorded 3918 kg/ha seed yield as compared to 3554 kg/ha with FP and additional net returns accrued were Rs. 15,756/ha.

- Demonstrations on remunerative castor based intercropping systems conducted by Anantapuramu, Palem, Bawal and Junagadh centres during *kharif* showed 36% increase in castor equivalent yield with IT (2779 kg/ha) as compared to FP (2046 kg/ha). The additional net returns accrued were Rs. 26,412/ha.
- Intensive studies on gray mold incidence using Wireless Sensor Networks (WSN) deployed in farmer's field of three districts in Telangana state indicated that 21 °C - 28 °C minimum and maximum temperature, 94% mean RH and 14 h of continuous wetness for a period of 4-5 days favoured gray mold disease development.
- Based on data from Wireless Sensor Networks, forecasting of gray mold incidence was done followed by SMS and voice alerts to about 4000 farmers. Weather indices based model using temperature, relative humidity, wetness hours and their interactions on disease severity, integrated with gray mold Decision Support System (DSS) was developed and validated at four field locations.
- Gray mold severity was higher in both June (92%) and July (96%) sown crops at Palem with favorable weather conditions like 549 mm rainfall in 44 rainy days, 30.4 °C and 17.6 °C maximum and minimum temperature and %77 relative humidity.
- Identified confirmed sources of resistance to wilt, root rot and gray mold. Castor genotypes ICI-RG-2787-89-20, ICI-RG-2746-1, RG-2034 showed resistance reaction to *Fusarium* wilt at S.K. Nagar, Palem and Hyderabad by sick pot method. ICI-RG-2787-89-20, ICI-RG 2719-10 and RG-529 were found resistant to root rot by stem tape inoculation method at Junagadh and genotypes RG-1963, RG-61, ICS-324 and ICS-325 were found moderately resistant to gray mold under epiphytotic conditions.
- In national screening nursery of wilt, ANDCH-1702, ICH-277, ICH-239, SHB-1055, SHB- 1061, SHB-1062, SHB-1063, SHB-1066, NAUCH-1603, DCS-119, IPC-34, IPC-35, JHB-1088 and JHB-1092 were found resistant to wilt at 3 sick plots of Hyderabad, Palem, S.K.Nagar.
- In integrated management of wilt disease, seed treatment with combination fungicide carboxin and thiram recorded low wilt incidence (30%) with high seed yield (1154 kg/ha) against control plots (64% wilt; 579 kg/ha seed yield) at Palem. In integrated management of root rot disease, seed treatment with *Trichoderma harzianum* and soil application of neem cake recorded low root rot incidence (12.2%) with high seed yield (3935 kg/ha) compared to control plots (28.3% root rot and 3112 kg/ha seed yield) at Junagadh.
- On farm demonstrations conducted in Telangana clearly showed the efficacy of two sprays of propiconazole (1 ml/l) for disease management based on the alerts generated by castor gray mold DSS developed by IIOR and weather data obtained from Wireless Sensors deployed in farmer's fields.
- In on-farm demonstration on management of root rot conducted at Junagadh, seed treatment and soil application of *T. harzianum,* local isolate showed low root rot incidence (6.8%) with higher seed yield (3308 kg/ha) compared to control (19.8% and 1876 kg/ha).
- Promising insect pests resistant advanced breeding materials, inbred lines and germplasm accessions were identified in multi-location screening for major sucking pests Leafhopper, thrips, whitefly: RG-311, RG-1621, RG-1624, RG-3425 and RG-3445 Leafhopper: ICI-RG-2661-7-3-5-6, ICI-RG-2661-16-2-2, ICS-200, ICH-588, JHB-1068 Whitefly: RG-3233 and RG-3428
- Among bioinsecticides, DOR Bt-127 SC @ 3 ml/l was found effective against lepidopteran defoliators (semilooper and *Spodoptera litura*) with higher seed yield (1012 to 2639 kg/ha) and cost benefit ratios (1: 1.56 to 1: 1.96) over commercial Btk (seed yields of 995 to 2376 kg/ha and cost

benefit ratios of 1: 1.43 to 1: 1.74) at Palem, Yethapur and S.K.Nagar.

- In management of castor whitefly, insecticides *viz.*, buprofezin 25 SC @ 1.5 ml/l, thiamethoxam 30 FS @ 0.5 g/l and profenofos 50 EC @ 2 ml/l were effective and resulted in higher seed yields (1045 to 1236 kg/ha) and cost benefit ratios (1: 2.06 to 1: 2.51) over conventional insecticide, dimethoate 30 EC @ 1.7 ml/l (seed yield of 887 kg/ha and cost benefit ratio of 1: 1.81) at Yethapur.
- Application of flonicamid 50 WG @ 0.2 g/l or thiamethoxam 30 FS @ 0.5 ml/l or profenofos 50 EC @ 2.0 ml/l was effective for management of whitefly in castor.
- Among insecticides evaluated against thrips at S.K. Nagar, dimethoate 30 EC @ 1.7 ml/l and profenofos 50 EC @ 1 ml/l reduced the thrips population while spray of acetamiprid 20 SP @ 0.2 g/l and flonicamid 50 WG @ 0.2 g/l resulted in higher or comparable yields and cost-benefit ratios.

Major Recommendations

- Variety GAC-11 was released for cultivation in middle Gujarat region under irrigated and rainfed conditions.
- Hybrid GCH-10 was released for cultivation in Gujarat.
- In north Gujarat, application of pendimethalin 1 kg a.i./ha (6.7 ml/l) (pre-emergence) + quizalofop ethy1 0.05 kg a.i. /ha (2 ml/l) (post - emergence at 25 DAS) + IC *fb* HW at 60 DAS resulted in effective weed management along with higher seed yield (2744 kg/ha) and higher profitability in light textured soil.

Sunflower

- Seventy seven germplasm accessions and inbreds were identified promising for agro-economic traits at different locations.
- Forty promising lines (20 RHA lines, 20 inbred lines) were deposited in NBPGR, New Delhi conservation for long term storage.
- Five CMS lines *viz.*, CMS-207A, CMS-852A, PET-2-7-1A, FMS-821A, CMS-10A and 11 trait specific germplasm accessions (TSG-255R, EC-601957, EC-601747, EC-279309, AKSF-12R, TSG-36, TSG-377, EC-279109, J-6, RHA-1-1, and LTRR-341) were found resistant to downy mildew under sick plot at Latur.
- New experimental hybrids developed at Akola (24), Bengaluru (62), Coimbatore (32), Hisar (14), Latur (31), Ludhiana (258), Nandyal (08), Nimpith (146) and Raichur (123) were evaluated in replicated trials with large plot size.
- Multilocation evaluation of experimental hybrids revealed superiority over the best check hybrids of PKVSH-985 (2474 kg/ha), PKVSH-987 (2423 kg/ha), PKVSH-986 (2389 kg/ha) and PKVSH-984 (2366 kg/ha) at Akola; SMLHT-Kh-19-02 (2503 kg/ha), SMLHT-Kh-19-01 (2490 kg/ha) and SMLHT-Kh-19-04 (2447 kg/ha) at Bengaluru; CSFH-18280 (2860 kg/ha) and CSFH-18284 (2970 kg/ha) at Coimbatore; HSFH-1708 (3165 kg/ha) and HSFH-1702 (3150 kg/ha) at Hisar; LSFH-1751 (2068 kg/ha) and PKVSH-959 (2013 kg/ha) at Latur; PSH-2625 (3003 kg/ha) at Ludhiana; SH-2335 (2467 kg/ha) and SH-2199 (2315 kg/ha) at Nandyal; and SMLHT-19-10 (2023 kg/ha), SMLHT-19-04 (2015 kg/ha) and SMLHT-19-12 (1702 kg/ha) at Raichur.
- The sunflower hybrid PSH-2080 of Ludhiana has been approved and released by the State Variety Approval Committee for release and general cultivation in the Punjab State during spring season.
- Evaluation of interspecific derivatives supplied by ICAR-IIOR, Hyderabad from the cross ARM-243B x ANN-232 at Latur centre resulted in identification of four pre-bred entries *viz.*, PB-151 (30.0 g/plant), PB-153 (28.0 g/plant), PB-158 (27.0 g/plant) and PB-147 (26.0 g/plant) with significantly higher seed yield over the check, Morden (20.0 g/plant).
- Two accessions ANN-61 and ANN-98 of wild *H. annuus* were found resistant to Alternaria leaf spot; sunflower necrosis and leaf curl diseases while ANN-1114 was found to be highly resistant to Alternaria leaf spot at Raichur.

- LSFH-1751 and KBSH-79 were promoted to the next level of testing during *rabi* 2019 and KBSH-85 and IIOSH-15-20 were promoted to further testing in *kharif* 2020.
- As per the indent for breeder seed received from DAC, GOI for the year 2018-19, a total of 43.72 q of breeder seed was produced as against an indent of 2.0 q.
- Pre emergence application of Pendimethalin 38.7 CS @ 0.75 kg a.i/ha followed by Propaquizofop (Agil) @ 62 g a.i/ha at 20 DAS as post emergence herbicide for *kharif* sunflower is recommended for Raichur region of Karnataka for higher yield and profits.
- Zero tillage was unsuccessful for rice fallow sunflower in black soils at Raichur, Karnataka.
- Sunflower hybrid KBSH-53 was suitable for rice fallow sunflower in sandy loam soils of Nimpith.
- Application of RDF: 90:45:45 N: P_2O_5: K_2O kg/ha with 2.5 kg/ha of hydrogel was promising at Latur, Maharashtra during *rabi* season.
- Ridges and furrow sowing at 60 x 30 cm increased sunflower yield at Coimbatore and Raichur over flatbed sowing or paired row planting either with broad bed or paired row.
- Maize - sunflower cropping system resulted in highest BCR (1.61) followed by sunflower - groundnut cropping system (1.52) at Coimbatore.
- Greengram - sunflower cropping system resulted in highest per day returns at Akola and highest benefit cost ratio at Tornala.
- Sunflower-chickpea resulted in highest benefit cost ratio at Nandyal, Andhra Pradesh.
- A total of 546 demonstrations were conducted during *rabi*/spring 2018-19 and *kharif* 2019 in eight major sunflower growing states.
- During *rabi*, the seed yield improvement was to the tune of 18.7% with improved technology (IT) (1760 kg/ha) as compared to farmers' practice (FP) (1483 kg/ha). The gross monetary returns with IT was Rs.64,594/ha as compared to Rs. 54,518/ha with FP. The additional net returns (ANR) accrued were Rs. 8,823/ha. The B:C ratio was 2.50 and 2.20 with IT and FP, respectively.
- During *kharif*, the seed yield improvement was 14.2% with IT (1844 kg/ha) as compared to FP (1880 kg/ha). The ANRs accrued were Rs. 11,394/ha. The B:C ratio was 2.64 and 2.19 with IT and FP, respectively.
- Screening of germplasm, CMS and R lines, and breeding/parental lines against major diseases revealed three entries (PM-83, GMU-938, R-64) which showed less than 20% average disease severity of Alternariaster leaf spot and 14 entries (RHA-95C-1, GMU-756, PM-82, RGM-49, NPI-6, RHA-1012, R-106, RHA-1114, RHA-271, RCR-39, RHA-1056, RHA-1232, GMU-896 and GMU-938) showed 0% disease severity for powdery mildew. Thirty entries showed no incidence of downy mildew. All entries recorded less than 10% sunflower necrosis disease (SND) incidence.
- Among the coordinated trial entries (IAHT) screened during *rabi* 2018-19 for leaf curl disease incidence, entries PSH-2091, BLSFH-15004, PSH-2080 and PSH-1962 recorded less than 10% disease incidence. Sunflower necrosis disease was less than 10% in all the IAHT entries.
- Among IHT entries, no downy mildew disease incidence was recorded in the entries and powdery mildew disease severity was low in KBSH-85 (15.4%), PSH-2080 (27.8%) and GK-202 (Private Check) (23.9%).
- During *kharif* 2019, downy mildew disease incidence was recorded only in four entries KBSH-44 (NC) (60%), BLSFH-15005 (AHT-II) (35%), DRSH-1 (NC) (85%) and RSFH-1887 (RC) (25%) and SND was less than 10% in all the AHT entries tested.
- Seed treatment with the plant defence 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 Alternariaster leaf spot, necrosis and powdery mildew diseases and highest seed yield and B:C ratio.
- Among combination fungicides tested, seed treatment with Carbendazim 12% + Mancozeb 63% WP (SAAF 75 WP) @ 2 g/kg seed followed

by two foliar sprays with difenoconazole 25% + propiconazole 25% (TASPA 500 EC) @ 0.25 ml/l) was found to be effective in management of Alternariaster leaf spot in two locations and no single common treatment was found best across the locations tested.

- 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 Alternariaster leaf spot and necrosis diseases with the highest seed yield and B:C ratio.
- In multi-location trial, seven entries *viz.,* GPN-219-2, GMU-520, GMU-490, GP6-442, NDR-71-1, ID-1079 and RHA138-2R were found moderately resistant to leafhoppers.
- Three disease resistant entries, 6D-1, HA-430A and GMU-440 were found either resistant or moderately resistant to leafhoppers at all the centres.
- After evaluating over 3 years at multiple locations, two entries, GMU-339 and GMU-696 were confirmed resistant while, GMU-504, GMU-669 and GP9-472-4-13 were found moderately resistant to leafhoppers.
- During *rabi*, 2018, coordinated entries, KBSH-81 and LFSH-1751 were found promising against leafhoppers across the four locations.
- During *kharif*, 2019, coordinated entries, KBSH-87, IIOSH-413, IIOSH-566, IIOSH-15-10 (AHT-II) and IIOSH-15-20 (AHT-I) were found promising against leafhoppers across the 4 locations.
- Based on the 3 years experimental data, Chlorantraniliprole 18.5 SC @ 0.3 ml/l and Bt-127 SC formulation @ 3.0 ml/l consistently performed well in all locations and effectively reduced the head borer population in sunflower and recorded higher yields. Bt-127 did not show any phytotoxicity to sunflower crop.
- Difenthiuron 50WP @ 1 g/l treatment significantly reduced the whiteflies population in sunflower in all locations.

Major Recommendations

- Pre-emergence application of Pendimethalin 38.7 CS @ 0.75 kg a.i/ha followed by Propaquizafop (Agil) @ 62 g a.i/ha at 20 DAS as post emergence herbicide is recommended for *kharif* sunflower in Raichur region of Karnataka for realizing higher yield and profit.
- Incorporation of black gram 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 boron is recommended for *rabi* sunflower in Vertisols of Nandyal, Andhra Pradesh for realizing high yield and economic returns.
- Seed treatment with bioagent consortium of PAU: *Trichoderma viride* (0.4%) + *Pseudomonas fluorescens* (0.4%) and soil application of *T. viride* @ 2.5 kg/ha is recommended for control of Alternariaster leaf blight

Safflower

- Three varieties *viz.,* SSF-13-71 for Zone-I, Chhattisgarh Kusum-1 (RSS 2012-11) for rice based late sown conditions in Chhattisgarh and Raj Vijay Safflower 14-1 (RVSAF 14-1) for Madhya Pradesh were identified through VIC / State Seed Sub-Committee.
- Four germplasm accessions with high or on par seed yield than the checks, A-1 or PBNS-12 were identified at AICRP Centres: GMU-3772 at Tandur (2435 kg/ha), GMU-7907 at Annigeri (2377 kg/ha), GMU-7905 at Solapur (1455 kg/ha) and Raipur (1820 kg/ha), GMU-2745 at Indore (2029 kg/ha) and Parbhani (1505 kg/ha).
- Two accessions, GMU-7898 and GMU-7899 recorded days to 50% flowering: 63-71 (rainfed) and 81-82 (irrigated); days to maturity: 109-113 (rainfed) and 122-127 (irrigated) in comparison to the early maturing check variety, JSI-99 [days to 50% flowering: 60 (rainfed) and 67 (irrigated); days to maturity: 99 (rainfed) and 113 (irrigated)]. Based on mean of six locations, GMU-7898 and GMU-7899 recorded seed yield of 993 kg/ha and 1235 kg/ha, respectively, compared to 299 kg/ha in the early maturing check variety JSI-99.

The accession, GMU-7899 recorded the highest seed yield at Raipur (2284 kg/ha) showing the potential for high yield under rice based late sown conditions.

- At Solapur, six breeding lines showed superior seed yield performance (1924-2160 kg/ha) over the check varieties, SSF-708 (1750 kg/ha) or A-1 (1657 kg/ha) under rainfed conditions.
- At Tandur, seven test varieties showed superior yield performance over the checks, A-1 or PBNS-12. The seed yield of the test varieties ranged from 1382-2454 kg/ha and the checks from 1017-1976 kg/ha under rainfed conditions.
- At Annigeri, a total of 34 breeding lines showed higher seed yield ranging from 1209 - 3042 kg/ha whereas the yield in checks A-1 or PBNS-12 ranged from 980 - 1759 kg/ha.
- At Parbhani, seven advanced lines recorded higher seed yield (1522 - 1850 kg/ha) than the check, PBNS-12 (1208 kg/ha).
- A total of 142 new CGMS-based hybrids were developed at the centres (Solapur, Indore and Parbhani) using the CGMS lines, A133-I and A133-II supplied by ICAR-IIOR, Hyderabad.
- Two short duration varieties, ISF-867 and JSI-106 were promising, which showed 12-17 days of early maturity and on par seed yield performance in comparison with the check, A-1.
- A total of 3145 individual plant selections were made from different segregating populations (F_2, F_3 and F_4 generations) at the centres (Solapur, Tandur, Raipur and Parbhani) under the activity on pre-breeding for high oil content (>35%).
- Superior selections for high seed yield were made from RIPE (Recurrent Introgressive Population Enrichment) population at four centres (Parbhani, Tandur, Raipur and Indore). Two selections, SAP-1904 and SAP-1907, showed 8.9% and 7.4% increase in seed yield respectively over the check A-1 at Solapur.
- In IVHT, the variety, ISF-123-sel-15 recorded 35.3% oil content, and 11.3% higher oil yield (682 kg/ha) than the check variety, A-1 (613 kg/ha) in Zone-I (rainfed). It recorded 35.29% oil content and 9.2% higher oil yield (693 kg/ha) than A-1 at national level. The CGMS hybrid, ISH-423 gave 2.8 and 16% higher seed and oil yield, respectively than the check variety, A-1 (2334 kg/ha and 635 kg/ha) at the national level.
- In AVT-I, at national level, the variety, SSF-17-04 recorded 11.8% higher seed yield (2107 kg/ha) than the check, A-1 (1885 kg/ha). The variety RVS-18-1 recorded 38.9% oil content, and 32.2% higher oil yield (722 kg/ha) than the check, A-1 (546 kg/ha) at the national level.
- In AVHT-II, the variety, SSF-16-02 recorded 15.2% increase in seed yield (2058 kg/ha) and 18.1% increase in oil yield (634 kg/ha) over the check, PBNS-12 (1787 kg/ha and 537 kg/ha) at national level. Two hybrids *viz.*, ISH-401 and ISH-402 recorded 31.3% and 38.6% increase in seed yield (2346 kg/ha and 2478 kg/ha), respectively over the check, PBNS-12 (1787 kg/ha). They exhibited 41.5% and 42.8% increase in oil yield (760 kg/ha and 767 kg/ha) over the check variety, PBNS-12 (537 kg/ha).
- A total of 41.6 q of breeder seed of nine varieties and parents of one hybrid was produced against the assigned target of 16.3 q breeder seed. Under seed hub programme, 38.5 q seed of four varieties(ISF-764, SSF-708, PBNS-12, PBNS-86) was produced by three centres (ICAR-IIOR, Hyderabad, MPKV, Rahuri and VNMKV, Parbhani).
- System productivity of soybean-safflower (7%) and rice-safflower (4%) decreased when short duration soybean/rice was introduced in the system in place of normal duration varieties of soybean/rice at Indore and Raipur, respectively. At Parbhani, the productivity of soybean-safflower was not significantly different with either short duration or normal duration soybean. System productivity of blackgram-safflower was greater (92%) than fallow-safflower at Solapur.
- In soybean-safflower system, the safflower equivalent yield with 5 rows/BBF x 100% RDF + *Azotobacter* (25 g/kg seed) + PSB (25 g/kg seed) was on par with 4 rows/BBF x 100% RDF

+ *Azotobacter* + PSB at Indore; while at Parbhani, 4 rows/BBF x %100 RDF + *Azotobacter* + PSB was on par with 3 rows/BBF x RDF + *Azotobacter* + PSB with safflower under zero tilled conditions in broad bed and furrow method of land configuration.

- In rice-safflower system, the safflower equivalent yield was the highest with 45 x 20 cm x 100% RDF + *Azotobacter* (25 g/kg seed) + PSB (25 g/kg seed) at Raipur with safflower under zero tillage conditions.
- In blackgram-safflower system, the safflower equivalent yield was the highest with 45 x 20 cm x 100% RDF + $ZnSo_4$ (120 kg/ha) + $FeSo_4$ (10 kg/ha) + *Azotobacter* (25 g/kg seed) + PSB (25 g/kg seed) at Solapur with safflower under zero tilled conditions in compartmental bunding method of land configuration.
- At Annigeri and Solapur, increase in yield was 7-8%, while reduction in cost of cultivation was 6-12% with mechanized conditions compared to farmer's practice. At Indore and Tandur, increase in yield was 14%, while reduction in cost of cultivation was 22-24% compared to farmer's practice. At Parbhani, increase in yield was 62%, while reduction in cost of cultivation was 19% with mechanized conditions compared to farmer's practice. At Raipur, increase in seed yield was meagre, while reduction in cost of cultivation was 11% with mechanized conditions compared to farmer's practice.
- Seed yield of safflower was 94%, 35%, 38% greater with the best management practices than the farmer's practice at Parbhani, Solapur and Tandur, respectively. The best management practices included region specific *recommended package along with INM, seed treatment with Trichoderma*. S, Zn and Fe application and BBF method of land configuration.
- A total of 234 FLDs were conducted by six AICRP centres, one voluntary centre and three other organizations covering six states. Improved technology (IT) led to productivity enhancement by 13% (1058 kg/ha) compared to 936 kg/ha with farmer's practice (FP) resulting in additional net returns of Rs.2,280/ha. The gross returns realized on IT and FP plots were Rs.38,097/ha and 33,254/ha respectively, while the operational cost of cultivation was Rs.21,230/ha and 18,667/ha on IT and FP plots. The B:C ratios were 1.79 and 1.78 on IT and FP plots, respectively.
- In Uniform Disease Nursery Trial, two safflower entries *viz.*, SAF-P-1603 and SAF-1711 were resistant to wilt at Solapur and free from wilt at Tandur. The highest seed yield was recorded by SAF-P-1603 at Solapur (983 kg/ha) and SAF-1711 at Tandur (1972 kg/ha). Therefore, both the entries *viz.*, SAF-P-1603 and SAF-1711 were identified as the most stable sources of resistance to Fusarium wilt disease of safflower.
- Based on disease reaction of selected differential lines of safflower using Fusarium isolates from Solapur, Tandur and IIOR, Hyderabad centres under wilt sick pot study, three entries *viz.*, PBNS-138, 96-508-2-90 and DSI-104 displayed variable reaction to wilt isolates from three locations indicating prevalence of races in major safflower growing areas of the country.
- Seed biopriming with *Trichoderma harzianum*, Th4d WP @ 10 g/litre water for 12 hrs or seed treatment with T.*harzianum*, Th4d WP @10 g/kg seed 1 hr before sowing is recommended for effective and economical management of Phytophthora seedling blight, Fusarium wilt and Macrophomina/Rhizoctonia root rot of safflower and getting higher seed yield under dryland condition.
- The germplasm accession, GMU-3256 was confirmed to be tolerant to aphids while four accessions *viz.*, GMU-1047, GMU- 6556, IC-338171 and SSF-17-13 were confirmed to be moderately tolerant to aphids, after two years of multilocation testing under artificial screening.
- Yield loss due to aphids was less than 25% in three aphid-tolerant accessions *viz.*, GMU-1626, GMU-2718 and SAF-1518.

Major Recommendations

- Released the first high oleic variety, Pride (ISF-1), for cultivation in Telangana, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Karnataka and Maharashtra.
- Released Lakshmi-Priya (ISF-764), a high yielding spiny variety for cultivation in Karnataka, Maharashtra, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Bihar, Chhattisgarh, West Bengal, Gujarat and Odisha.
- Released variety SSF-12-40, for cultivation in Maharashtra, Karnataka and Telangana.
- In scarcity zone of Maharashtra, ensure timely sowing as late planting one month beyond recommended sowing time reduces the seed yield (16%), oil content (5.3%), oil yield (17%) and net returns (21%) of safflower.
- Application of PSB (25 g/kg seed) + 5 t/ha FYM to greengram and 100% P to safflower increases the system productivity of greengram-safflower in Telangana.
- Seed treatment of safflower with either thiamethoxam 30 FS @ 10 ml/kg or imidacloprid 600 FS @ 8 ml/kg and foliar spray with pymetrozine 50 WG @ 300 g/ha effectively reduces aphid population and results in higher seed yield in scarce rainfall zone of Maharashtra.

ICAR-IIOR

Annual Report 2020

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
- Promotions/Transfers/Superannuations
- Personnel


2019/8/19 11:04

Extension and Other Activities

I. Activities under Tribal Sub-Plan (TSP)

Tribal sub-plan programme was implemented in 32 villages of 4 aspirational districts in 3 states *viz.*, Telangana, Andhra Pradesh and Gujarat with the objective of reducing poverty among the scheduled tribal population and creation of productive assets for them. Tribal farmers in aspirational districts were encouraged to take up cultivation of traditional oilseed crops by providing seed of improved cultivars of safflower (ISF-764), sesame (YLM-66), niger (KGN-2) and castor (GNCH-1). Focused group discussions/ training programmes and capacity building programmes were organized and demonstrations on safflower, sesame, niger and castor were conducted by providing all the critical inputs *viz.*, fertilizers, plant protection chemicals and need based small farm implements. Under the programme, about 315 scheduled tribe farmers were benefitted during 2019-20.

Organization	State	Aspirational districts	Villages	No. of beneficiaries	Crop / Variety / hybrid demonstrated
ICAR IIOR through Ekalavya Foundation, RARS-AICRP (Niger)-Chintapalle; NAU, Navasari	Telangana, Andhra Pradesh and Gujarat	Adilabad Vishakapatnam Vizianagaram Tapi	32	315	Safflower: ISF-764 Niger: KGN-2 Sesame: YLM-66 Castor: GNCH-1

Demonstration of safflower variety ISF-764 and safflower-chickpea intercropping (1:4) at Sirpur, Adilabad district

TSP activities on castor in Tapi district, Navasari, Gujarat

TSP programmes taken up under ICAR Network Project on AMAAS during 2020

Adilabad, Telangana

The programme was implemented in two tribal villages *viz*., Borigam (GP) and Chinna Borigam with more than 98% of the population is of Gondu Tribes with the help of an NGO VRSS. One hundred and twenty five (125) farmers were selected. Awareness programme on seed treatment with Trichoderma for management of root rot and wilt diseases in sesame, soybean, groundnut and safflower was conducted on 10-09-2020 and about 100kg Trichoderma powder has been distributed. As farmers requested during interaction for small farm implements for various agricultural operations items like hand hoe, secateurs, trowels, power sprayers and plastic tarpaulins were distributed

TSP programme in Adilabad district

Vizianagaram, Andhra Pradesh

IIOR in collaboration with REEDS (NGO) implemented AMAAS-TSP activity at Pachipenta village of Vizianagaram district of AP. One awareness programme on importance of seed treatment in various crops for management of various soil borne diseases was conducted and 80kg *Trichoderma* formulation was distributed to about 250 farmers on 19-03-2020. Seeds of Sesame variety YLM 66 was distributed and about 25 acres of sesame crop has been grown totally with organic inputs including soil and seed treatment with biological control agents. Farm implements like hand hoe, sickles, spades and power sprayers were also distributed.

TSP programme in Vizianagaram district

II. Activities under Scheduled Caste Sub Plan (SCSP)

Based on the interactions with the SC communities, 670 beneficiaries were identified for implementation of SCSP activities during 2020-21 in Andhra Pradesh, Telangana, Karnataka, Chhattisgarh and West Bengal. Improved castor hybrids ICH-66 and YRCH-2, safflower variety ISF-764, sunflower hybrids NDSH-1012 and KBSH-78 were provided to the SC communities. The farm labourers and farm women were provided battery-cum-manual operated

sprayers, weeders, ploughs and tarpaulins. Awareness was created among SC communities on improved cultivars, nutrient management, pest and disease management.

In order to create awareness on consumption of quality oil among the SC beneficiaries in their households and develop entrepreneurial expertise, oil expellers were installed at four locations and training was imparted.

Training on castor cultivation and input distribution to SC beneficiaries in Anantapuramu, Andhra Pradesh

Distribution of quality seed of minor millets and pulses in Ranga Reddy district

Distribution of weeders to SCSP beneficiaries

Oil extraction unit at Anantapuramu

III. North East Hill (NEH) Region Programme

A. Evaluation of short duration sunflower hybrids for suitability in NEH Region

he objective of this programme was to identify the suitability of short duration cultivar of sunflower and sesame for different locations in NEH regions for further demonstration in farmer's fields. During second year trials, nine sunflower hybrids were evaluated in RBD with three replications with plot size of 5.4 x 4.8m per entry in four locations of NEH region during *rabi* 2019-20. The data has been presented for different locations *viz.*, College of Agriculture, Tripura (CAT), Lembucherra, ICAR-National Organic Farming Research Institute (NOFRI), Sikkim, and School of Agricultural Sciences and Rural Development (SASRD), Nagaland. Data from one centre (ICAR-Nagaland) was not available due to crop failure.

Performance of short duration sunflower cultivars across NEH region

Hybrid / Variety	Seed yield (q/ha)		
	CAT, Tripura	NOFRI, Sikkim	SASRD, Nagaland
COSFV-5	14.3	15.9	4.9
CO-2	15.2	16.5	7.9
RSFH-1887	15.2	22.3	5.9
KBSH-71	17.1	14.0	6.2
KBSH-74	19.7	15.1	6.4
KBSH-78	17.3	21.6	6.6
CO(H)3	15.2	18.0	6.5
IIOSH-14-2	14.3	20.7	6.1
PSH-1962	16.1	19.1	6.6
SEm ±	0.80	0.70	0.46
CD at 5%	2.4	2.0	1.4
CV (%)	12.5	13.4	12.1

At CAT, Tripura, the hybrid KBSH-74 was highest yielder with 19.7 q/ha seed yield and matured in 98 days. The hybrids COSF-5 and IIOSH-14-2 matured in 105 days and were tall. At ICAR- NOFRI, the hybrids RSFH-1887 and KBSH-78 were at par with each other. IIOSH-14-2 and PSH-1962 were equally good seed yield. At SASRD Nagaland, the yield of hybrid CO-2 was found to be highest (7.9 q/ha).

B. Evaluation of short duration sesame varieties for suitability in NEH Region

Fourteen sesame varieties were evaluated in five locations in NEH region during *rabi* 2019-20 for second year. The data has been presented for different locations *viz.*, College of Agriculture Tripura (CAT), Lembucherra, ICAR-NOFRI, Sikkim and SASRD, Nagaland. At initial stage the sesame crop growth was good at ICAR-Basar centre, Arunachal Pradesh but due to excess rainfall it could not be harvested.

Performance of short duration sesame varieties in NEH region

Variety	Seed yield (q/ha)		
	NOFRI, Sikkim	CAT, Tripura	SASRD, Nagaland
VRI SV-1	2.2	9.6	3.8
Swetha til	4.1	5.9	1.6
VRI SV-2	6.4	8.6	3.0
JLT-408	1.7	11.9	5.6
Amrit-2017	2.5	13.9	4.2
TMV SV-7	1.2	7.1	3.1
GT-10	8.9	10.8	6.4
G-TIL-3	4.2	6.7	3.2
Savithri	4.0	12.1	5.4
VRI-3	1.2	7.6	1.5
Prachi 2017	4.4	9.0	5.5
AT-332	1.2	6.4	3.2
DSS-9	1.4	5.9	3.2
HIMA	2.2	-	3.0
SEm±	0.38	0.61	0.38
CD at 5%	1.1	1.7	0.8
CV (%)	14.0	25	12.4

At Sikkim, sesame variety GT-10 recorded the highest seed yield (8.9 q/ha) followed by VRI SV-2 (6.4 q/ha). At this centre, sesame cultivation is fully under organic management as Sikkim has been declared as organically cultivated state. At Tripura centre, the highest yield was noticed in sesame varieties Amrit-2017 (13.9 q/ha) > JLT-408 > GT10 (10.8 q/ha). At SASRD Nagaland centre, the highest yield was recorded in GT-10 (6.4 q/ha)> JLT-408 (5.6 q/ha)> Savithri (5.4 q/ha). However, it was noticed that the performance of GT-10 was good across the three states.

C. Demonstrations in NEH Region

Sesame trial at Gori farm, ICAR-RCNEHR, Basar, Arunachal Pradesh

Sunflower field day at ICAR-NOFRI, Sikkim (04-02-2020)

IV. Mera Gaon Mera Gaurav

A total of 47 visits were made by the MGMG teams covering 2683 farmers in the forty identified villages and the following activities were conducted in the villages. Due to Covid-19 pandemic from March 2020, online interface meetings were conducted and mobile advisories were given to the farmers in the selected villages.

Name of activity	No. of activities conducted	No. of farmers participated / benefitted
Visit to village by teams	47	742
Interface meeting / *Gosthies* / Trainings	30	402
Demonstrations conducted (ha)	92	187
Mobile based advisories (No.)	41	807
Literature support provided	13	172
General awareness created	21	373

V. Exposure visit cum training for ICAR-Skilled Support Staff (SSS)

Exposure visit cum Training for Skilled Supporting Staff (SSS) from IIOPR Pedavegi, IIRR and IIOR Hyderabad was organized on February 26, 2020. The Inaugural session was chaired by Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. He emphasized the advantages and benefits of working in an organization like ICAR. He encouraged the participants to work with more zeal and enthusiasm. Practical exercises in field management were conducted at the Narkhoda Research farm of IIOR. Lectures on topics pertaining to 'Personality Development and Motivation' were also organized. A total of 20 participants have benefitted from the programme.

Practical exercises for Skilled Support Staff

VI. Trainings of farmers, participation in field days and exhibition

Theme	Organiser	Date	No. of beneficiaries
Technologies for increasing productivity of oilseed crops	ICAR-IIOR	February 26, 2020	50 ADAs and MAOs under NFSM (Oilseeds) of Ranga Reddy district
Technologies for enhancing productivity of *rabi* oilseed crops and income of farmers (Online)	ICAR-IIOR	September 29, 2020	60 farmers and officers of agricultural departments of Andhra Pradesh and Telangana
microbialational Webinar on 'Best Management Practices (BMPs) for increasing the productivity of safflower and farmers income'	ICAR-IIOR	October 29, 2020	75 participants including officials of agricultural department, representatives of NGOs, scientists of KVKs, progressive farmers from 12 districts of Andhra Pradesh and Telangana
Farmers FIRST Programme			
Input licensing	ICAR-IIOR	October 8 and 26, 2020	48 FPO members and progressive farmers participated at Rampur thanda Vikarabad district
Value addition for increased income	ICAR-IIOR	November 27-28, 2020	36 members of Vikarabad farmer producer organization (FPO) and progressive farmers participated at Aampally and Guridhotla villages, Vikarabad district

Participation in Agritech South 2020 and Agri Vision 2020

Theme	Organizers	Location	Date	Participation (No.)
Agritech South-2020 and Agri Vision 2020	CII, Telangana State and PJTSAU, Hyderabad	PJTSAU, Hyderabad	February 22-24, 2020	3000 farmers and others visited ICAR-IIOR stall

VII. ICAR-Seed Production in Agricultural Crops (SPAC)

Seven trainings were conducted for skill development among the seed producers for quality maintenance of oilseed crops varieties and hybrids programme in Andhra Pradesh, Telangana, Karnataka, Maharashtra. A total of 775 seed growers were benefitted through these training programmes.

S. No.	Trainings/ Field days organised	Date	Stakeholders	No. of beneficiaries
1.	Seed production technologies of oilseeds	February 26, 2020	ADAs, SMSs, AOs of Department of Agriculture, Rangareddy district, TS	50
2.	Hybrid seed production in sunflower and castor 'Quality seed grower' skill development training	March 18, 2020	Agricultural diploma students, seed growers, Officials of Agri. dept at Banaganapalli and Allgadda, Andhra Pradesh	25
3.	Safflower seed production technology	September 24, 2020	Farmers of Chincholi, Karnataka	10
4.	Sunflower hybrid seed production technology	September 26, 2020	Farmers affiliated to Mulkanoor Co-operative Rural bank & Marketing society, Karimnagar dist, T.S	10
5.	Castor hybrid seed production technology	October 1, 2020	Farmers, AOs of Cherukur, Nagarkurnool dist, T.S	30
6.	Best Management Practices and Seed Production in Safflower	November 6, 2020	Farmers, ADAs, SMSs, AOs, scientists, extension personnel, block officers	300
7.	Technologies for Increasing Safflower Productivity and Quality Seed Production	November 11, 2020	Farmers, ADAs, SMSs, AOs, scientists, extension personnel, block officers	350
Field day				
1.	Safflower Field day -Khanapur, Tandur	February 17, 2020	Safflower farmers, other farmers, KVKs, NGOs, Marico, Grameen Mall, State dept of agriculture	250

Field day at Khanapur, Tandur (17-02-20)

Training on hybrid seed production of sunflower to 'Skill India' trainees (KVK, Yagantipalli, 18-3-2020)

Pawanachal village, Sindewahi block (6-11-20)

Karanji, Waroha Block (11-11-20)

Farmer groups participating in training programmes

VIII. National Agricultural Innovation Fund (NAIF) Activities

Component I: ITMU

Technology licensing and patenting

- Licensing of DOR Bt-1 Technology to M/s Siddaganga Oil & Bio Industries LLP, Tumkur, Karnataka.
- Processing of technology licensing documents to six firms for DOR Bt-1.
- Processing of patent application entitled 'Value added film forming polymeric compositions for seed coating of obtaining the same and uses therefore'.

Component II: ABI

Training programmes

- Four Entrepreneurship Development Programmes (EDP) on 'Value Addition of Edible Oils' were organized for a total of 109 entrepreneurs/ NGO's and progressive farmers on January 3, 17, 27 and 28, 2020.
- Training on 'Mass Production and Quality Testing of Microbial Pesticides for Management of Crop Pests and Diseases' was conducted on September 21, 2020. Fifty eight participants including Assistant Directors of Agriculture and Agriculture Officers (Biological Control Laboratory, State Department of Agriculture), Subject Matter Specialists (KVK) and Research Fellows from six states participated in the virtual training. Resource persons from IIOR imparted training on mass production and quality testing of microbial biocontrol agents of plant pathogens, insect pests and plant parasitic nematodes.

IX. World Soil day organized under Farmer FIRST Programme

The World Soil day was organized on December 5, 2020 at Rampur thanda, a tribal hamlet and FFP adopted village on the theme 'Keep soil alive, protect soil biodiversity'. Around 150 farmers from the Farmers FIRST programme villages and neighbouring villages participated in the day long interaction and awareness programme on the theme.

The programme included visiting the farmers' fields and interactions with them on the NRM component including various aspects of soil management. The field interaction focussed on the use of microbials, PSB, and importance of Integrated Nutrient Management in oilseeds based cropping systems. The farmers were sensitized on the importance of soil, the role of soil biodiversity and conserving and protecting the soil bio diversity towards ensuring long run sustainable agricultural production. The officials from State Deptartment of Agriculture besides NGO's also advised farmers to play attention towards protecting soil biodiversity.

A few farmers from the adopted villages shared their experiences on the advantage of using microbials as seed treatment. On the occasion, samples of *Trichoderma harzianum* Th4d were distributed to the farmers towards seed treatment of crops for the ensuing Zaid season.

Monitoring of fields and interaction with the farmers

Awareness cum interaction programme

X. Parthenium Awareness week

Organized Parthenium Awareness week from August 16-22, 2020. The Awareness week was organized by following all the suitable COVID-19 preventive precautions. A session on 'Awareness programme cum Interaction meeting on Parthenium' was organized at Rajendranagar farm. The technical staff, SRFs, students, TSL of IIOR attended the session. Dr. M. Sujatha, Director, IIOR gave an overview of harmful effects of Parthenium on agricultural crops, general public and livestock. Dr. S.N. Sudhakara Babu, Principal Scientist, elaborated the need for

Integrated Parthenium Management at community level. This was followed by scouting the farm by the staff to identify and remove Parthenium from premises of IIOR. Charts, posters received from Directorate of Weed Research, Jabalpur and live samples were displayed in and around IIOR farms and campuses.

During the period of campaign (August 20-22, 2020), awareness cum action programmes were organized in Narkhoda farm on Integrated Parthenium Management through various means *viz.*, mechanical, cultural, chemical, biological methods along with display of posters and colour charts.

Parthenium Awareness week organized in Research farms of ICAR-IIOR

XI. *Swachhta Pakhwada*

'Swachhta Pakhwada' activities were conducted from December 16-31, 2020. Banners were displayed at prominent places, activities to be organized during pakhwada were briefed, swachhta pledge taken in English and Hindi by IIOR scientific, technical, administrative staff, farm labours and students under the leadership of Dr. M Sujatha, Director (A). Swachhta Awareness March was orgnaised by IIOR staff within the institute. Employees of ICAR-IIOR participated with dedication and enthusiasm. Cleaning drive was undertaken at the office premises. Parthenium weeds, polythene bags and waste materials were removed from office premises and segregated for composting. Waste collection bins were arranged within office premises for biodegradable and non-biodegradable waste disposal.

Cleanliness and sanitation drives were undertaken in the adopted village- Bodakonda of Ranga Reddy District under the Mera Gaon Mera Gaurav (MGMG) Programme and other ICAR-IIOR schemes by involving the village community. Swachhta programmes were also conducted in MGMG villages *viz.*, Sankarakonda Tanda and Medigadda of Amangal mandal, Mahaboobnagar District, Telangana. IIOR scientists, farmers and villagers participated in the programme and Swachhta Pledge was taken by farmers of these villages. Swachhta Pakwada posters were displayed to create awareness of Swachhta. Celebrations of Kisan Diwas (Farmer's Day) on December 23 included visit of 25 farmers from Narva Mandal, Mahabhoobnagar Dist. to IIOR for exposure to technologies developed by the Institute. Swachhta awareness was created in tribal communities of ICAR-IIOR adopted MGMG village, Meddigadda in Mahabubnagar district and pledge was administered. The farmers were briefed on practices of clean cultivation for realizing high yields and profits from crops with special emphasis on groundnut.

A series of lectures with emphasis on agricultural waste management, secondary agriculture and other related issues were organized through Video Conference.

- Redesigning of lignin from agricultural wastes to commercial use in agriculture and food industry' by Mrs. K.S.V.P. Chandrika, Scientist (Agril. chemicals), ICAR-IIOR
- Potentially revolutionizing the food tech industry: Types of Adulteration in edible oils, test to identify, Fat profiling across various oils and Expellers by Mr. Anupam Anand, Anveshan Foundation, Rushikesh
- Value addition on linseed, and linseed technologies by Dr. Anand Zanwar, Scientist, AICRP-Linseed
- Linseed nutraceutical and fibre properties by Dr. Suma Mogali, Senior Scientist, AICRP-Linseed from UAS-Dharwad

- Techno Management Development Programme (T-MDP) on Extruded Food Products Manufacturing by Dr. Chenna Kesava Reddy, IIPM, Bengaluru.

A Quiz competition on 'Swachhta Pakhwada' on Swachh Bharat Mission (SBM) was conducted and 30 staff members of IIOR i.e., scientists, technicians, students, skilled helpers participated in the competition.

The Concluding Session of the Swachhta pakhwada - 2020 was held on December 31, 2020 and presided over by the Director, IIOR. The Nodal Officer briefed about the activities undertaken during Swachhta Pakhwada from December 16-31, 2020. The winners of the quiz competition were felicitated with prizes. The employees participated with great enthusiasm throughout the Pakwada. The Swachhta Pakwada samaapan samaaroh was concluded with determination for Cleaner India.

Swachhta Pakhwada at ICAR- IIOR, Hyderabad (December 16-31, 2020)

Education and Training

Details of students working for Ph.D. (2020)

Name of the student	Title of the thesis	Discipline	University
Major Advisor: **Dr. Ratna Kumar Pasala**			
Mr. Manikanta Chennamsetty	Studies on traits associate with moisture stress tolerance in safflower	Plant Physiology	IGKV, Raipur
Ms. P. Lora Anusha	Studies on physiological and biochemical characterization of sesame (*Sesamum indicum* L.) genotypes under moisture stress	Plant Physiology	ANGRAU, Tirupati
Co-Major Advisor: **Dr. S.V. Ramana Rao**			
Mr. P. Praveen Kumar	Growth and efficiency of oilseeds in India	Agricultural Economics	IGKV, Raipur
Mr. Krishna Teja	Increasing productivity and profitability of oilseeds based production systems in Andhra Pradesh	Agricultural Economics	ANGRAU, Guntur
Co-Major Advisor: **Dr. S. Senthilvel**			
Mr. Manmode Darpan Mohanrao	Studying allelic relationship and identification of SNP markers linked to specific Fusarium wilt resistance genes in castor (*Ricinus communis* L.)	Genetics and Plant Breeding	PJTSAU, Hyderabad
Ms. K. Divya Sravanthi	Mapping of QTL and discovery of candidate genes for Fusarium wilt resistance in castor (*Ricinus communis* L.)	Molecular Biology and Biotechnology	ANGRAU, Guntur
Co-Major Advisor: **Dr. P. Kadirvel**			
Member, Advisory Committee: **Dr. P.S. Srinivas**			
Ms. K. Divya	Molecular mapping and validation of QTLs associated with resistance to aphid (*Uroleucon compositae*) in safflower (*Carthamus tinctorius* L.)	Genetics and Plant Breeding	PJTSAU, Hyderabad
Co-Major Advisor: **Dr. R.D. Prasad**			
Mr. S. Vijaykumar	Biopolymer based multilayer seed coatings with *Trichoderma, Rhizobium* or *Bacillus* and compatible fungicides against seed and soil borne diseases in sesamum, groundnut and soybean	Plant Pathology	PJTSAU, Hyderabad
Ms. K. Greeshma	Studies on the role of cuticular wax conferring resistance against gray mold disease of castor	Plant Pathology	PJTSAU, Hyderabad

Name of the student	Title of the thesis	Discipline	University
Co-Major Advisor: **Dr. G.D.Satish Kumar**			
Ms. Chandana Bhumi Reddy	Impact of public and private extension on farmers knowledge and adoption of sesame production technologies	Agricultural Extension	IGKV, Raipur
Co-Major Advisor: **Dr. P. S. Srinivas**			
Ms. Tabassum Fatima	Resistance to leafhopper, *Amrasca bigittula bigittula* Ishida in sunflower: Screening and identification of mechanisms of resistance	Agricultural Entomology	PJTSAU, Hyderanad
Co-Major Advisor: **Dr. P. Duraimurugan**			
Mr. Borkar Sundar	Studies on bio-ecology and management of storage insect pests of sesame	Agricultural Entomology	JNKVV, Jabalpur
Ms. Navya Matcha	Biorational approaches for management of *Spodoptera* species complex in major oilseed crops	Agricultural Entomology	JNKVV, Jabalpur
Member, Advisory Committee: **Dr. Ch. Sarada**			
Mr. R. Arut Selvan	Studies on influence of weather parameters in occurrence and development of gray mold disease of castor and its management	Plant Pathology	PJTSAU, Hyderabad

Details of students working for M.Sc. (2020)

Name of the student	Title of the thesis	Discipline	University
Co-Major advisor: **Dr. R.D. Prasad**			
Ms. Pattan Ayesha Parveen	Studies on the role of waxy bloom and cutin on biochemical and molecular mechanisms of resistance/susceptibility of castor to gray mold (*Botyrinia ricini*)	Plant Pathology	ANGRAU (AP)
Mr. Kunam Vinod Kumar Reddy	Studies on management of seed and soil borne pathogens of oilseed crops (castor, sesame, groundnut and soybean) by using a biopolymer based *Trichoderma* blend and compatible fungicides	Plant Pathology	JNKVV, Jabalpur
Mr. Surendra P	Studies on variability and management of Fusarium wilt in safflower (*Carthamus tinctorius* Linn.) *Fusarium oxysporum* f.sp. *carthami* Klisiewicz and houston	Plant Pathology	IGKV, Raipur
Co-Major Advisor: **Dr. Ch. Sarada**			
Ms. N. Sandra	Spatio-Temporal Analysis of Indian Castor Oil Exports-A Statistical Perspective	Agricultural Statistics	IGKV, Raipur

Name of the student	Title of the thesis	Discipline	University
Co-Major Advisor: **Dr. K. Alivelu**			
Ms. Abha Goyal	Evaluation of ANN (Artifical Neural Network and penalized regression model prediction of sunflower (*Helianthus annuus* L.) yield based on weather parameters in India	Agricultural Statistics	IGKV, Raipur
Co-Major Advisor: **Dr. P. Kadirvel**			
Ms. R. Navya	Identification of QTLs associated with oil content related traits in safflower (*Carthamus tinctorius* L.)	Genetics and Plant Breeding	ANGRAU, Guntur
Co-Major Advisor: **Dr. Ramya, K.T.**			
Mr. P. Vamshi	Genetic variability studies in advance breeding lines for yield and *Macrophomina* root rot resistance in sesame (*Sesamum indicum*.L)	Genetics and Plant Breeding	ANGRAU, Guntur
Ms. M. Mukthambika	Morphological and genetic diversity analysis in Sesame (*Sesamum indicum* L.) using microsatellites	Genetics and Plant Breeding	JNKVV, Jabalpur
Co-Major Advisor: **Dr. G. Suresh**			
Mr. P. Sai Ram	Response of *rabi* sunflower to different levels of drip irrigation regimes and fertigation	Agronomy	PJTSAU, Hyderabad

Ph.D. degree awarded

Name of the student	Title of the thesis
 Dr. E. Bharathi	Variability in pathogen population of castor wilt fungus and its management Degree awarded by Osmania University, Hyderabad **Supervisor** Dr. M. Santha Lakshmi Prasad Principal Scientist (Plant Pathology) ICAR-IIOR, Hyderabad
 Dr. Brij Bihari Pandey	Physiological mining of sesame (*Sesamum indicum* L.) for maximization of yield and its biochemical profile under moisture stress condition Degree awarded by Indira Gandhi Agricultural University (IGKV), Raipur **Supervisor:** Dr. Ratna Kumar Pasala Principal Scientist (Plant Physiology) ICAR-IIOR, Hyderabad

Name of the student	Title of the thesis
 Dr. B. Madhu	Development of regeneration and transformation protocols in safflower [*Carthamus tinctorius* L.] Degree awarded by School of Life Sciences, University of Hyderabad **Supervisor:** Dr.V. Dinesh Kumar Principal Scientist (Biotechnology) ICAR-IIOR, Hyderabad
 Dr. K. Aravind Kumar	Molecular approaches for necrotrophic fungal tolerance Degree awarded by School of Life Sciences, University of Hyderabad **Supervisor:** Dr.V. Dinesh Kumar Principal Scientist (Biotechnology) ICAR-IIOR, Hyderabad

Professional attachment training of ARS Scientists

Name of the scientist	Discipline	Institute of regular posting	Mentors
 Dr. Papa Rao Vaikuntapu	Plant Biotechnology	ICAR - Directorate of Groundnut Research, Junagadh	Dr. M. Sujatha Dr. V. Dinesh Kumar
 Dr. P. S. Basavaraj	Plant Breeding	ICAR - National Institute of Abiotic Stress Management, Baramati	Dr. P. Kadirvel Dr. S. Senthilvel Dr. P. Ratna Kumar

Organisation of Germplasm-cum-Breeders Field Day

Sunflower

The sunflower germplasm-cum-breeders field day was organised on February 9, 2020 at IIOR-Rajendranagar farm to showcase the breeding material. A total of 390 pre-bred lines received from USDA, USA and 120 CMS A and B lines from all AICRP centres were raised at IIOR. Eleven breeders from AICRP (Sunflower) centres participated and made selections.

Participation of sunflower breeders in Field day

Safflower

Safflower Germplasm-cum-Breeders Field Day was organized on February 25, 2020 at IIOR-ICRISAT farm. Seven breeders from AICRP (Safflower) centres attended the programme and observed the variability among the fresh accessions from USDA, trait specific germplasm and other promising accessions under evaluation. The participants selected accessions for utilization in breeding. Participants also visited breeding plots including populations, advanced generation breeding lines, hybrids and other trait specific breeding material in different generations.

Visit of breeders to safflower germplasm and breeding plots

Awards and Recognitions

Awards

- Dr. P. Duraimurugan received 'All India Paramount Achievement Award 2019' presented by the Society for Advancement of Human and Nature, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh.
- Dr. Ramya K.T. was awarded 'Young Scientist Award 2020' from Indian Society of Genetics, Biotechnology Research and Development, Agra, Uttar Pradesh.
- Dr. H.P. Meena received 'Scientist of the Year Award-2020' for his contribution in the field of Plant Breeding by Society for Scientific Development in Agriculture and Technology, Ghaziabad, Uttar Pradesh.
- Dr. P. Duraimurugan, received 'Scientist Award 2020' for his contribution to Agricultural Entomology with focus on IPM and Screening of Crops for Pest Resistance by Dr. B. Vasantharaj David Foundation, Chennai, Tamil Nadu.
- Dr. T. Boopathi, received 'Scientist Award 2020' for his commendable contribution to Agricultural Entomology by Dr. B. Vasantharaj David Foundation, Chennai, Tamil Nadu.
- Dr. Sankari Meena received 'Young Scientist Award 2020' for her commendable contribution to Nematology by Dr. B. Vasantharaj David Foundation, Chennai, Tamil Nadu.
- Dr. S.N. Sudhakara Babu received Best poster award for the paper entitled 'Seed setting and filling under pollination with stored pollen in sunflower (*Helianthus annuus* L)' authored by S.N. Sudhakara Babu, M. Leelavathi, G. Balakishan, N. Prabhakara Rao and A. Vishnuvardhan Reddy at the National Seminar on Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security organized by ISOR and IIOR from February 7-8, 2020 at Hyderabad, Telangana.
- Dr. H.P. Meena, received Best poster award for the paper entitled 'Development of random mating population for genetic enhancement of yield traits in sunflower' authored by H.P.Meena, Praduman Yadav, Lakshmi Prayaga and A.Vishnuvardhan Reddy at the National Seminar on Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security organized by ISOR and IIOR from February 7-8, 2020 at Hyderabad, Telangana.
- Dr. M. Santhalakshmi Prasad received Best poster award for the paper entitled 'Studies on transmission of sesame phyllody through different methods' authored by K. Prasindhu, M. Santha Lakshmi Prasad, R. Sarada Jayalakshmi Devi and P. Duraimurugan at the National Seminar on Technological Innovations in Oilseed Crops for Enhanced Productivity, Profitability and Nutritional Security organized by ISOR and IIOR fom February 7-8, 2020 at Hyderabad, Telangana.
- Dr. T. Manjunatha received Best poster award for the paper entitled 'Development and Evaluation of Diverse Wilt Resistant Monoecious Lines in Castor (*Ricinus communis* L.)' authored by T. Manjunatha, C. Lavanya, M. Santha Lakshmi Prasad, S. Senthilvel, A. J. Prabhakaran, G. Balakishan and A.Vishnuvardhan Reddy at the National Seminar on Technological Innovations in Oilseed Crops for Enhanced Productivity, Profitability and Nutritional Security organized by ISOR and IIOR from February 7-8, 2020 at Hyderabad, Telangana.
- Best poster award for the poster entitled 'Morphological and pathogenic variation in population of *Fusarium oxysporum* f.sp. *ricini*, wilt pathogen of castor in India' authored by E. Bharathi, M. Santha Lakshmi Prasad and Bee Hameeda in International e-conference on 'Advances in Microbial biotechnology and bio therapeutics' from September 10-12, 2020

organized by Osmania University, Hyderabad, Telangana.

- Dr. H.P. Meena, received Best (first) oral presentation certificate for the paper 'Heterosis breeding in sunflower (*Helianthus annuus* L.) in India: Present status and future prospects' authored by H.P. Meena, M. Sujatha and M.Y. Dudhe in International Web Conference on Perspective on Agricultural and Applied Sciences in COVID-19 Scenario (PAAS-2020) organized from October 4-6, 2020 by AETDS, Uttarakhand.

Institutional Awards

The staff members who were awarded for their best performance and other achievements at the ICAR-IIOR Foundation day on August 1, 2020 are as follows.

- Best Worker (Technical): Sri N. Vasanth
- Best Worker (Administration): Sri G. Rakesh
- Best Worker (SSS): Sri B. Gyaneshwar and Sri. P. Srinivas
- Best Worker (TSCL): Smt. Y. Satyamma, Sri. B. Anjaiah, Smt. E. Sujatha
- Best Research Paper: Dr. H.P. Meena, Dr. M. Sujatha, Dr. Pushpa, H.D. and Dr. J.J. Lal for their publication entitled 'Cytomorphological and molecular characterization of inter-specific hybrid between cultivated sunflower and *Helianthus argophyllus*' in Journal of Environmental Biology 41: 66-72 (2020).

Chairman/Member of Committees/ Panels

- Dr. S.N. Sudhakara Babu acted as Chairman, for review of research and finalization of technical programme on Linseed Agronomy, Biochemistry and Value addition during Annual group meeting of Safflower and Linseed, (VC), IIOR, August 14, 2020.
- Dr. G. Suresh was nominated as Chairman, Assessment Committee for consideration of Promotion case of technical staff of ICAR-IIMR, Hyderabad during 2020.
- Dr. S.N. Sudhakara Babu was nominated as Member, Academic Council, ANGRAU (2020-2021).
- Dr. V. Dinesh Kumar has been nominated as IMC member of ICAR-National Institute for Plant Biotechnology, IARI Campus New Delhi, ICAR-Indian Institute of Agricultural Biotechnology, Ranchi, Jharkhand and ICAR-Indian Institute of Oil Palm Research, Pedavegi, AP.
- Dr. P. Duraimurugan has been nominated as a Member of the Academic Committee of National Institute of Plant Health Management, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, Hyderabad.
- Dr. P. Duraimurugan has been nominated as a Member of the Technical Sub-Committee to Develop Peril Specific Protocol for Implementation of Two Step Crop Yield Estimation Process under PMFBY, Credit Division, DAC&FW, GoI, New Delhi.
- Dr. P.S. Srinivas was nominated by DG, NIPHM as an Expert Member of committee for scrutiny of applications for the post of Director (PMS), NIPHM, Hyderabad.
- Dr. Ch. Sarada was appointed subject expert in the Selection Committee for teaching faculty of Ag. Statistics and Computer Applications, School of Agricultural Sciences and technology, NMIMS (Deemed to be University), Maharashtra.
- Dr. K. Alivelu was appointed as subject expert in the Selection Committee for the promotion of faculty members of Department of Agricultural Statistics and Mathematics, PJTSAU on November 18, 2020.
- Dr. Ch. Sarada was appointed as Expert member in Selection Committee for various awards constituted for faculty members of PJTSAU, Hyderabad during 2020.
- Dr. H.H. Kumaraswamy was one of the science mentors in a national level program 'Vidhyarthi Vigyan Manthan (VVM)', initiated by the Vigyan Bharati in collaboration with Vigyan Prasar, a platform to inculcate and generate interest in pure science and to foster excellence among students and nurture and mentor them.

Fellowship of Scientific Societies

- Dr. N. Mukta was elected as Fellow of Indian Society of Plant Genetic Resources (ISPGR) for the year 2019 for significant contributions in the field of plant genetic resources.
- Dr. M. Santha Lakshmi Prasad was awarded Fellow of Indian Phytopathological Society (FPSI-2018) for the year 2018-19 during IPS 7th International Conference on 'Phytopathology in Achieving UN Sustainable Development Goals' held in January 16-20, 2020 at IARI, New Delhi, India.
- Smt. B. Usha Kiran has been admitted as Fellow of Indian Society of Oilseeds Research (ISOR), Hyderabad on February 8, 2020 for the outstanding contribution in the field of oilseeds research and development in India.
- Dr. H.H. Kumaraswamy has been admitted as a Fellow of Indian Society of Oilseeds Research (ISOR), Hyderabad, for the outstanding contribution in the field of oilseeds research and development in India.

Editor of Recognised Journals

- Dr. V. Dinesh Kumar has been selected as a member of the Editorial Board of Journal of Plant Biochemistry and Biotechnology.
- Dr. P. Duraimurugan has been recognized as Editorial Board Member, Journal of Food, Agriculture and Environment, WFL Publisher (Science and Technology), Finland.
- Dr. P. Ratnakumar has been recognized as Editorial Member for Journal of Functional and Environmental Botany - 2020.
- Dr. H.H. Kumaraswamy has been recognized as Editorial Member for International Journal of Agricultural Sciences, Published by Bioinfo Publications, Pune, Maharashtra, India.
- Dr. H.H. Kumaraswamy has been recognized as Editorial Member for ACTA Scientific Agriculture, Published by ACTA Scientific Publications Pvt Ltd, Hyderabad, Telangana, India.
- Dr. H.P. Meena has been appointed as Editorial Board Member of International Journal of Agricultural Invention from October 2020.
- Dr. P.S. Srinivas was recognised as Associate Editor of Journal of Allium Research, Indian Society of Alliums, Rajgurunagar, Pune, Maharashtra.
- Dr. H.H. Kumaraswamy has been recognized as Editorial Member for a monthly e-newsletter 'Science for Agriculture and Allied Sectors (AGRIALLIS)', published by Growing Seed (Social Welfare Organization), Dharmanagar, North Tripura, India.
- Dr. Ramya K.T has been selected as a member of the Editorial Board of journal 'Plant' published by Science Publishing Group, New York, USA. from September 2020.
- Dr. Senthilvel Senapathy acted as a member of Editorial Board of the journal 'Scientific Reports'

Examiners/Guides

- Dr. S.V. Ramana Rao was nominated by NTA, Dept of Higher Education, MHRD GOI as a subject expert for ICAR AICE-JRF/SRF EXAM (February 1-3, 2020)
- Dr Ch. Sarada has been nominated as External Examiner by ANGRAU for conducting qualifying (oral) examination of M.Sc (Ag. Statistics) students, S.V. Agricultural College, Tirupati on August 14, 2020.
- Dr. P. Duraimurugan has been recognized as External Examiner for evaluation of M. Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Others

- Dr. P. Ratna Kumar was Co-Chairman for the Workshop-cum-Brainstorming on 'Mitigation strategies for stress management' in ISPP North Zonal Seminar jointly organized by ISPP, New Delhi and CSAUAT, Kanpur on February 22, 2020.
- Dr. S.N. Sudhakara Babu was nominated as Rapporteur, National Oilseeds Brainstorming Meet (Research – Industry – Farmer Interface) September 23-25, 2020; Virtual Conference: Host IISR, Indore.

On-going Research Projects

A. INSTITUTE SUPPORTED PROJECTS

S. No	Project No.	Project Name	Investigators
1	101-5	Exploitation of inter and intraspecific genetic resources for development of agronomically superior inbred lines and populations in sunflower	H.P. Meena M. Sujatha M.Y. Dudhe Pushpa H.D. Lakshmi Prayaga K. Sakthivel P. S. Srinivas K. Alivelu A. Vishnuvardhan Reddy
2	102-7	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	Development of parental lines with high oil yield and wilt resistance in safflower	K. Anjani R.D. Prasad
4	102-9	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	102-10	Diversification of safflower germplasm through exploitation of wild species	N. Mukta H.P. Meena Praduman Yadav R.D. Prasad P.S. Srinivas
6	102-11	Improvement of safflower for high oil content, biotic and abiotic stress resistance coupled with high seed yield through recombination and heterosis breeding	Pushpa H.D. Praduman Yadav R.D. Prasad P.S. Srinivas P. Ratna Kumar
7	103-12	Exploitation of plant genetic resources for development of superior inbred lines in castor	K. Anjani M. Santhalakshmi Prasad P. Duraimurugan Praduman Yadav P. Lakashmamma J. Jawahar Lal

S. No	Project No.	Project Name	Investigators
8	103-13	Diversification of pistillate base and development of superior parental lines in castor	T. Manjunatha C. Lavanya S. Senthilvel P. Lakshmamma
9	103-14	Development of genomic resources and tools for applications in castor breeding	S. Senthilvel R.D. Prasad M. Santha Lakshmi Prasad
10	103-15	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 R.D. Prasad Rohini Sreevathsa, (NRCP-B,IARI, New Delhi)
11	103-16	Exploitation of plant genetic resources for identification of trait specific accessions with resistance/tolerance to biotic/abiotic stresses in castor	J. Jawahar Lal T. Manjunatha Praduman Yadav
12	104-12	Agronomic interventions for increasing productivity and resource use efficiency (nutrient and moisture) of emerging cropping systems involving oilseeds	S.N. Sudhakara Babu Md. A. Aziz Qureshi
13	104-13	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 Md. A. Aziz Qureshi P. Ratna Kumar K. Alivelu
14	104-14	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. Sudhakara Babu Lakshmi Prayaga
15	104-15	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
16	104-16	Developing best management practices for organic soybean-sesame cropping system	K. Ramesh Md. A. Aziz Qureshi P. Duraimurugan Praduman Yadav P.C. Latha (ICAR-IIRR)
17	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 (BITS, Hyderabad) Anupama Singh (ICAR-IARI, New Delhi)

S. No	Project No.	Project Name	Investigators
18	104-18	Agronomic interventions for enhancing resource use efficiency in castor based cropping systems	G. Suresh Md. A. Aziz Qureshi
19	104-19	Developing best management practices for sesame under rice-sesame cropping system	K. Ramesh Md. A. Aziz Qureshi Praduman Yadav Harisudan (Vridhachalam, TNAU) K.V. Ramanamurthy (Ragolu, ANGRAU) B.C. Dhir (Mahisapet, OUAT)
20	104-20	Resource mapping enabled AER specific technology assemblage for sustainable oilseed production	P. Padmavathi K. Ramesh K. Alivelu
21	105-11	Development of water dispersible granular (WDG) formulation of *Bacillus thuringiensis* var. *kurstaki* for management of *Spodoptera litura*	P. Duraimurugan K.S.V.P. Chandrika
22	105-12	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
23	105-14	Screening and identification of dependable sources of resistance to insect pests of castor and deciphering the associated mechanisms	P. Duraimurugan
24	105-15	Screening and identification of dependable/ durable sources of resistance to biotic stresses of sesame and deciphering the associated mechanisms	K. Sakthivel M. Santha Lakshmi Prasad P. Duraimurugan H.H. Kumaraswamy Ramya K.T.
25	105-16	Exploiting the bio-efficacy of entomopathogenic nematodes against Tobacco caterpillar (*Spodoptera litura*) and Serpentine leaf miner (*Liriomyza trifoli*) in oilseed crops	B. Gayatri P. Duraimurugan Sunanda B.S. (Nematology), NIPHM
26	105-17	Screening and identification of durable sources of resistance to castor diseases and race identification of wilt pathogen	M. Santhalakshmi Prasad T. Manjunatha
27	105-18	Identification of sources of resistance to leaf webber/capsule borer and leafhopper and understanding the mechanisms of resistance in sesame	T. Boopathi
28	105-19	Exploitation of chitinolytic bacteria and development of effective formulation against major insect pests, diseases and plant parasitic nematodes of oilseed crops	K. Sankari Meena R.D. Prasad P. Duraimurugan K.S.V.P. Chandrika

S. No	Project No.	Project Name	Investigators
29	106-2	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. Rama Rao (ICAR-DOP) M. Santha Laxmi Prasad
30	107-16	ICT mediated knowledge management and dissemination in different oilseed crops	P. Madhuri G.D. Satish Kumar S.V. Ramana Rao Ch. Sarada C. Lavanya M. Sujatha N. Mukta Pushpa H.D Praduman Yadav G. Suresh S.N. Sudhakara Babu P. Padmavathi K. Ramesh P. Duraimurugan H.P. Meena
31	107-17	On-farm demonstrations of improved technologies and impact assessment of the adoption	S.V. Ramana Rao G.D. Satish Kumar P. Madhuri
32	107-18	Impact assessment of varieties/hybrids of IIOR mandated crops in varied agro ecological regions of India	S.V. Ramana Rao Ch. Sarada PI: K.P. Thakar, (SDAU, S.K. Nagar)
33	107-19	Development of models to predict yield responses to climate change in oilseed crops	K. Alivelu C. Sarada
34	107-20	Development of ICT tools for technology dissemination in oilseed crops	P. Madhuri C. Lavanya N. Mukta H.P. Meena Ramya K.T. Pushpa H.D J. Jawahar Lal G.D. Satish Kumar S.V. Ramana Rao
35	107-21	Development of websites for AICRP Oilseeds and field monitoring system for the trials	P. Madhuri C. Lavanya N. Mukta A.L. Rathnakumar H.P. Meena Ch. Sarada K. Alivelu

S. No	Project No.	Project Name	Investigators
36	107-22	A cross platform application for identification and advisory for managing diseases and insects in oilseed crops through Image Analysis and Artificial Intelligence	C. Sarada R.D. Prasad M. Santha Lakshmi Prasad K. Sakthivel P.S. Srinivas P. Duraimurugan S.V. Ramana Rao G.D. Satish Kumar
37	108-1	Development of stable cytoplasmic genetic male sterile system in sesame through wide hybridization	J. Jawahar Lal
38	108-2	Exploitation of inter and intra specific genetic resources for development of elite breeding lines in sesame	Ramya K.T. J. Jawahar Lal A.L. Rathnakumar P. Ratna Kumar K. Sakthivel K. Alivelu
39	108-3	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
40	109-1	Exploitation of plant genetic resources for development of improved breeding populations in Niger [*Guizotia abyssinica* (L. f.) Cass.]	Pushpa H.D. A. Vishnuvardhan Reddy
41	110-1	Development of seed production and seed quality maintenance technologies for oilseed crops	C. Manimurugan S.N. Sudhakara Babu M.Y. Dudhe J. Jawahar Lal Pushpa H.D. T. Boopathi

B. EXTERNALLY FUNDED PROJECTS

S. No	Project title	Investigators	Sponsoring organization	Budget (Rs. in lakh)
1	Mass production of *Bacillus thuringiensis* (Bt) and *Beauveria bassiana*, formulation as oil based suspension concentrates singly & in combination and field evaluation	P. Duraimurugan K.S.V.P. Chandrika	ICAR Network-AMAAS	8.15
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 K.S.V.P. Chandrika P. Lakshmamma Md. A. Aziz Qureshi	ICAR Network-AMAAS	8.20
4	Frontline demonstrations (FLDs) on oilseeds and other extension activities	G.D. Satish Kumar S.V. Ramana Rao Ch. Sarada	NMOOP, DAC&FW, GoI	300.00

S. No	Project title	Investigators	Sponsoring organization	Budget (Rs. in lakh)
5	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 P. Lakshmamma P. Padmavathi G.D. Satish Kumar K. Alivelu Md. A. Aziz Qureshi P. Duraimurugan Ramya K.T. T. Manjunatha P. Madhuri S.T. Viroji Rao Gnan Prakash Sarat Chandra Venkata Ramana G. Vidyasagar Reddy	KVK Scheme Extension Division, ICAR	14.71
6	Seed production in agricultural crops	J. Jawahar Lal S.N. Sudhakara Babu T. Manjunatha H.P. Meena Ramya K.T.	ICAR Network	9.25
7	Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority (Annual)	N. Mukta C. Lavanya M.Y. Dudhe	PPV & FRA, GoI	10.25
8	Development of distinctiveness, uniformity and stability (DUS) testing guidelines for niger [*Guizotia abyssinica* (L.f.) Cass.]	N. Mukta H.P. Meena	PPV & FRA, GoI	9.00
9	Delineating the effector biology of phytoplasma affecting selected crop taxa in India with special emphasis on sesame (*Sesamum indicum* L.)	V. Dinesh Kumar Suman Lakhanpaul, Department of Botany, Delhi University	NASF, ICAR	15.03
10	Establishment of Biotech-KISAN Hub at Agri Biotech Foundation, Hyderabad	Md. A. Aziz Qureshi P. Padmavathi	DBT	17.00
11	Exploitation of genetic and genomic resources for improvement of niger (*Guizotia abyssinica* L.F. Cass) through breeding and biotechnological tools	M. Sujatha Pushpa H.D. Praduman Yadav	DBT	235.63
12	Exploiting genetic diversity for improvement of safflower through genomics-assisted discovery of QTLs/genes associated with agronomic traits	P. Kadirvel N. Mukta R.D. Prasad P.S. Srinivas Praduman Yadav Lakshmi Prayaga P. Ratna Kumar P. Padmavathi Md.A. Aziz Qureshi Ch. Sarada	DBT	493.07

Committees

Research Advisory Committee

Dr. P. Raghava Reddy	Former Vice Chancellor ANGRAU H.No.3-1-5/41/G1 Sri Sai Nilayam, Attapur Hyderabad – 500 048	Chairman
Dr. B.B. Singh	Former ADG (OP), ICAR 281 Utsav 1 Apartment Flat No.201, Lakhanpur Kanpur – 208 024	Member
Dr. Sreenath Dixit	Principal Scientist & Head ICRISAT Development Center (IDC) ICRISAT, Patancheru Telangana – 502 324	Member
Dr. V.G. Malathi	Principal Scientist (Retd.) G1 Sree Kumaran Hill Crest Apartment East GKS Avenue, Thondamuthur road Coimbatore – 641 046	Member
Dr. D.M. Hegde	Former Director, ICAR-IIOR C-108, SMR Vinay Galaxy Hoody Junction, CTPL Road White field, Mahadevapura Bangalore – 560 048	Member
ADG (OP), ICAR	ICAR, Krishi Bhawan, New Delhi – 110 001	Member
Director, ICAR-IIOR	ICAR-IIOR, Rajendranagar, Hyderabad	Member
Dr. P.S. Srinivas	Principal Scientist (Agricultural Entomology) ICAR-IIOR, Rajendranagar, Hyderabad	Member-Secretary

Institute Management Committee

Director, ICAR-IIOR	Director ICAR - Indian Institute of Oilseeds Research, Hyderabad	Chairman
ADG (OP)	ICAR, 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 – 431 402, Maharashtra	Member

Shri Kuchakulla Yadagiri Reddy	H.N.16-2-751/C/14, FF-6 Shreys Apartments, Asmangad, Malakpet Hyderabad-500 036, Telangana State	Member (Non-Official)
Shri Kondela Saya Reddy	H.No.11-1-1815, Maruthinagar Nizamabad – 503 002	Member (Non-Official)
Dr. C. Aruna	Principal Scientist (Plant Breeding) ICAR-Indian Institute of Millets Research Hyderabad	Member
Dr. Pankaj Sharma	Principal Scientist (Plant Pathology) ICAR-Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur	Member
Dr. Sammi Reddy K	Head of the Division I/c Division of Resource Management ICAR – Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad	Member
Dr. A.K. Singh	Head (Agricultural Engineering) ICAR- Indian Institute of Sugarcane Research (IISR), Lucknow	Member
Finance & Accounts Officer	ICAR – Central Tobacco Research Institute (CTRI), Rajahmundry	Member
Shri Shitanshu Kumar	Senior Administrative Officer ICAR – Indian Institute of Oilseeds Research Rajendranagar, Hyderabad	Member-Secretary

Meetings and Events

Institute Management Committee (IMC)

The 43rd meeting of the Institute Management Committee (IMC) was held at Hyderabad on January 2020 ,24. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR and Chairman of IMC presented the Research Highlights and other extension activities of ICAR-IIOR during the year 2019 to the house. Shri Shitanshu Kumar, Senior Administrative Officer, ICAR-IIOR and Member-Secretary of IMC presented the agenda of IMC meeting including the budget estimates and expenditure incurred till the date. The house appreciated the scientific achievements/ contributions as presented by the chairman and noted the expenditure incurred so far in ICAR-IIOR-Unified Budget including the AICRP and also ongoing in-house and external projects of ICAR-IIOR. The IMC members expressed their satisfaction for overall functioning of ICAR-IIOR.

National Seminar on 'Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security'

A National seminar on 'Technological Innovations in Oilseed Crops for Enhanced Productivity, Profitability and Nutritional Security' (NOS-2020) was organized at Hyderabad during February 7-8, 2020 under the aegis of Indian Society of Oilseeds Research (ISOR). A total of 477 delegates representing scientific, extension, industry and d evelopmental agencies attended. Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, New Delhi and President, ISOR inaugurated the semi nar. In his inaugural address, Dr. Mohapatra emphasized on the need to adopt modern breeding techniques such as genome editing, speed breeding, marker assisted breeding and also to continue the research efforts for value addition in crops like castor, reducing gap from lab to land with better out-reach activities; and higher value chain from seed to industry etc. to break the intrinsic yield barriers in oilseed crops. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIO R, Hyderabad and Vice-President, ISOR, provided the status and background of vegetable oils in the country. Dr. V. Praveen Rao, Vice-Chancellor, PJTSAU, Rajendranagar, Hyderabad, Dr. Mangala Rai, Former Secretary, DARE & DG, ICAR and Dr. Panjab Singh, Former Secretary, DARE & DG were the guests of honour.

During the two day seminar, in-depth discussions were held under seven themes *viz.*, accelerated breeding and boosting crop yields through genetic improvement; conservation agriculture and enhancing resource use efficiency in production systems; stress management and climate change; processing, value addition, specialty oils and secondary sources of oil; knowledge management and technology transfer for reaching farmers and consumers; marketing, policy support and consumer awareness; and agri-innovation and entrepreneurship opportunities. The key recommendations made to boost R&D efforts and assist suitable policy decisions required to achieve self-reliance in vegetable oil production in the country are listed. Crop improvement research needs to focus on germplasm enhancement, pre-breeding, gene discovery with the application of modern tools such as speed breeding, genomics, genome editing, etc. Breeding for climate resilience needs to be expedited by adopting phenomics and remote-sensing platforms for large-scale screening. Integrating the developments in sensor technology and IT tools with micro-irrigation system, strengthening conservation agriculture technologies and developing small implements and machinery suitable for smallholder oilseed farmers were identified as the key areas of attention in crop production research. Need for strong basic research on deciphering mechanisms of resistance to pests and diseases and deployment of wireless sensor networks (WSN) and decision support system (DSS) for management of diseases were recognised in the area of crop protection. Development of technologies for processing, value addition, specialty oil types and secondary oil sources need major attention. Yield enhancement in oil palm, promotion of virgin coconut oil, ecological mapping of suitable areas for olive cultivation, technology licensing for speciality products of soybean, bioethanol production etc. need to be taken up through public private partnership,

on priority. All the interactive mobile apps, DSS and other ICT approaches developed by different institutions must reach farmers for bridging the gap between attainable yields with improved technologies compared to farmers' practices. Policy support for adoption of Genetically Modified (GM) crops, imposing quantitative restrictions on import of edible oil, price tracking through market intelligence etc. were suggested for promoting domestic vegetable oil production.

The session ended with vote of thanks by Dr. M. Sujatha, General Secretary, ISOR and Principal Scientist, ICAR-IIOR, Hyderabad.

Annual Group Meeting of Castor, Sunflower, Sesame & Niger, 2020

The Annual Group Meeting of Castor, Sunflower, Sesame & Niger was organized from May 26-27, 2020. With the outbreak of the COVID-19 in the country, the meeting was organized through Video Conference, in accordance with the MHA Guidelines. During the Plenary Session on May 27, 2020, Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR) emphasized the need for harnessing the benefits of advancement in Genomics in genetic improvement of oilseeds. He highlighted the importance of developing appropriate SOPs and facilities for phenotyping for various biotic and abiotic stresses and provide adequate training to AICRP scientists in the niche areas. In the inaugural address, Dr. T.R. Sharma, Deputy Director General (Crop Science), ICAR, stressed the need for extensive utilization of pre-breeding, speed breeding and allele mining tools and techniques for bringing out significant yield enhancement and quality improvement in oilseed crops. Dr. D.K. Yadava, ADG (Seeds), ICAR highlighted the need to replace old varieties with the newly released cultivars. Dr. S.K. Jha, ADG (O&P) urged the scientists to address the gaps in FLDs for expansion of the area under oilseeds. Dr. P. Raghava Reddy, Vice-Chancellor (Retd.), ANGRAU, Hyderabad emphasized the need to set higher targets for yield and utilize the germplasm available for enhanced tolerance to biotic and abiotic stresses and sustainability in production. Dr. M.K. Naik, Vice-Chancellor, University of Agricultural & Horticultural Sciences, Shivamogga suggested identifying one hot spot area for each of the diseases and conducting the screening trials to identify resistant lines for exploitation in the breeding programmes. Dr. P.K. Chakrabarthy, Member, ASRB opined that the approaches for conservation and deployment of pollinators should be considered while developing pest management strategies. Dr. D.M. Hegde, Former Director, ICAR-IIOR; Dr. Y.G. Prasad, Director, ATARI, Hyderabad; Dr. G. Ravindra Chary, Director, CRIDA; Dr. T. Radhakrishnan, Director, DGR-Junagadh; Dr. M. Krishna Reddy, PSIIHR, Bengaluru; Dr. Mahendra Kumar, PS, ICAR-IIRR, Hyderabad; Dr. M. Ramachandram, PS (Retd.), ICAR-IIOR acted as Chairmen/ Subject experts for different sessions of the group meeting and helped in formulating a sound technical programme for 2020-21. The results of the experiments and FLDs conducted during *rabi*-summer 2018-19 and *kharif*-2019 were presented by the respective crop PIs and Co-PIs. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR and Dr. Rajani Bisen, I/c Project Coordinating Unit (Sesame & Niger) presented the achievements of four *kharif* oilseed crops. A total of 224 delegates participated in the group meeting.

Institute Research Committee (IRC)

The IRC meeting for *kharif* season was conducted during June 2020 ,12-05 and for *rabi* season was conducted on September 2020 ,09, September ,16 2020 and October 2020 ,09. Dr. A. Vishnuvardhan Reddy, Director and Dr. M. Sujatha, Director (Acting) chaired the *kharif* and *rabi* sessions, respectively. A special discussion on the new proposals was also conducted on 07 December 2020. A total of 53 projects including 41 institute supported projects and 12 externally funded projects were discussed and technical programme for 2020-2021 was formulated.

ICAR-IIOR Foundation Day Celebrations

The Foundation Day of ICAR – Indian Institute of Oilseeds Research was celebrated on August 3, 2020 through Video conference hosting from ICAR – IIOR, Hyderabad. The events included invited lecture on COVID-19 by the noted immunologist Dr. Vishnun Rao Veerapaneni, practicing at SWASA Hospital, Hyderabad. Dr. Vishnun Rao gave detailed account of COVID-19 from its nature, threat, sources of infection, symptoms, avoidance, treatment and care to dispel the misconception and social stigma attached with the infection. The lecture was useful and assuring in the present situation of fears in facing COVID-19.

This was followed by the release of a publication on Sesame varieties jointly brought out by PC Unit Sesame & Niger, Jabalpur and ICAR-IIOR; presentation of awards to individuals of IIOR for the best achievements in science, technical, administrative, SSS and TSCL categories.

About 75 participants had witnessed the events through video conference. At IIOR, the SSS and TSCL staff witnessed the event in Farmers meeting hall and Seminar Hall adhering to COVID-19 guidelines.

Release of publication staff on sesame varieties Foundation Day

Dr. Vishnun Rao Veerapneni

SSS and TSCL staff delivering lecture on COVID-19 through VC

Felicitation of the retired staff participating in the Foundation Day

Annual Group Meeting on Safflower and Linseed, 2020

The Annual Group Meeting of Safflower and Linseed was conducted during August 13-14, 2020 through Video Conferencing. Introductory session was held on August 13, 2020 under the chairmanship of Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR welcomed the participants and presented the highlights of overall achievements of the projects.

The safflower crop sessions on Breeding, Agronomy and Plant Protection were conducted on August 13, 2020. The breeding session was chaired by Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi and Co-Chaired by Dr. S.K. Jha, ADG (O&P), ICAR, New Delhi. Dr. D.M. Hegde, Former Director, ICAR-IIOR, Hyderabad and Dr. Y.G. Prasad, Director, ATARI, Hyderabad were the subject experts for agronomy and plant protection sessions, respectively and chaired the respective sessions. The Co-PIs: Dr. N. Mukta, Dr. K. Anjani, Dr. P. Padmavathi, Dr. S.V. Ramana Rao, Dr. R.D. Prasad and Dr. P.S. Srinivas presented the consolidated progress reports of Genetic resources & Seed production, Breeding, Agronomy, FLDs, Pathology and Entomology programmes, respectively.

The linseed crop sessions on Breeding, Agronomy and Plant Protection were conducted on August 14, 2020. The breeding session was chaired by Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi and Co-Chaired by Dr. S.K. Jha, ADG (O&P), ICAR, New Delhi. Dr. P.K. Singh, Former PC (Linseed) & Prof. (PI. Breeding), CSAUA & T, Kanpur; Dr. M.P. Dubey, Professor, JNKV, Sagar and Dr. Ashok Kumar, Former Professor, CSKHPKV, Palampur were the subject experts for breeding, agronomy and plant protection sessions, respectively. Dr Nandan Mehta, PI (Breeding), IGKV, Raipur; Dr. J.R. Katore, PI (Agronomy), CoA, Nagpur; Dr. Ajith Kumar K. PI (Pathology), UAS, Raichur and Dr. B.P. Katlam, PI (Entomology), IGKV, Raipur presented the consolidated annual progress reports (2019-20) and tentative technical program (2020-21) of Breeding and Germplasm, Agronomy, FLDs, Pathology and Entomology programs, respectively.

The plenary session was held on August 14, 2020. Dr. T. Mohapatra, Secretary, DARE & DG, ICAR was the chief guest. Dr. T.R. Sharma, DDG (CS), ICAR chaired the session and Dr. S.K. Jha, ADG (O&P), ICAR co-chaired the session. Dr. M. Sujatha, I/c Director, ICAR-IIOR, Hyderabad and Dr. G.P. Dixit, PC (Linseed), ICAR-IIPR, Kanpur presented the overall proceedings of the meeting for safflower and linseed, respectively. While appreciating the progress made in both the projects, Dr. T. Mohapatra expressed serious concern over the rapid declining trend of acreage of these crops in the country and asked the scientists to develop action plan for area expansion in order to sustain the R&D programmes. The meeting ended with the vote of thanks proposed by Dr. M. Sujatha.

Research Advisory Committee (RAC)

The 34th Research Advisory Committee meeting was conducted virtually during November 20-21, 2020 under the chairmanship of Dr. P. Raghava Reddy, Former Vice Chancellor, ANGRAU. The members, Dr. B.B. Singh, Former ADG (O&P), Dr. D.M. Hegde, Former Director, IIOR, Hyderabad; Dr. V.G. Malathi, Former Principal Scientist, IARI, New Delhi; Dr. Sreenath Dixit, Head, IDC, ICRISAT, Hyderabad; Sh. K. Saya Reddy, Sh. K. Yadagiri Reddy, Dr. M. Sujatha, Director (A), ICAR-IIOR, and Dr. P.S. Srinivas, Principal Scientist, ICAR-IIOR, Member-Secretary and all the scientists of IIOR attended the meeting.

Dr. M. Sujatha, Director (A), IIOR welcomed the Committee and presented the highlights of the achievements made by IIOR during the last year. Significant research achievements made under different research projects were presented before the committee by the respective Heads of the sections/ Lead Scientists. New research programmes proposed

in EFC document were also presented before the committee for suggestions. The Action Taken Report was presented by Dr. P.S.Srinivas, Member-Secretary. After interaction and thorough discussion with the scientists, the RAC made recommendations for further improvement of the research output.

Review meeting on Oilseeds Seed Hub of DAC&FW and Inauguration of infrastructure facility at RA KVK, Nimpith, West Bengal

A review meeting on Oilseeds Seed Hub of DAC&FW, New Delhi being coordinated by ICAR – Indian Institute of Oilseeds Research was organized on January 24, 2020 at RA KVK, Nimpith. Ms. Shobha Thakur, Joint Secretary (Oilseeds & Crops), DAC&FW, GoI, New Delhi chaired the meeting. Dr. Anupam Barik, ADC (Oilseeds), DAC &FW, Dr. S.K. Jha, ADG (Oilseeds and Pulses), ICAR, New Delhi, the Co-nodal officers represented by Dr. Radhakrishnan, Director, DGR, Junagadh; Dr. Bhatia, IISR, Indore; Dr. Bhagirat Ram, PS, DRMR, Bharatpur and Dr. S.N. Sudhakara Babu, ICAR-IIOR were the chief dignitaries in addition to the Director, DOD, Hyderabad, Director, Jute Development, Kolkata and Revered Swami Sadanandji Maharaj, Chairman of RA KVK, Nimpith. A total of 110 participants including representatives of 35 seed hub centres attended the programme.

The infrastructure facilities of seed processing plant and seed storage godown of RA KVK, Nimpith, West Bengal build at a cost of Rs.50 Lakhs were inaugurated by Ms. Shobha Thakur, Jt. Secretary (Oilseeds and Crops).



International Women's Day

International Women's day was celebrated on March 9, 2020 under the UN theme 'I am Generation equality: Realizing Women's Rights'. The Chief Guest, Smt. Radhika Rastogi, IAS, DDG, NIRD & PR addressed the staff on discrimination and invisible barriers present in the society for development of women. She reiterated that basic amenities should be provided to women to facilitate in fulfilling their responsibilities efficiently and meeting their aspirations. She stressed that equality needs to be inculcated in the minds of children and this will pave the way for realizing gender equal society in the near future. She urged that all of us should speak and stand up for the victim and privileged people should help the less privileged especially in terms of rights of women. She also highlighted the role being played by many self-help groups, social committees, NGOs and Government agencies, in addressing women-centric problems and issues.



Dr. A. Vishnuvardhan Reddy, Director, IIOR also emphasized the need of gender equality even at the work place. He requested scientists to sensitize people on women-centric issues in MGMG villages. A total of 100 staff including scientific, administration, technical, SSS, TSL, RAs, SRFs and students attended the meeting. The session ended with vote of thanks by Mr. Shitanshu Kumar, SAO, ICAR-IIOR.

Celebrations culminating in the 150th Birth Anniversary of the Father of the Nation, Mahatma Gandhi

The activities were conducted under Swachh Bharat Mission from 25th September 2020. In addition to regular cleanup of the office/lab and IIOR premises, other sanitization drives were also undertaken at IIOR. COVID-19 awareness program was conducted at IIOR and IIOR Research Farm, Narkhoda. All degradable wastes such as weeds and unwanted wood material was put in compost pits with the active participation of farm staff. Banners of 'Swachhta Pakwada' were displayed to create awareness. Swachhta and COVID-19 awareness was created in MGMG villages and clean up drive was conducted at Ibrahimpally, R.R. Dist. Telangana.

On the 151st Birth Anniversary (i.e., 02. Oct., 2020) of the Father of the Nation, Mahatma Gandhiji, the ICAR-IIOR organized Shramadan under Swachh Bharat Programme under the chairmanship of Dr. M. Sujatha, Director, ICAR-IIOR. All scientific, administrative, technical, contractual staff and students of IIOR participated with great enthusiasm and dedication. A quiz competition was conducted and awards were distributed on this occasion by the Director. Dr. S.N. Sudhakara Babu, Principal Scientist, IIOR delivered a lecture on Gandhiji's Principles. The celebrations concluded with vote of thanks.

Human Resource Development

Annual Training Plan Implementation

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

Category-wise training attended

S. No.	Category	Total no. of employees	No. of employees attended training
1	Scientist	39	6
2	Technical	37	2
3	Administrative & Finance	22	2
4	SSS	20	0
	Total	**118**	**10**

a) Scientific staff

S. No.	Name of employee	Desig-nation	Name of the training pro-gramme attended	Date and Organizer/ Venue
1.	Dr. Senthilvel Senapathy	Principal Scientist	E-training workshop for Vigilance officers of ICAR institutes (online)	August 5-7, 2020 ICAR-NAARM, Hyderabad
2.	Dr. M. Santhalakshmi Prasad	Principal Scientist	Leadership and organisation development for women scientists and technologists (online)	October 12-16, 2020 COD, Hyderabad
3.	Dr. J. Jawaharlal	Senior Scientist	Analysis of experimental data using SAS (online)	November 9-14, 2020 ICAR-NAARM, Hyderabad
4.	Dr. G.D. Satish Kumar	Principal Scientist	Market research and chain value management for agricultural commodities (online)	November 17-21, 2020 ICAR-NAARM, Hyderabad
5.	Smt. K.S.V.P. Chandrika	Scientist	Training on Nano technology (Online)	November 23-27, 2020 ICAR-CIRCOT, Mumbai
6.	Dr. V. Dinesh Kumar	Principal Scientist	MDP on Leadership Development (online)	December 8-19, 2020 ICAR-NAARM, Hyderabad

b) Technical staff

S. No.	Name of employee	Designation	Name of the training pro-gramme attended	Date and Organizer/ Venue
1.	Shri M. Bhaskar Reddy	CTO	Repair and maintenance of office, residential building including guest houses	January 21-23, 2020 ICAR-CIAE, Bhopal
2.	Smt. Ch. Hari Priya	CTO	Motivation, positive thinking and communication skills for technical officers of ICAR (online)	December 17-22, 2020 ICAR-NAARM, Hyderabad

c) Administration

S. No.	Name of employee	Designation	Name of the training programme attended	Date and Organizer/Venue
1.	Shri G. Raghava Kiran Kumar	Stenographer	Enhancing efficiency and behavioural skills for stenographers	February 24-29, 2020 ICAR-NAARM, Hyderabad
2.	Smt. S. Swaroopa Rani	Assistant	Establishment rules - 2 (online)	November 23-27, 2020 ISTM, New Delhi

Other trainings attended

Scientific staff

Name	Designation	Training Programme	Date and Organiser/Venue
Dr. S. V. Ramana Rao	Principal Scientist	International Workshop on Pathways of Agricultural Extension for Enhancing Food and Nutritional Security and Developments	February 18-19, 2020 MANAGE, Hyderabad.
Dr. Ch. Sarada Dr. K. Alivelu	Principal Scientist Principal Scientist	Quantitative Methods for Social Sciences (online)	June 1-23, 2020 NCAP, New Delhi
Dr. K. Alivelu Dr. N. Mukta	Principal Scientist Principal Scientist	Digital data recording in plant breeding (online)	September 19, 2020
Dr. K. Alivelu	Principal Scientist	National Webinar on Statistical Computing Using R software (Online)	September 28-30, 2020
Dr. Lakshmi Prayaga	Principal Scientist	Climate change: Challenges and response (online)	October 5-10, 2020 LBSNAA, Mussoorie
Dr. K. Ramesh	Principal Scientist	Analysis of experimental data using SAS (online)	November 9-14, 2020 ICAR-NAARM, Hyderabad
Dr. Praduman Yadav	Scientist	Market research and chain value management for agricultural commodities (online)	November 17-21, 2020 ICAR-NAARM, Hyderabad
Smt. Usha kiran	Scientist	Emotional intelligence at work place for women scientists and technologists (online)	November 23-27, 2020 COD, Hyderabad
Dr. Ch. Sarada	Principal Scientist	Management Development Program for Women in Development Sector (online)	December 14-18, 2020 MANAGE, Hyderabad
Dr. Sankari Meena	Scientist	Integrating gender concerns in agricultural research and extension for improving livelihood of farm women (online)	December 15-19, 2020 ICAR-CIWA, Bhubaneswar

Technical staff

Name of employee	Designation	Training programme	Date and Organiser/ Venue
Shri P. Demudunaidu Shri J. Ashok Smt. G. Sailaja	T3 T1 T1	National Workshop on Farm Mechanization for small and marginal farmers	March 5-6, 2020 NIPHM, Hyderabad

Administrative staff

Name of employee	Designation	Training programme	Date and Organiser/Venue
Shri. G.S. Yadav	PA	Capacity Building programme for CJSC members	January 27-31, 2020 NAARM, Hyderabad
Smt. C. Lalitha Smt. P. Swapna	Pri. Secretary LDC	Basic Training Programme for use of Hindi on Computer	February 10-14, 2020 Central Hindi Training Institute

Participation in Conference/Seminars/Symposium/Workshops/Meetings

Name	Programme	Organised by	Date
Dr. M. Sujatha	IMC meeting	IIMR, Bharatpur	January 6, 2020
Dr. A. Vishnuvardhan Reddy (Director) and 51 Scientific and technical personnel	National Seminar on 'Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security'	Indian Society of Oilseeds Research Hyderabad & ICAR-Indian Institute of Oilseeds Research Hyderabad	February 7-8, 2020
Dr. K. Ramesh	International Conference on Recent Advances in Material Chemistry (ICRAMC 2020)	SRM University, Chennai	February 19-21, 2020
Dr. J. Jawahar Lal	Agri Tech South 2020 and Agri Vision	PJTSAU, Hyderabad	February 22-24, 2020
Dr. Ch. Sarada	Preparation of protocol for implementation of Technology Driven Two-Step yield estimation approach to conduct need based crop cutting experiments under PMFBY	Credit Division, Ministry of Agriculture and Farmers welfare, GOI	May 27, 2020
Dr. H.H. Kumaraswamy	National Webinar on 'Statistics and Agriculture'	Kasturba Gandhi Degree and PG College for Women, Hyderabad	May 27, 2020
Dr. M. Sujatha	International Sunflower Association Board Meeting	ISA, France	June 17, 2020
Dr. S.V. Ramana Rao	Annual Review Workshop of Farmers FIRST Programme	Division of Agricultural Extension, ICAR	June 17-18, 2020
Dr. Praduman Yadav	'Food Matrices-Major Challenges & Critical Application Based Solutions'	Waters India Ltd.	June 18, 2020
Dr. Praduman Yadav	Purification solutions using Flash Chromatography	Spinco Biotek	June 25, 2020
Dr. P. Ratna Kumar	Recent Physio-Molecular Digital tools in Abiotic stress Mangement for crop modeling	VNMKV, Parbhani	June 29-30, 2020

Name	Programme	Organised by	Date
Dr. R.D. Prasad	'Annual Review Workshop of ICAR Network Project on Application of Microorganisms in Agriculture and Allied Sectors (AMAAS)'	ICAR-NBAIM, Mau	July 1-2, 2020
Dr. H.P. Meena	Brain Storming Session on Enhancing Oilseed Brassica Production: Technological Innovations and Marketing Strategies	Society for Rapeseed-Mustard Research, Bharatpur and ICAR-DRMR, Bharatpur	July 4, 2020
Dr. H.H. Kumaraswamy	National Webinar on 'Mendelian Genetics to Modern Genomics'	NAHEP (ICAR)-CAAST, IARI, New Delhi	July 11, 2020
Dr. Ch. Sarada	Sensitization on uploading data in KRISHI Repositories	IASRI, New Delhi	July 15, 2020
Dr. H.H. Kumaraswamy	International webinar on 'COVID-19 Pandemic: Crisis and Aftermath'	Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, UP	July 20-21, 2020
Dr. H.H. Kumaraswamy	International webinar on 'Achieving Land Degradation Neutrality'	ICAR-Indian Institute of Soil and Water Conservation, Dehradun	July 22-24, 2020
Dr. Ch. Sarada Dr. M. Santha Lakshmi Prasad Dr. H.P. Meena Dr. K. Ramesh Dr. G. Suresh	National Webinar on 'Enhancing Castor Production: Genetic Reformation and Technological Intervention'	Castor Mustard Research Station S.D.A.U. Sardarkrushinagar, Gujarat	July 23, 2020
Dr. Praduman Yadav	HPLC column maintainance	Phenomenex India	July 23, 2020
Dr. C. Lavanya Dr. H.P. Meena	Webinar on 'Breeding of Oilseeds: A Challenge for Self Sufficiency'	Bihar Agricultural University, Sabour, Bihar	July 29, 2020
Dr. Praduman Yadav	International Webinar on 'Strengthening the Immune System against COVID-19 through Agricultural Innovations'	SKNAU Jobner, Rajasthan	July 29, 2020
Dr. G.D. Satish Kumar	National Conference on 'Transformation of Agricultural Extension-Strategies for Effective Reformation'	ANGRAU Agricultural College, Bapatla	August 20-21, 2020
Dr. Mangesh Y. Dudhe	Legal Framework for Protection of Plant Varieties in India: Challenges and Opportunities	ICRISAT and European Business and Technology Centre (EBTC)	August 26, 2020
Dr. P. Padmavathi Dr. Lakshmi Prayaga Dr. G. Suresh Dr. K. Ramesh Dr. P. Ratna Kumar	National webinar on 'Abiotic stress in agriculture: Geospatial characterization and management options'	National Institute of Abiotic Stress Management, Baramati	August 27, 2020

Name	Programme	Organised by	Date
Dr. G. Suresh	Inauguration and Address by Hon'ble Prime Minister of India during 'Academic and Administrative Building of Rani Lakshmi Bai Central Agricultural University, Jhansi'	Rani Lakshmi Bai Central Agricultural University (RLBCAU), Jhansi	August 29, 2020
Dr. K. Ramesh	Webinar on Organic farming: Opportunities and challenges	Agrovision India, Nagpur	September 2, 2020
Dr. Mangesh Y. Dudhe	ICDSB workshop on 'Fundamentals of Biology, Foundations for Data Science, Galaxy'	Institute of Bioinformatics (ISB), Bangalore	September 3, 2020
Dr. G. Suresh	Commemorative Address on 'Humanity at Crossroads with Wicked Problems of Global Pandemics, Climate Change and Food Security' by Dr. P.V. Vara Prasad, Director, Sustainable Intensification Innovation Lab, University Distinguished Professor on the occasion of the Foundation Day of PJTSAU, Hyderabad	PJTSAU, Hyderabad	September 3, 2020
Dr. Mangesh Y Dudhe	International Conference on Data Science in Biology (ICDSB) 2020	Insitute of Bioinformatics (ISB), Bangalore	September 4-5 & 8, 2020
Dr. Ch. Sarada Dr. K. Alivelu	Webinar on 'Sustaining Agriculture through Collectives, Cooperatives and Farmer Producer Organization'	VAMNICOM	September 8, 2020
Dr. P. Padmavathi Dr. P. Ratna Kumar	National webinar on 'Drone remote sensing in Agriculture'	Department of Agricultural Physics, ICAR-IARI, New Delhi	September 9, 2020
Dr. C. Lavanya	Webinar on 'Contemplative Perspectives on Seed-Conservation, Quality Assurance & Supply Systems'	ICAR-IISS, Mau	September 10, 2020
Dr. G. Suresh	Foundation laying of various academic facilities and inauguration of 'School of Agri-business and Rural Development' by Hon'ble Prime Minister of India	Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar	September 10, 2020
Dr. P. Duraimurugan	International e-Conference on 'Advances in Microbial Biotechnology and Biotherapeutics'	Osmania University, Hyderabad	September 10-12,2020

Name	Programme	Organised by	Date
Dr. G. Suresh	National Webinar on 'Soil Survey and Land Use Planning for Realizing Sustainable Development Goals of the United Nations' by Prof. Rattan Lal, World Food Prize Laureate, Ohio State University, USA	ICAR-NBSSLUP, Nagpur	September, 11, 2020
Dr. H.H. Kumaraswamy	Educational webinar on 'Transforming your manuscript into an engaging scientific talk'	Letpub, Accdon LLC, Boston, The USA	September 11, 2020
Dr. K. Ramesh	Netherlands & India: Climate Smart Agriculture - Opening & Water session	Netherlands Embassy in India and Netherland Enterprise Agency	September 14, 2020
Dr. S.V. Ramana Rao	Progress on ZTMC (Zonal Technology Management Centre) Activities in ICAR Crop Institutes in the Southern Indian zone.	ICAR-IIMR, Hyderabad	September 15, 2020
Dr. M. Santha Lakshmi Prasad	Webinar on 'Advances in Plant Pathology with special reference to diagnosis and management'	Dr. Y. S. R. Horticultural University, V.R. Gudem, Andhra Pradesh.	September 16, 2020
Dr. K. Alivelu	Birth centenary symposium on contributions of Prof. C.R. Rao in statistics	ICAR-IASRI, New Delhi	September 19, 2020
Dr. M. Sujatha	5th Technical Evaluation Committee meeting of DBT	DBT, New Delhi	September 21-22, 2020
Dr. M. Sujatha Dr. S.V. Ramana Rao Dr. N. Mukta Dr. M. Santha Lakshmi Prasad Dr. H.P.Meena Dr. S. Senthilvel Dr. P. Padmavathi Dr. G.D. Satish Kumar Dr. G. Suresh Dr. P.S. Srinivas Dr. Lakshmi Prayaga Dr. H.H. Kumaraswamy Dr. P. Ratna Kumar	National Oilseed Brainstorming Meet (Research - Industry - Farmer interface)	ICAR-IISR, ICAR-IIOR, ICAR-IIOPR, ICAR-DGR, and ICAR-DRMR	September 23-25, 2020
Dr. Mangesh Y. Dudhe	Three days National Webinar on 'Statistical Computing using R Software'	Acharya NG Ranga Agricultural University Agricultural College Bapatla	September 28-30, 2020

Name	Programme	Organised by	Date
Dr. G. Suresh	62nd Foundation Day Lecture on Soil and Water Management: Key to Agricultural Sustainability by Dr. S.K. Chaudhari, DDG (NRM), ICAR, New Delhi	ICAR-Central Arid Zone Research Institute, Jodhpur	September, 30, 2020
Dr. G. Suresh	Inaugural Ceremony of Vaishvik Bhartiya Vaigyanik (VAIBHAV) Summit, a global virtual summit of Overseas Indian Researchers and Academicians by Hon'ble Prime Minister of India	Ministry of Communication and IT, Govt of India, New Delhi	October 2, 2020
Dr. H.P. Meena	Web Conference on 'Perspective on Agricultural and Applied Sciences in COVID-19 Scenario'	Agricultural and Environmental Technology Development Society, Uttarakhand.	October 4-6, 2020
Dr. Ch. Sarada Dr. Mangesh Y Dudhe	Virtual Global Summit on Responsible Artificial Intelligence (AI) for Social Empowerment (RAISE 2020)	NITI Aayog and Ministry of Electronics and Information Technology, Govt. of India	October 5-9, 2020
Dr. R.D. Prasad	National Meeting on Biopesticides - Registration and Quality Assurance: Issues and Way forward	ICAR-NBAIR, Bangalore	October 6, 2020
Dr. R.D. Prasad	Technical Sub-Committee Meeting to Develop Peril Specific Protocol for Implementation of Two Step Crop Yield Estimation Process under PMFBY	Credit Division, DAC&FW, GoI, New Delhi	October 7, 2020
Dr. N. Mukta Dr. H.P. Meena Dr. C. Lavanya Dr. M.Y. Dudhe	International webinar on 'DUS testing data management/ Automation/ Image Analysis' under Indo-German bilateral program	PPV&FRA, DAC&FW, New Delhi and Federal Ministry of Food & Agriculture (BMEL) Germany	October 6-7, 2020
Dr. P. Ratna Kumar	National webinar on Translating Physiology into Techniques for biotic Stress tolerance	ICAR-NIASM, Baramati	October 9, 2020
Dr. S.V. Ramana Rao	Workshop and Annual Review Meeting of National Agricultural Innovation Fund (NAIF) Scheme of ABI/ ZTMC/ ITMU of Crop Science Division	IP&TM Unit, ICAR	October 9-10, 2020
Dr. H.H. Kumaraswamy	Conference on 'Plant Genomics in a Changing Environment'	Welcome Genome Campus, Hinxton, Cambridgeshire, The UK.	October 12-14, 2020
Dr. G.D. Satish Kumar	E-Review Workshop of 'National Extension Programme and IAR-VOs partnership outreach programme'	IARI, New Delhi	October 20, 2020
Dr. P. Ratna Kumar	The Research Grant Application Guide	WILEY	October 22, 2020

Name	Programme	Organised by	Date
Dr. R.D. Prasad	Meeting on 'Regional Expert Consultation on Agriculturally Important Microorganisms'	ICAR-NBAIM, Mau India; APAARI, Thailand and Council of Agriculture (COA), Taiwan	October 28, 2020
Dr. G. Suresh	Farmer Scientist Interaction meet on 'Promoting oilseed cultivation after Rice/ Rice fallows in Telangana and Andhra Pradesh'	Bharatiya Kisan Union and ICAR-IIOR Hyderabad	October 31, 2020
Dr. M. Sujatha (Director) and All scientists	Interactive meeting on 'Making India Self Sufficient in Edible Oils'	ICAR-DGR, Junagadh	November 2, 2020
Dr. K. Ramesh	Agronomic research for developing climate resilient technologies	Telangana chapter of Indian Society of Agronomy	November 5, 2020
Dr. M. Sujatha	83rd CVRC meeting	DAC&FW, New Delhi	November 9, 2020
Dr. H.H. Kumaraswamy	International e-conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity'	University of Horticultural Sciences, Bagalkot, Karnataka	November 24-27, 2020
Dr. H.H. Kumaraswamy	Webinar on Genomics Strategies for Improvement of Abiotic Stress Tolerance in Crop Plants	ICAR-NIASM, Baramati	November 27, 2020
Dr. H.P. Meena	National Workshop on Intellectual Property Management in Agriculture	ICAR-IIAB, Ranchi	November 28, 2020
Dr. K. Ramesh	9th Agrochemicals Conference	FICCI	December 01, 2020
Dr. M. Sujatha Dr. S.N. Sudhakara Babu	UK-India Agriinnovation: Future Proofed and Climate Smart Partnerships	British High Commission, New Delhi	December 1-4, 2020
Dr. M. Sujatha	ICAR Director's Conference	ICAR, New Delhi	December 5, 2020
Dr. S.V. Ramana Rao Dr. G. Suresh Dr. R.D. Prasad	World Soil Day under Farmers First Programme at Rampur Thanda, Vikarabad	ICAR-IIOR, Hyderabad	December 5, 2020
Dr. P. Duraimurugan	Second National Conference on 'Recent Scientific Advances in Agricultural and Environmental Sciences'	Dr. B. Vasantharaj David Foundation, Chennai	December 5, 2020
Dr. Ch. Sarada	National Seminar on Big Data Analytics in Agriculture	ICAR-NAARM, Hyderabad	December 10-11, 2020
Dr. M. Sujatha	42nd PGRC meeting	NBPGR, New Delhi	December 21, 2020

Note: Programmes from May onwards were attended in virtual mode unless otherwise indicated (*)

हिन्दी गतिविधियाँ

नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के अधिकारियों कर्मचारियों हेतु संस्थान में राजभाषा कार्याशाला आयोजित

नगर राजभाषा कार्यान्वयन समिति2- के तत्वावधान में तिलहन अनुसंधान संस्थान, राजेंद्रनगर में एक कार्यशाला का आयोजन 27.2.20 को नराकास 2- के सदस्य कार्यालयों के अधिकारियों व अन्य स्टॉफ सदस्यों के लिए किया गया।

डॉ. एस. के. सोम, संयुक्त निदेशक, नार्म ने कार्यक्रम की अध्यक्षता की तथा अपने संबोधन में इस तरह नियमित रुप से कार्यशाला आयोजन से हिन्दी में सरकारी काम-काज में अपार वृद्धि होने की संभावना है। इसका असर भी दिखाई दे रहा है।

श्री. शीतांशु कुमार, वरिष्ठ प्रशासनिक अधिकारी, आईआईओआर ने सहभागियो का स्वागत करते हुए बताया कि किस तरह आईआईओआर के विभिन्न अनुभागों में हिन्दी कार्य में वृद्धि हुई है तथा वित्त एवं लेखा अनुभाग तो लक्ष्य से काफी आगे बढ कर कार्य कर रहा है तथा अन्य अनुभागों को उनका अनुसरण करना चाहिए। इसके साथ ही कार्यक्रम का उद्देश्य एवं कार्यक्रम की जानकारी भी दी। श्रीमती अनिता पांडे, सदस्य-सचिव, नराकास ने हिन्दी शिक्षण योजना हैदराबाद द्वारा चलाए जा रहे कंप्यूटर पर हिन्दी में काम करने हेतु चलाए जा रहे पांच दिवसीय कार्यक्रमों में सभी कार्यलयों से सदस्यों को नामित करने का अनुरोध किया। श्रीमती आकांक्षा शुक्ला, एसोसिएट प्रोफेसर एवं प्रभारी राजभाषा, एनआईआरडी ने इस प्रकार के आयोजन के महत्व को बताते हुए प्लास्टिक मुक्त कार्यालय परिसर की ओर काम करने की बात कही।

कार्यक्रम के दूसरे तकनीकी सत्र में डॉ. प्रद्युम्न यादव, वरिष्ठ वैज्ञानिक आईआईओआर ने खाद्य तेल एवं उनसे जुडी भ्रांतियां पर अपना प्रस्तुतीकरण दिया। उन्होंने खाद्य तेलों से जुडे बहुत से मिथकों पर प्रकाश डाला तथा सहभागियों की शंकाओं का निराकरण भी किया।

श्री. रंगा साई, सहायक महा प्रबंधक, एसबीआई, हैदराबाद ने कंप्यूटर में हिन्दी में काम करने की अद्यतन तकनीक पर प्रस्तुतीकरण दिया। आपने विभिन्न ऑन लाइन अनुवाद की सुविधाओं के बारे में तथा वाईस टाईपिंग का विस्तृत विवरण दिया। इनसे जुडी सहभागियों की समस्या एवं जिज्ञासा का भी निवारण किया। सहभागियों ने इस जानकारी को अत्यंत उपयोगी बताया।

उपरोक्त कार्यशाला में विभिन्न कार्यालयों के लगभग 60 अधिकारियों एवं कर्मचारियों नें भाग लिया। श्री. प्रदीप सिंह, सहायक निदेशक (राजभाषा) आईआईओआर के धन्यवाद प्रस्ताव से कार्यशाला का समापन हुआ।

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Research Papers

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Souvenir Articles

Dixit, G.P. and Sujatha, M. 2020. An Overview of Linseed Research in India. Souvenir, IOPEPC Global Oilseeds Conference, October 15-16, 2020.

Lavanya, C., Praduman Yadav and Sujatha, M. 2020. Castor: Status and Strategies for Enhancing Export. Souvenir, IOPEPC Global Oilseeds Conference, October 15-16, 2020.

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Vishnuvardhan Reddy, A., Sudhakara Babu, S.N., Radhakrishnan, T., Bhatia, V.S. and Rai, P.K. 2020. Status and technological options for increasing oilseeds production. Souvenir, National Seminar on Oilseeds, ISOR-IIOR, Hyderabad, February 7-8, 2020.

Presentation in Seminars/Symposia/Workshop/Meetings/Conferences

Name of the presenter	Title	Place	Date
Dr. P. Kadirvel	Safflower Network Project Proposal in the Sub-Committee Meeting of APEX Board	DBT, New Delhi	January 10, 2020.
Dr. P. Kadirvel	Annual Progress Review Meeting of the programme Advisory Committee on OEB-Plant Sciences under SERB, DST in connection with the DST-SERB sponsored project titled 'Mapping of QTLs associated with resistance to aphid (*Uroleucon compositae* Theobald) in safflower (*Carthamus tinctorius* L.) using genome-wide SNP markers' (2017-2020).	INSA, New Delhi	January 21, 2020
Smt. Usha Kiran, B.	*'In vitro* regeneration in castor (*Ricinus communis* L.),' Oral and Poster Presentation in National Seminar on 'Technological Innovations in Oilseed Crops for Enhanced Productivity, Profitability and Nutritional Security'	Hyderabad	February 7-8, 2020
Dr. Ch. Sarada	'Development of decision support system (DSS) for forecasting of gray mold disease of castor (*Ricinus communis* L.) using internet of things (IoTs),' Oral presentation in National Seminar on 'Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security'	Hyderabad	February 7-8, 2020
Dr. K.B. Durga Bhavani	'Early events of root colonization in castor by the biocontrol agent *Trichoderma,'* Oral presentation in National Seminar on 'Technological Innovations in Oilseed Crops for Enhancing Productivity, Profitability and Nutritional Security'	Hyderabad	February 7-8, 2020
Dr. K. Ramesh	Phosphate rock: The ecofriendly natural material for direct application to organic sesame production. Oral presentation at International Conference on Recent Advances in Material Chemistry (ICRAMC 2020)	SRM University, Chennai	February 19-21, 2020
Dr. Praduman Yadav	Invited lecture on 'khadya tel or bhrantiyan' in नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों के अधिकारी व कर्मचारियों के लिए तकनीकी हिन्दी कार्यशाला	ICAR-IIOR, Hyderabad	February 27, 2020
Dr. A. Vishnuvardhan Reddy Dr. M. Sujatha	Castor scenario in India: Then and now. Presented during the National Webinar on 'Enhancing Castor Production Genetic Reformation and Technological Intervention'	SDAU, SK Nagar, Gujarat	July 23, 2020
Dr. C. Lavanya	'Castor productivity enhancement through new breeding techniques' in National Webinar on 'Enhancing castor production: Genetic Reformation and Technological Intervention'	SDAU, SK Nagar, Gujarat	July 23, 2020

Name of the presenter	Title	Place	Date
Dr. M. Sujatha	'Prebreeding and genetic enhancement in oilseeds crops' during the Webinar on Breeding of Oilseeds: A challenge for self-Sufficiency	BAU, Sabour, Bihar	July 29, 2020
Dr. G.D. Satish Kumar	'Is mobile phone a powerful tool in the hands of a farmer?' Lead paper presented under the theme 'Innovative methods for transfer of technology'. National Conference on Transformation of Agricultural Extension-Strategies for Effective Reformation	ANGRAU, Agricultural College, Bapatla, A.P.	August 20-21, 2020
Dr. P. Duraimurugan	Field persistence of SC formulations of *Bacillus thringiensis* singly and in combination with entomopathogenic fungi against lepidopteran pests in oilseeds ecosystem. International e-Conference on Advances in Microbial Biotechnology and Biotherapeutics (Poster presentation).	Osmania University, Hyderabad	September 10-12, 2020
Dr. G. Suresh	Agronomic management in castor & sesame to farmer trainees of Farmers-Scientists Interaction Meeting	ICAR-IIOR Hyderabad	September 15, 2020
Dr. P.S. Srinivas	Pest management in oilseed crops in Interaction Meeting with Farmers (online)	ICAR-IIOR, Hyderabad	September 15, 2020
Dr. R.D. Prasad	Delivered a guest lecture on 'Mass Production and Quality Testing of Microbial Biocontrol Agents of Plant Diseases' during the Virtual Training Programme on 'Mass Production and Quality Testing of Microbial Pesticides for Management of Crop Pests and Diseases'	Agribusiness Incubation Unit, ICAR-IIOR, Hyderabad.	September 21, 2020
Dr. P. Duraimurugan	Delivered lecture on 'Mass Production and Quality Testing of Microbial Biocontrol Agents of Insect Pests' during the Virtual Training Programme on 'Mass Production and Quality Testing of Microbial Pesticides for Management of Crop Pests and Diseases'	Agribusiness Incubation Unit, ICAR-IIOR, Hyderabad.	September 21, 2020
Dr. G. Suresh	Best management practices for increasing yield and income of oilseed farmers (castor, sunflower, sesame and safflower) to the farmers of Online training (webinar) on Technologies for enhancing productivity of rabi oilseed crops and income of farmers	ICAR-IIOR Hyderabad	September 29, 2020
Dr. P.S. Srinivas	Integrated management of insect pests of *rabi* oilseed crops in training programme on Technologies for Enhancing Productivity of Rabi Oilseeds Crops	ICAR-IIOR, Hyderabad	September 29, 2020

Name of the presenter	Title	Place	Date
Dr. H.P. Meena	Oral presentation of the paper 'Heterosis Breeding in sunflower *(Helianthus annuus L.)* in India: Present status and future prospects' during International Web Conference	AETDS, Uttarakhand	October 4-6, 2020
Dr. T. Manjunatha	Diverse Pistillate Lines as New Sources of Resistance to Fusarium Wilt in Castor In 'International E-conference on Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture'	College of Horticulture, Bangalore, University of Horticultural Sciences (Bagalkot)	October 6-9, 2020
Dr. H.H. Kumaraswamy	Optimization of PCR Conditions Imparts Robustness to SSR markers as Potential Genomic Resources in Indian Sesame (*Sesamum indicum* L.) in a virtual conference on 'Plant Genomics in a Changing Environment'	Welcome Genome Campus, Hinxton, Cambridgeshire, The UK.	October 12-14, 2020.
Dr. P. Padmavathi	Best management practices for safflower for Telangana	ICAR-IIOR, Hyderabad	October 29, 2020
Dr. R.D. Prasad	Guest lecture on 'Management of diseases of safflower' in National Webinar on 'Best Management Practices (BMPs) for increasing the productivity of safflower and farmers income' under NFSM (Oilseeds)	ICAR-IIOR, Hyderabad	October 29, 2020
Dr. P.S. Srinivas	Insect pest management in safflower in National webinar on Best Management Practices for increasing the productivity of safflower and farmers income' under NFSM	ICAR-IIOR, Hyderabad	October 29, 2020
Dr. R.D. Prasad	Delivered a guest lecture on 'Trichoderma and Plant Health Management" in a National Webinar on Soil Borne Plant Pathogens-Management with emphasis on biocontrol agents	Dr. YSR Horticulture University	November 5, 2020
Dr. P.S. Srinivas	Integrated pest management in safflower in Orientation cum training programme on Best Management Practices and seed production in safflower	ICAR-IIOR, Hyderabad	November 6, 2020
Dr. P. Kadirvel	Safflower Network Project Proposal in the 3rd meeting of Scientific and Technical Appraisal and Advisory Groups (STAG)	DBT, New Delhi	November 8, 2020.
Dr. P.S. Srinivas	Integrated pest management in safflower in Online Training cum interaction on technologies for increasing safflower productivity and quality seed production	ICAR-IIOR, Hyderabad	November 11, 2020

Name of the presenter	Title	Place	Date
Dr. H.H. Kumaraswamy	Genetically stable genotypes with contrasting phenotypes have potentiality as genetic resources for mapping yield-contributing traits in sesame (*Sesamum indicum* L.) in International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity'	University of Horticultural Sciences, Bagalkot, Karnataka	November 24-27, 2020
Dr. H.P. Meena	Poster presentation on 'Screening and identification of sunflower (*Helianthus annuus* L.) genotypes resistant to powdery mildew' during International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity'	University of Horticultural Sciences, Bagalkot, Karnataka	November 24-27, 2020
Dr. T. Manjunatha	Influence of Node Number of Castor Hybrids on Seed Yield in Different Agroclimatic Conditions. In International E-conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity'	University of Horticultural Sciences Bagalkot, Karnataka	November 24-27, 2020
Dr. G. Suresh	Best management practices of oilseed crops grown in Andhra Pradesh during SAMETI-AP Online training programme for ADAs and AOs of Andhra Pradesh on 'Improved Production packages of Oilseeds in Andhra Pradesh'	SAMETI, Guntur, A.P	December 3, 2020
Dr. M. Sujatha	Strategies for making India Self-sufficient in Oilseeds for the FOCARS trainees	ICAR-NAARM Hyderabad	December 8, 2020

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. 9.5 lakhs was spent during the period under report to acquire nine books and for subscription to 52 Indian periodicals and 6 foreign periodicals, 2 databases *viz*., India Patent and India Agri. Stat. A total of 47 publications was 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' A total of 268 articles have been delivered to indenters through e-mails have been published and circulated to all scientists working in AICRP (Sunflower, Safflower, Castor and Sesame & Niger) centres across different states. 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 2020.

Civil works

Name of the work	Status
Processing Lab for Seed, Bt and Biopesticides	In progress
Construction of Seed Processing cum Storage Unit at Narkhoda Research Farm	In progress
Renovation of shed for Oil Extraction Unit	Completed

Promotions/Transfers/Superannuations

Promotions

Name	Position/Grade	Effective Date
Smt. B. Usha Kiran	Promoted to the next higher grade i.e. Level-12 and designated as Scientist	10.02.2019
Dr. Pushpa H.D	Promoted to the next higher grade i.e. Level-11 and designated as Scientist	01.01.2019
Dr. J. Jawaharlal	Promoted to the next higher grade i.e. Level-12 and designated as Senior Scientist.	15.12.2018
Dr. P. Ratna Kumar	Promoted to the next higher grade i.e. level-14 and designated as Principal Scientist.	04.07.2018
Dr. P. Duraimurugan	Promoted to the next higher grade i.e. level-14 and designated as Principal Scientist.	04.04.2018
Shri. S. Saida Reddy	Promoted to the next higher grade i.e. Tech. Asstt. T3	18.05.2019
Shri. G. Pardhasaradhi	Promoted to the next higher grade i.e. Tech. Officer T5	01.01.2020

Transfer

Name	Post	From	To	Date
Smt. B. Gayatri	Scientist (Nematology)	ICAR-IIOR Hyderabad	ICAR-NRRI, Cuttack, Odisha	07.08.2020 (AN)

Superannuations

Name	Post	Date
Shri.SurendraPrasad	Technical Officer T5	31.05.2020
Shri. G.Y. Prabhakar	Technical Officer T5	30.06.2020
Smt. R. Raji	Private Secretary	01.08.2020
Dr. K. Anjani	Principal Scientist (Plant Breeding)	30.09.2020
Shri. D. Balaiah	SSS	31.12.2020

Personnel

Dr. A. Vishnuvardhan Reddy	Director (upto 14.08.2020)
Dr. M. Sujatha	Director (A) from 21.08.2020

Director's Cell

Smt. C. Lalitha	Private Secretary
Shri. P. Srinivasa Rao	Personal Assistant

Research Sections

Crop Improvement

Dr. K. Anjani (Plant Breeding)	Head & Principal Scientist (up to 30.9.2020)
Dr. V. Dinesh Kumar (Biotechnology)	Head & 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
Dr. A.L. Ratnakumar (Plant Breeding)	Principal Scientist
Dr. T. Manjunatha (Plant Breeding)	Sr. Scientist
Dr. Mangesh Y. Dudhe (Plant Breeding)	Sr. Scientist
Dr. H.H. Kumaraswamy (Biotechnology)	Scientist
Smt. B. Usha Kiran (Biotechnology)	Scientist
Dr. H.P. Meena (Plant Breeding)	Scientist
Dr. C. Manimurugan (Seed Science & Technology)	Scientist
Dr. Ramya, K.T. (Genetics & Plant Breeding)	Scientist
Dr. Pushpa, H.D. (Genetics & Plant Breeding)	Scientist
Shri. P. Gopinadhen	Tech. Officer T-5 (F/F)
Shri. G. Srinivasa Rao	Tech. Officer T-5 (F/F)
Smt. P. Mary	Technician T-1
Shri. J. Narasimha	Technician T-1
Smt. G. Sailaja	Technician T-1

Crop Production

Dr. S.N. Sudhakara Babu (Agronomy)	Head & Principal Scientist
Dr. G. Suresh (Agronomy)	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)	Principal Scientist
Dr. Praduman Yadav (Biochemistry)	Scientist
Smt. K.S.V.P. Chandrika (Agril.Chemicals)	Scientist
Smt. Ch.V. Haripriya	Chief. Tech. Officer (F/F)
Shri. S. Narsimha	Tech. Officer (T-5)

Crop Protection

Dr. R.D. Prasad (Plant Pathology)	Head & Principal Scientist
Dr. M. Santha Lakshmi Prasad (Plant Pathology)	Principal Scientist
Dr. P. Satya Srinivas (Agril. Entomology)	Principal Scientist
Dr. P. Duraimurugan (Agril. Entomology)	Principal Scientist
Dr. T. Boopathi (Agril. Entomology)	Senior Scientist
Smt. B. Gayatri (Nematology)	Scientist
Dr. K. Sakthivel (Plant Pathology)	Scientist
Dr. K. Sankari Meena (Nematology)	Scientist
Shri. Ch. Anjaiah	Sr. Technician (F/F)
Shri. S. Saida Reddy	Tech. Assistant (F/F) T-3

Social Sciences

Dr. S.V. Ramana Rao (Ag. Economics)	Head & Principal Scientist
Dr. Ch. Sarada (Agril.Statistics)	Principal Scientist
Dr. G.D. Satish Kumar (Agril. Extension)	Principal Scientist
Dr. K. Alivelu (Agril. Statistics)	Principal Scientist
Smt. P. Madhuri (Computer Applications)	Scientist (SS)

Seed Section

Dr. J. Jawaharlal	Senior Scientist (Pl. Breeding) & Incharge
Shri. T. Veeraiah	Sr. Technical Asst. T4 (F/F)

Support Services

AKMU Cell

Shri. P. Srinivasa Rao	Asst. Chief Tech. Officer (Engg. & Workshop)

Library & Documentation

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

Technical Coordination Cell

Smt. R. Raji	Private Secretary (up to 1.8.2020)

Farm Section

Shri. M. Bhaskar Reddy	Chief Tech. Officer (F/F) & Head (FOM)
Shri. G. Balakishan	Chief Tech. Officer (F/F)
Shri G.Y. Prabhakar	Tech. Officer T-5 (up to 30.6.2020)
Shri. C. Prabhudas	DMO
Shri. Surender Prasad	Tech. Officer T-5 (Workshop) (upto 31.5.2020)
Shri. A. Srinivasa Raju	Tech.Asstt. (A/c Mechanic) T3
Shri. N. Vasanth	Tech.Asstt. (Workshop) T3
Shri. K. Srinivas	Tech.Asstt. (Workshop) T3
Shri. M. Indrasena Reddy	Tech.Asstt. (Tractor Driver) T3
Shri. Y. Venkateshwar Rao	Tech.Asstt. (Tractor Driver) T3
Shri. T. Bichanna	UDC
Shri. Demudu Naidu Panchada	Tech. Asst. T3
Shri. J. Ashok	Technician T1
Shri. S. Venu	Technician T1

Administration

Shri. Shitanshu Kumar	Sr. Administrative Officer
Shri. Pradeep Singh	Assistant Director (OL)
Smt. R.A. Nalini	Asst. Admn. Officer
Shri. G. Srinivas Yadav	Personal Assistant
Shri. P.R. Varaprasada Rao	Assistant
Shri. E.V.R.K. Nagendra Prasad	Assistant
Smt. P. Gyaneshwari	UDC
Shri. B. Giri	UDC
Smt. P. Swapna	LDC

Stores

Shri. Rakesh Geeda	Assistant
Shri. G.B. Nagendra Prasad	Assistant
Smt. G. Maheshwari	LDC

Audit & Accounts

Shri. K. Srinivasa Rao	Finance & Accounts Officer
Shri. A. Prem Kumar	Jr. Accounts Officer
Shri. G. Raghava Kiran Kumar	Stenographer
Smt. S. Swarupa Rani	Assistant

Drivers

Shri. V. Yadagiri Swamy	Sr. Tech. Asstt. Driver T-4
Shri. G. Ramulu	Tech. Asstt. Driver T-1-3

Shri. G. Pardhasaradhi	Tech. Officer T-5
Shri. E. Ravi Kumar	Tech. Asstt. Driver T3

Skilled Supporting Staff

Shri. G. Mallesh	Skilled Supporting Staff
Shri. M.Venkatesh	Skilled Supporting Staff
Shri. A. Rambabu	Skilled Supporting Staff
Shri. M. Ramulu	Skilled Supporting Staff
Shri. D. Balaiah	Skilled Supporting Staff
Smt. B. Kistamma	Skilled Supporting Staff
Shri. K. Sanjeeva	Skilled Supporting Staff
Shri. B. Vishnu	Skilled Supporting Staff
Smt. G. Bharathamma	Skilled Supporting Staff
Shri. Narsimha	Skilled Supporting Staff
Shri. B. Gyaneshwar	Skilled Supporting Staff
Shri. P. Srinivas	Skilled Supporting Staff
Smt. K. Kalavathi	Skilled Supporting Staff
Smt. A. Lalitha	Skilled Supporting Staff
Smt. K. Suseela	Skilled Supporting Staff
Smt. K. Narsamma	Skilled Supporting Staff
Smt. G. Chennamma	Skilled Supporting Staff