ALL INDIA COORDINATED RESEARCH PROJECT ON OILSEEDS
50
1967-2017
AICRPO

भाकृअनुप
ICAR





ICAR-IIOR

Annual Report 2017-18

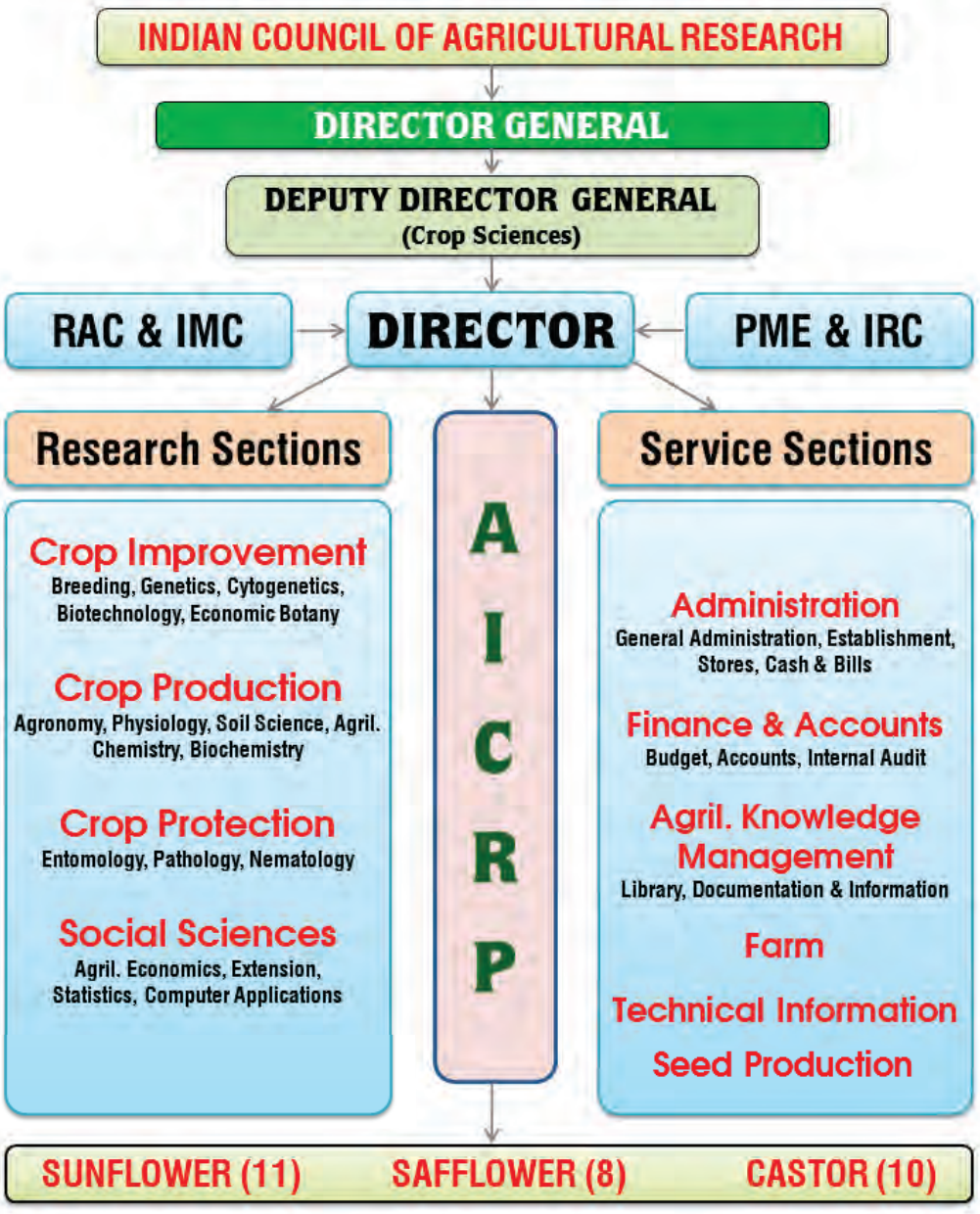
भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान

ICAR-Indian Institute of Oilseeds Research

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

An ISO 9001 : 2008 Certified Institute

ICAR-IIOR
ORGANOGRAM



ICAR-IIOR
ANNUAL REPORT

वार्षिक प्रतिवेदन
Annual Report
2017-18

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

ICAR-IIOR

Annual Report

Citation
ICAR–IIOR, 2018, Annual Report 2017-18.
ICAR–Indian Institute of Oilseeds Research, Hyderabad.

Editors
Dr. A. Vishnuvardhan Reddy
Dr. I.Y.L.N. Murthy
Dr. M. Sujatha
Dr. V. Dinesh Kumar
Dr. P.S. Vimala Devi
Dr. S.V. Ramana Rao
Dr. P. Kadirvel
Dr. D. Pati

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

Cover Design
Shri P. Srinivasa Rao

Photo credits
Shri B.V. Rao
Shri B.V. Noble

Designed & Printed at
Balajiscan Private Limited
11-2-1145, Beside Matas Temple,
Opp: Subhan Bakery, Nampally,
Hyderabad, Telangana – 500001, INDIA.
Tel: 23303424/25, 9848032644
Press: 9248007736/37

PREFACE

I have great pleasure in presenting the Annual Report of ICAR-Indian Institute of Oilseeds Research (IIOR) for the year 2017-18. The diverse agro-ecological conditions in the country were favourable for growing the IIOR mandate crops *viz*., sunflower, sesame, safflower, niger and two non-edible oilseeds, castor and linseed. Oilseeds cultivation was undertaken across the country in about 27 million hectares mainly on marginal lands under rainfed farming condition. The year 2017-18 marks the Golden Jubilee year of the All India Coordinated Project on Oilseeds and during the 50 years period, about 740 high yielding cultivars along with appropriate production and protection technologies have been recommended in different oilseed crops. IIOR is constantly pursuing its research and extension efforts to meet the growing challenges in oilseed sector by developing new varieties/hybrids, production and protection technologies besides dissemination of the developed technologies to the farmers' fields.

Salient achievements for the year 2017-18 of IIOR include: Registration of a leafhopper resistant accession, RG-2661 (IC374272; INGR17049) with Plant Germplasm Registration Committee; development of three castor hybrids GNCH-1 YRCH-2, GCH-8 under AICRP on castor scheme using the parental lines developed at IIOR, their notification and release through CVRC; development of the TNAU-IIOR joint sunflower hybrid COH 3 (CSFH 12205) identified for release in Tamil Nadu; demonstration of drip irrigation to *rabi* castor resulted in saving of 27% water with a high water-use efficiency (3.53 to 4.85 kg/ha-mm); establishing that gray mold disease of castor could be controlled by prophylactic spraying of fungicide propiconazole 0.1%; development of castor knowledge management portal, gray mold advisory system web page; mobile apps on safflower and sesame for usage by the various stakeholders; conducting of frontline demonstrations on oilseeds in 7445 acres in various agro-ecological regions of the country to disseminate technologies to farmers and conducting of 49 trainings for input dealers, agricultural officers and extension workers.

As a part of the mission to increase productivity through use of quality seeds, a total of 694 q of breeder/foundation seed of Institute mandate crops were produced and five trainings were conducted for different stakeholders on various aspects of seed production. For exploring the possibility of area expansion, evaluation of promising hybrids of sunflower and varieties of sesame and niger was taken up in NEH states. Also, to facilitate soil test based fertilizer application, 230 soil health cards to farmers in Rampur Tanda, Vikarabad dist. Telangana were distributed. A National Oilseeds Kisan Mela, sponsored by NMOOP, DAC & FW, Govt. of India was successfully organised at the Institute which benefited more than 2500 farmers and other stake holders. Under Mera Goan Mera Gaurav (MGMG), farmers of nearly 50 villages in Telangana state were periodically updated about various technologies related to agriculture and allied fields as well as on different government schemes.

I place on record my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. Anand Kumar Singh , Deputy Director General (Crop Science)/Additional Charge, ICAR; Dr. P. K. Chakrabarty, Asst. Director General (OP) Acting, ICAR for their generous guidance and support in executing the mandate of the Institute. I express my thankfulness to the Chairman and members of the IIOR-Research Advisory Committee for the critical assessment and refining the research programmes. My sincere appreciation goes to Dr. I.Y.L.N. Murthy and team of editors of the ICAR-IIOR Annual Report and other staff members of the Institute for their efforts and cooperation in bringing out the publication. The contribution of Smt. R. Raji, PA for secretarial assistance and Shri P. Srinivasa Rao, PA for editorial assistance, proof reading and final page setting is thankfully acknowledged.

IIOR, Hyderabad
July 6, 2018

(A. VISHNUVARDHAN REDDY)
Director

CONTENTS

ICAR-IIOR

Annual Report
2017-18

Executive Summary

EXECUTIVE SUMMARY

Major highlights of the results under various research projects and other outreach activities are summarised crop-wise:

CASTOR

Crop Improvement

Germplasm

- A leafhopper resistant accession, RG-2661 (IC374272; INGR17049) was registered with Plant Germplasm Registration Committee, NBPGR, New Delhi.
- Developed 33 inbred lines possessing extra-early maturity (85-88 days), early maturity (90-91 days) and high ricinoleic acid content (90-92%) from germplasm accessions.
- Developed nine inbred lines resistant to wilt (0% wilt incidence), 13 inbreds resistant to root rot and wilt (0-17.4% wilt incidence), nine inbreds resistant to leafhopper and wilt (0-10% wilt incidence) and one inbred line resistant to leafhopper, root rot (stem-tape technique) and wilt (0% wilt incidence).
- The drought tolerant accession, RG-72 recorded 37% higher seed yield (2308 kg/ha) over the best check, GC-3 (1684 kg/ha) under rainfed conditions at multilocation trials.
- Twelve leafhopper resistant inbred lines exhibited resistance reaction to wilt (0-15.8% wilt incidence) in the second consecutive year in wilt sick plot.
- Eleven selections from RG-2800 and RG-2774 confirmed resistant reaction to capsule borer with less than 10% capsule damage as compared to 66.7% capsule damage in susceptible check, DCS-9 under net confined and open field conditions in infester-row method.
- Fifteen selections from non-VP-1 (TSP-10R) type source stably expressed pistillate trait up to quaternary to higher order spikes.
- Two accessions, RG-2048 and RG-2124 exhibited less reduction in seed yield (13-16%) under moisture stress conditions with Drought Susceptibility Index (DSI) of 0.3 and 0.36, respectively.
- The accession, RG-1494 showed less reduction in seed yield (0-18%) when exposed to drought stress at different days after sowing (34, 66, 86, 100 days). The check, DCH-519 had 24.9-44.3% reduction while 48-1 had 11-38% reduction in seed yield under stress conditions.

Breeding

- Three hybrids namely GNCH-1 (SKP-84 x DCS-94), YRCH-2 (M 619-1 x SKI-215), GCH-8 (JP-96 x DCS-89) developed using the parental lines contributed from IIOR were notified and released through CVRC.
- A set of 27 new male lines (ICS-124 to ICS-150) and four pistillate lines were stabilized.
- Evaluation of male lines indicated that ICS-121 (668 g /plant) and ICS-128 (486 g/plant) were promising with significantly higher seed yield and wilt resistance (<10% wilt incidence) than the best check, DCS-107 (328 g/plant).
- In the confirmatory yield trials, new male lines ICS-232 (1924 kg/ha) and ICS-233 (1982 kg/ha) showed superior seed yield performance compared to the check variety DCS-107 (1439 kg/ha).
- Among 31 experimental hybrids evaluated under rainfed conditions, ICH-182 (3984 g/plot), ICH-261(3719 g/plot), ICH-278 (3494 g/plot), ICH-859 (3659 g/plot) and ICH-138 (3280 g/plot) were higher yielding than best check, DCH-177 (2661 g/plot). ICH-859 (5569 g/plot) and ICH-266 (5633 g/plot) and ICH-261 (4954 g/plot) were found superior than the best check DCH-519 (4236 g/plot) under irrigated conditions.
- Among 39 experimental hybrids, ICH-623 (DPC-23 x DCS-86) (3029 kg/ha) was significantly higher yielding than the best check, GCH-7 (1872 kg/ha). Three more promising hybrids, ICH-630, ICH-621 and ICH-707 with >20% yield increase over the check, GCH-7 were also based on DPC-23, which is a new pistillate line. Six hybrids were promising for high seed yield and harvest index (HI) (21.5-27.6%).
- Screening for drought tolerance indicated that germplasm accessions *viz.*, RG-27, RG-72, RG-82, RG-111, RG-298, RG-1437, RG-1494, RG-2139 and RG-2797 and parental lines *viz.*, DPC-19, M-571, DCS-78, DCS-108 recorded low DSI values (<1). DPC-9 based crosses recorded higher seed yield under stress, less per cent yield reduction and low DSI (45 g, 20.9%, 0.47) than the crosses with M-574 (19.9 g, 71.0%, 1.6).

Biotechnology

- A major QTL for gray mold resistance in castor was mapped on linkage group-9 (linked to SNP marker, Rc_29969-30048) based on two year data.

- Germplasm lines, RG-1354 and RG-2874 were found to carry non-allelic genes for wilt resistance, which can be pyramided in a single genetic background for imparting durable resistance.
- In an attempt to develop *in vitro* regeneration protocol, four media combinations (1-2 mg/l 2iP + 0.5 mg/l TDZ + 0.2 mg/l IBA; 0.5 mg/l BAP + 0.5 mg/l TDZ + 0.1 mg/l IBA; 1 mg/l BAP + 0.5 mg/l TDZ + 0.5 mg/l IBA, 1.5 TDZ + 0.5 BAP + 0.75 IBA) were identified as promising for shoot induction with 6-7 day old aseptically grown seedling derived hypocotyl explants.
- In another approach, hypocotyl explants derived from developing embryos pre-treated with TDZ responded well for a three step shoot induction procedure with explants being cultured on three media *viz.*, MS medium supplemented with 2 mg/l 2-iP + 0.5 mg/l IAA + 0.1 mg/l TDZ, MS medium supplemented with 1 mg/l 2-iP + 1.0 mg/l BA + 0.5 mg/l TDZ + 0.5 mg/l IBA and MS medium supplemented with 0.5 mg/l BAP sequentially with each cycle of 15 days. Multiple shoots were observed on the third medium.
- Putative transgenic plants positive for *AtEBP* transgene cassette specific PCRs were realized in T_1 and T_2 generation plants obtained through *in planta* transformation method in castor.
- Alcohol dehydrogenase gene was found to be differentially and highly expressed in male flowers in monoecious line RG-156, which was still higher in samples collected in July (Tmax: 31°C) compared to that in May (Tmax: 41°C).
- A meristem identity gene was found to be expressed only after differentiation of shoot apical meristems and highly expressed in male flowers of RG-156 in May and July collected samples.

Crop Production

- Significantly higher *rabi* castor seed (3302 kg/ha) and oil yield (1599 kg/ha) were recorded when irrigations were scheduled by drip at 0.8 Epan with the supply of full amount of N and K through fertigation. Drip irrigation resulted in saving of 27% water with high water-use efficiency (3.53 to 4.85 kg/ha-mm).
- Under rainfed conditions, 100% RDF + 5 t FYM/ha recorded highest seed yield of sorghum (2955 kg/ha; sustainable yield index [SYI]: 0.53) and castor (1050 kg/ha; SYI: 0.22) crops in Alfisol.

Crop Protection

- An improved water dispersible granule (WDG) formulation (67% a.i.) of DOR Bt-127 strain was developed through agglomerative granulation (pan drying).
- Bt-127 SC formulation as a component of IPM for management of lepidopteran pests of castor showed better performance (net returns: Rs. 6,270/acre; CBR: 1.99) over the farmer's practice (net returns: Rs. 2,796/acre; CBR: 1.5).
- A weather based prediction model was developed for gray mold of castor through deployment of Wireless Sensor Networks and development of web based interface for storage and downloading weather data.
- Castor Gray Mold Advisory system web page developed.
- Sowing of castor during second fortnight of October and second fortnight of December coupled with planting infester rows were found to be reliable and cost effective methods for mass screening of genotypes for resistance to leafhopper and whitefly, respectively under field conditions.

Social Sciences

- Impact assessment of hybrids/varieties of IIOR mandate crops showed that the productivity of castor hybrids (DCH-177, DCH-519, PCH-111) in Mahabubnagar district of Telangana was 16% higher over the existing castor hybrids from the private sector resulting in additional net returns of Rs. 7,784/ha. Furthermore, the study revealed that the acreage with the public sector castor hybrids can enhance the productivity and income of the farmers in the above region.
- Decomposition analysis to examine the effect of area and productivity on castor production at the national level revealed that contribution of technology (yield effect) and area to the production was 56% and 34%, respectively during the period 1966-67 to 1976-77. During the periods 1977-78 to 1987-88 and 1988-89 to 2005-16, the production was primarily driven by area contributing to 76 and 75% of production, respectively. However, during 2006-07 to 2015-16, area and technology (yield effect) contributed to 42 and 40% of the production, respectively.
- In Gujarat and Rajasthan, the castor production was primarily accounted by area effect; more than 50% during the period 1988-89 to 2005-06 and more than 70% during the period 2006-07 to 2015-16.

- In the major castor growing districts of Gujarat, production was mainly attributed to area (>50%) in the districts of Banaskanta (62%), Surendernagar (58%), Kutch (63%), Gandhinagar (79%) and Jamnagar (58%) while yield effect (technology) contributed to 80% in Mehsana, 44% in Sabarkanta, 37% in Rajkot and 25% in Vadodara.
- Castor knowledge management portal was developed with the pertinent information for the benefit of stakeholders.
- Mobile app on IIOR biocontrol products, derived from *Bacillus thuringiensis* (Bt) and *Trichoderma harzianum*, was developed.
- FLDs were conducted by IIOR at Mahabubnagar, Nalgonda and Ranga Reddy districts of Telangana State. The seed yield improvement ranged from 16.7% (when gray mold was controlled with one spray of fungicide) to 27.8% (when gray mold was controlled by two prophylactic sprays of fungicide) as compared to farmers' practice of not following any prophylactic sprays, with highest additional net returns (Rs. 7,500/ha) obtained when two sprays were taken up. These demonstrations have clearly indicated the possibility of management of gray mold of castor by two prophylactic sprays.
- Under the Farmer FIRST programme, in Vikarabad (Telangana) area, mungbean-castor (late *kharif*) cropping sequence with castor hybrid DCH-519 resulted in productivity of 2.5 q/ha of mungbean and 18 q/ha of castor, which provided net returns of Rs. 48,000/ha at the system level.
- Intercropping of castor with redgram (PRG 176 + castor [DCH-519]) in the row ratios of (1:3) and (1:1) vs sole redgram (local variety) with complete technology assemblage resulted in 2.5 q/ha of red gram and 2.5 q/ha of castor while the sole redgram yielded 3.75 to 4 q/ha; thereby providing additional net returns of Rs. 6,250/ha could be realised due to inter cropping.

SUNFLOWER

Crop Improvement

Germplasm

- A total of 2300 accessions were multiplied and 167 accessions, including genetic stocks, supplied to different researchers.
- A set of 1015 accessions were deposited in medium term storage facility of IIOR and 101 accessions sent to NBPGR for long term storage.
- A set of 103 CMS lines along with their respective B lines were assembled for their use in development of superior inbreds or hybrids.
- Trait specific accessions were confirmed, which include: PM-81 (powdery mildew resistance); PS-2023A/B (powdery mildew susceptible); TSG-339 and GP-4-1424 (high oil content, consistently >40%); TSG-17 (high oleic, ~83%); TSG-208 (Alternaria susceptible); HA-124A/B (tolerant to Alternaria); TSG-292 (RHA-348) and TSG-411 (high seed yield); TSG-355 (early flowering, 44 days); TSG-207, TSG-24, RHA-9 and TSG-212 (leafhopper resistance).

Breeding

- IIOSH-15-10, a new hybrid with 8.3% and 18.1% yield superiority over check hybrids, KBSH-44 and DRSH-1, respectively was promoted from IHT to AHT-I.
- Four good combiner inbreds were converted into PET-1 based CMS lines (CMS-1007A to CMS-1010A).
- Based on DSI and seed yield reduction (%) under stress condition, seven genotypes namely RGP-21-P, RGP-21-P6, RGP-21-P8, RGP-50-P1, RGP-60-P1, RGP-60-P2 and RGP-95-P1 were found promising for drought tolerance. The lowest DSI and yield reduction (0.2 and 11%) was reported in genotype RGP-95-P1 followed by RGP-21-P6 (0.3 and 11%) and RGP-21-P2 (0.4 and 15%).
- Under pre-breeding programme, nine interspecific cross combinations (six with wild *Helianthus annuus* and three with *H. argophyllus*) were advanced from BC_2F_2 to BC_2F_3 generation, while seven combinations (two with *H. praecox,* one with *H. argophyllus*, one with wild *H. annuus,* one with *H. petiolaris* and two with *H. debilis*) were advanced from BC_2F_1 to BC_2F_2 generation.
- A total of 349 RILs of the crosses *viz.,* Morden x EC-537925 (118); PS-2023 x TX16R (129); ID-25 x TX16R (102) were advanced. RILs of PS-2023 x TX16R and ID-25 x TX16R crosses in F_8 generation segregated for resistance and susceptibility with the ratio of 1:1 (Chi-square=0.93 and 1.22, respectively) in the downy mildew sick plot, which indicated the involvement of a single gene for resistance to downy mildew in TX16R.

Crop Production

- The SYI of long term integrated fertilizer management treatments showed highest SYI for sorghum with 150% recommended dose of fertilizer (RDF) application to both crops with mean seed yield of 4300 kg/ha followed by 100% RDF+ 5 t/ha FYM and 100% RDF+B applied

to sunflower in the system. Highest SYI of sunflower was recorded with RDF + S and RDF + S + B + Zn treatments.

- Economics of long term nutrient management treatments in sorghum-sunflower cropping system in Alfisol indicated that application of 150% of RDF to both crops recorded highest system gross and net returns while RDF + crop residue application treatment recorded highest system B:C ratio (3.02). Nutrient inadequacy or imbalance treatments recorded lowest economics and sustainability.
- Among single season *kharif* crops, maize recorded highest seed yield of 1980 kg/ha followed by groundnut and sunflower. Seed yield of other major competing crops cotton and pigeonpea was 1719 and 1035 kg/ha, respectively. Greengram - zero till castor gave highest castor equivalent yield (3213 kg/ha).
- Sunflower-maize recorded highest maize yield of 3.7 t/ha. Seed yield of *rabi* castor was highest with preceding maize. The economics in terms of gross and net returns and B:C ratio was highest with greengram - zero till castor system (Rs.1,12,455 and Rs. 75,455/ha, respectively).
- Priming of seed with Th4d (strain of *Trichoderma harzianum*) significantly improved the plant stand (18.3 plants/row) under salinity of 6.0 dS/m against control (13.8 plants/row).

Crop Protection

- A set of 28 sunflower parental lines and 14 germplasm accessions were found highly resistant to leafhopper and did not exhibit any hopperburn while 9 accessions exhibited resistant reaction to whitefly infestation.

Social Sciences

- The FLDs conducted across two clusters in Siddipet district of Telangana under rice-fallow situation revealed yield improvement by 14.5 to 16.3% over the farmer's practice providing additional returns ranging from Rs. 4,315 to 5,075/ha.

SAFFLOWER

Crop Improvement

Germplasm

- A set of 58 trait specific accessions were augmented from USDA through NBPGR, New Delhi.
- Rejuvenation of 467 accessions and multiplication of 169 promising accessions were undertaken. Seeds of 430 accessions and 89 trait specific accessions were supplied for utilization in breeding, screening against wilt, aphid and salinity tolerance at multi-locations.
- Six accessions (GMU-5338, GMU-5774, GMU-5865, EC-739480, GMU-696, GMU-5660) were confirmed for high seed yield ranging from 20 to 28.4 g/plant, oil yield ranging from 6.1 to 8.8 g/plant based on mean performance over two years (2015-16 and 2016-17).

Breeding

- Developed 59 new safflower hybrids; three hybrids were entered in IHT-2017.
- Two varieties, ISF-764 (spiny) and ISF-763 (non-spiny) were promoted to AVT-II-2017 and a non-spiny variety, ISF-1258-15 was promoted to AVT-I-2017.
- Developed wilt resistant inbred line, ISF-87-15 possessing 43.8% oil and giving 25% higher seed yield (2041 kg/ha) than A-1, and 20 wilt resistant safflower inbred lines possessing 29-36% oil content and giving 20-62% higher seed yield (2660-3996 kg/ha) than the best check, A-1 (2210 kg/ha & 2837 kg/ha) in different trials.
- Developed four high oil (35-38.4%) non-spiny inbred lines giving 12-34% higher seed yield (1833-2193 kg/ha) than check, NARI-6 (1631 kg/ha).
- Developed 139 high oil type inbred lines possessing 35-39.6% oil content and 831-1416 kg/ha seed yield compared to the best check, A-1 (26.4% oil content and 1037 kg/ha seed yield).
- In prebreeding aimed at disease resistance, F_1 of (A-1 x [*C. oxyacantha* x *C. palaestinus*]) and F_5 and F_6 generations of (*C. oxyacantha* x *C. palaestinus*), (A-1 x *C. palaestinus*) and (A-1 x *C. oxyacantha*) recorded 0-9.5% wilt incidence in wilt sick plot.
- Thirty eight interspecific derivatives exhibited 0-10% Alternaria severity while the checks, A-1 and PBNS-12 had 100% disease severity under severe disease conditions in the field when sown in first week of August.
- Seven interspecific derivatives recorded Aphid Infestation Index (AII) of 1-2 while the susceptible check had AII of 4-5 under infester row method in late sown conditions.
- Seventy best selections recorded remarkable improvement in seed yield (76-174 g/plant) over 2nd cycle population (30-88 g/plant).
- Developed 41 new oleic type inbred lines possessing 73-83% oleic acid content and 35-41% oil content.

- Fifteen high oleic inbred lines recorded 11-46% higher seed yield (2225-2630 kg/ha) than the check, A-1 (2210-2245 kg/ha).
- Two high oleic varieties, ISF-1 and ISF-2 have been promoted to AVT-II-2017.

Biotechnology

- *De novo* genome sequencing of cultivar, A-1 was performed using Illumina Hiseq 2500 with 100X genome coverage and assembled into174,116 scaffolds.
- A total of 1,39,418 class I SSRs (>20 bp) from genomic regions were identified.
- The safflower association mapping panel showed wide variability for 21 agronomic and seed quality traits.
- The allelic information of the association mapping panel was generated using 186 SSR markers for association mapping for oil content and quality in safflower.
- The SSR marker, CtDES-91 showed putative association with oil content in a F2:3 population produced from the cross: A-1 x CW-99 (EC-755664).
- The SSR markers (CtDES-83, CtDES-320, CtDES-331, CtDES-237 and CAT-85) showed putative association with resistance to aphid in F6-RIL population of the cross: CO-1 (susceptible) x EC-523368-2 (resistant).
- A set of eight high oleic (~80%) lines derived from Bhima x Montola-2000 cross by marker-assisted selection were evaluated for yield performance. Mean seed yield per plant of high oleic backcross progenies ranged from 28.1 to 32.9 g, which was comparable with the check varieties A-1 (24.3 g), Bhima (29.3 g) and PBNS-12 (32.5 g).

Crop Production

- The system productivity (in terms of safflower equivalent yield) was the highest with soybean (normal duration)-safflower (3200 kg/ha) and the lowest with fallow-safflower (1000 kg/ha).
- A FT-NIR protocol was developed for the estimation of oil content and fatty acid profile of safflower seeds.

Crop Protection

- Chitosan based biopolymer has been developed and seed treatment with biopolymer blend resulted in 100% seed germination and highest vigour index in safflower and also inhibited the growth of soil borne pathogens of safflower *viz*., *Phytophthora, Macrophomina, Fusarium* and *Sclerotium*
- Six sub-core safflower lines: GMU-1047, GMU-2594, GMU-2718, GMU-2987, GMU-3256 and GMU-6556; three high oleic breeding lines: Sel-35 (BC_2F_6-38-1-7-OL), Sel-36 (BC_2F_6-38-9-4-OL) and Sel-37 (BC_2F_6-38-14-5-OL) were found resistant to aphids.

Social Sciences

- A total of 100 demonstrations were conducted through cluster approach by IIOR in collaboration with KH Patil KVK, Hulkoti in Gadag District of Karnataka. The results revealed that the productivity increase of the demonstrations ranged from 27.63 to 34.16% over the farmers' practice resulting in additional net returns ranging from Rs. 4,013 to 5,237/ha.
- Mobile app on safflower was developed for usage by the various stakeholders' *viz*., researchers, developmental agencies, students, industry professionals, NGOs and farmers.

SESAME

Crop Improvement

Germplasm

- A set of 1936 germplasm accessions was multiplied and maintained. A set of 430 germplasm accessions was multiplied, characterized and deposited in national gene bank of NBPGR, New Delhi under Consortium Research Project.
- Oil content ranged from 37-54.1% in white, 23.5-52.8% in brown and 29.5 to 51.2% in black seed coat accessions. Variation for oil content was high in black seeded accessions than brown and white seeded types.

Breeding

- Pollen sterility in different backcross generations (derived from *S. malabaricum* x *S. indicum* cross) ranged from 72.1-87.1%.
- A line IOS-17 developed from cross, SP-2 x TKG-22 with traits such as: less branches (1-2), basal bearing capsules from ground level at 10 cm height, 5.5 cm long capsules, bold, white seeded within 100 seeds per capsule, synchronous maturity with an average of 50-70 capsules per plant. This line may be suitable for high density planting and intercropping systems.
- A high oil yielding line IOS-1101 was developed by pure line selection from germplasm accession, IC-205312 which is a landrace of Maharashtra. Oil content was improved from 48 to 54% after six rounds of single plant selections. Seed yield per plant improved from 14.5 to

20 g with 178 effective capsules per plant, 115-138 cm of plant height and 65-80 seeds per capsule.

- The role of honey bees in sesame pollination was studied by artificially removing only anthers from flower or by removing both anthers and corolla. High capsule setting of 42% in flowers where only anthers were removed, clearly proved that honey bees may play a significant role in seed setting in emasculated flowers in hybrid seed production. It also showed the prominent role of corolla in honey bees mediated pollination.

Biotechnology

- Additional 74 SSR markers with polymorphism information content varying from 0.18 to 0.43 (in a panel of hundred genotypes) were added to the working set of microsatellite markers.

Crop Production

- A set of 83 sesame lines were identified based on their maximum yield (>7g/plant) and oil content (>45%) in sesame core set under stress conditions. IC-203987 recorded maximum linoleic acid (62.31%) and minimum oleic acid content (25.55%). IC-26304 showed maximum oleic acid (52.68%) and minimum linoleic acid content (32.66%).
- IC-204622 was identified with high leaf, stem and capsule pubescence, basal branching, high number of capsules (260 maximum), basal capsule bearing, cooler leaf temperature, profuse deeper roots, partially fertile pollen under stress, high seed yield (9 g/plant) and oil content (48%) and JCSDT-26 with profuse root system, cooler leaf temperatures, high relative water content (RWC) chlorophyll content and partially fertile pollen under stress, high seed yield (9 g/plant) and oil content were identified as promising accessions, which could be exploited in drought breeding programmes. Further, JCS DT-26, IC-204090 and IC-204622 genotypes with potential root length density (RLD) were identified, which could be exploited in location specific varietal development in sesame breeding programmes.

Crop Protection

- Electron microscopy of phyllody infected sesame leaves revealed presence of phytoplasma bodies inside the midrib, phloem cells and sieve tubes.

Social Sciences

- The FLDs conducted in Siddipet, Mahbubnagar and Vikarabad districts of Telangana State revealed that productivity enhancement ranged from 25-33.3% and could provide additional monetary returns of Rs. 20,400 to 25,500/ha.
- A mobile app on sesame was developed for usage by the researchers, developmental agencies, students, industry professionals, NGOs and farmers.

NIGER

- A set of 335 germplasm accessions were collected from different sources.
- Characterization and evaluation of germplasm accessions was carried out in two different seasons. Seed yield varied from 2.2 g to 4.83 g and the oil content ranged from 27.1 to 40.1%.

Other Extension Activities

- Under the NMOOP, FLDs on oilseeds were conducted in 7445 acres by the oilseed Institutions/Directorates/ Project Coordinating Units and Indian Institute of Farming Systems Research in various agro-ecological regions of the country and 49 trainings were conducted for input dealers, agricultural officers and extension workers.
- Under the Farmer FIRST programme, 400 soil health cards were distributed. This has facilitated farmers in reducing the cost of cultivation in redgram by Rs. 2,000-2,500/ha and in groundnut by Rs. 2,625-2,750/ha, respectively.
- Under the HRD component, training was imparted to farmers on vermicomposting and mushroom production technologies.

ICAR-IIOR

Annual Report 2017-18

The Institute

- Mandate
- Staff Position
- Financial Statement

THE INSTITUTE

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

Mandate

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

Staff position as on March 31, 2018

Category	Sanctioned	Filled	Vacant
Scientific	43*	42	1
Technical	49	35	14
Administrative	29	24	5
Skilled supporting	25	19	6
Total	**146**	**120**	**26**

*including one RMP

Financial Statement

Allocation and Expenditure

Head of Account	Allocation (₹ in lakhs)			Expenditure (₹ in lakhs)		
	IIOR Unified Budget	AICRP (OS + S&N + LIN)	Total	IIOR Unified Budget	AICRP (OS + S&N+ LIN)	Total
A. GRANT IN AID - CAPITAL						
Works	20.00		20.00	20.00		20.00
Equipment	57.46	5.00	62.46	57.45	5.00	62.45
Information & Technology	4.00		4.00	3.95		3.95
Library	7.00		7.00	7.00		7.00
Vehicle & Vessels	14.50		14.50	7.08		7.08
Furniture	76.04		76.04	76.04		76.04
B. GRANT IN AID - SALARIES			0.00			0.00
Establishment Charges	1573.44	2738.00	4311.44	1573.44	2738.00	4311.44
Wages	302.8		302.80	302.77		302.77
Overtime Allowance	0		0.00			0.00
Pension	257.03		257.03	257.03		257.03
			0.00			0.00
C. GRANT IN AID - GENERAL			0.00			0.00
TA	25.00	82.52	107.52	24.99	82.52	107.51
Res. & Operational Expenses	341.25	159.29	500.54	341.25	159.29	500.54
Administrative Expenses	238.00		238.00	237.98		237.98
Miscellaneous Expenses	14.50		14.50	14.50		14.50
Need Based Research	0.00	21.19	21.19	0.00	21.19	21.19
N.E.H.	10.00		10.00	10.00		10.00
Tribal Sub-Plan	8.00	17.00	25.00	8.00	17.00	25.00
Total	**2949.02**	**3023.00**	**5972.02**	**2941.48**	**3023.00**	**5964.48**

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					5.00	5.00
Grants for Salaries	1280.00	1280.00	958.00	958.00	500.00	500.00
Grants for General	139.00	139.00	67.00	67.00	57.00	57.00
Tribal Sub-Plan	11.00	11.00	3.00	3.00	3.00	3.00
Total	**1430.00**	**1430.00**	**1028.00**	**1028.00**	**565.00**	**565.00**

Resource Generation

Particulars	Amount (₹ in lakhs)
Sale of farm produce	8.578
Sale of other products	0.005
Sale of IIOR publications & tender forms etc.	0.288
Contract research	0.115
Contract services	1.444
Analytical testing charges	11.288
Training	0.500
Total	**22.218**

Funds Received for Externally Sponsored Projects

Particulars	Fund (₹ in lakhs)	
	Receipt	Expenditure
DST Projects *	9.60	24.98
Deposit Schemes	226.74	225.07
Total	**236.34**	**250.05**

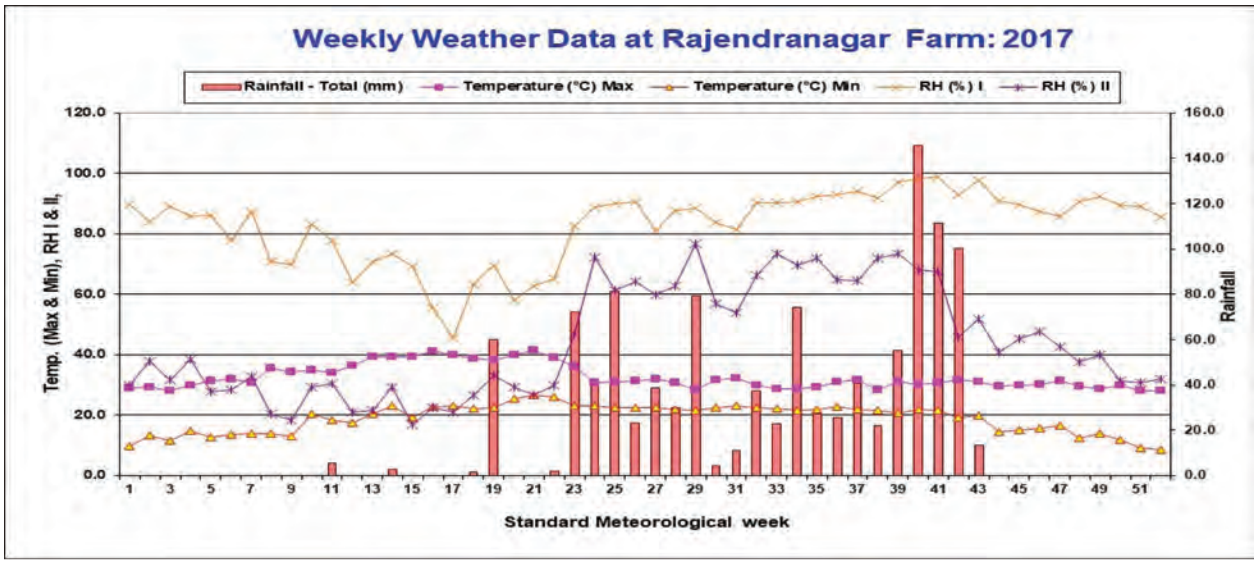
*Under DST Projects (for 2 out 3 Projects) previous year unspent balances have been utilized for expenditure

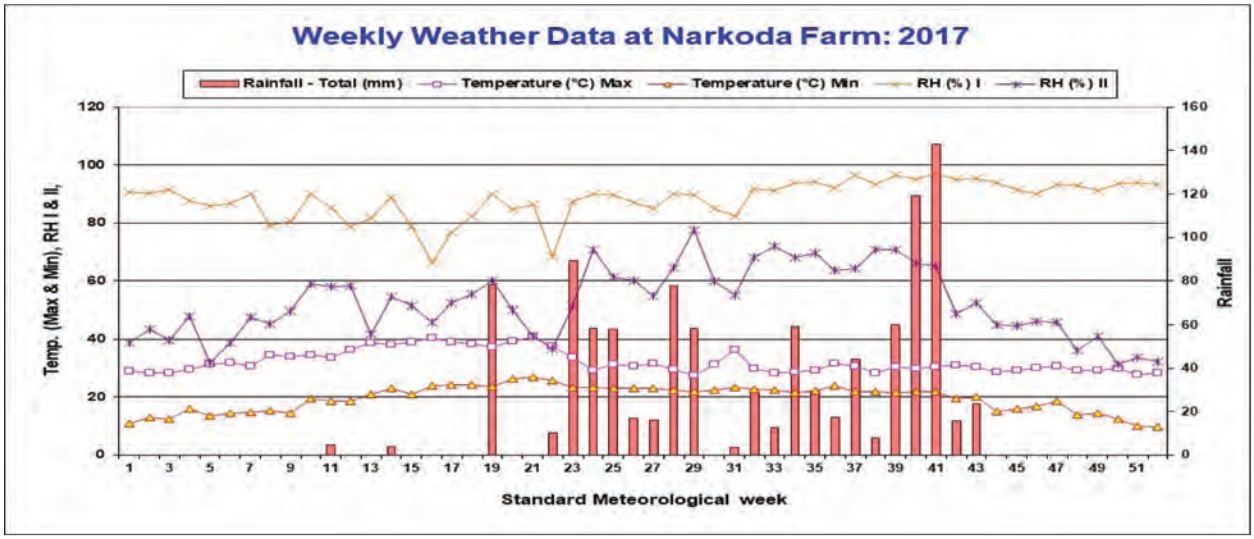
ICAR-IIOR

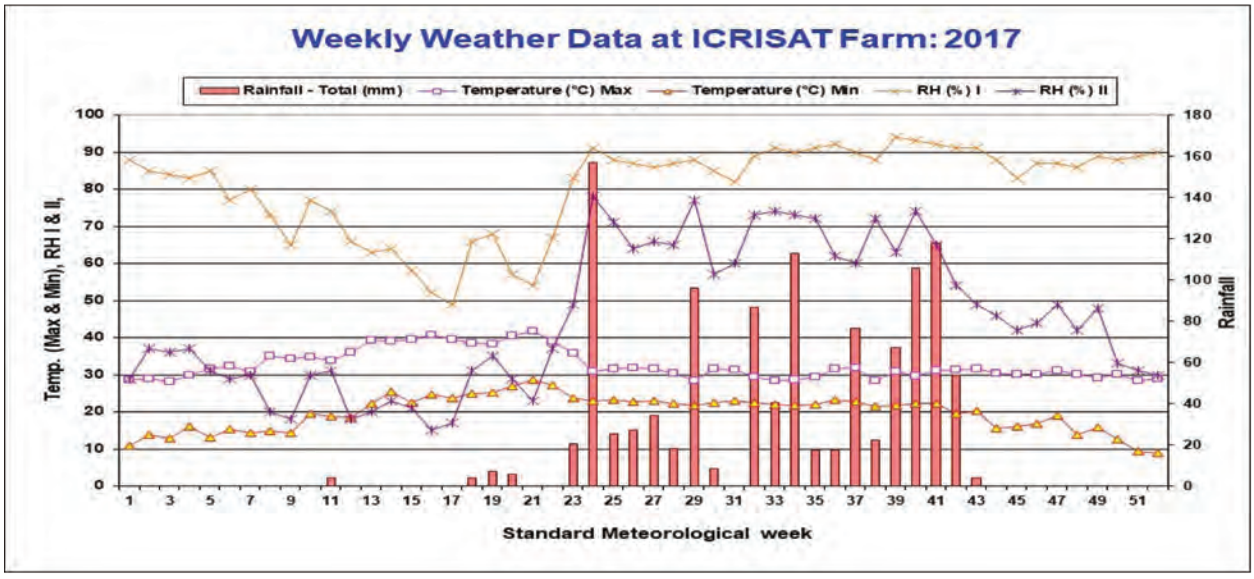
Annual Report 2017-18

Research Achievements

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


Weekly Weather Data at Rajendranagar Farm: 2017
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at Narkoda Farm: 2017
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week


Weekly Weather Data at ICRISAT Farm: 2017
Rainfall - Total (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) I
RH (%) II
Temp. (Max & Min), RH I & II,
Rainfall
Standard Meteorological week

CASTOR

CROP IMPROVEMENT

Development of trait-specific inbred lines

Inbred lines possessing desirable phenology and oil quality traits: Developed 33 inbred lines possessing extra-early maturity (<30 days to 50% flowering), early maturity (<35 days to 50% flowering) and high ricinoleic acid content (>90%) from germplasm accessions.

Performance of extra-early, early and high ricinoleic acid type inbreds under rainfed conditions

Trait	No. of inbred lines	No. of nodes	Days to 50% flowering	Days to maturity	Seed yield (g/plant)
Extra-early maturity	21	5-7	26-29	85-88	33-85
Early maturity	6	8-9	32-33	90-91	107-176
High ricinoleic acid (90-92%)	6	12-13	52-55	115-120	225-252
GC-3 (Check)	-	13	52	115	265
DCS-9 (Check)		13	50	112	145
SEm±		0.75	0.92	1.24	5.72

Biotic stress resistant inbred lines: Developed 32 inbred lines possessing resistance to *Fusarium* wilt (<20%). Additionally, some of these inbreds possessed resistance to other biotic stresses such as root rot and leafhopper.

Biotic stress resistant inbred lines

Specific trait	No. of inbred lines	Wilt incidence (%)
Wilt resistance	9	0
Wilt and root rot resistance	13	0-17.4
Wilt and leafhopper resistance	9	0-10
Wilt, leafhopper and root rot resistance	1	0

Extra-early maturing selections from extra-early genepool: Advanced 12 high yielding extra-early S_3 selections (no. of nodes to primary (NN): 6-7, days to 50% flowering (DF): 26-28, days to maturity (DM): 86-88) derived from an extra-early genepool developed using extra-early germplasm accessions. Seed yield in these selections ranged from 136-165 g/plant whereas the early variety, DCS-9 recorded 145 g/plant (NN: 13, DF: 50, DM:111).

Evaluation of drought and salinity tolerant germplasm accessions under rainfed conditions: Twenty drought tolerant and two drought and salinity tolerant accessions were evaluated for seed yield in RBD with two replications of 10.8 sq.m plot size and 90 x 45 cm spacing under rainfed conditions. Two accessions namely, RG-111 and RG-248 recorded higher seed yield (338 g/plant and 313 g/plant, respectively) than the best check, GC-3 (299 g/plant) while the drought tolerant accession, RG-72 was on par with the check (272 g/plant). RG-111 was also resistant to *Fusarium* wilt and root rot.

Performance of promising drought tolerant accessions under rainfed conditions

Accession	Plant height (cm)	No. of nodes	Days to 50% flowering	Days to maturity	Effective length of primary spike (cm)	100-seed weight (g)	Oil content (%)	Total seed yield (g/plant)
RG-111	93	16	57	109	27	29.2	48.9	338
RG-248	58	12	53	105	21	30.6	46.3	313
RG-72	56	11	53	105	27	39.0	47.8	272
GC-3 (check)	64	13	50	112	46	33.8	50.2	299
CV (%)	4.2	1.6	0.5	0.9	5.6	2.9	0.2	18.7
CD (P=0.05)	9	4.8	1.4	2.7	16	-	-	18

Screening of inbred lines against biotic stresses

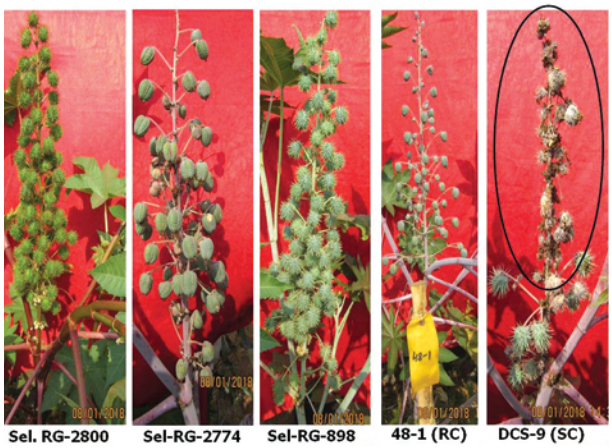
***Fusarium* wilt:** Twenty six inbred lines/selections were screened against wilt in wilt sick plot; of which, 10 selections possessing resistance to *Macrophomina* root rot recorded resistant reaction against wilt (0-18.2% wilt incidence); 12 leafhopper resistant inbred lines derived from RG-2661 exhibited resistance reaction (0-15.8% wilt incidence) in the second year of testing where JI-35 (susceptible check) showed 100% susceptibility and the resistant check (48-1) recorded upto 8.3% wilt incidence.

Capsule borer: Seventeen capsule borer resistant selections (S_4) derived from three accessions *viz*., RG-2774, RG-2800, RG-898 were screened along with susceptible (DCS-9) and resistant (48-1) checks under epiphytotic conditions and artificial release of capsule borer moths under net caged condition. Infester row technique with DCS-9 (one row after every 2 rows in sandwich method) was followed. S_4-selections of RG-2800 and RG-2774 recorded less than 10% capsule damage and confirmed resistant reaction to capsule borer as compared to 66.7% capsule damage in susceptible check, DCS-9.

Reaction of selections from germplasm against capsule borer

Source accession	No. of selections from source	Capsule damage (%)	
		Open field	Net-cage
RG-2800	8	0 - 6.3	0 - 6.9
RG-2774	3	4.7 - 6.7	3.7- 7.5
RG-898	6	0 - 13.6	0 - 16.2
48-1 (Res. check)	-	2.5 -12.8	1.4 - 8.1
DCS-9 (Sus. check)	-	27.3 - 66.7	30.6 - 58.5

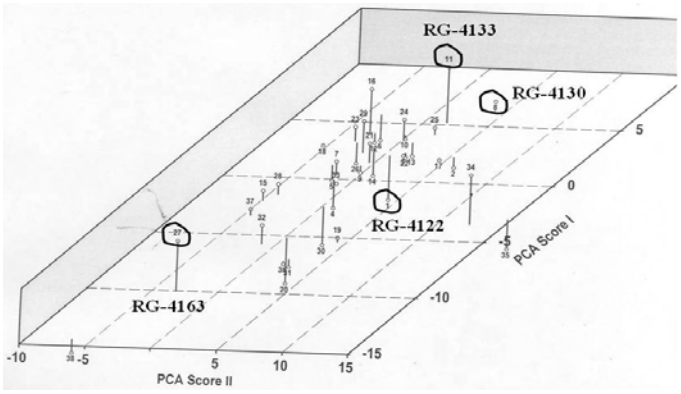
Reaction of a selection from RG-2800 and susceptible check, DCS-9 against capsule borer. Arrows indicate the damage on the spikes



Reaction of selections from germplasm and of resistant check, 48-1 and susceptible check, DCS-9 to capsule borer

Stabilization of non-VP1 (TSP-10R) based pistillate selections from germplasm: Of the 100 pistillate selections assessed for stability of pistillateness, 15 selections stably expressed pistillate trait up to quaternary or higher order spikes.

Characterization and evaluation of germplasm: Forty three accessions collected from Odisha were evaluated along with checks, DCS-9 and GC-3 in ARBD under rainfed conditions. The accession, RG-4163 recorded higher seed yield (254 g/plant) than the best check, GC-3 (238 g/plant). RG-4122 was identified for effective primary spike length (35 cm) while RG-4133 and RG-4130 were at par with early maturing check, DCS-9 (DF: 50; DM: 112) with respect to maturity. The Principal Component Analysis plotted RG-4163, RG-4122, RG-4133 and RG-4130 in separate groups.



Principal Component Analysis of 43 accessions from Odisha

Confirmation of drought tolerance of genotypes with good root traits

Sixteen germplasm lines with good root growth along with checks were sown in field during November, 2017 and water stress was imposed from 30-90 DAS along with irrigated control plots in split plot design with three replications. There was significant reduction in plant height, leaf number, branch production and total dry matter (TDM) under drought stress. SPAD chlorophyll meter reading (SCMR), specific leaf weight (SLW) increased, specific leaf area (SLA), membrane stability index (MSI) and bloom content decreased while relative water content (RWC) recorded no change under stress condition.

Drought stress reduced spike growth and seed yield of primary and secondary spikes. Tertiaries were produced in a very few genotypes and yield was negligible. Among the genotypes evaluated, RG-2048, RG-2124, RG-2714 and 48-1 had seed yield ≥ 45 g/plant, <30% reduction in seed yield under stress and with <0.70 Drought Susceptibility Index (DSI).

Total seed yield, % reduction in seed yield under stress and drought susceptibility index (DSI) of different castor genotypes

Genotype	Total seed yield (g/plant)		% reduction in seed yield	DSI
	Control	Stress		
RG-415	85.2	48.9	42.7	0.94
RG-1617	72.7	40.6	44.2	0.98
RG-1618	78.8	20.3	74.3	1.65
RG-1628	51.4	37.4	27.3	0.60
RG-2048	63.3	54.7	13.6	0.30
RG-2074	93.5	36.5	61.0	1.35
RG-2124	52.7	44.3	16.1	0.36
RG-2127	65.7	28.8	56.2	1.24
RG-2147	48.4	19.2	60.4	1.34
RG-2155	77.3	20.7	73.2	1.62
RG-2169	38.1	26.5	30.3	0.67
RG-2714	70.9	48.9	31.0	0.69
RG-2850	69.9	41.3	40.9	0.91
NAUCI-3	74.0	38.7	47.7	1.06
48-1	61.0	48.4	20.6	0.46
DCH-519	84.5	41.2	51.2	1.13
Mean	68.0	37.3		

Confirmation of selected drought tolerant germplasm by imposing stress at different stages

Four drought tolerant germplasm lines, RG-72, RG-298, RG-1494, RG-1826 were evaluated for confirmation along with checks (48-1, DCH-519) during *rabi* season (November sown) in a field experiment. For each stress regimen imposed on a plot basis in an unreplicated manner, eight rows each of the four genotypes were sown. Different stress treatments were imposed by withholding two scheduled irrigations starting from 30, 66, 86 and 100 DAS followed by one irrigation as compared to the continuously irrigated control plot and the pattern was continued throughout the crop growth.

Irrigation schedule followed in different stress treatments

No. of irrigations	DAS	Irrigation interval (in days)				
		Control	Stress 1	Stress 2	Stress 3	Stress 4
		Irrigated	from 34 DAS	from 66 DAS	from 86 DAS	from 100 DAS
1	1	1	1	1	1	1
2	6	5	6	5	5	5
3	14	8	8	8	8	8
4	34	20	X	20	20	20
5	50	16	X	16	16	16
6	66	16	52	X	16	16
7	86	20	X	X	X	20
8	100	14	X	50	X	X
9	121	21	55	X	55	X
10	133	12	X	X	X	47
11	148	15	X	37	X	X
Total		**11**	**5**	**7**	**7**	**8**

X – indicates skipped irrigation

Among different types of stress treatments, stress from 34 DAS (stress 1) affected crop growth the most followed by the stress imposed from 66 DAS (stress 2) and reduction in stem dry weight was more than that of the reduction in leaf and spike weight which indicated mobilization of stem reserves in drought tolerant genotypes. Primary seed yield reduction was more in stress 1, 2 than stress 3. Reduction in secondary seed yield was more in stress 1, 2, 3 than stress 4. In three genotypes (RG-298, RG-1494 and RG-1826), stress at any stage did not reduce the seed yield significantly as these lines have been selected repeatedly for tolerance under imposed moisture stress from 30-90 DAS.

Total seed yield and percent reduction under different drought stress regimen

Genotype	Total seed yield (g/plant)					Percent reduction compared to control			
	Control	Stress 1 (from 34 DAS)	Stress 2 (from 66 DAS)	Stress 3 (from 86 DAS)	Stress 4 (from 100 DAS)	Stress 1 (from 34 DAS)	Stress 2 (from 66 DAS)	Stress 3 (from 86 DAS)	Stress 4 (from 100 DAS)
RG-72	52.1	38.5	35.5	44.3	48.8	26.1	32.0	15.0	6.4
RG-298	39.9	18.6	37.6	36.6	40.8	53.3	5.7	8.1	-2.4
RG-1494	44.2	36.3	64.7	49.1	61.3	18.0	-46.2	-10.9	-38.7
RG-1826	63.6	41.6	53.2	48.9	52.5	34.6	16.4	23.1	17.4
48-1(check)	56.4	36.5	35.0	42.3	50.2	35.2	38.0	25.1	11.0
DCH-519 (check)	94.3	52.5	50.0	62.5	70.8	44.3	47.0	33.7	24.9
Mean	58.4	37.4	46.0	47.3	54.1	35.2	15.5	15.7	3.1

Seed multiplication, documentation, conservation, supply and utilization

Multiplied/rejuvenated 303 accessions; supplied 297 accessions to Gene bank (MTS), ICAR-IIOR and maintained and conserved 3214 accessions under ambient conditions. Supplied 343 accessions for screening against various biotic stresses under AICRP (Castor); 72 accessions for research purpose and 20 best trait-specific accessions to all castor breeders in AICRP (Castor) to utilize in crossing programmes.

List of the best 20 trait-specific accessions supplied to AICRP (Castor) breeders

Accession	Specific trait(s)	Accession	Specific trait(s)
RG-22	Extra-early maturity (DM: 87) and high ricinoleic acid content (91%)	RG-392*	Wilt and root rot resistance
RG-18*	Early maturity and high per day productivity	RG-2819*	Wilt and root rot resistance
RG-43*	Early maturity, leafhopper and wilt resistance	RG-2787*	Wilt and root rot resistance, moderate resistance to gray mold
RG-72*	Drought tolerance	RG-2661*	Leafhopper resistance
RG-109	Wilt resistance	RG-1771*	Leaf miner resistance
RG-2818*	Wilt resistance	RG-2104	High100-seed weight (75 g)
RG-1608*	Wilt resistance	RG-3100	Wilt resistance, high seed yield and high oil content (50%)
RG-1624	Wilt resistance	RG-3160	High seed yield and high ricinoleic acid content (91%)
RG-2722*	Root rot resistance	RG-3477	High seed yield and high ricinoleic acid content (91%)
RG-2822*	Root rot resistance	RG-3798	High seed yield and high ricinoleic acid content (91%)

*Accessions already registered with Plant Germplasm Registration Committee of ICAR

Utilization of germplasm: Seventeen germplasm accessions supplied by ICAR-IIOR have been utilized in breeding programmes by AICRP (Castor) centres during the reporting period. Thirteen crosses made using germplasm are at F_2 stage in different centres. Palem centre has developed a new monoecious line, PCS-329 using germplasm, RG-14-1 in the initial cross; Junagadh identified RG-27 and RG-111 as good combiners for seed yield and other traits. S.K.Nagar developed three preliminary hybrids using RG-27, RG-1623 as male parents; these hybrids recorded 14-22% and 10-12% higher seed yield (3181-3418 kg/ha) than the recently released hybrids, GCH-9 and GCH-8, respectively under irrigated conditions at S.K. Nagar.

Germplasm registration: A leafhopper resistant accession, RG-2661 (IC374272; INGR17049) was registered with Plant Germplasm Registration Committee of ICAR on October 23, 2017.

Diversification of pistillate base and development of superior parental lines

Three approaches were followed for creating variability in pistillate character. A gene pool was initiated by using four pistillate parents of diverse origin and morphological characters (2 dwarf and 2 normal plant types) and F_1 seed was collected. Two double crosses *viz*., (DPC-25 x Rb-13-1854) x (CNES-1 x NES-6) and (DPC-21 x DCS-106) x (JP-77-1 x DPC-21) were made to generate a multiple parent cross. Three more single crosses were generated using six pistillate lines *viz*., DPC-23 x DPC-21, Rb-13-1854 x DPC-25, DPC-16 x M-571 to diversify the pistillate base. The F_1s were backcrossed to pistillate sources like CNES-1, FC-8 and Kh-13-154 to widen the genetic base of the pistillate source.

New pistillate lines

Fifteen advanced pistillate lines were evaluated for yield components and sex expression in a RBD with two replications in *rabi* 2017-18. Among them, Rb-17-45-3, Rb-17-68-1, Rb-17-91-2 and Rb-17-127-1 were promising for stable pistillate expression and yield components. Selfed seed of the four pistillate lines was bulked to generate the nucleus seed for further use.

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

Thirty nine progenies were selected from 2500 F_2 progenies based on desired agro-morphological traits and advanced to F_3 generation. Among 142 male lines evaluated in preliminary trials for node number, branching, proportion of male flowers and other yield characters, 106 male lines were found promising for node number (range 14-16), good branching, medium spike length (40-60 cm) with 2-5 whorls of male flowers.

Among 44 male lines tested for wilt resistance in wilt sick plot for two years (2016-17 to 2017-18), 16 male lines were resistant (<20% wilt incidence). All 142 male lines were multiplied and maintained for further use in breeding programme.

Among 19 male lines evaluated in a confirmatory yield trial along with four checks, in RBD with two replications, ICS-232 and ICS-233 recorded 34 and 38%, higher seed yield than the best check, DCS-107 (1439 kg/ha). Among 80 RILs maintained, 39 RILs were evaluated for seed yield in a RBD with two replications and wilt resistance in sick plot. ICS-234 was the highest yielding while three entries recorded <20% wilt incidence.

Seed yield of promising male lines in preliminary yield trials

Entry	No. of nodes to primary	Days to 50% flowering	Plant height (cm)	Total spike length (cm)	Effective spike length (cm)	No. of capsules	100-seed weight (g)	Seed yield (g/plant)
1752-1	14	63	97	55	54	63	21	188
2169-1	18	67	135	54	53	39	43	159
1696-1	14	61	111	40	33	36	38	159
1895-1	17	63	116	54	49	61	33	154
2206-1	15	62	81	42	38	44	28	153
2127-1	9	57	59	37	36	32	23	151
48-1©	16-18	63-65	83-114	39.2-47	38.4-44	45.8-55	25.5-30	62-185.2
DCS-107©	16.6	64-66	80- 103	30.2- 43.4	30.2- 43.4	36-46	27.5	68- 166.2

Promising monoecious lines resistant to wilt

Entry	No. of nodes to primary	Days to 50% flowering	Plant height (cm)	Total spike length (cm)	Effective spike length (cm)	No. of capsules	100-seed weight (g)	Seed yield (g/plant)	Wilt at 150 DAS (%)
1512-1	14	63	72	49	49	41	31	97	0
1513-1	15	64	73	60	58	37	33	123	11.5
1520-1	14	65	97	38	38	34	28	85	7.8
1938-1	14	59	66	52	52	35	25	107	17
2018-1	13	58	89	70	69	48	26	93	5.6
2046-1	12	56	75	40	40	39	25	100	16.6
2048-1	14	64	73	43	42	48	30	88	2.2
2058-1	16	66	86	48	47	65	34	80	0
2164-1	15	61	112	64	63	38	34	84	3
2165-1	16	67	120	39	39	53	27	45	11.4
2170-1	15	64	71	50	46	39	38	146	0
2193-1	14	58	78	63	55	32	27	97	8.8
2205-1	15	64	95	50	45	56	29	120	4.4
2206-1	15	62	81	42	38	44	28	153	4.8
2211-1	15	60	83	47	45	69	17	73	14.8
48-1 ©	16-18	63-65	83-114	39.2-47	38.4-44	45.8-55	25.5-30	62-185.2	2.2
DCS-107 ©	16.6	64-66	80- 103	30.2- 43.4	30.2- 43.4	36-46	27.5	68- 166.2	

Promising male lines in confirmatory yield trials

Entry	Plant height up to primary (cm)	Days to 50% flowering	No. of nodes to primary spike	Total primary spike length (cm)	Effective spike length (cm)	Final seed yield (kg/ha)
Confirmatory yield trial, Set-I						
ICS-232	76	42	11	29	28	1924*
ICS-233	95	50	14	33	31	1982*
DCS-107 ©	125	60	16	39	38	1439
LSD at 5%	NS	5.9	NS	9.8	9.6	323.3
Confirmatory yield trial (RILs)-Set-II						
ICS-234	97	56	15	41	41	3348*
48-1 ©	93	59	16	40.8	40.4	1605
LSD at 5%	24.3	6.2	1.9	6.3	7.7	712.5

*Significantly higher over best check

New monoceious lines developed

A total of 27 new monoecious lines (ICS-124 to ICS-150) stabilized for morphological characters and sex expression were evaluated for seed yield, yield components and wilt incidence in sick plot. Two lines *viz.*, ICS-121 and ICS-128 with significant higher seed yield and wilt resistance (<10% wilt incidence) were promising.

New male lines identified for seed yield and wilt incidence in sick plot

Entry	Plant ht. (cm)	Node number	Total spike length (cm)	Effective spike length (cm)	Effective spikes /plant	100 seed weight (g)	Seed yield (g/ plant)	Wilt (%) in sick plot
ICS-121	57.5	12.6	35.0	34.2	12.1	26.1	668	5.0
ICS-142	89.5	16.6	41.4	40.6	10.9	22.0	473	17.7
ICS-144	69.3	14.6	36.2	35.4	9.3	23.5	474	19.4
ICS-127	82.2	12.4	44.9	45.0	9.7	30.0	637	15.4
ICS-128	102.8	13.4	30.1	32.2	7.1	27.3	486	7.1*
ICS-132	101.2	13.8	43.9	46.0	13.9	29.4	357	8.3
ICS-133	116.8	14.2	61.3	61.8	6.3	32.2	264	12.2*
ICS-134	123.6	15.8	44.1	42.8	11.9	31.1	297	8.3*
ICS-136	91.0	13.0	47.1	49.2	11.1	30.6	295	13.9*
ICS-137	97.6	13.6	56.3	57.6	15.3	34.4	490	13.3
ICS-139	67.5	11.8	31.8	28.8	6.6	32.5	398	3.8
DCS-9 ©	59.7	12.1	31.3	30.6	7.3	26.0	159	
DCS-107 ©	113.5	14.8	38.9	38.6	7.6	32.2	328	
C.D(p=0.05)	39.6	NS	1.1	0.9	9.8	10.1	97.8	
C.V (%)	17.4	8.1	6.4	6.2	9.9	10.4	12.0	

*wilt incidence tested for two years

Development of genepool for gray mold resistance

A random mating population was generated through open pollination (two cycles) among the progenies derived by intercrossing 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) for development of gene pool for gray mold resistance in castor.

Development of wilt and leaf hopper resistant, early, medium, late duration hybrids suitable for early, late *kharif* and *rabi* seasons in traditional and non-traditional castor growing states of the country

A set of 171 fresh crosses was generated using 14 pistillate lines and 45 male lines in *rabi* 2017-18. Four hybrids *viz*. ICH-404, ICH-603, ICH-278, ICH-576 were contributed for AICRP coordinated trial-IVHT 2018-19. In addition, OBCH-1 (PHT-BP-14-3), a hybrid with 18% higher seed yield than DCH-177 (1279 kg/ha) for two years in preliminary yield trials at Bhawanipatna centre was contributed to IVHT-2018-19 as a collaborative entry.

Female line	Male line
M-571, M-574, M-619,	RG-3088-1, CI-2, P3-47, P3-98, P3-124, P3-140, P3-207, P3-283, P3-290, RG-714-1, RG-2195-1, P2-38, P3-212
SKP-84, JP-77-1, DPC-14, DPC-18, DPC-20, DPC-21, DPC-25, DPC-27, DPC-28, DPC-29, IPC-30	ICS-127, ICS-128, ICS-130, ICS-132, ICS-133, ICS-134, ICS-139, ICS-140, ICS-141, ICS-121, ICS-159, ICS-161, ICS-169, ICS-163, ICS-177, ICS-182, ICS-205, DCS-89, ICS-228, RG-2800, DCS-9, DCS-78, DCS-89, DCS-94, DCS-107, DCS-108, DCS-119, DCS-121, 48-1
	RG-72, RG-111, RG-122

Evaluation of hybrids

New hybrids generated during *rabi* 2016 were evaluated during *kharif* 2017 in an Augmented design using DCH-177, DCH-519 and GCH-7 as checks. Out of 117 hybrids evaluated, six hybrids were found promising with significantly higher yield than the best check, GCH-7.

Performance of promising hybrids in the preliminary evaluation trial

Hybrid	Days to 50% flowering	100-seed weight (g)	Seed yield (g/plant)
ICH-354	52	34	179
ICH-353	56	34	155
ICH-326	38	31	153
ICH-380	58	32	134
ICH-351	56	33	130
ICH-355	58	36	128
Check			
GCH-7	56	34	112
DCH-177	43	33	89
DCH-519	55	31	85
S.E.D	2.4	1.16	12
CD (p = 0.05)	6.1	3	33

In an advanced confirmatory yield trial of Set-I 31 experimental hybrids and three checks (DCH-177, DCH-519 and GCH-7) were evaluated under rainfed conditions in RBD with two replications of plot size of 21.6 sq.m. Promising hybrids like ICH-182, ICH-261, ICH-278, ICH-859 and ICH-138 were higher yielding than the best check, DCH-177 (2661 g/plot). Genotypes with stronger capsule stalks could withstand the impact of heavy and continuous rains by minimizing the "dropping off" of capsules. Among the 31 advanced hybrids, 20 hybrids along with two checks, *viz*., DCH-519 and GCH-7 were evaluated at Anand centre, under irrigated conditions in RBD with two replications and a plot size of 11.52 sq. m. Three entries *viz*., ICH-859, ICH-266 and ICH-225 were promising both under rainfed and irrigated conditions.

Performance of promising hybrids in the advanced yield evaluation trial, Set-I, IIOR, Hyderabad

Entry	No. of nodes to primary spike	Days to 50% flowering	Plant ht. (cm)	Total length of primary spike (cm) length	Effective spike length of primary (cm)	No. of capsules per primary spike	100 seed weight (g)	Seed yield (g/plot)
ICH-182	15.0	54.0	77.6	51.6	47.7	44.6	25.0	3984
ICH-261	16.3	53.5	75.5	60.2	60.0	60.1	29.8	3719
ICH-278	15.8	56.0	80.7	63.2	58.4	41.6	32.3	3494
ICH-859	13.1	54.0	60.8	53.7	49.4	65.9	27.8	3659
ICH-138	13.6	50.0	69.5	52.4	51.8	50.6	30.3	3280
ICH-266	12.3	46.0	50.4	40.8	40.5	86.1	28.3	2675
DCH-177 ©	14.0	48.5	66.1	51.5	50.2	75.5	29.3	2661
DCH-519 ©	15.6	54.5	85.4	57.3	55.9	30.1	23.8	2441
GCH-7 ©	16.7	54.5	81.1	52.9	49.0	36.9	28.3	2602
ICH-66	16.9	55.5	81.6	62.5	50.9	31.1	29.8	3200
ICH-68	16.3	57.0	75.5	54.0	46.5	29.1	28.0	3092
CD (p=0.05)	1.4	3.4	11.4	9.23	8.63	29.9	3.8	NS
CV (%)	4.5	3.09	7.5	8.37	8.23	31.47	6.6	11.8

In a confirmatory yield trial of Set II, 39 hybrids were evaluated in RBD with two replications in *kharif* under rainfed conditions for seed yield. ICH-623 (DPC-23 x DCS-86) (3029 kg/ha) was significantly higher to the best check, GCH-7 (1872 kg/ha). Three other promising hybrids, ICH-630, ICH- 621 and ICH-707 with >20% increase over the check, GCH-7 were based on the new pistillate line, DPC-23.

Performance of promising hybrids in the advanced yield evaluation trial, Set-II of IIOR, Hyderabad

Entry	Plant height up to primary (cm)	No. of nodes to primary	Total primary spike length (cm)	Effective primary spike length (cm)	100-seed weight (g)	Seed yield (kg/ha)	% increase over best check
ICH-623	82	13.2	42.7	34.6	32.1	3029	62
ICH-625	95	13.3	46.7	32.0	25.8	2181	17
ICH-630	68	10.1	40.2	29.4	26.4	2304	23
ICH-621	71	13.2	60.2	55.7	27.3	2394	28
ICH-707	59	12.1	53.9	46.3	22.7	2282	22
ICH-352	95	14.7	57.2	51.8	33.2	2057	10
DCH-177	87	12.9	52.5	52.5	28.6	1929	
LSD at 5%	19.45	2.1	9.8	13.0	2.8	299	
CV(%)	10.8	7.9	9.6	13.9	5.2	9.3	

Evaluation of hybrids for drought tolerance

Eighteen hybrids developed by crossing two pisillate parents, DPC-9 and M-574, with nine identified drought tolerant lines *viz.*, RG 27, RG 72, RG 82, RG 111, RG 298, RG1 437, RG- 1494, RG 2139 and RG 2797 were evaluated for drought tolerance during late *rabi*, 2017 (November). These 18 F_1s were evaluated along with parents and promising pistillate lines in single rows by imposing drought stress (30-90 DAS) along with irrigated control. Drought stress resulted in growth reduction in terms of reduced plant height, leaf number, stem girth, branches, relative water content (RWC) and spike characters.

Growth and seed yield of primary and secondary spikes were also reduced. The crosses with DPC-9 recorded higher seed yield under stress, less per cent reduction and low DSI (45.0 g, 20.9%, 0.47) than crosses with M-574 (19.9 g, 71.0%, 1.60) though the crosses involving M- 574 recorded better seed yield under control conditions. Among six PMC lines studied, PMC-16 performed better with 44% seed yield reduction and 0.99 DSI. Among different genotypes screened, DPC-9 x RG 27, DPC-9 x RG 72, DPC-9 x RG 82, DPC-9 x RG 1494, DPC-9 x RG 2797, and parental lines were drought tolerant with low DSI value (<1.0).

Evaluation of hybrids for physiological parameters

Thirty-two hybrids of Set-II, along with four checks were also evaluated for physiological parameters like total dry matter (TDM) and harvest index (HI). Six hybrids were found promising for high seed yield and HI (21.5-27.6%). Genotypes with high seed yield and HI recorded moderate TDM.

Harvest index and TDM production in the promising hybrids

Genotype	Seed yield (g/plant)	HI (%)	TDM at harvest (g/plant)
ICH-620	110.6	25.8	564
ICH-621	88.1	21.5	409
ICH-342	90.7	27.6	329
ICH-659	92.6	23.7	390
ICH-702	99.1	22.5	441
ICH-718	92.9	21.8	425
DCH-177 (C1)	79.2	23.3	340
DCH-519 (C2)	100.1	26.2	383
PCH-111 (C3)	108.7	31.9	341
GCH-7 (C4)	112.7	22.3	507

Ideal plant type for *rabi* situation

Fifty four genotypes including varieties, hybrids, germplasm and parental lines, were grown in two rows during *rabi*, 2016 in RBD with two replications to define ideal range for each character and finally the suitable plant type for *rabi*. Range and mean values for plant height, node number, stem girth, branching pattern, branch and leaf angle, petiole length, yield and other components of different spike orders were recorded. For each of the traits studied there was sufficient variability as indicated by the range.

Confirmation of genomic region associated with gray mold resistance

A major QTL on LG-9 associated with gray mold resistance was identified earlier based on the genotypic and phenotypic data collected from circa 80 RILs of JC12 × 48-1. To confirm the results, a larger population (156 RILs) of the same cross was evaluated for gray mold resistance during *kharif* 2017. The RILs along with parents and susceptible check (DCH-519) were raised in the Rajendranagar farm of IIOR. Under epiphytotic condition, the RILs were scored for disease severity. The disease severity among the RILs ranged from 0 to 60 per cent. The disease severity data were used along with genotypic data from 1,089 SNP markers in QTL analysis using QTL Cartographer. The same QTL region identified in the earlier study was again detected with a very high level of statistical significance (LOD: 18.3 and R^2: 0.42).

Reaction of RILs of JC12 × 48-1 for gray mold at Rajendranagar farm of IIOR during *kharif* 2017

Additionally, a mapping population of 350 F_2 individuals was generated by crossing JC-12 (susceptible line) with a new resistant source, RG-1963 to validate the known QTL or identify novel QTLs for gray mold resistance in castor.

Allelic relationship of wilt resistance genes in castor germplasm sources

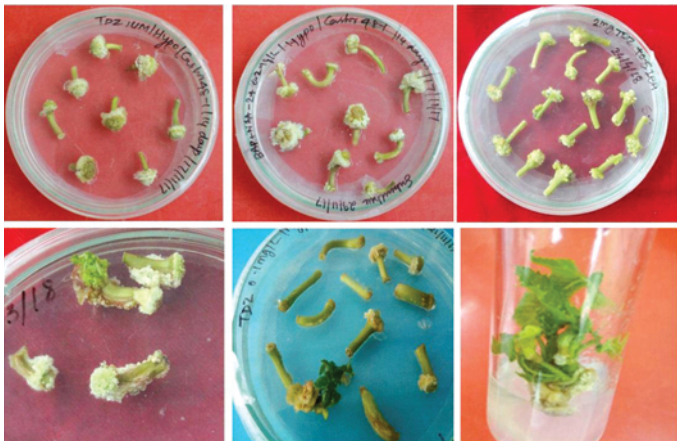
The allelic relationship of wilt resistance genes in two germplasm sources *viz*., RG-1354 and RG-2874 was studied. The F_2 population of the cross RG-1354 × RG-2874 was raised in the wilt sick plot of IIOR during *kharif* 2017. The reaction of individual plants to *Fusarium* infection was scored at 150 days after sowing. Out of 142 F_2 plants, 135 were resistant and 7 were susceptible. The observed ratio of resistant and susceptible individuals matched well with the expected ratio of 15:1 (Chi-square = 0.423; $p = 0.52$), if independent dominant genes are responsible for wilt resistance in the parents. The result indicates that resistant sources, RG-1354 and RG-2874 may carry non-allelic genes.

Towards development of near isogenic lines 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_1F_1 population of JI-35 × RG-999 and F_1s of JI-35 × RG-1673 and JI-35 × 48-1 were generated for further backcrossing.

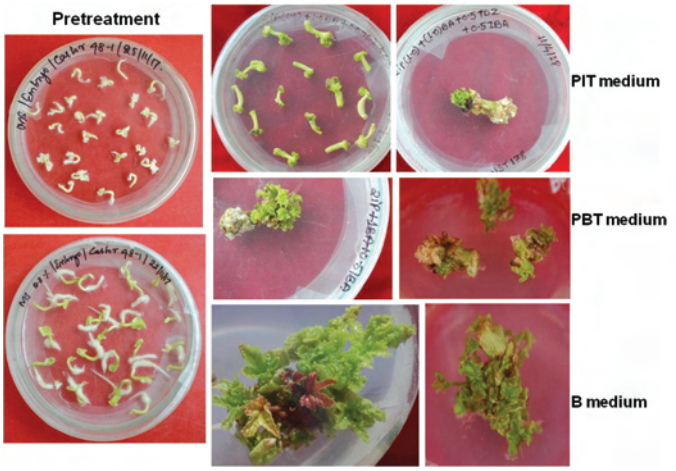
Optimization of regeneration and transformation protocols to realize grey mold resistant transgenic castor

***In vitro* regeneration studies:** Explants such as shoot tips, embryo axes, cotyledons and hypocotyls derived from 6-7 day old seedlings of the variety 48-1 (Jwala), were tried for their direct or callus mediated regeneration ability using different media combinations. Murashige and Skoog (MS) medium supplemented with different concentrations of auxins IAA (0.2, 0.5 and 1 mg/l), NAA (0.2, 0.5, 0.8, 1 mg/l), and IBA (0.2, 0.5, 1 mg/l); cytokinins 2iP (0.5, 0.8, 1, 2 mg/l), BAP (0.1, 0.2, 0.5, 0.8, 1, 2 mg/l), and TDZ (0.1, 0.2, 0.3, 0.5, 0.75, 1, 2 mg/l), in combination were tried to assess their ability to support regeneration. With shoot tips, multiple shoots (3-5 per explant) were obtained with MS medium containing BAP (either at 0.5 or 1mg/l) + TDZ (either at 0.2 or 0.5 mg/l) while embryo axes responded by producing a single plantlet with both shoot and root system on media with BAP or 2iP + IBA. With cotyledonary explants only callus was obtained on all the media combinations tried. Hypocotyl explants produced either nodular callus or callus with shoot initiation on media containing BAP+TDZ+IBA in different concentrations. Among the media tried, four combinations (1-2 mg/l 2iP + 0.5 mg/l TDZ+ 0.2 mg/l IBA, 0.5 mg/l; BAP + 0.5 mg/l TDZ+ 0.1 mg/l IBA, 1 mg/l BAP + 0.5 mg/l TDZ+ 0.5 mg/l IBA, 1.5 TDZ+0.5 BAP + 0.75 IBA) were promising in terms of the number of explants producing the shoot initials. Further fine tuning of these media is expected to increase the frequency of regeneration as well as improve the quality of the shoots produced.



Callus formation and shoot initiation from hypocotyl explants

In another approach, embryos (harvested from the mature seeds) of variety Jwala were pre-treated for 5-6 days on MS medium supplemented with 0.3 mg/l of TDZ and then explants were taken from the plantlet produced from the embryos. Shoot apices produced multiple shoots on medium supplemented with either BAP or TDZ or a combination of both. Hypocotyl explants from the plantlets were tried on different media for organogenesis. Among the media tried, MS supplemented with 2 mg/l 2-iP + 0.5 mg/l IAA + 0.1 mg/l TDZ (PIT) gave better response by producing green nodular structures in about 60% of the explants within 15 days after inoculation. Then the responding explants were transferred to MS medium supplemented with 1 mg/l 2-iP + 1.0 mg/l BA+ 0.5 mg/l TDZ + 0.5 mg/l IBA (PBT) for further development of the shoot initials. After 15 days on this medium, responding explants with shoot initials were transferred on to MS medium supplemented with 0.5 mg/l BAP (B) for further elongation of the shoots. Multiple shoots were observed on the third medium.

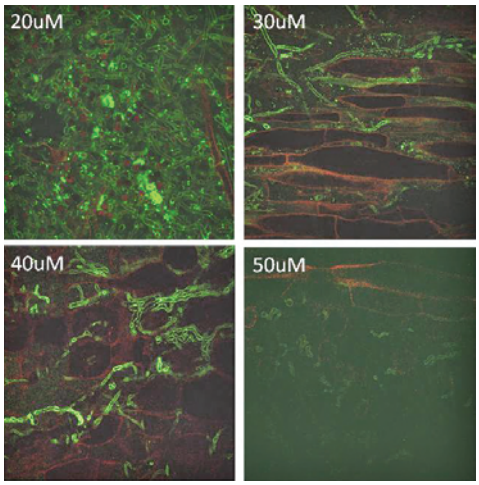


Shoot initiation from the hypocotyl explants derived from pretreated embryo axes

***In planta* transformation studies:** T_1 progeny plants from 150 (100 with *AtEBP* gene construct and 50 with *BIK1* gene construct) plants were screened with gene specific PCRs. Three plants were PCR positive for the entire cassette. Analyses of T_2 plants from 10 T_1 plants those were positive (last year) for *AtEBP* gene cassette identified PCR positive plants for the cassette in each of the progenies and seeds have been harvested for further analysis. A few critical parameters such as seedling age, seeding transplantation methods, induction of *Agrobacterium* virulence, etc. that affect *in planta* transformation have been optimized and using the modified procedure 200 seedlings were subjected to transformation using the *gus* construct.

Deciphering molecular mechanism of induction of biotic stress tolerance by *Trichoderma* spp.: As reported earlier, 1-hydroxy 3-methyl anthraquinone (1H3MA) had been identified as an elicitor produced and secreted into the medium during specific interaction between castor variety DCS-107 and Th4d strain of *Trichoderma*. This compound, when used in fungal free hydroponic system, had shown the induction of systemic resistance in the seedlings

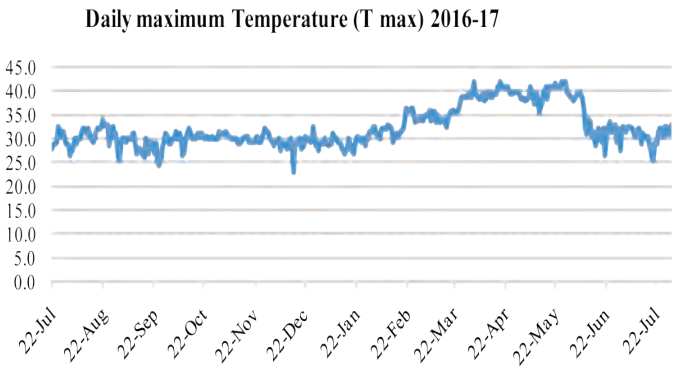
against seedling blight. To understand whether analogues of this compound could be produced that will have higher efficiency in terms of ISR activity or any antimicrobial activities, six analogues were synthesized by modifying the methyl group of the parental compound. Hydroponic experiments indicated that except the analogue Prenyl ether none of the others induced systemic resistance against *Phytophthora*. Culture inhibition studies carried out using the analogues and parental compound indicated that Prenyl ether analogue had inhibitory effect on fungal pathogens *Fusarium oxysporum f.sp. ricini* and *Phytophthora* as well as on bacterial plant pathogen *Xanthomonas* and human enteric bacteria *E. coli*. Pathways up/down regulated during ISR prime and Boost critical differences as well as similarities were observed between these two types of ISR. During prime response, basically MAMP pathway triggered resulting in redox signalling, ROS production, both SA as well as JA production, WRKY 75, Flavonoid and anthocyanin, PR 1 regulon activated within 24 hours; during boost reaction, PAMP recognition and calcium transporters, ROS breakdown, JA pathway, Production of anthocyanins, lignin production, PR1 regulon were upregulated while SA pathway was down regulated. Through confocal laser scanning microscopy studies, it was established that *Trichoderma* colonizes only up to 50 uM depth from surface and thus restricted to the cortical cells and also occupy mainly the interstitial spaces.



Confocal laser scanning microscopy images of castor roots colonized by Th4d after 7 days post inoculation. Values indicate the depth of scanning from the root surface.

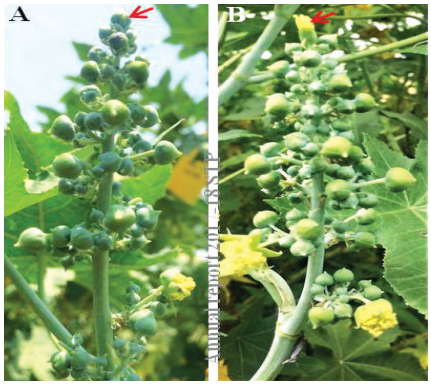
Elucidating molecular mechanisms governing sex expression

Various factors such as genetic, cytogenetic, epigenetic, physiological and environmental factors may affect sex expression in castor. The effect of temperature on sex expression was studied during summer till July 2017 in the crop sown on June 2016. The variation in daily maximum temperatures during the growing season was analyzed.



Variations in daily maximum temperatures during the growing season till July 31, 2017

Sex phenotype of inflorescence was altered in all seven genotypes in summer. The inflorescence had less number of floral whorls, less number of buds per floral whorl, sparsely distributed buds, increased proportion of male flowers and occurrence of bisexual flowers (female flowers reverted to bisexual with rudimentary stamens) by May 3rd week (T_{max}: 38-41 °C). But the normal phenotype was restored by June 4th week when daily maximum temperatures (T_{max}) dropped down to 28-33 °C. In M574-OS1 and DPC-9-OS2 having completely staminate inflorescences with male flowers as the tip in summer, female flowers started appearing in terminal position in inflorescences at later orders when the temperatures dropped down by June 3rd week. This indicated that the transition of monoecious inflorescence with 20% female flowers and tip bisexual flower, to staminate inflorescence with bisexual flower and later to completely staminate inflorescence (from 4th or higher branching order onwards), could be due to the effect of temperature rather than the branch order or ageing during the advancement of growing season.

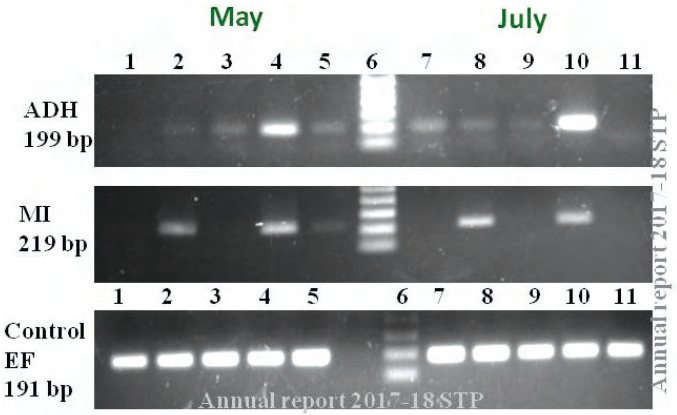


Effect of temperature on sex phenotype in staminate M574-OS1

A. Completely staminate inflorescence with tip male flower was observed in summer (May 3rd week of, T_{max}: 38-41°C), B. Completely staminate inflorescence with terminal female flower was observed at lower temperatures by June 4th week, T_{max}: 28-33 °C. The same effect was observed in DPC-9-OS2 as well.

An intermediate bisexual state exists in both male and female flowers. Bisexuality in castor flowers alters with temperature. The sex of the terminal flower in different inflorescences varies from female to bisexual to male with increase in temperatures during summer and then from male to bisexual to completely female when the temperatures drop down after summer. The temperature conditions prevailing during inflorescence bud initiation affects the sex phenotype and the proportion of male and female flowers in the inflorescence. Hence, the mean temperatures of T_{max} T_{min} and T_{avg} existing for 2-3 weeks prior to actual observation of the altered phenotype in summer were calculated, and the altered phenotypes were observed at T_{max} > 38 ^{0}C, T_{min} >23 ^{0}C and T_{avg} > 30 ^{0}C. Rather than the absolute value of T_{max} sudden variation (rise or drop) in temperatures seem to alter sex expression. In addition to temperature, genetic factors also contribute to sex variations, since completely male inflorescence was observed even by August-September 2017 in the primaries of DPC9-OS2. To know if cytological abnormalities govern sex expression, different stages of meiosis were observed in apical male (DPC17-S3) and staminate lines (M574-OS1 and DPC-9 OS2) and the lines were found to be meiotically stable.

To understand the expression pattern of selected genes in different plant tissues as well as at different growing temperature conditions, primers for four control genes and five candidate genes were designed and RT-PCR was performed using RNA from samples (5 different tissues/ stages) collected from the field grown monoecious RG-156 during May (T_{max}: 41 ^{0}C) and July 2017 (T_{max}: 31 ^{0}C). Differential gene expression of dehydrogenase and meristem identity genes was observed. Alcohol dehydrogenase gene (*ADH*) was observed at higher level during July when compared to May and meristem identity gene MI was expressed only in shoot apical meristem after differentiation and in male flowers but absent in shoot apical meristem before differentiation and in leaf while negligible expression was noticed in female flower buds. This was confirmed in monoecious (DCS-107) and pistillate (DPC-9) lines. Other genes such as SH, SN, SM, GT etc. involved in methylation and oxidative stress were found to be nearly constitutive in expression.



Differential gene expression of alcohol dehydrogenase gene (Rc *ADH)* and meristem identity gene (MI) in monoecious RG 156.: Lanes 1-5 and 7-11 represent samples collected during May and July, respectively lanes 1 and 7: Undifferentiated shoot apical meristem; 2 and 8: Differentiated shoot apical meristems; 3 and 9: Leaf; 4 and 10: male flower and 5 and11: female flower, Lane 6: 100 bp ladder. Lower panel shows gene expression in control gene EF.

Alteration of sex phenotype of inflorescence in summer in different genotypes of castor

Genotype	Phenotype (normal growing season)	Phenotype (summer 2nd and 3rd week of May)	Bisexual flowers
DCS-107	Monoecious	90% male throughout inflorescence,	Yes
	3-4 whorls (30-50%) male flowers at bottom	Interspersed Staminate Flowers (ISF)	Terminal
RG-156	Monoecious	90-95% male flowers,	Yes
	70-80% male flowers alone at bottom	Tip flowers male occasionally, female flower buds round	Female flowers with reverted stamens
M 574-OS1	Staminate inflorescence (4th order and above), tip bisexual flower	Completely staminate	Yes
			Terminal and subterminal
DPC-9-OS2	Predominantly staminate with tip bisexual flower	Completely staminate	Yes
			Terminal and subterminal
DPC-17-S3	Apically interspersed staminate	90-95% male flowers	Yes
			Terminal and subterminal
DPC-9	Completely pistillate	Interspersed staminate flowers (ISF)	Yes
			Reverted female flowers with rudimentary stamens
DPC-21	Emerges as completely pistillate with ISF at capsule formation	80-85% male throughout the inflorescence	Yes
			Sub terminal and random

DUS testing

Under the Central Sector Scheme for Plant Variety Protection and Farmers Rights Authority, DUS testing of two farmers' varieties of castor was undertaken along with two reference varieties and data on 30 DUS traits were recorded. Initial characterization for one fresh farmers' variety was also completed.

CROP PRODUCTION

Agro-techniques (planting time, genotypes and drip fertigation scheduling) were standardized for *rabi* castor. Among four different sowing schedules, planting during 1st week of October registered the highest mean seed yield (2614 kg/ha), net returns (Rs. 69,332) and B:C ratio (3.31). With delay in planting from 1st October to 15th November, seed yield declined by about 30%. Among the genotypes, significantly the highest seed yield was recorded in DCH-519 (2985 kg/ha) which was at par with GCH-7 (2884 kg/ha) followed by YRCH-1 (2184 kg/ha). Highest mean seed yield was obtained when accumulation of growing degree days, *Helio* thermal units, photo thermal units and heat use efficiency were highest.

Performance of *rabi* castor (DCH-519) to drip fertigation at 0.8 Epan-80% N and K through fertigation

Significantly higher *rabi* castor seed yield (3302 kg/ha) and oil yield (1599 kg/ha) were registered when irrigations were scheduled by drip at 0.8 Epan along with supply of full amount of N and K through fertigation. Drip irrigation resulted in saving of 27% water with a high water-use efficiency (3.53 to 4.85 kg/ha-mm).

Moisture and nutrient dynamics on sorghum – castor cropping system

Moisture and nutrient dynamics on sorghum – castor cropping system in Alfisol under rainfed condition in fixed plots revealed that under normal rainfall distribution, application of FYM with 100% or 50% NPK recorded highest seed yield. Under rainfed conditions, 100% RDF + 5 t FYM/ha recorded highest seed yield of sorghum (2955 kg/ha; sustainable yield index 0.53) and castor (1050 kg/ha; SYI 0.22) crops in Alfisol closely followed by application of 25% N through FYM with 75% NPK as inorganic fertiliser. The later treatment also performed superior under drought conditions of 2014-15.

The INM practice also resulted in higher organic C (0.5%) and available N (210 kg/ha). Moisture content was higher in organic treatments. Substituting 25% N requirement through FYM can mitigate the effects of drought effectively with sustainable soil fertility.

Influence of integrated nutrient management in castor – sorghum cropping system in Alfisol under rainfed conditions

Yield of castor in the system

Treatment		Seed yield (kg/ha)							
Castor	Sorghum	2012	2013	2014	2015	2016	2017	Mean	SYI
N (60kg/ha)	N (60kg/ha)	225	499	251	1619	296	695	648	0.06
NP (60:40:0)	NP (60:30:0)	676	524	320	1694	528	735	911	0.16
NPK (60:40:30)	NPK (60:30:30)	635	591	270	1715	646	920	929	0.18
50% NPK (30:20:15)	50% NPK (30:15:15)	353	641	407	1505	571	657	736	0.20
75% NPK + 25% N (FYM) (45:30:22) (15N)	75% NPK + 25% N (FYM) (45:22:22) (15N)	259	730	527	2266	767	896	966	0.11
NPK (P through SSP)	NPK (P through SSP)	398	769	405	1777	510	926	868	0.17
NPK (60:40:30)	NPK (60:30:30) + 10kg Zn/ha (ZnO)	423	796	333	1629	542	941	896	0.18
NPK + 5t FYM/ha	NPK + + 5t FYM/ha	597	846	340	1864	860	1140	1050	0.22
No manure/ fertilizer	No manure/ fertilizer	87	289	397	1383	532	428	495	0.03
General mean		406	632	361	1717	584	815	833	0.17
SEm ±		22.6	33.2	66.5	74.0	65.5	45.2		
CD (P = 0.05)		67.7	99.9	NS	222	196.5	135		
CV (%)		9.6	7.5	31.9	7.5	19.4	9.6		
Cropping season rainfall (mm)				373	391	715.6			

Yield of sorghum in the system

Treatment		Seed yield (kg/ha)							
Castor	Sorghum	2012	2013	2014	2015	2016	2017	Mean	SYI
N (60kg/ha)	N (60kg/ha)	2215	2106	2002	2106	1598	997	1787	0.55
NP (60:40:0)	NP (60:30:0)	3089	3595	3104	3595	2046	1723	2694	0.44
NPK (60:40:30)	NPK (60:30:30)	4012	3574	3074	3574	2343	1718	2916	0.44
50% NPK(30:20:15)	50% NPK(30:15:15)	2524	3519	2624	3519	1640	939	2414	0.37
75% NPK + 25% N (FYM) (45:30:22) (15N)	75% NPK + 25% N (FYM) (45:22:22) (15N)	3149	3495	3363	3495	2081	1249	2747	0.48
NPK (P through SSP)	NPK (P through SSP)	3648	3187	2697	3187	1950	1346	2399	0.44
NPK (60:40:30)	NPK (60:30:30) + 10kg Zn/ha (ZnO)	3058	2984	3096	2984	1742	1654	2468	0.50
NPK + 5t FYM/ha	NPK + + 5t FYM/ha	3644	3582	3501	3582	2279	1792	2955	0.53
No manure/ fertilizer	No manure/fertilizer	2068	1602	1505	1602	946	279	1359	0.35
General mean		2934	3072	2774	3190	1847	1300	2439	0.47
SEm ±		168.4	133.4	261.9	219.4	171.0	107		
CD (P=0.05)		504.8	399.9	785.8	658	513	321		
CV (%)		9.94	7.5	16.3	11.9	16.0	14.3		
Cropping season rainfall (mm)				338	364	514.4			

CROP PROTECTION

Establishment of relationships between weather and gray mold disease

Wireless Sensor Networks (WSN) were deployed in the castor crop canopy at different places in the farmers' fields of Jangamreddipalle and Minugonipalle villages of Mahabubnagar district and research farms of IIOR, Hyderabad and RARS, Palem. Weather data on hourly temperatures, relative humidity (RH) and wetness hours was transmitted to central server through GPRS enabled gateway. Observations on disease severity (percent disease index) were recorded manually on a daily basis.

Development of weather based prediction model

The weather and disease severity data collected were utilized for developing prediction models. Among all the procedures, backward regression was attempted to get the reliable prediction model according to the least AIC criteria. The final model that resulted from backward regression was

$$PDI = -91.623 + 2.303Z_{RH} + 64.204\ Z_{wetness\ hours} - 0.07729\ Z_{temperature*RH} - 0.67016\ Z_{RH*Wetness\ hours}$$

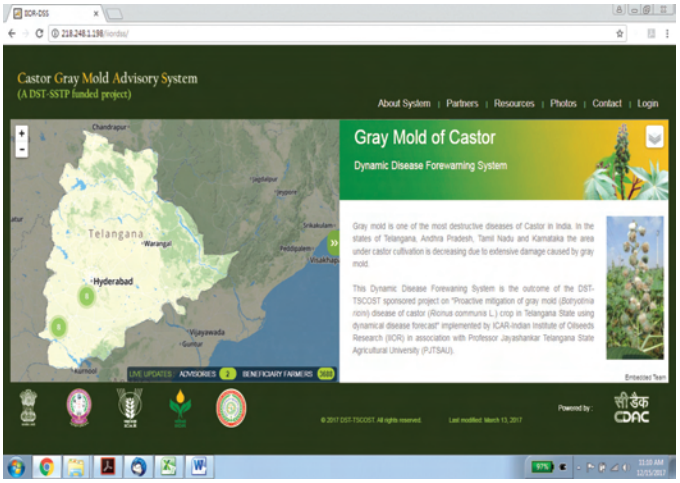
Comparison of regression models based on different criteria

Criteria	Backward	Forward	Lasso
Root MSE	6.22	6.95	6.95
Dependent Mean	44.47	44.47	44.47
R-Square	0.97	0.97	0.97
Adj R-Sq	0.96	0.94	0.94
AIC	61.39	64.03	64.03
AICC	78.19	112.03	112.03
BIC	58.20	67.71	67.71

Criteria	Backward	Forward	Lasso
C(p)	3.60	7.00	7.00
PRESS	924.89	2402.15	2402.15
SBC	49.81	53.42	53.42
ASE	22.55	20.13	20.13

Development of decision support system (DSS)

Castor gray mold advisory system web page was developed. Village level weather data collected by WSN were stored and retrieved by DSS. The DSS displays predicted disease severity values based on which disease management decision is taken and alerts are sent to the farmers.



Decision Support System (DSS) for castor gray mold

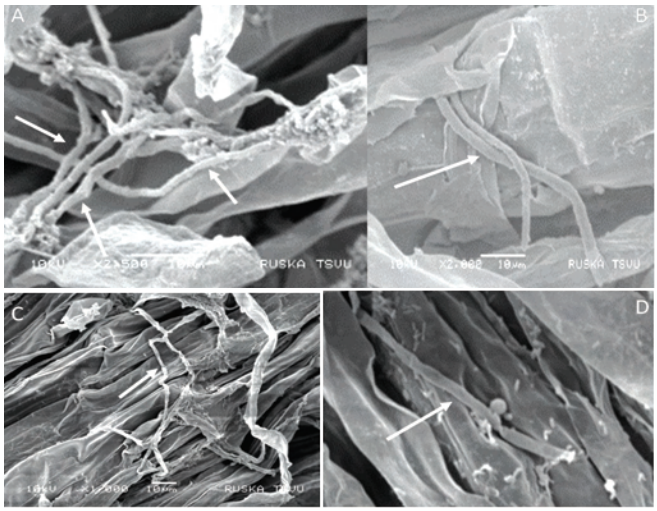
On farm management of gray mold disease

On farm demonstration of management of gray mold of castor using the chemical fungicide propiconazole 0.1%

was taken up in farmers' fields at Mahabubnagar district of Telangana state during *kharif* 2017. Favourable weather conditions for gray mold development prevailed during the months of August and September. Prophylactic spray of fungicide was given on 19th August based on information obtained from Wireless Sensors installed in farmers' fields on temperature, humidity and wetness. Second spray was also given in fields on 3rd September. In the fields sprayed with fungicide once or twice, the disease severity ranged from 10 and 12% with 1105 and 980 kg/ha seed yield, respectively. Disease severity of 65 and 78% and seed yield of 400 and 545 kg/ha was recorded in unsprayed fields.

Host pathogen interactions during wilt disease

Scanning electron microscopy images of castor cultivars JI-35 (susceptible) and 48-1 (resistant) inoculated with *F. oxysporum* f. sp. *ricini* showed more mycelium adhered on the root surface of JI-35 than 48-1 at 48 hours after inoculation. The surface of root tissue was healthy and clean with no mycelium in uninoculated samples in both the genotypes. Transmission electron microscopy images showed more spores and few tyloses observed in xylem vessels of JI-35 at 7 days after inoculation. Lignification of cell walls was observed in 48-1 while spores were not present in uninoculated root tissue of both the genotypes.



Scanning electron microscopic images of JI-35 and 48-1 after inoculation with *F. oxysporum* f. sp. *ricini*. a.c. JI-35 inoculated, 48 hrs after inoculation; b.d. 48-1 inoculated, 48 hrs after inoculation. White arrow indicates the mycelium of *F. oxysporum* f. sp. *ricini* on root tissue

Host plant resistance

Evaluation of parental lines / experimental hybrids against wilt in sick plot

A set of 134 parental lines and 47 experimental hybrids was screened against wilt under sick plot conditions.

Parental lines: Twenty lines were promising with resistant reaction <10% to wilt *viz*., PVT-11-3, 11-11, 11-18, 11-59, 12-2, K 16-1520-1, 16-2018-1, 16-2048-1, 16-2058-1, 16-2164-1, 16-2193-3, 16-2205-1, 16-2206-1; RG-1963, 566, P3-207, JI-244, (PMC-13 x 999) x PMC 13 BC 2_1, (PMC-13x999) x PMC 13 BC 2_2, (PMC-13x999) x PMC 13 BC 2_10. The genotypes PVT-11-3, PVT-11-17, PVT-11-18, PVT-11-21 and PVT-11-26 showed resistance to wilt during second year of testing as well.

Experimental hybrids: Twelve hybrids recorded <10% wilt incidence *ie.,* ICH-430, 446, 454, 460, 462, 463, 492, 503, 504, 506, 507 and 513. The susceptible check JI-35 recorded 92.8% wilt incidence while the resistant check 48-1 recorded 8% wilt incidence.

Screening in wilt sick pots: Five genotypes showed <10% disease incidence (RG-2787-60-3, 2787-89-20, 2787-110-9, 2787-181-12 and 2787-217-6). JI-35 and 48-1 recorded wilt incidence of 100 and 12.6%, respectively.

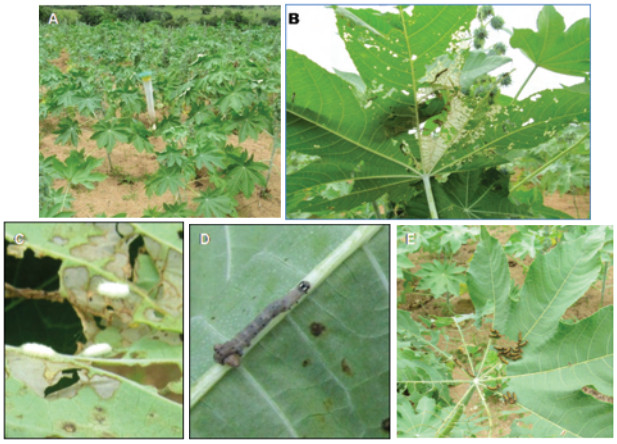
Studies on variability in *F. oxysporum* f. sp. *ricini*

Thirty one different castor genotypes including germplasm accessions/parental lines/inbreds were selected and screened against six *F. oxysporum* f.sp. *ricini* (*F. o. r.*) isolates collected from different locations (Hyderabad, Palem, S.K. Nagar, Narkhoda, Yethapur, Junagadh) under pot culture conditions. Among them five lines RG-2746, AP-56, AP-33, AP-200, AP-156 showed resistant reaction (<20% wilt) to all isolates. Fourteen genotypes showed differential reaction to all six isolates. Genotypes *viz.,* RG-1963, RG-3322, RG-2064 and AP-163 showed differential reaction to *F. o. r.* isolates for consecutively two years.

Field evaluation of Bt-127 SC formulation against major lepidopteran pests

An SC formulation of a local strain of *Bacillus thuringiensis* var. *kurstaki* (Btk) strain DOR Bt-127 was evaluated as a component of integrated pest management (IPM) in castor in farmers' fields at Rachakonda village, Nalgonda district, Telangana. Monitoring of *Spodoptera litura* was done using pheromone traps (4/acre) and hand collection of gregarious larval stages with damaged leaves was carried out. Spraying of Bt-127 SC formulation @ 3 ml/l for lepidopteran pests (semilooper, *Spodoptera* and hairy caterpillar) was undertaken coinciding with early instars and 25% defoliation. Acephate spray was taken up in farmer's practice for management of the hairy caterpillar *Euproctis fraterna*. Incidence of *S. litura* and *Euproctis fraterna* was reduced by 94.8% and 98.4%, respectively due to Bt-127 SC formulation in IPM trial. The formulation was not

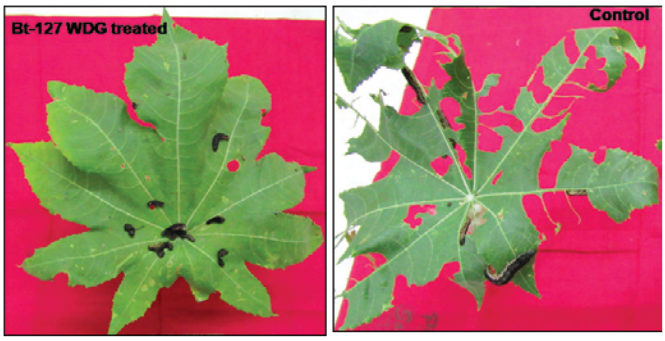
phytotoxic and was safe to the natural enemies *Microplitis maculipennis* and *Cotesia marginiventris*. Incidence of natural enemies was 0.38 and 0.36/plant in IPM trial and farmers' practice, respectively revealing safety of Bt-127 SC formulation to the natural enemies. The IPM trial resulted in net returns of Rs. 6,270/acre with a CBR of 1.99 over net returns of Rs. 2,796/acre with a CBR of 1.5 in farmers' practice.



A. Castor IPM field with pheromone trap, B. *S. litura* infested leaf, C. *Cotesia marginiventris,* D. Semilooper larva parasitized by *Microplitis maculipennis,* E. *Euproctis fraterna* infestation

Development of water dispersible granules (WDG) of Btk strain DOR Bt-127

An improved WDG formulation (67% a.i.) of DOR Bt-127 strain was developed through agglomerative granulation (pan drying). Potency of the formulation was 82,100 SU/g against 7 day old *Spodoptera litura* larvae 72 h after treatment. The formulation was effective against 9 and 12 days old larvae with an LC_{50} of 0.87 and 1.21 mg/ml at 72 and 96 h, respectively after treatment. Heat viable spore count of Bt-127 was 10^{16}/g while protein content was 134.65 mg/g (13.46%).



Bioassays with Bt-127 WDG (pan drying) against 9 days old *S. litura* larvae on castor

Evaluation of DOR Bt-127 WDG formulation

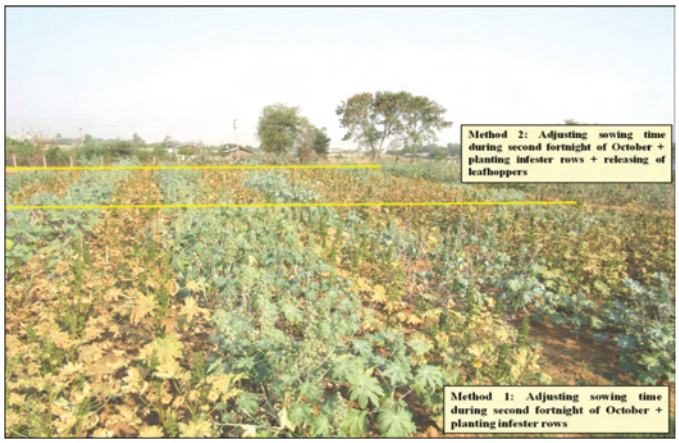
Two WDG formulations of DOR Bt-127 (65% from IPFT, Gurgaon and 67% from ICAR-IIOR) at three doses each (1.0, 1.25, 1.5 g/l of water) with DOR Bt-127 SC formulation (developed by ICAR-IIOR), the commercial Btk formulation (Delfin®) and an unsprayed control were evaluated against 7-day-old larvae of *S. litura* on castor raised in pots using completely randomized design with three replications. Results revealed that Bt-127 67% WDG @ 1.5g/l, Bt-127 SC formulation @ 3 ml/l and Delfin @ 1 g/l were statistically on par with 91.7% mortality at 5 days after treatment. It was followed by Bt-127 67%WDG @ 1.25 g/l which resulted in 81.7% mortality, while the larval mortality in different doses of 65% WDG formulations ranged between 28.3 and 76.7%.

Efficacy of Bt-127 WDG formulations (67%) against *Spodoptera litura* on castor

Improved methodology for mass screening for leafhopper resistance

Two methods for screening castor genotypes for resistance to leafhopper under field conditions were compared: (i) Adjusting sowing time during second fortnight of October + planting infester rows (one infester row, DPC-9 after 2 rows of test entries), (ii) Adjusting sowing time during second fortnight of October + planting infester rows (one infester row, DPC-9 after 2 rows of test entries) + releasing of leafhoppers (raising of susceptible plants DPC-9 at 15 days before sowing of test entries, removal of

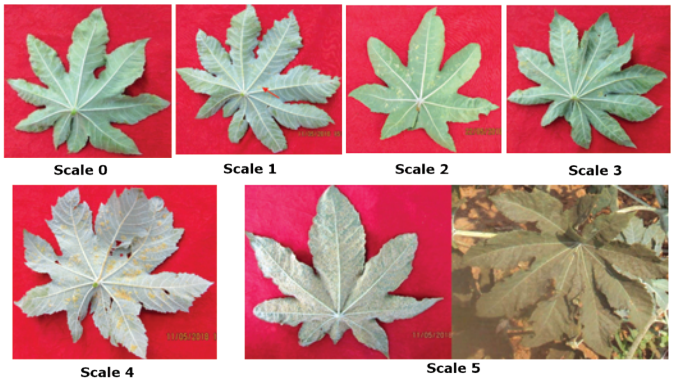
plants after insect infestation and releasing on test entries). The effectiveness of the methods was compared in their capacity to differentiate levels of resistance/susceptibility to leafhopper in castor germplasm using strip plot design with two replications. Fourteen genotypes (seven each of resistant and susceptible lines) were used. Results indicated that adjusting sowing time during second fortnight of October + planting infester rows + releasing of leafhoppers significantly increased population in susceptible genotypes (up to 376 leafhoppers/3 leaves/plant) as compared to screening method with adjusting sowing time during second fortnight of October + planting infester rows (up to 272.5 leafhoppers/3 leaves/plant), while there were no significant differences among resistant genotypes in both the methods (1.5 to 84 leafhoppers/3 leaves/plant and 1.0 to 68 leafhoppers/3 leaves/plant, respectively). Expression of hopperburn among resistant (hopperburn grade 1 on 0 to 4 scale) and susceptible (hopperburn grade 4 on 0 to 4 scale) genotypes was similar in both the methods and was found statistically on par with each other. Hence, screening method *viz*., adjusting sowing time during second fortnight of October + planting infester rows can be used as a reliable and cost effective method for mass screening of castor genotypes for resistance to leafhopper.



Expression of hopperburn among resistant and susceptible genotypes in different screening methods against leafhopper under field conditions

Improved methodology for mass screening for resistance to whitefly

Two methods of screening of resistance in castor to the whitefly under field conditions were compared: (i) Adjusting sowing time during second fortnight of December + planting infester rows (one infester row, M-574 after 2 rows of test entries); (ii) Adjusting sowing time during second fortnight of December + planting infester rows (one infester row, M-574 after 2 rows of test entries) + releasing of whiteflies (raising of susceptible plants M-574 at 15 days before sowing of test entries, removal of plants after insect infestation and releasing on test entries). Fourteen castor genotypes (seven each resistant and susceptible lines) were used to compare the screening methods using strip plot design with two replications. Whitefly population was assessed on 0 to 5 scale (0: No nymphs and pupae; 1: 1 to 50 nymphs and pupae; 2: 51 to 100 nymphs and pupae; 3: 101 to 200 nymphs and pupae; 4: 201 to 500 nymphs and pupae; 5: more than 500 nymphs and pupae and honey dew secretion with black sooty mould fungus). The results revealed that both the methods are effective to distinguish resistance among castor genotypes. Population scale of whiteflies in resistant (Scale 1 to 2 on 0 to 5) and susceptible (Scale 5 on 0 to 5) genotypes were similar in both the methods and found statistically on par with each other. No significant differences were observed among absolute population of adult whiteflies on fully developed top leaf during peak infestation in both the methods. Hence, adjusting sowing time during second fortnight of December+ planting infester rows can be used as dependable and cost effective method for mass screening of castor genotypes for resistance to whitefly under field conditions.

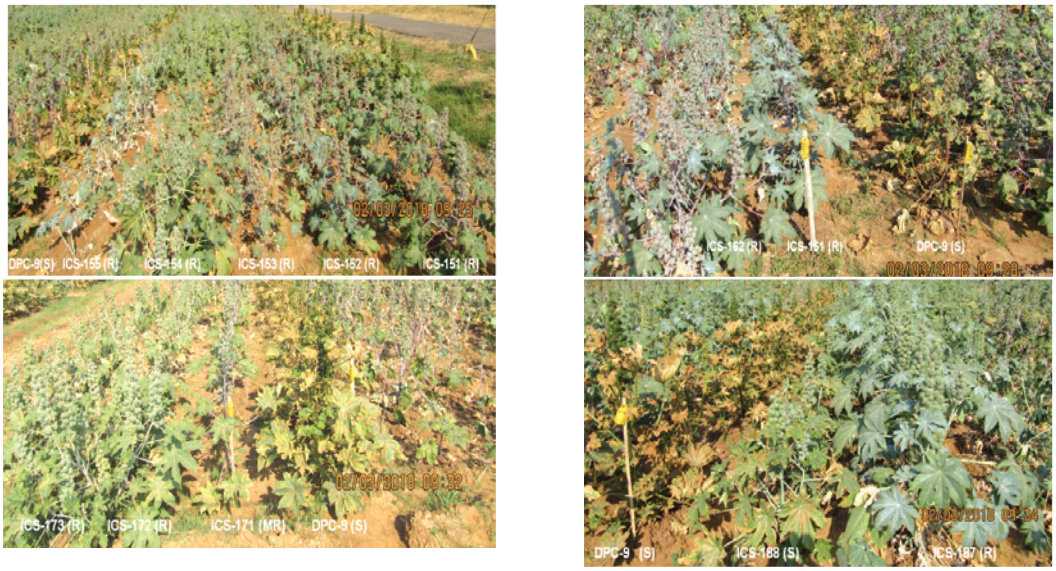


Assessment of whitefly population of castor on a 0 to 5 scale

Screening of parental lines against sucking pests

A total of 81 castor monoecious lines along with susceptible and resistant checks were screened for their reaction to sucking pests (leafhopper, thrips and whitefly) under field conditions using infester row technique. Of these, 28 lines (ICS-151, ICS-152, ICS-153, ICS-154, ICS-155, ICS-156, ICS-158, ICS-161, ICS-162, ICS-163, ICS-166, ICS-170, ICS-172, ICS-186, ICS-187, ICS-190, ICS-191, ICS-194, ICS-195, ICS-197, ICS-200, ICS-201, ICS-210, ICS-216, ICS-217, ICS-220, ICS-229, ICS-231) were found to be highly resistant to leafhopper (hopperburn grade 0 on 0-4 scale) as compared to grade of 4 in susceptible checks (DPC-9 and DCH-177). Twelve lines (ICS-155, ICS-156, ICS-170, ICS-172, ICS-176, ICS-178, ICS-182, ICS-194, ICS-200, ICS-202, ICS-207, ICS-217) were found promising against thrips and recorded lower thrips infestation of less than 5.0 thrips/spike as compared to 34.8 thrips/spike in susceptible check, DPC-9.

Among the lines screened against whitefly, 25 lines (ICS-159, ICS-160, ICS-165, ICS-170, ICS-172, ICS-174, ICS-178, ICS-180, ICS-181, ICS-188, ICS-192, ICS-200, ICS-203, ICS-204, ICS-206, ICS-208, ICS-210, ICS-211, ICS-213, ICS-214, ICS-216, ICS-218, ICS-225, ICS-226, ICS-228) recorded low population scale of 1 (on 0 to 5 scale) as compared to scale 4 in susceptible check, M-574.



Reaction of promising monoecious lines and susceptible check, DPC-9 to leafhopper

Screening of germplasm accessions against sucking pests

Among 52 castor accessions screened, 14 accessions (RG-3491, RG-3494, RG-3495, RG-3496, RG-3497, RG-3452, RG-3503, RG-3506, RG-3511, RG-3514, RG-3476, RG-3477, RG-3485, RG-3489) were found highly resistant to leafhopper and recorded hopperburn grade 0 on 0-4 scale as compared to grade 4 (on 0-4 scale) in susceptible checks (DPC-9 and DCH-177). Nine accessions (RG-3417, RG-3419, RG-3421, RG-3423, RG-3424, RG-3427, RG-3428, RG-3465, RG-3513) exhibited resistant reaction to whitefly infestation with population scale of 0 on a 0 to 5 scale as compared to scale 4 in susceptible check, M-574.

Development and reproduction of reniform nematode

Development and reproduction of reniform nematode was studied in the castor genotypes *viz.,* JI-35, 48-1 and JC 12 and all the genotypes were susceptible to reniform nematode. JI-35, 48-1 and JC-12 recorded 32, 26 and 21 egg masses per plant and a reproduction factor of 1.97, 3.07 and 1.63 respectively. Results indicated that JI-35 and 48-1 were highly susceptible and JC-12 is comparatively less susceptible to reniform nematode.

Efficacy of entomopathogenic nematodes against *S. litura* larvae

Sixty soil samples were collected from IIOR farm of which only one sample was found positive to the entomopathogenic nematodes (EPNs). Preliminary laboratory bioassays with the IIOR native isolate and EPNs *Steinernema carpocapsae*, *Heterorhabditis indica* at a dose of 100 juveniles/ larva resulted in complete mortality of fifth instar *S. litura* larvae.

SOCIAL SCIENCES

With the aim of assessing the benefits of technologies developed by IIOR, as a first exercise impact assessment of hybrids of castor released by IIOR and AICRP (Castor) has been taken up. To understand this, enumerating of the costs, returns and profitability of castor based production systems was undertaken through primary data in three villages in Amrabadmandal and two villages in Waddepallimandal of Mahabubnagar district of Telangana for the agricultural year 2016-17. The results indicated that the productivity of castor hybrids (DCH-177, DCH-519, PCH-111) was 16.1 q/ha over the existing castor hybrids from the private sector with an additional net returns of Rs. 7,784/ha. The results showed that area coverage with the castor hybrids released from the public sector can enhance the productivity and income of the castor farmers in the above selected villages. On the production systems mode, the net returns from the public sector hybrids was marginally superior to redgram (productivity level of 11.3 q/ha) with an additional net returns of Rs.1,956/ha. For complementarity and enhancing the farmers income, promoting inter cropping of castor + redgram could be a possible solution as a risk mitigation strategy to sustain the farmers' income. Also, the castor hybrids DCH-177, DCH-519, PCH-111 have outperformed cotton (productivity of

18.8 q/ ha) in terms of additional net returns of Rs. 5,920 ha. Although highest gross returns were evidenced in cotton farming (Rs. 72,643/ha), the increasing operational costs of Rs. 41,589/ha resulted in lower additional net returns over castor. It was also observed that the performance of the private sector hybrids was not profitable over cotton farming. However, castor when compared to maize is a losing proposition due to higher additional net returns of Rs. 14150/ ha from maize cultivation (productivity of 65 q/ha). In light of the above, it is warranted that concerted efforts are required for popularizing the castor hybrids (DCH-177, DCH-519, PCH-111) for enhanced farm returns.

Further to examine the contribution of area and yield to the total production, decomposition analysis was attempted at the national level for four periods *viz.,* 1966-67 to 1976-77; 1977-78 to 1987-88; 1988-89 to 2005-06 and 2006-07 to 2015-16. Considering the gainful strides made by in Gujarat and Rajasthan in the above periods decomposition analysis was carried out for two periods 1988-89 to 2005-06 and 2006-07- 2015-16.

It was observed that technology (yield effect) contributed to 56% of the production and area contributed to 34% during the period 1966-67 to 1976-77 while in the periods 1977-78 to 1987-88 and 1988-89 to 2005-16, the production was primarily driven by area contributing to 76 and 75% of production, respectively. However, during 2006-07 to 2015-16, area and technology (yield effect) contributed to 42 and 40% of the production, respectively.

Decomposition analysis of area, production and yield of castor (All India)

Period	Area effect (%)	Yield effect (%)	Interaction effect (%)
	All India		
1966-67 to 1976-77	34	56	10
1977-78 to 1987-88	76	17	7
1988-89 to 2005-06	75	15	10
2006-07 to 2015-16	42	40	18
Base data (Triennium ending)	Area ('000 ha)	Production ('000 t)	Yield (q/ha)
1966-67	411.36	115.56	0.28
1976-77	487.00	177.43	0.37
1977-78	440.80	208.53	0.48
1987-88	628.30	336.10	0.53
1988-89 to 2005-06	604.33	375.93	0.60
2005-06	681.13	672.53	0.97
2006-07 to 2015-16	745.20	848.80	1.14
2015-16	1071.08	1782.78	1.66

A perusal of decomposition analysis indicated that the production was accounted by more than 50% through area effect (68 and 57% in Gujarat and Rajasthan) during the period 1988-89 to 2005-06. While for the period 2006-07 to 2015-16, production was influenced by area in both the states (84 and 70%)

Decomposition analysis was further extended to the district wise data from Gujarat for the Triennium ending 2012-13 over Triennium ending 2005-06. It was observed that production was chiefly attributed to area (>50%) in the districts of Banaskanta (62%), Surendernagar (58%), Kutch (63%), Gandhinagar (79%) and Jamnagar (58 %) while yield effect (technology) contributed to 80% in Mehsana, 44% in Sabarkanta, 37% in Rajkot, 25% in Vadodara and 24% in Mehsana.

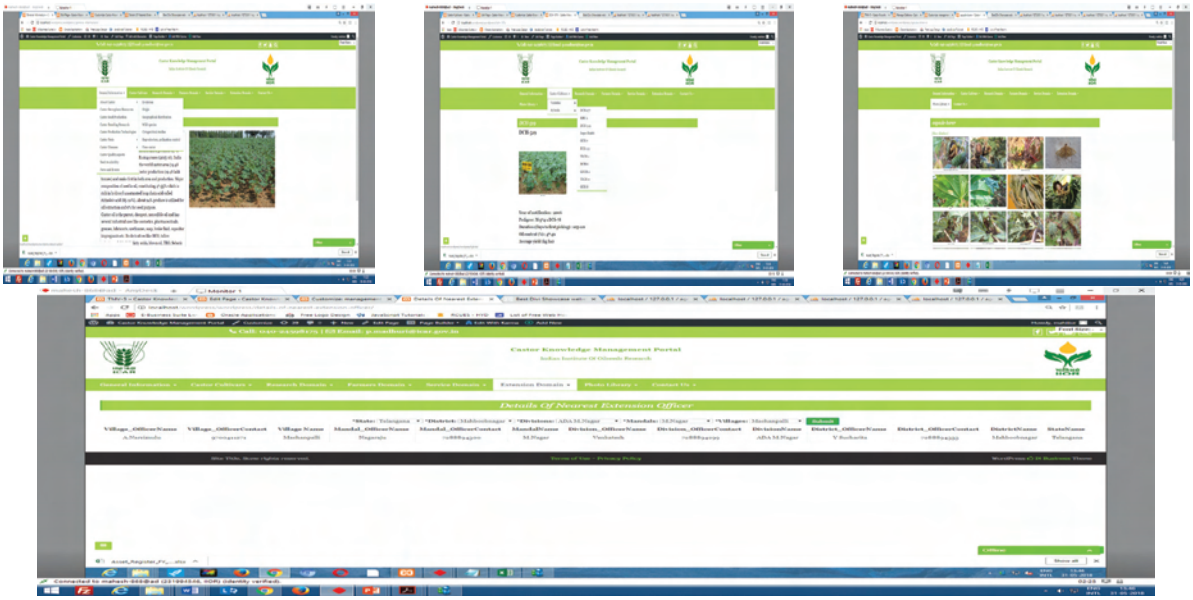
Decomposition analysis of area, production and yield of castor (Gujarat and Rajasthan)

Period	Area effect (%)	Yield effect (%)	Interaction effect (%)
Gujarat			
1988-89 to 2005-06	68	19	13
2006-07 to 2015-16	84	8	8
Base data (Triennium ending)	Area ('000 ha)	Production ('000 t)	Yield (q/ha)
1988-89	167.20	236.27	1.33
2005-06	286.03	462.50	1.59
2006-07	318.53	587.10	1.84
2015-16	685.33	1385.62	2.02
Rajasthan			
1988-89 to 2005-06	57	7	36
2006-07 to 2015-16	70	13	17
Base data	Area ('000 ha)	Production ('000 t)	Yield (q/ha)
1988-89	9.58	9.00	0.64
2005-06	60.57	65.93	1.06
2006-07	92.30	108.63	1.18
2015-16	204.35	297.04	1.45

Castor knowledge management portal

Castor knowledge management portal was designed and developed with the objective of compiling the pertinent information on castor to the benefit of all stakeholders. Accordingly, the content was developed and uploaded under five major domains *viz*., General domain, Research domain, Extension domain, Farmers' domain and Service domain. Under the general domain, content on the basic information on castor, data on area, production and productivity, seed production, hybrids and varieties, production technologies,

pests and diseases, quality aspects were uploaded to the portal. On the research domain, content on breeding aspects, details of AICRP centres working on castor, and information on other oilseeds research organizations were uploaded. The extension domain basically contained the information on package of practices, contingency plans, FAQs and links to voice advisories. The domain was also enriched with unique digital photo library for castor which has 300-350 photographs categorized into management practices, varieties, hybrids, pests, diseases, intercropping systems, deficiency symptoms and by-products. The information on nearest extension officer in retrieval form from query based database at different levels (state, district, mandal and village) for the major castor growing states was also included in this domain. The farmers and service domain provides information which are of direct utility to the farmers. The user can browse the information on government schemes related to the farmers, innovations by the farmers, sources of seed availability, market prices, exports and imports and State-wise recommended varieties and hybrids.



Snap shots of Castor Knowledge Management Portal

Frontline demonstrations

In order to showcase the productivity potential and profitability of improved technologies of castor, 70 FLDs were conducted by IIOR in traditional castor growing districts of Mahabubnagar (Meenugovanipalle and Jangamreddypalle), Nalgonda (Rachakonda) and Ranga Reddy (Thippaiguda) districts of Telangana State. The details of village-wise productivity potential were arrived at.

Productivity potential of improved technologies

Village	Area (acre)	Seed yield (kg/ha)		% increase in seed yield
		IT	FP	
Rachakonda	20	728	585	24.3
Thippaiguda	20	649	545	19.0
Meenugovanipalle	19	901	732	23.2
Jangamreddypalle*	08	980	840	16.7
Jangamreddypalle**	03	1150	900	27.8

IT = Improved technology (DCH-519, seed treatment with *Trichoderma*; spacing = 90 cm x 60 cm and management of gray mold by prophylactic sprays); FP = Farmers' practice (GCH-4/GCH-7, spacing = 90 cm x 45 cm); * = one spray of Tilt; ** = two sprays of Tilt

The seed yield improvement ranged from 16.7% in Jangamreddypalle, when gray mold was controlled with one fungicidal spray to 27.8%, when gray mold was controlled by two prophylactic sprays of fungicide as compared to farmers' practice of not following any prophylactic sprays.

Highest additional net returns and B:C ratio was obtained, when two prophylactic sprays were done for the management of gray mold in castor based on the weather conditions. The demonstrations have clearly indicated the possibility of management of gray mold of castor with two prophylactic sprays.

Profitability of improved technologies

Village	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	B:C ratio	
	IT	FP	IT	FP		IT	FP
Rachakonda	15725	15261	27350	21970	4916	1.72	1.43
Thippaiguda	14497	13997	24010	20162	3348	1.66	1.44
Meenugovanipalle	15758	15474	33682	27337	6060	2.14	1.77
Jangamreddypalle*	16500	15500	35280	30240	4040	2.14	1.95
Jangamreddypalle**	17500	16000	41400	32400	7500	2.37	2.03

CoC = Cost of cultivation; GMR = Gross monetary returns; ANR = Additional net returns; B:C ratio = Benefit cost ratio
* = one spray of Tilt; ** = two sprays of Tilt

Demonstrations of DCH-519 in Jangamreddypalle, Mahabubnagar

SUNFLOWER

CROP IMPROVEMENT

Conservation and maintenance of germplasm

Major emphasis during the year was on multiplication of sunflower accessions conserved and maintained at IIOR. A set of 2300 accessions was multiplied and 167 accessions, including genetic stocks, were supplied to different researchers. A set of 1015 accessions were deposited in medium term storage facility of IIOR and 101 accessions sent to NBPGR for long term storage.

Identification of trait specific germplasm

Trait	No. of accessions	Particulars
Petiole pigmentation	24	GMU-579, 815, 559, 700, 693, 779, 811, 815, 969
Stem pigmentation	20	GMU-564, 565, 641, 646, 819, 731, 704, 589, 615, 631, 646, 641, 694, 905, 850, 969
Very late (>100 days)	12	GMU-860, 861, 862, 863, 864, 865, 866, 849
Two stems	6	Selection GP6-158, GP6-160
Three stems	1	GMU-170
Five stems	1	GP6-570

For development of superior hybrids and for studies on combining ability of the new inbreds, 80 CMS lines along with maintainer lines were procured from seven AICRP-Sunflower centres. A set of 170 lines including the CMS lines obtained from USDA, USA (32) and those available at the GMU Unit, IIOR were multiplied. A final set of 80 CMS lines excluding duplicates, pollen shedders and asynchronous lines is maintained as a repository of CMS lines for the benefit of the breeders.

Development of germplasm core

A core collection is defined as a sample of accessions that represent, with the lowest possible level of redundancy, the genetic diversity (the richness of gene or genotype categories) of the entire collection. To establish such a core in sunflower, the passport data on the characterization and evaluation of 2,149 IIOR sunflower accessions collected during 2011-13 were used. 'R software' based package "ccChooser" was used for the development and evaluation of core collection and the analysis was carried out in three parts. In the first part the cluster analysis was performed using two classical methods (UPGMA and Ward methods) and number of groups were designated based on the 'dendrograms' function (function – cut tree). Second part of the analysis assigned genotypes from original collection to core collection based on four allocation methods. Last part of the analysis was used to evaluate the cluster analysis methods and allocation methods. The Ward cluster analysis and D3 allocation method proved to be the most optimal and efficient in development of the sunflower core collection from the dataset. The core collection created as a result of these methods was characterized as lowest value dD% (5.080867) and relatively low value of MD% (0.78302285). Based on this strategy, 216 accessions were selected for core collection which is approximately 10% of the entire collection.

Exploitation of inter and intraspecific genetic resources for development of agronomically superior inbred lines and populations

Evaluation and confirmation of trait specific inbreds: A total of 76 trait specific inbreds was raised for different traits which included accessions resistant/tolerant (15) and

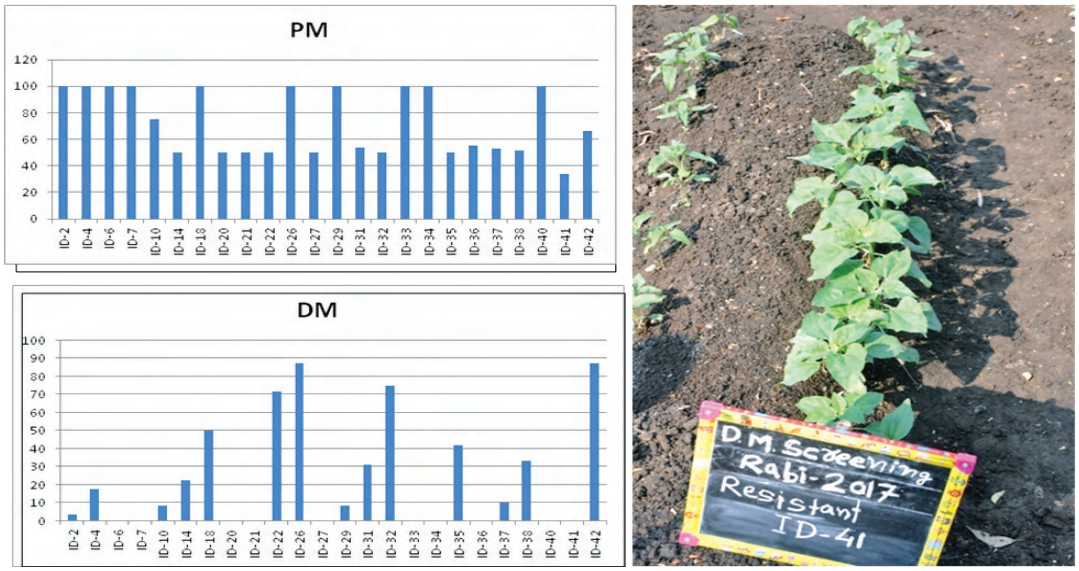
susceptible (1) to powdery mildew; accessions tolerant (4) and susceptible (1) to *Alternaria helianthi*; early maturing genotypes (5); high oil (14); high oleic (1); dwarf (6); leafhopper resistance (11); and interspecific derivatives with multiple disease resistance traits (16). Based on appropriate method for confirmation of the trait, the acce-ssions were selected for exploitation in breeding programmes and also for their use as resis-tant and susceptible checks in pathology screening trials. These include PM-81 from Raichur (Resistant, score 0 on 0-9 scale) and PS 2023 (Susceptible, score 9 on 0-9 scale) for powdery mildew; HA 124A/B (tolerant; score 2 on a 0-9 scale), and TSG 208-HA 380 (Highly susceptible, 9 on a 0-9 scale) for *A. helianthi,* GP-4-1424, TSG 339-ARG-1575-1, CMS 300 A/B with more than 40% oil content; TSG 207-HA379, TSG 24-RHA 271, HAR-9, TSG 212-HA385, TSG 401-SUMV-2, TSG 217-HA407, GMU 339, GMU 25 for leafhopper resistance; TSG-17-Pervenets for high oleic (>83%); TSG 355-ID-ERLYC for early maturity (44 days to flowering); TSG 292 (RHA 348), TSG 411 for high seed yield (>30 g/plant even for a R line); TX 16R and HAR-9 (purple disc) for multiple resistance; TSG 332-RHA857 for high photosynthetic rate. The high oil line GP-4-1424 was consistent for its high oil (40-42.7%) for four consecutive years regardless of the seasons. Of the three powdery mildew resistant accessions obtained from Raichur (PM-61, PM-81 and PM-82) and tested using conidial dusting method, PM-61 was found to be moderately susceptible to powdery mildew; PM-82 showed infection on the lower leaves while PM-81 was completely free of the disease even up to maturity. The interspecific derivative PS 2023 developed at IIOR and found susceptible to powdery mildew was found to be susceptible to leafhopper as well.

PS 2023: a line susceptible to powdery mildew showing susceptibility to leafhopper as well

PM-81: Resistant to powdery mildew

TSG 208-HA 380: Highly susceptible to Alternaria helianthi and close up of a plant and capitulum showing the disease intensity

Twenty four interspecific derivatives obtained from USDA, USA were assessed for their reaction to powdery mildew at IIOR using the dusting method and for downy mildew in the sick plot at ORS, Latur. While none of the accessions were found to be resistant to powdery mildew, 13 accessions (ID-1, ID-6, ID-7, ID-16, ID-20, ID-21, ID-27, ID-30, ID-33, ID-34, ID-36, ID-40 and ID-41) were found to be free from downy mildew infection in the sick plot at Latur.



Reaction of interspecific derivatives to powdery mildew (PM) and downy mildew (DM)

Generation advancement and characterization of RILs

A total of 349 RILs of the crosses Morden x EC537925 (118); 2023 x TX16R (129); ID-25 x TX16R (102) were multiplied and evaluated for reaction to *Alternaria* and powdery mildew at IIOR and for downy mildew reaction in sick plot at Latur. While the RILs of the crosses Morden x EC537925; 2023 x TX16R attained near homozygosity, the RILs from ID-25 x TX16R need two more cycles for the required homozygosity. TX16R is reported to be resistant to downy mildew and the RILs involving 2023 x TX16R and ID-25 x TX16R in F_8 generation segregated for 1:1 resistant and susceptible in the DM sick plot with chi square of 0.93 and 1.22, respectively for a single gene. Eleven RILs (6, 36, 40, 120, 148, 161, 162, 171, 172, 175, 176) from ID-25 x TX16R; 17 RILs (47, 49, 85, 94, 95, 104, 109, 127, 134, 138, 146, 151, 186, 210, 229,262,277) from 2023 x TX16R and 1 RIL (147) from Morden x EC537925 cross combinations were found to be resistant to both downy mildew and powdery mildew.

Reaction of RILs to downy mildew in the sick plot at ORS, Latur

Generation advancement and characterization of interspecific derivatives involving *H. praecox*

A total of 1491 plants of 234A x *H. praecox* in F_2 and BC_1F_2 generations and two sets of progenies derived from CMS 243B X *H. praecox* comprising 30 plants were phenotyped for reaction to powdery mildew and genotyped for *AHAS* allele for resistance to SU based herbicides and plants with powdery mildew resistance carrying the 187 bp allele representing *AHAS* allele were selected for further generation advancement and backcrossing.

The two parents, PS 2023 and TX 16R used in RIL development were screened for molecular polymorphism using 484 SSR markers. A total of 168 primers showed polymorphism (34%) among the two parents which are being tested in the RIL population to find markers associated with powdery mildew and downy mildew resistance.

Pre-breeding

Generation advancement of pre-bred material from BC_2F_2 to BC_2F_3 generation: A total of nine interspecific cross combinations (six combinations with wild *H. annuus* and three combinations with *H. argophyllus*) was advanced from BC_2F_2 to BC_2F_3 generation during late *rabi* 2017-18.

Generation advancement from BC_2F_1 to BC_2F_2 generation and characterization: Interspecific hybrids involving *H. praecox* (PRA-1823 and PRA-1154), *H. argophyllus* (ARG-153), *H. petiolaris* (PET-1910), *H. debilis* (DEB-361 and DEB-691) and wild *H. annuus* (ANN-2101) were advanced from BC_2F_1 to BC_2F_2 generation through selfing during *rabi* 2017-18. All individual plants of each combination were characterized for days to 50% flowering, plant height (cm), number of leaves/plant, head diameter (cm), seed yield/plant (g), 100-seed weight (g) and oil content (%) under selfing. Wide variability was observed for most of the traits evaluated.

Generation advancement and characterization

Trait	ARM-243B x ANN 2101		ARM-243B x ARG-153		ARM-243B x PRA-1154		ARM-243B x DEB-691	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Days to 50% flowering	68.9	65.0-81.0	79.9	78.0-81.0	72.6	67.0-81.0	71.1	65.0-78.0
Plant height (cm)	235.0	180-280	169.4	134-199	207.1	174-270	203-1	108-280
No. of leaves/plant	33.0	14.0-49.0	29.0	21.0-37.0	28.1	20.0-34.0	34.1	26.0-49.0
Head diameter (cm)	14.6	8.3-18.9	12.1	8.0-15.0	11.8	7.0-16.0	11.7	7.0-17.0
Seed yield/plant (g)	37.2	15.0-73.0	31.0	22.5-39.0	36.9	20.0-57.0	39.4	16.0-73.0
100-seed weight (g)	6.8	3.5-9.5	6.0	5.5-6.5	6.7	5.5-8.0	6.6	3.5-9.5
Oil content (%)	32.1	29.0-35.0	-	-	35.3	33.0-38.9	32.4	30.0-35.0

Diversification of CMS and restorer system and development of agronomically superior parental lines

Promising sunflower genotypes for root characteristics: Root traits were studied in 15 restorer lines (R x R gene pool progenies) along with DRSH-1 and 298R as checks, by growing the plants in poly bags for confirming the results obtained during the previous year. Plants were grown for 65 days and harvested. Observations on root length (cm), root volume (cc), root weight (g/plant), root/shoot ratio, total dry matter (TDM) (g/plant) and water use efficiency (g/ℓ water) were recorded at the time of harvest. Significant variation was observed for different characters among the lines studied. Two genotypes namely, RGP-50-P2 and RGP-46-P3 were found promising for multiple root traits among the lines tested and RGP-21-P6 was good under control conditions. RGP-60-P2 (mono head) genotype was found promising for root volume and root weight.

Important root traits in the selected genotypes

Trait	Control	Stress
Root length (cm)	DRSH-1 (70), RGP-60-P1 (69), RGP-33-P5 (65), RGP-50-P1 (62), RGP-21-P6 (62)	RGP-50-P2 (64), RGP-21-P5 (61), RGP-33-P5 (59), RGP-61-P1 (58),DRSH-1 and RGP-60-P2 br (55)
Root volume (cc)	RGP-46-P3 (24.5), DRSH-1 (20), RGP-50-P1 and RGP-50-P2 (18.3), RGP-21-P6 (17.4), RGP-60-P1 (17.0)	RGP-50-P2 (14.0), RGP-46-P3 (13.1), RGP-95-P1 (10.2), DRSH-1 (10.0), RGP-60-P2 mono (8.5)
Root weight (g/plant)	RGP-50-P2 (4.5), RGP-50-P1 (4.1), RGP-60-P2 mono (4.0), RGP-21-P6 (3.7), DRSH-1 (3.6)	RGP-50-P2 (3.2), RGP-46-P3 (2.2), DRSH-1 (1.9), RGP-60-P2 br (1.7), RGP-60-P2 mono (1.6)
TDM (g/plant)	DRSH-1 (31), RGP-46-P3 (28), RGP-50-P2 (27), RGP-60-P1, 61-P1, RGP-21-P5 (26), RGP-60-P2 br (25)	RGP-50-P2 (20), RGP-60-P2 br (15.8), DRSH-1 (13.9), RGP-46-P3 (12.8), RGP-50-P1 (12.8)
Root/shoot ratio	RGP-60-P2 mono (23), RGP-50-P2 (21), RGP-33-P5 (20), RGP-21-P6 & 46-P3 (19)	RGP-33-P5 (27), RGP-50-P2 &RGP-46-P3 (20), RGP-60-P1 (18), RGP-21-P5 (17), DRSH-1, 298 R and RGP-61-P2 (16)

Confirmation of drought tolerant R x R gene pool progenies under field conditions: Fifteen newly developed sunflower R x R gene pool progenies selected based on desired root traits along with two checks, DRSH-1 and 298R were sown in the field during the last week of December 2017. Crop was subjected to water stress by withholding irrigation from 40-75 days after sowing. Observations on growth parameters were recorded before imposing stress, before relieving stress and at harvest. Drought significantly affected the different parameters studied. The most affected was dry matter production and the least affected was the leaf number. Based on drought susceptibility index (DSI) and % seed yield reduction under stress condition, seven genotypes namely RGP-21-P, RGP-21-P6, RGP-21-P8, RGP-50-P1, RGP-60-P1, RGP-60-P2 and RGP-95-P1 were found promising. The lowest DSI and yield reduction (0.2 and 11%) was reported in genotype RGP-95-P1 followed by RGP-21-P6 (0.3 and 11%) and RGP-21-P2 (0.4 and 15).

Drought tolerance in R x R gene pool selections

Genotype	Seed yield (g/plant)		DSI	% yield reduction
	Control	Stress		
RGP-21-P2	7.5	6.4	0.4	15
RGP-21-P6	4.5	4.1	0.3	11
RGP-21-P8	4.3	3.3	0.7	24
RGP-95-P1	5.2	4.7	0.2	8
RGP-60-P2 (full br)	5.1	3.5	0.9	32
RGP-50-P1	14.4	11.4	0.6	21
RGP-60-P1	17.8	13.4	0.7	25
RGP-32-P1	9.2	3.4	1.8	64
RGP-33-P5	5.7	2.7	1.5	53
RGP-46-P3	17.4	8.5	1.5	51
RGP-60-P2 (mono)	17.3	7.2	1.7	58
RGP-61-P1	10.0	5.1	1.4	49
RGP-61-P2	12.5	3.6	2.0	71
DRSH-1 ©	28.1	25.2	0.3	10
298 R ©	19.8	12.1	1.1	39
Mean	11.4	7.6	1.0	35

Generation advancement of B x B gene pool progenies: A total of 100 individual plant progenies of maintainer gene pool were advanced from S_3 to S_4 generation through selfing. Five genotypes namely MGP-23-S2 (35.7%), MGP-37-S2 (34.9%), MGP-26-S1 (34.8%), MGP-118-S1 (34.6%), MGP-42-S4 (34.6%), MGP-118-S2 (34.5%) were found promising for oil content, MGP-11-S1 (55 days), MGP-29-S3 (56 days), MGP-11-S3 (56 days) and MGP-99-S1 (57 days) for earliness and MGP-85-S3 (24.8 g), MGP-42-S1 (17.5 g), MGP-24-S4 (15.7 g) were found promising for seed yield compared to checks [CMS-17B: (12.7 g/plant) and ARM-243B: (10.8 g/plant)].

Generation advancement and utilization of R x R gene pool progenies: A total of 150 individual plant progenies were advanced from S_3 to S_4 and S_5 generations during *kharif*-2017 and *rabi* 2017-18, respectively through selfing and sibbing. RGP-14-P1 (55 days), RGP-50-P1-S4 and RGP-96 (56 days), RGP-87-P3-S1 (57 days), RGP-50-P2-S2, RGP-50-P1-S4, RGP-93-P1-S1, RGP-95-P1-S3 and RGP-32-P1-S1 (58 days) were found promising for earliness. From the R x R gene pool progenies, 140 progenies were utilized as male parents and synthesized 196 new experimental hybrids using existing CMS lines as well as a few lines imported from USDA during *rabi* 2017-18.

Conversion of good combiner inbreds into CMS: Four good combiner inbreds were converted into new CMS lines with PET-1 cytoplasm (CMS-1007A to CMS-1010A). The days to flowering varied from 64 to 70 days; plant height from 108 to 136 cm; head diameter 10.6 to 14.2 cm and oil content 32.7 to 37.0%. Newly developed lines, CMS-1008A had oil content of 37.0% and short stature (108.0 cm) compared to other CMS lines. These lines will be utilized in hybrid breeding program to develop promising hybrids.

Evaluation of hybrids for seed yield and physiological parameters in *rabi* season: In advanced hybrid evaluation trial, 11 hybrids (identified to be superior in two years of trials) along with two checks (DRSH-1 and KBSH-44) were evaluated in augmented design in 5.0 x 4.0 m plot. Of these, four hybrids namely IIOSH-111, IIOSH-109, IIOSH-107 and IIOSH-106 were found promising for seed yield and oil content over the checks. Hybrids IIOSH-106 and IIOSH-111 were found promising for harvest index compared to national checks. Based on all the traits, IIOSH – 111 was identified as a superior hybrid.

Hybrids promoted from IHT to AHT-I: IIOSH-15-10, a new hybrid with 8.3% and 18.1% yield superiority over check hybrids, KBSH-44 and DRSH-1, respectively was promoted from IHT to AHT-I.

Hybrids promoted from IHT to AHT-I

Hybrid	Zone-IV	Zone-V	Overall seed yield (kg/ha)	Mean oil yield (kg/ha)
IOSH-15-10	1689	1686	1760	391
KBSH-44 (C)	1537	1605	1625	359
DRSH-1 (C)	1526	1267	1490	375
CD (p=0.05)			80.6	
CV (%)			11.4	

Identification of optimum range for development of ideotype

Sunflower yield level has reached a plateau with the existing plant types. A prerequisite for breeding plant types with enhanced yield potential through genetic manipulation of individual trait is determining a range for each traits for attaining a defined yield. For this, 90 genotypes with wide variability for different traits were studied during *rabi* 2017 to define optimum range for each trait. Observations on 20

Evaluation of hybrids for seed yield and physiological parameters

Hybrid	Pedigree	Days to 50% flowering	Plant height (cm)	Head diameter (cm)	Seed yield (g/plant)	100 seed weight (g)	Oil content (%)	Harvest index(%)
IIOSH-101	CMS-17A x EC-601932	69.0	175.1	13.4	28.3	5.0	32.3	22
IIOSH-102	CMS-234A x DRSI-185	64.0	182.0	14.4	29.1	5.4	34.9	20
IIOSH-103	ARM-243A x DRSI-46	64.0	182.1	14.6	40.9	5.6	32.5	22
IIOSH-104	CMS-2A x DRSI-17	65.0	198.4	15.8	43.0	6.4	31.9	12
IIOSH-105	ARM-243A x DRSI-22	59.0	107.8	13.4	30.6	6.0	33.9	23
IIOSH-106	CMS-234A x DRSI-297	62.0	146.4	15.6	41.3	5.9	35.8	26
IIOSH-107	ARM-243A x DRSI-33	65.0	182.4	13.6	38.6	5.9	35.8	17
IIOSH-108	CMS-852A x DRSI-44	66.0	182.6	14.8	37.5	4.4	35.3	17
IIOSH-109	CMS-234A x LTRR-341	62.0	170.2	14.8	41.3	5.9	35.4	20
IIOSH-110	ARM-243A x RGP-22-P3	64.0	187.6	16.2	34.7	6.3	35.9	18
IIOSH-111	ARM-243A x RGP-11-P1	69.0	177.8	15.2	38.2	5.2	37.4	35
DRSH-1(C)		63.0	202.6	15.4	30.9	5.8	36.2	20
KBSH-44 (C)		69.0	188.2	16.2	36.7	5.4	30.0	20

traits were recorded at different growth stages. To develop an ideotype, optimum range for each of these traits will be arrived at by employing suitable statistical models.

Variability for different traits among 90 genotypes selected

Trait	Mean	Range
Plant height (cm)	114	51-164 (SCG-40)
No. of nodes	25	13-41 (SCG-40)
Stem girth (mm)	17.5	10.7-24.3 (NDCMS 30A)
Leaf length (cm)	17.3	12.8-24.6 (NDCMS 30A)
Leaf width (cm)	14.4	10.2-24.0 (NDCMS 30A)
Specific leaf area (sq/cm)	169	117-248 (189/1R)
Days to 50% flowering	65	54-77 (SCG-64)
Days to maturity	97	90-103 (302A)
Seedling vigor (mg/pl)	220	70-490 (DRSF-113)
Internodal length (cm)	4.4	2.7-6 (DRSH-1 and NDCMS 30A)
TDM (g/pl) at harvest	83	24.5-146.5 (NDCMS 30A)
Head diameter (cm)	15.3	8.6-20.4 (RFH-1887)
SPAD		
Upper leaves	39.2	26.7 – 52.2 (LDM -02)
Middle leaves	43.7	24.7 – 63.6 (ARM -243B)
Lower leaves	28.0	12.1 – 47.9 (CPI 3)
Seed yield (g/pl)	22.7	1.5-45.1 (DRSF-113)
HI (%)	27	4-45 (DRSF-113)

Nucleus seed production: Nucleus seed of DRSH-1 parental lines (ARM-243A and B and RHA-6D-1) and two populations (DRSF-108 and DRSF-113) was produced during *kharif* 2017 and *rabi* 2017-18, respectively.

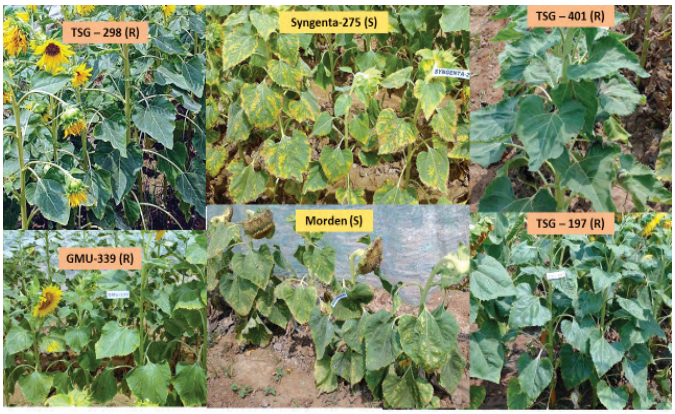
Under the Central Sector Scheme for Plant Variety Protection and Farmers Rights Authority, 17 parental lines of sunflower were characterized for 32 DUS traits to ascertain the revised range for states for some of the traits and recording of observations for six additional traits.

Modification of screening technique for leafhopper resistance

To increase the leafhopper population on sunflower plants and also to ensure their uniform spread across the plot, an attempt was made by sowing okra and sunflower in the ratio of 2:1 ratio during *rabi*, 2017-18. Initial build-up of leafhopper population was good on okra. However, okra could not grow properly under the shade of sunflower. There was no significant increase in damage and number of leafhoppers.

Identification of sources of resistance to leafhoppers

A field trial was conducted during *rabi* 2017-18, to identify the resistant sources of sunflower to leafhoppers. Sixty two germplasm lines were evaluated for the second year to record their reaction to leafhoppers under natural infestation.



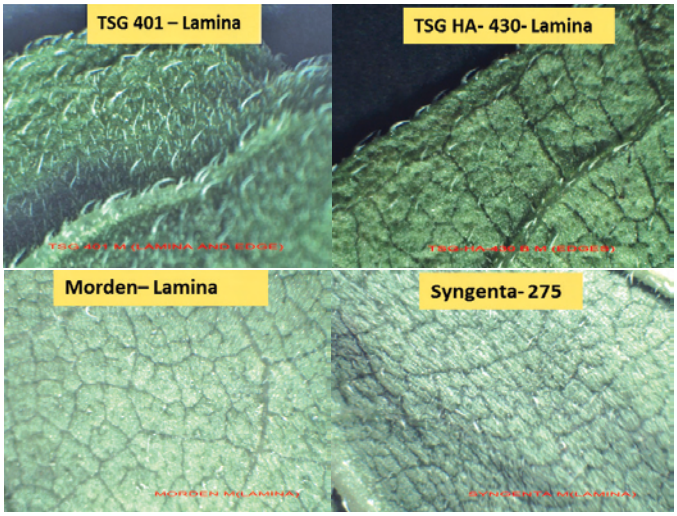
Differential reaction to leafhopper

Twenty five lines, *viz.*, GMU-339, GMU-504, GMU-669, GMU-696, GMU-776, GMU-1029; TSG-195, TSG-196, TSG-197, TSG-216, TSG-217, TSG-238, TSG-258, TSG-278, TSG-298, TSG-337, TSG-338, TSG-339, TSG-349, TSG-400, TSG-401; PSCIM-138, AKSFI-46-2, GP6-570, GP9-472-4-13 were found resistant to leafhopper with the injury grade 1 on a 0 – 5 scale. Four lines, PSMO-53-B-1, PSCIM-186, PSERM-127, PSECO-86 and susceptible check, Morden were found susceptible with an injury grade of 4.

Mechanism(s) of resistance against leafhoppers

Through choice experiments, antixenosis was studied during *rabi* 2017-18. Leafhoppers showed highest preference of 15.7% (PSECO-79) to 25.7% (Morden) towards susceptible lines compared to 10% (GMU-25) to 11.9% (TSG-217) in the resistant lines. Further investigations on bio-physical properties suggested that trichome density on midrib, lamina and veins and trichome length on leaves significantly played a role in non-preference of leaf hoppers towards resistant lines. Leaf thickness of sunflower did not show any effect on antixenosis. Significant negative correlation was observed between leafhopper population and trichome density and trichome length on midrib, lamina and veins.

Character		Resistant	Susceptible	T- value
Trichome density	Midrib	92.03 ± 8.45	46.54 ± 4.34	4.7**
	Lamina	103.95 ± 11.0	20.25 ± 4.5	7.0**
	Veins	72.23 ± 9.83	37.27 ± 6.79	2.92**
Trichome length	Midrib	157.51 ± 28.4	126.95 ± 18.28	ns
	Lamina	123.04 ± 15.26	79.26 ± 8.75	2.49**
	Veins	141.34 ± 10.7	86.5 ± 9.2	3.4**
Leaf thickness		0.41 ± 0.02	0.37 ± 0.18	ns



Trichome density on leaf lamina of resistant *vs* susceptible lines

CROP PRODUCTION

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

Long-term fertiliser studies for sustainable sunflower production in Alfisol

A fixed plot field experiment was initiated during *kharif* 1999 to assess the need and response of major, secondary and micronutrients on a long-term basis for sustainable sunflower production in sorghum (*kharif*) – sunflower (*rabi*) cropping systems in Alfisol. Sorghum yield showed significant variation from the second cropping cycle onwards and application of 150% RDF had recorded the highest yield. Response to K was negative for sorghum seed yield up to 2007-08 and from 2009-10 onwards, K application has resulted in increase in yield over NP. The response to boron (B) was significant in sunflower from 4th crop cycle onwards, over 100% NPK. Supplementation of 5 t FYM/ha with RDF to *kharif* sorghum followed by raising sunflower with its recommended NPK gave higher sunflower seed yield compared to 150% NPK to both the crops in the system. Un-manured control or nutrient imbalance with application of N or NP alone or reducing the fertilizer dose by 50% resulted in lowest growth and seed yield of sorghum and sunflower, delayed flowering, lowest test weight and lower sustainable yield index. Soil fertility in general is declining over the years except for increase noticed for organic carbon in treatment receiving FYM or crop residue with NPK. P build up was significant over the years in all treatments receiving regular P application over only N or no manure applications. Sorghum yield showed a declining trend due to application of Zn with NPK to preceding sunflower possibly due to antagonistic effect of P and Zn under the conditions of very high P build up in P applied treatments. Profile soil depth was 1.15 m and the fertility declined with depth from 30 cm downward.

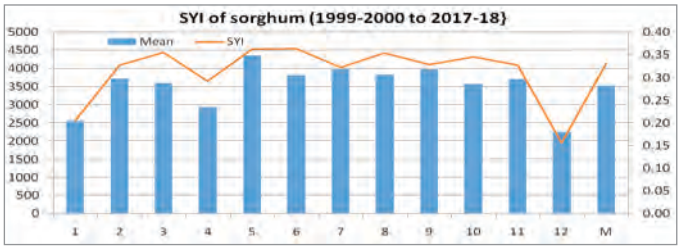
During the year 2016, the trial was modified to include two more treatments as only organic sources of nutrition. The treatments were accommodated in the same plot as extension of the existing experiment. This modification with two treatments had the same background of soil and growing conditions except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

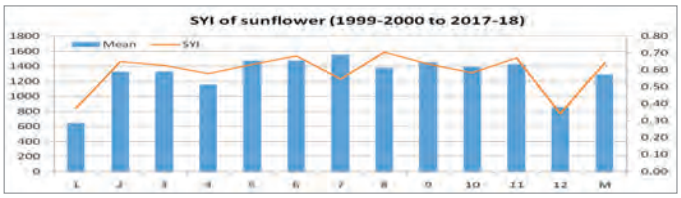
Performance of sorghum: The general growth of sorghum (Hybrid CSH-16) during *kharif* 2017 (19th crop cycle) was good being grown under protective irrigation. The treatment variations were clear and significant for the growth and flowering parameters. The grain yield ranged from 433 to 2190 kg/ha across 14 treatments. Highest seed yield (2190 kg/ha) and harvest index (40%) was recorded with 150% recommended dose of fertilizers to both crops. The new integrated organic treatment (FYM + goat manure + poultry manure) was at par with 150% RDF treatment. Whereas the single organic source (FYM) to supply equivalent N nutrition recorded lower yield at par with 50% recommended NPK. The integrated organic manure treatment recorded highest dry stover yield (4.37 t/ha), fresh fodder yield (16.2 t/ha) and total biological yield (6.52 t/ha) with a harvest index of 30.8%. The treatment, 50% NPK recorded significantly lower yield while no manure or N alone recorded significantly lowest yield, test weight and delayed flowering.

Performance of sunflower: Growth and yield of sunflower (DRSH-1) succeeding sorghum in *rabi* 2017 differed significantly due to long term nutrient management treatments. Seed yield was significantly highest with new organic treatments (1560 to 1630 kg/ha) compared to the highest of NPK+ crop residue (2210 kg/ha). Overall sunflower yield ranged from 553 to 1629 kg/ha. Lowest growth parameters *viz*., plant height, stem girth, head diameter, seed filling, was recorded in N alone or no manure treatments. Soil fertility after *kharif* sorghum in 2017 varied significantly due to long term effects of fertilizer management treatments. Soil organic carbon (OC) was significantly highest (0.94 and 1.04%) under new organic manure treatments followed by high OC of 0.45 and 0.40% with integration of FYM and crop residues with recommended NPK, respectively. The new organic manure treatments recorded similar higher available P and K levels. Available soil P was higher with 150% RDF and

RDF + FYM (42 and 40 kg/ha *vs* initial 13 kg/ha). Available soil Zn was highest with Zn application treatments (12-13 mg/kg compared to the rest of the treatments 2.5 to 4 mg/kg). Similarly available S was highest with recommended NPK application.

The sustainable yield index (SYI) of long term integrated fertilizer management treatments indicated highest SYI for sorghum with 150% recommended NPK application to both crops with mean seed yield of 4300 kg/ha followed by NPK + FYM and NPK + B applied to sunflower in the system. Highest SYI of sunflower was recorded with recommended NPK + S and rec. NPK + S + B + Zn treatments. Economics of long term nutrient management treatments in sorghum-sunflower cropping system in Alfisols indicated that application of 150% of rec. NPK to both crops recorded highest system gross and net returns while recommended.NPK + crop residue application treatment recorded highest system B:C ratio (3.02). Nutrient inadequacy or imbalance treatments recorded lowest economics and sustainability.





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

The response curves fitted for the crop yield over 19 years indicate that the seed yield of sorghum was in general declining over the period and steepness and uncertainty was high when the crop was grown without fertilizers of only 50% RDF. With recommended NPK and balanced nutrition, the seed yield was maintained stable across *kharif* seasons of varied weather and productivity levels indicating the non-exploitative mining of soil nutrients and conservation. The sunflower yields showed increasing trend over the years in treatments of adequate and balanced nutrition with secondary and micronutrients.

Under long term fertility experiment, highest seed yield (2190 kg/ha) of *kharif* sorghum was recorded with 150% RDF to both crops that was at par with use of 3 organic manures (goat + poultry + FYM) together to supply 25 kg N/ha for each crop. Whereas the organic manure treatment recorded highest seed yield of sunflower (1260 kg/ha) and also highest test weight of both the crops.

Assessing productivity, profitability and resource use pattern of emerging crop sequences involving sunflower in Alfisol and Vertisol

The objective of the trial is to assess the productivity, profitability and resource use of different and emerging cropping systems including sunflower and other oilseed crops under limited irrigated situation in Alfisols. In Alfisols, major crops *viz*., cotton, maize, pigeonpea, groundnut, sunflower and greengram-castor crops were grown in *kharif* with different *rabi* crops (chickpea, safflower, sunflower, mustard, sesame, maize and groundnut) under the background of each of the *kharif* crops in fixed plots. The productivity, resource use (inputs, irrigation, labour, time, soil fertility, etc.) were accounted for growing each crop(s) and the total productivity and resource use efficiency (RUE) comparisons were made. The performance of *kharif* crops indicated a very high variation in RUE and productivity, profitability and land utilization efficiency. Among single season *kharif* crops, maize recorded highest seed yield of 1980 kg/ha followed by groundnut and sunflower. Seed yield of other major competing crops cotton and pigeonpea was 1719 and 1035kg/ha, respectively. Greengram - zero till castor gave highest castor equivalent yield (3213 kg/ha). The productivity of *rabi* crops with the background of different preceding *kharif* crops varied significantly. Sunflower-maize recorded highest maize yield of 3.7 t/ha. Seed yield of *rabi* castor was highest with preceding maize. The economics in terms of gross and net returns and B:C ratio was highest with greengram - zero till castor system (Rs.1, 12,455 and Rs. 75,455/ha, respectively). Other crops were economical during 2017-18 especially for *rabi* groundnut, sunflower, chickpea and *kharif* full season cotton. The land utilization index (LUI) was highest with greengram - zero till castor followed by cotton and pigeonpea. Zero tillage establishment of castor at harvest of greengram in August was successful with better utilization of soil moisture through mulching effect.

Productivity of competing cropping systems in Alfisol

Kharif crop	Yield (kg/ha)	*Rabi* crop (kg/ha)							
		Groundnut	Maize	Sunflower	Sesame	Safflower	Mustard	Chickpea	Castor
Groundnut	1567	697	2164	854	327	911	856	526	844
Maize	1980	607	2404	1054	402	781	871	532	1145
Sunflower	1198	564	3669	988	396	1050	854	356	737
Pigeonpea					1719				
Cotton					1035				
Greengram-Castor*					3213				

*zero till

Gross returns (Rs/ha) of competing cropping systems in Alfisol

Kharif crop	Gross returns (Rs/ha)	*Rabi* crop							
		Groundnut	Maize	Sunflower	Sesame	Safflower	Mustard	Chickpea	Castor
Groundnut	62680	27880	27591	29890	21255	29152	34240	21040	29540
System GR		90560	90271	92570	83935	91832	96920	83720	92220
Maize	25245	24280	30651	36890	26130	24992	34840	21280	40075
System GR		49525	55896	62135	51375	50237	60085	46525	65320
Sunflower	38336	22560	46780	34580	25740	33600	34160	14240	25795
System GR		60896	85116	72916	64076	71936	72496	52576	64131
Pigeonpea	85950	-	-	-	-	-	-	-	-
Cotton	39847	-	-	-	-	-	-	-	-
Greengram-Castor	112455	-	-	-	-	-	-	-	-

Assessment of Pusa hydrogel

Assessment of Pusa hydrogel in sunflower for summer season (2018) was carried out for irrigation water use and productivity. Data on soil moisture content by gravimetric method, total dry matter, leaf area index, harvesting parameters of sunflower and oil content were recorded. Physiological parameters like relative water content, membrane stability, chlorophyll content and carotenoids at different stages were also recorded.

In addition to the hydrogel, a new product in development pipeline (K-gel) was also evaluated. Irrigation was given at 60% depletion of soil moisture from field capacity. There were no perceptible changes in soil moisture content across treatments. The maximum variation was for one or two days. There were no significant differences in crop growth, yield and soil moisture and plant physiological parameters.

CROP PROTECTION

Effect of *Trichoderma* isolates on imparting salinity tolerance

A field trial was conducted to evaluate the performance of potential *Trichoderma* isolates capable of imparting salinity tolerance in sunflower with Chitosan through seed priming in natural saline soils (EC = 6.0 dS/m) at ARS Gangavathi, UAS Raichur. The soil type was black cotton belonging to Vertisol soil order with clay texture and poor drainage. Experiment consisted of five treatments laid with simple RBD design with four replications. Size of each treatment plot was 3.0 m x 5.0 m with five rows of 5.0 m length. Among all the treatments, seed priming with Th-4d had significantly improved the sunflower plant stand (18.3 plants/row) under salinity of 6.0dS/m against control (13.8 plants/row).

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

Treatment	No. of plants/row	Head diameter (cm)	Seed yield (g)*
Seed priming-Th-4d	18.3	8.8	59.8
Seed priming-TN-13	16.0	8.7	53.1
No inoculation (Control)	13.8	7.2	39.2
Mean	15.8	8.1	48.6
CD (P=0.05)	1.6	1.0	6.2
CV (%)	7.4	9.1	9.3
SEm±	0.5	0.3	2.2

*average of five plants

Seed treatment with *T. asperellum* (N13) and *T. harzianum* (Th-4d) resulted in better grain filling and head diameter compared to control.

Sunflower with Th-4d

Sunflower with N-13

Without *Trichoderma* (Control)

SOCIAL SCIENCES

Frontline demonstrations on sunflower were conducted in 40 acres in two villages *viz*., Kokkonda and Itikyal of Siddipet district, Telangana State under rice-fallow situation. The improved technology of using sunflower hybrid DRSH-1, seed treatment with Imidacloprid and *Trichoderma*, optimum spacing and spray of boron at ray floret stage was demonstrated during *rabi* 2017-18. This has resulted in 16.3 and 14.5% increase in seed yield in Kokkonda and Itikyal villages, respectively as compared to farmers' practice.

Productivity potential of improved technologies of sunflower demonstrated during *rabi*

Village	Area (acre)	Yield (kg/ha)		% increase over FP
		IT	FP	
Kokkonda	25	988	847	16.3
Itikyal	15	1050	917	14.5

IT = DRSH-1, seed treatment with Imidacloprid and *Trichoderma*; spacing = 60 x 30 cm; spray of boron at ray floret stage; FP = Private hybrid (SB-275/Ganga Kaveri), spacing =45x30 cm; boron spray not practiced

The GMR of Rs. 35,582/ha and Rs. 37,275/ha was recorded with improved technology in Kokkonda and Itikyal villages, respectively as compared to farmers' practice. The B:C ratio was also higher in IT (2.06 and 2.03) as compared to FP.

Demonstration of sunflower hybrid DRSH-1 in Siddipet

Profitability of improved technologies of sunflower demonstrated during *rabi*

Village	CoC (Rs./ha)		Gross returns (Rs./ha)		ANR (Rs./ha)	B:C ratio	
	IT	FP	IT	FP		IT	FP
Kokkonda	17265	16500	35582	30502	4315	2.06	1.85
Itikyal	18400	17400	37275	31200	5075	2.03	1.79

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

SAFFLOWER

CROP IMPROVEMENT

Genetic resources

A set of 58 trait specific accessions for high seed yield, salinity tolerance, high alpha tocopherol content, resistance to *Phytophthora* rot and *Alternaria* tolerance was augmented from USDA, USA. Seeds for a set of 628 accessions conserved in the medium term cold storage module for six years were tested for viability, 81% accessions recorded germination ≥85%. Rejuvenation was undertaken for 467 accessions and 169 promising accessions were multiplied. A total of 430 accessions were supplied to indentors for utilization in breeding, screening against wilt, aphid and salinity tolerance at multilocations. This was in addition to the 89 trait specific accessions supplied to AICRP (Safflower) breeders of eight centres for evaluation and utilization during *rabi* 2017-18.

Six accessions (GMU-5338, GMU-5774, GMU-5865, EC-739480, GMU-696, GMU-5660) were confirmed for high seed yield ranging from 20.0 to 28.4 g/plant, oil yield ranging from 6.1 to 8.8 g/plant compared to checks (seed yield 17.1-23.0 g/plant and oil yield 5.4-6.0 g/plant) based on mean performance over two years (2015-16 and 2016-17).

Promising accessions were also identified for yield related traits *viz.*, number of seeds per primary capitula (6), number of effective capitula per plant (5) and capitulum diameter (8).

Trait specific accessions for oil yield

Accession	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of effective capitula/ plant	No of seeds/ primary capitula	Capitulum diameter (mm)	100-seed weight (g)	Hull content (%)	Oil content (%)	Seed yield /plant (g)	Oil yield / plant (g)
GMU-5338	83	132	64.0	14	44	16	18.9	4.2	47.5	31.2	28.4	8.8
GMU-5865	85	135	79.5	21	54	20	21.8	5.3	47.3	30.0	24.8	7.4
GMU-5660	81	129	72.0	11	33	12	19.0	6.1	50.7	29.0	23.1	6.7
GMU-696	82	130	79.4	14	47	24	22.7	4.3	51.0	30.2	21.6	6.6
GMU-7772	83	134	60.6	24	98	16	19.1	3.5	46.1	29.8	20.9	6.2
GMU-5774	82	133	74.5	13	45	18	21.4	5.0	45.4	30.6	20.0	6.1
NARI-57 (C)	91	138	84.6	11	40	20	21.4	3.8	36.0	34.9	17.1	6.0
A-1 (C)	86	133	79.9	11	37	16	21.0	6.4	52.1	26.0	23.0	5.9
PBNS-12 (C)	83	135	75.2	13	41	13	20.2	5.9	49.8	27.4	19.9	5.4

Promising accessions for yield related traits

Trait	Promising accession
No. of effective capitula/ plant (50-108)	GMU-7493, GMU-7772, GMU-5865, GMU-1756, GMU-5229
No. of seeds/capitula (28-44)	GMU-7386, GMU-7388, GMU-3420, GMU-1923, GMU-472-1
Capitulum diameter (22.7-31.5 mm)	GMU-3420, GMU-472-1, GMU-1923, GMU-7465, GMU-734, GMU-1923, GMU-7388, GMU-7386

A replicated trial comprising the 44 best accessions identified on the basis of seed yield >22 g/plant and oil yield >8 g/plant from among the 241 accessions evaluated during *rabi* 2016-17 was conducted along with four checks (A-1, PBNS-12, NARI-57 and Bhima) during *rabi* 2017-18 to confirm the performance.

Ten accessions of the 13 accessions collected from Odisha during 2016 germinated and seed yield ranged from 3.9-37.9 g/plant, 100-seed weight from 2.7-5 g and oil content from 25-30.7% during 2016-17. The collections from Maharashtra (63) and Odisha (10) were raised for 1st and 2nd year evaluation, respectively along with four checks during *rabi* 2017-18.

Diversity in germplasm collections from Odisha

Development of varieties and inbred lines

High yielding varieties: Two varieties, ISF-764 (spiny) and ISF-763 (non-spiny) were promoted to AVT-II-2017 in AICRP (Safflower), and a non-spiny variety, ISF-1258-15 recording 25% higher seed yield over non-spiny check, NARI-6 in IVT was promoted to AVT-I-2017. Variety release proposal of a variety non-spiny SPP-70 giving 21.7% higher seed yield and 8.1% higher oil yield than the non-spiny check, NARI-6 over three years of evaluation was submitted to CVRC. In IVT-2017, three high yielding spiny varieties, ISF- 112-15, ISF-28-15, and ISF-122-15 giving 2690-3996 kg/ha seed yield and a non-spiny variety, ISF-53-15 giving 1833 kg/ha seed yield were entered in IVT-2017.

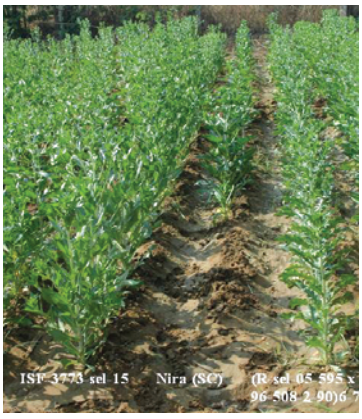
Wilt resistant-high yielding inbred lines: Of the 44 wilt resistant (0-10% wilt incidence) inbred lines evaluated in two different trials in RBD with two replications, 20 lines recorded 20-62% higher seed yield (2660-3996 kg/ha) than the best check, A-1 (2210 kg/ha and 2837 kg/ha). Oil content in the 20 inbred lines ranged from 29-36.2%. The wilt resistant high yielding inbred line, [(R-sel-05-595 x 96-508-2-90)25-3] recorded the highest oil content (36.2%).

High yielding inbred lines: Of the 79 parental lines evaluated in four separate trials in RBD with two replications, 11 lines recorded 2019-2747 kg/ha with 21-68% increase over the best check, A-1 (2210 kg/ha, 1635 kg/ha, 1985 kg/ha, 2298 kg/ha). One inbred, [(A-1 x *C. oxyacantha*) -2-2-22] was an interspecific derivative, and the inbred, ISF-87-15 giving 25% higher seed yield (2041 kg/ha) over A-1 possesses 43.8% oil content. These two inbred lines were also found to be resistant to wilt (0-10%wilt incidence) in wilt sick plot.

High yielding-high oil non-spiny inbred lines: Among the 16 non-spiny inbred lines evaluated in RBD with two replications along with non-spiny check, NARI-6, four lines recorded 12-34% higher seed yield (1833-2193 kg/ha) than check, NARI-6 (1631 kg/ha). Oil content in these inbreds ranged from 35-38.4%. Two of the non-spiny high yielding-high oil inbred lines *viz.*, w-SFS-2035 and ISF-53-15 exhibited wilt resistance (0-8.2%) in wilt sick plot.

Development of high oil inbred lines: A set of 139 high oil inbred lines was evaluated for the third consecutive year to assess the oil content and seed yielding ability. Oil content among the inbred lines ranged from 35-39.6%, seed yield ranged from 831-1416 kg/ha, the 100-seed weight varied from 3.2-4.6 g while the oil content and seed yield in the check, A-1 was 26.37% and 1037 kg/ha, respectively.

Wilt resistant inbred lines: Twelve inbred lines *viz.*, 1703-7-7-1-15-2-4-1-2-4, 1703-7-7-1-15-6-6-1-1-2, 3404–bulk-3-1-3-2-2-3, (R-sel-05-595 x 96-508-2-90)-6-7, 2997-11-7, ISF-3840-sel-15, ISF-3773-sel-15, R-sel-05-63-4-5-19 and [Ms 9(o) x 13-321-5-4-28-63-25] exhibited resistance to wilt (0-8.7%) in wilt sick plot.



Wilt resistant inbred lines in wilt sick plot (left & right rows); susceptible check, Nira (center row) succumbed to wilt.

Pyramiding wilt resistant genes from wild species into A-1 background: The F_1 of (A-1 x [*C. oxyacantha* x *C. palaestinus*]) recorded 6.7-9.1% wilt incidence in wilt sick plot. F_5 generation of (*C. oxyacantha* x *C. palaestinus*) recorded 0-91% wilt incidence and F_6 generation of (A-1 x *C. palaestinus*) exhibited resistance against wilt (0-8.7% wilt incidence) while F_6 of (A-1 x *C. oxyacantha*) had 5.6-95% wilt incidence.

Development of *Alternaria* resistant inbred lines: Of the total 78 interspecific derivatives screened against *Alternaria* by taking up early sowing in the 1st week of August, 38 derivatives exhibited 0-10% *Alternaria* severity while the checks, A-1, PBNS-12 showed 100% disease severity under severe disease conditions in the field. Two inbred lines, DSF-5 and DSI-104 recorded 32% *Alternaria* severity as against 96% in susceptible check, Manjira under heavy disease pressure when early sowing was taken up at Solapur.

Aphid tolerant inbred lines: Seven interspecific derivatives namely, ISF-36-15, ISF-19-15, ISF-20-15, ISF-22-15, ISF-23-15, ISF-25-15 and ISF-28-15 recorded 1-2 Aphid Infestation Index (AII) while NARI-6 had 4-5 A.I.I on 1-5 scale with 1 being highly resistant and 5 being highly susceptible under infester row method in late sown condition.

Development of inbred lines through population improvement: Selected a total of 327 individual plants out of 5015 plants in 3rd cycle population, of which 70 best selections were retained. Great phenotypic variation such as spiny, non-spiny, sparsely-spiny, yellow, orange, white and red flower colours, and erect, spreading, appressed and semi-appressed plant types were observed among the selections. The re-selections recorded remarkable improvement over 2nd cycle (30-88 g seed yield/plant) with respect to seed yield ranging from 76-174 g/ plant; among the selections, 100-seed weight was 4.2-7.5 g, number of capsules/plant was 32-67, plant height was 67-112 cm, height of the branching from base was 1-10 cm and days to 50% flowering was 82-91. Using the selected plants, 4th cycle population was generated under isolation.

Development of breeding lines with high oil yield: A set of 29 breeding lines was evaluated along with checks (A-1, Bhima, PBNS-12, NARI-57) in a replicated trial. A series of breed-ing populations (MAGIC F_3 lines-458; A-1 x CW 99-189; A-1 x Centennial-145; A-1 x EC-755673-1) were advanced to exercise pedigree based selections for high oil content and seed yield. Efforts have also been intensified to develop backcross based breeding populations in order to develop high oil lines in the background of the most popular variety A-1. Currently, a single backcross progeny (A-1 x CEN-BC_1F_2-2) from the cross involving A-1 x Centennial has been advanced to BC_1F_3 generation. The BC_2F_1 population of the cross A-1 x Centennial was backcrossed to A-1 to produce BC_3F_1 population. Simultaneously, the BC_2F_1 population was selfed to produce BC_2F_2 progenies. In order to further diversify the backcross based population base, F_1s of the crosses: A-1 x EC-755673-1; A-1 x CW-99; A-1 x Montola 2000, A-1 x Oker and A-1 x EC-736487 were backcrossed with A-1 and BC_1F_1 populations were produced. An attempt has been made to develop recurrent selection programme for improvement of oil yield in safflower using GMS system. For this purpose, conversion of A-1 into GMS has been initiated so that recurrent selection programme would be carried out in the background of an agronomically superior GMS line. GMS source, MMS1-3 (Akola) was grown and the population was ascertained for GMS (30 sterile plants out of 90). Sterile plants of MMS1-3 were pollinated with A-1 pollen and F_1 seeds (MMS1-3 x A-1) were produced.

Development of new CMS-based hybrids

CMS hybrids: Three new hybrids were entered in IHT-2017. Fifty nine CMS based hybrids were evaluated in RBD with two replications in four trials along with check hybrid, DSH-185 and varieties, A-1 and PBNS-12. All the hybrids were on par to checks with respect to days to 50% flowering (75-80) and days to maturity (120-125) and plant height (95-105 cm). Germination was 100% in all hybrids, and hybrids were both male and female fertile and produced abundant pollen indicating no effect of sterile cytoplasm obtained from CMS parent.

Seed production of DSH-185: 240 kg seed of the released hybrid, DSH-185 was produced during 2017-18. 163 kg seed of DSH-185, produced during 2016-17, was supplied to various KVKs through Seed Unit, ICAR-IIOR for demonstration purpose in farmers' fields and KVKs during 2017-18.

Seed production of CMS lines: Nucleus seed of CMS lines, A-113-1A (O) and A-133-IIA (w) was produced under isolation through paired crossing with their B-lines. B-lines were maintained through self-pollination.

Development of high oleic genotypes for Indian conditions

Two high oleic varieties, ISF-1 and ISF-2 have been promoted to AVT-II-2017 and two high oleic lines, ISF-10 and ISF-11 were entered into IVT-17 of AICRP (Safflower). Seeds of ISF-4, ISF-5, ISF-7, ISF-9 were produced under nets. Twenty six high oleic lines were evaluated in ARBD along with check, A-1 in 63 sq.m/entry plot size. Fifteen lines recorded 11-46% higher seed yield (2225-2630 kg/ha) than the check, A-1 (2210 kg/ha to 2245 kg/ha). Among 76 high oleic lines evaluated in ARBD

with plot size of 4.5 sq.m/entry, 35 lines had 77-82% oleic acid content and 28-34% oil content while 41 had 73-83% oleic acid content and 35-41% oil content. The high oil lines had 3.8-6.0 g 100-seed weight and were white to light wheat colour hull.

Seed traits of high oleic high oil inbred lines

Molecular breeding

Development of genomic and genetic resources

Genome sequencing through NGS: *De novo* genome sequencing of safflower cultivar, A-1 was performed using Illumina Hiseq 2500 with 100X genome coverage. The four libraries (2 paired end and 2 mate pair) generated 1,697 million high quality clean raw reads which correspond to 287, 349 Mb size. These reads were assembled using MaSuRCA assembler. The reads assembled into 174,116 scaffolds with N50 scaffold length 15,515. Repeat Scout tool was used to predict repeats in safflower genome; as the available organism repeats like *Arabidopsis* did not yield good results with downstream gene prediction. The assembly was found to be 66% repeat rich. These repeats were used for masking the assembly using repeat masker. The repeat masked genome was then subjected to gene prediction using Augustus using *Arabidopsis* species as model organism. The number of predicted CDS was 40,800. When the predicted protein sequences from these CDS were searched against plant NR database using BLASTP, it could identify 33,482 CDS to be coding for proteins. Identified genes have been assigned to known biosynthetic pathways. The oil biosynthetic pathway genes identified will be useful in allele mining for identification of sequence variation for high oil content in safflower.

Raw read summary of Illumina data of safflower genome sequencing

Sample name	No of raw reads (R1 + R2)	No of bases (Mb)	GC (%)	Q 30	Read length
Safflower-A1-2-3 kb-MP	159,475, 460	39,868	38.67	83.62	250 X 2
Safflower-A1-6-8 kb-MP	167,591, 888	41,897	38.74	81.585	250 X 2
Safflower A1 300 bp PE	570,017, 852	85,502	40. 095	85.705	150 X 2
Safflower A1 800 bp PE	800,549, 592	120, 082	40. 935	75.42	150 X 2

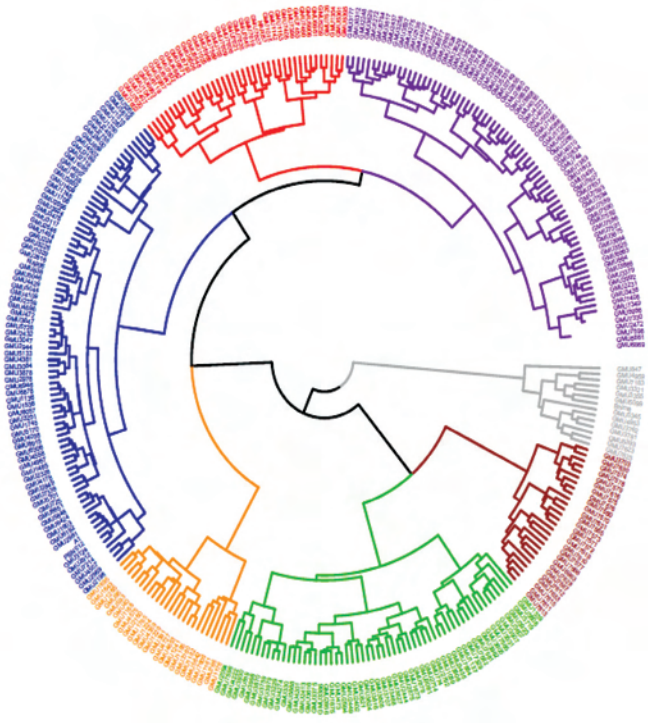
(PE- Paired end, MP – matepair data)

Development of genomic SSR markers: Genomic SSRs were predicted on the assembly (>-500 bp) using MISA tool. A total of 3, 77, 825 SSRs were identified and primer pairs were designed for 3, 15, 289 regions. The class I SSRs (>20bp) and class II SSRs (10 to <20 bp) were 1, 39, 418 and1, 75, 871 respectively. The safflower genome was found to be rich in dinucleotide repeats followed by mono (98,808), di (1,49,687), tri (28,914), tetra (2,759), penta (914) and hexa (1,261) nucleotides. Apart from perfect SSRs, the genomic sequence also identified SSRs 93,227 imperfect and 2,255 compound. SSR primers were synthesized for a subset of 500 microsatellite (>30 bp) loci for testing amplification and identification of polymorphic markers in parental panel of 24 safflower germplasm lines.

Evaluation of association mapping panel for agronomic and seed traits: The association mapping panel of safflower germplasm lines was evaluated for agronomic and seed quality traits *viz*., days to 50% flowering, days to maturity, number of branches per plant, number of capitula per plant, number of seeds per capitula, 100 seed weight, seed yield per plant, hull content, seed length, seed breadth, seed thickness, oil content, fatty acid composition, 2,2-diphenyl-1-picrylhydrazyl, total phenolic content, calculated oxidizability value and peroxidability index. Ward's method was used to quantify the genetic divergence among the germplasm accessions (hierarchial clusters analysis) to identify diverse cluster which has good yield attributing characters along with improved seed quality traits. At the Euclidean distance of 18, the germplasm accessions grouped into seven clusters.

Variation of different traits in safflower association germplasm mapping panel

Trait	Range	Mean	Variance
Days to 50% flowering	63-106	82.28	60.52
Days to maturity	100-147	121.14	91.58
Number of branches/plant	2.4-20.6	9.61	7.40
Number of capitula/plant	5.8-68.0	28.21	137.82
Number of seeds/capitula	7.4-58.7	28.92	86.49
100 seed weight (g)	2.10-7.97	4.36	0.96
Hull content (%)	24.4-57.5	45.25	19.80
Seed yield (g)	2.5-83.2	23.33	142.32
Seed length (mm)	1.38-9.92	7.68	1.82
Seed breadth (mm)	0.34-5.29	4.05	1.06
Seed thickness (mm)	0.24-6.86	3.35	0.83
Oil content (%)	23.6-48.4	33.44	0.13
Palmitic acid (%)	1.2-10.8	6.58	17.72
Stearic acid (%)	0.87-5.77	2.77	1.32
Oleic acid (%)	9.9-80.5	29.38	0.45
Linoleic acid (%)	12.2-81.8	61.25	376.74
2,2-diphenyl-1-picrylhydrazyl (DPPH) (%)	1.6-90.4	34.28	318.62
Total phenol content (TPC) mg GAE /g DW	4.9-15.6	9.9	3.45
Calculated oxidizability value (COX)	2.06-8.52	6.6	3.31
Peroxidability index (PI)	14.2-82.0	61.99	362.14



Dendrogram showing the genetic relatedness among safflower germplasm accessions based on agronomic and seed quality traits

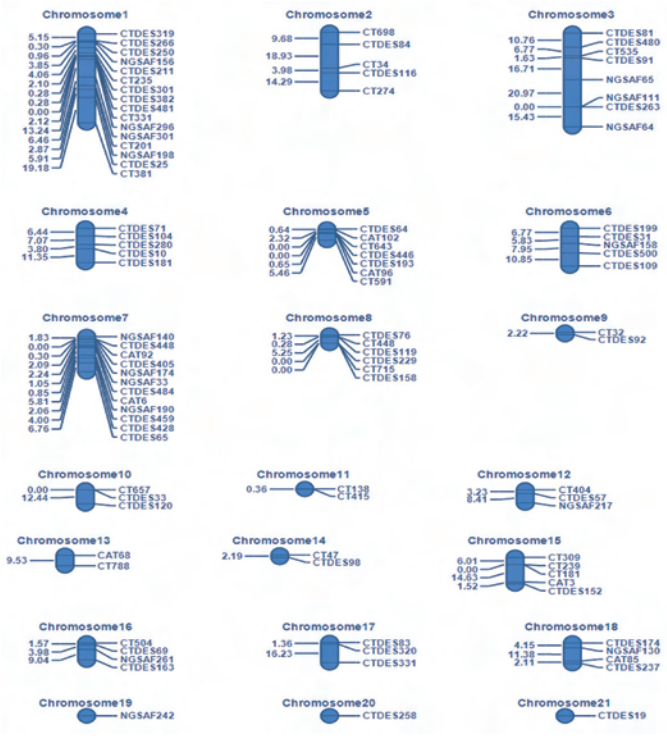
Genotyping of association mapping panel: Genotyping of 240 safflower association mapping panel was performed using 210 SSR markers, out of which 186 were polymorphic. The SSR markers generated a total of 588 alleles with an average of 3.16 alleles per locus. The number of alleles per locus ranged from 2 to 16. The observed heterozygosity (*Ho*) had a low average value of 0.101 and ranged from 0 to 0.26. Information on allelic diversity will be used for association mapping for oil content and quality in safflower.

QTL analysis

Oil content: Two F_2 populations (n = 177 each) namely A-1 x CW-99 and A-1 x Centennial were genotyped with 50 and 25 polymorphic SSR loci, respectively. This genotypic data would augment previously generated skeleton linkage map of A-1 x EC-755673-1 F_2 population and facilitate development of consensus SSR linkage map of safflower using multiple mapping populations. An attempt was also made to validate the association of putative SSR loci with oil content (previously detected in A-1 x EC-755673-1 $F_{2:3}$ population) in a different $F_{2:3}$ population. Simple regression analysis showed that a SSR locus, CtDES-91 had significant association with oil content in a $F_{2:3}$ population (n = 176) produced from the cross: A-1 x CW-99 (R^2 = 5.8%; P = 0.00125). The results are preliminary and require validation by a robust QTL analysis. However, it is an encouraging lead that the same locus showed association with oil content in two different populations.

Aphid resistance: Recombinant inbred line (RIL) population (n = 220) of F_6 generation of the cross: CO-1 (Susceptible) x EC-523368-2 (resistant) was genotyped with 97 polymorphic SSR loci. In linkage analysis, out of 97 loci, 94 loci could be grouped into 18 linkage groups and remaining 3 loci were unlinked. This is only a tentative and highly fragmented map. The mapping population needs to be genotyped with more number of marker loci in order to obtain a well defined linkage map of safflower with 12 linkage groups.

In single marker analysis, five SSR loci namely CtDES83 (LOD = 5.1, R^2 = 5.9%, Additive effect = -1.3), CtDES320 (LOD = 3.35, R^2 = 3.97%, Additive effect = -1.0), CtDES331 (LOD = 3.24, R^2 = 3.85%, Additive effect = -1.05), CtDES237 (LOD = 4.125, R^2 = 4.85%, Additive effect = -1.18) and CAT85 (LOD = 4.4, R^2 = 5.17%, Additive effect = -1.22) showed putative association with aphid resistance (based on days-to-wilt) in the RIL population.

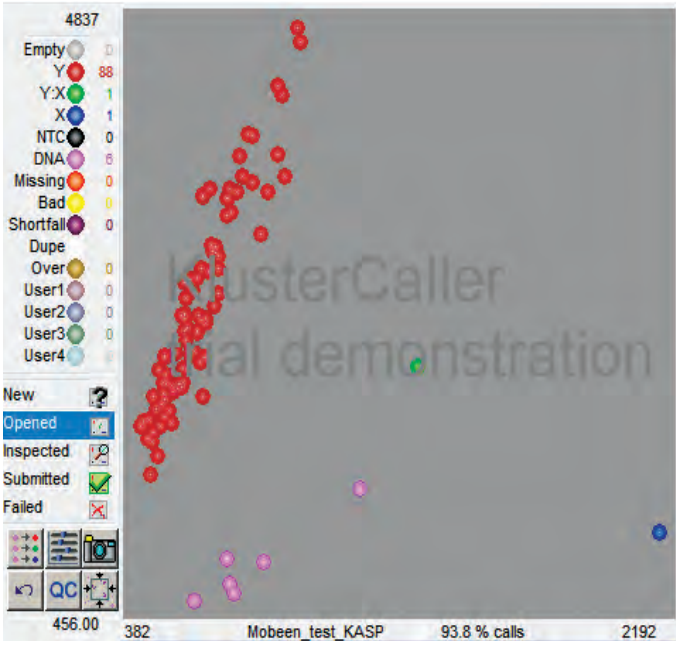


Skeleton SSR linkage map of CO-1 x EC-523368-2 RIL population

Additive sign of the putative markers was negative indicating that the resistant parent EC-523368-2 could be the source of putative QTL alleles for aphid resistance. Further mapping of putative genomic regions is required using a large number of marker loci for validation of these QTLs.

Marker assisted selection

Field evaluation of high oleic MAS lines: A set of eight high oleic lines derived from Bhima x Montola-2000 cross was evaluated in field for yield performance during *rabi* 2017-18 along with A-1, Bhima, PBNS-12 and NARI-57 as checks. Status of high oleic allele (*ol*) was verified by KASP genotyping, which showed that most of the plants were positive for *ol* allele (homozygous) with a maximum of 2% off-types. The off-types were removed based on genotypic data and selfed seeds were collected from the desirable plants for future trials. Mean seed yield performance of high oleic lines ranged from 14.6 to 32.9 g/plant. The oil content ranged from 32.8 to 35.5%. The results are indicative of comparable yield performance of backcross lines with the recurrent parent, Bhima.



KASP assay of backcross lines for detection of high oleic allele, *ol*

Allelic status of high oleic lines

Line ID	No. of plants genotyped by KASP assay	High oleic (*ol*) +ve plants	Off-types
BC_1F_6-39-3-3-OL	38	38	0
BC_2F_6-38-1-7-OL	33	31	2
BC_2F_6-38-9-4-OL	42	42	0
BC_2F_6-38-14-15-OL	40	39	1
BC_3F_4-16-12-OL	42	41	1
BC_3F_4-16-27-OL	33	33	0
F_6-5-3-2-OL	33	33	0
F_6-84-7-2-OL	33	31	2

Yield performance of high oleic lines

Line ID	Seed yield/ plant (g)*	Oil content (%)	Oil yield/ plant (g)
BC_1F_6-39-3-3-OL	28.1 (105)	35.5	10.0
BC_2F_6-38-1-7-OL	30.7 (92)	33.6	10.3
BC_2F_6-38-9-4-OL	32.7 (119)	33.6	11.0
BC_2F_6-38-14-15-OL	31.7 (89)	34.1	10.8
BC_3F_4-16-12-OL	30.2 (67)	33.7	10.2
BC_3F_4-16-27-OL	30.0 (83)	32.8	9.8
F_6-5-3-2-OL	18.1 (92)	35.1	6.4
F_6-84-7-2-OL	15.4 (100)	35.4	5.5
A-1	25.2 (113)	29.7	7.5
Bhima	29.8 (94)	31.6	9.4
PBNS-12	31.8 (66)	29.6	9.4
NARI-57	21.2 (64)	35.7	7.6

*Values in parenthesis indicate no. of plants

CROP PRODUCTION

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

The experiment was conducted with three safflower based cropping systems *viz*. fallow-safflower, greengram-safflower, soybean (short duration)-safflower and soybean (normal duration)-safflower. Safflower was cultivated with zero tillage. In each cropping system, eight treatment combinations *viz*., two spacing levels (as main plot) and four fertilizer levels (as sub-plot) were tested in split plot design with four replications. The two spacings are 2 rows and 3 rows on each broad bed (120 cm) and furrow (30 cm) land configurations. The four fertilizer levels are control (no fertilizer), 100% recommended fertilizer, site specific nutrient management (SSNM) and 50% SSNM. The amount of rainfall received during the cropping season (June to February) was 1110 mm. Greengram and soybean crops were sown on 27 June 2017. Safflower was sown on 30 October in fallow, greengram, soybean (short duration) and soybean (normal duration) plots. The productivity of greengram, soybean (short duration) and soybean (normal duration) was 750, 2000, 2200 kg/ha, respectively. The system productivity (in terms of safflower equivalent yield) was the highest with soybean (normal duration) - safflower (3200 kg/ha) and the lowest with fallow-safflower (1000 kg/ha). Significant differences were not found with respect to moisture use, nutrient use and soil nutrient availability. Relative water content, chlorophyll and canopy temperature were measured in safflower at vegetative and flowering stages. Significant variations were observed among the treatments in relative water content and leaf temperatures indicating better plant water status and stay greenness under residual moisture with different doses of nutrient application.

Assessment of Pusa hydrogel

Assessment of Pusa hydrogel in safflower during *rabi* season was carried out for its irrigation water use and productivity for second season. Data on soil moisture content, total dry matter, leaf area index, harvesting parameters of safflower and oil content were collected. Physiological parameters like relative water content, membrane stability, chlorophyll content and carotenoids at different stages were measured. Pusa hydrogel did not influence significantly any of these parameters.

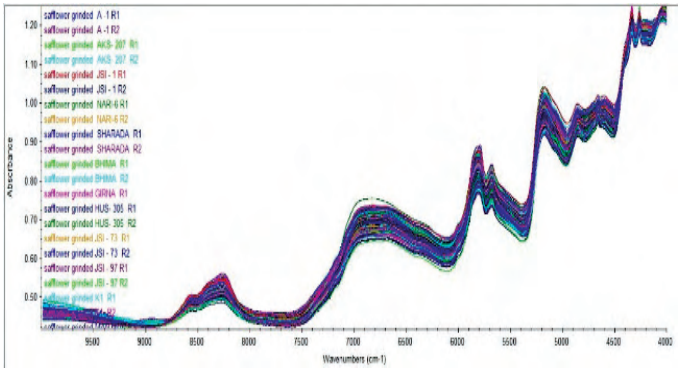
The varieties, A-1 and NARI-6 showed no significant differences in productivity in the hydrogel treatments over control in Vertisol.

Preparation and characterization of protein hydrolysates from safflower seed cake

Protein content and antioxidant capacity (DPPH, ABTS, CUPRAC and ORAC) of 24 released varieties of safflower were assessed. PBNS-12 showed maximum protein content and antioxidant potential. Hence, it was selected for making protein isolates and hydrolysates. Protein content of PBNS-12 was assayed in the whole seed (21.5%), kernel (31.6%), defatted seed (37.3%) and defatted kernel (66.2%). Safflower seed cake was utilised for making protein isolates. Safflower protein isolate (SPI) contained 90-95% protein. A process was standardised for making protein hydrolysates. SPI's were hydrolysed by commercial proteases (pepsin, flavorzyme, trypsin, neutrase, papain, alcalase). The effects of pH, temperature and time of hydrolysis on antioxidant capacity were investigated. Protein isolates extracted were non-ionic to alkaionic surfactants having better foaming ability in salt solutions compared to distilled water. Wettability was also very fast.

Oil content and fatty acid profile

A FT-NIR protocol was developed for the estimation of oil content and fatty acid profile of safflower seeds. A set of 250 genotypes of safflower was analysed for oil content and fatty acid profile by nuclear magnetic resonance spectrometer and gas chromatography, respectively. All samples were ground individually and FT-NIR spectra were generated. A chemometric model was used for analysis in the Thermo FT-NIR (IS-50) system. Spectral range was 4250.34 to 9999.10 and path length was standard normal variate. For smoothening of data, Savtzky-Golay filter was applied. Partial Least Squares (PLS) analysis was performed using TQ-Analyst software. The model developed enabled the spectra to be correlated to oil content, oleic acid content and linoleic acid content with excellent prediction agreement with the measurements.



FT-NIR spectra of safflower genotypes (n = 250)

CROP PROTECTION

Resistant sources to Fusarium wilt

Five safflower germplasm lines *viz*., GMU-819, 1078, 2718, 4627 and 5032 were resistant to wilt (0% incidence) and can be utilised as sources of resistance in breeding programmes.

Standardization of biopolymer chitosan based delivery systems of Trichoderma

Chitosan blend with PEG and glycerol (chitosan1.5% + PEG 0.5% + glycerol 1%) did not show any significant inhibition in mycelial growth of *T. harzianum*. Chitosan @ 1 and 2% concentrations completely inhibited the growth of soil borne pathogens of safflower *viz*., *Phytophthora, Macrophomina, Fusarium* and *Sclerotium*. In safflower, seed treatment with biopolymer blend resulted in 100% seed germination and highest vigour index.

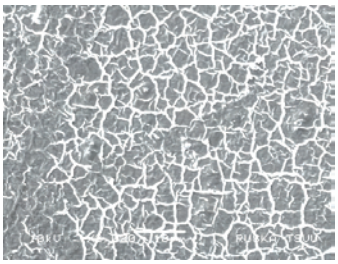
A biopolymer based *T. harzianum* Th4d formulation was developed and used for seed coating which formed a fine uniform film on safflower seed. Seed treatment with biopolymer in combination with *T. harzianum* resulted in reduction of Macrophomina root rot incidence by 62% in safflower.

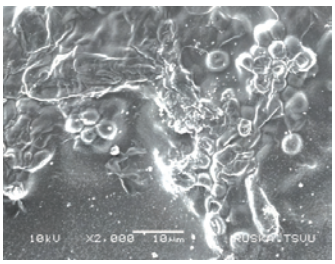
Biopolymer film

Biopolymer + ***T. harzianum*** film

Structural characterization of biopolymer based *Trichoderma* formulation

Polymerization of biopolymer was confirmed by difference in transmittance peaks obtained from FTIR graphs. Scanning electron microscopic (SEM) analysis showed entrapment of *Trichoderma* conidia in polymer matrix.





(a) Chitosan biopolymer film
(b) Entrapment of *Trichoderma* conidia in biopolymer matrix

Reaction of safflower sub-core, other germplasm and high oil selection lines to aphids

To identify the sources of resistance to aphids, 100 diverse germplasm lines of sub-core and 10 new germplasm collections from Odisha were evaluated for their reaction to aphids through artificial release of aphids in the field during *rabi* 2017-18. Six sub-core safflower lines, *viz*., GMU-1047, GMU-2594, GMU-2718, GMU-2987, GMU-3256 and GMU-6556 were found resistant with an injury rating of 2 on a 0-5 scale.

Five lines, GMU-40, GMU-95, GMU-671, GMU-2969 and GMU-3703 were found moderately resistant to aphids. Two lines from safflower sub-core, GMU-5908 and GMU- 5935 were also found resistant to aphids for the second year. Among the 10 fresh germplasm lines from Odisha, GMU-7858 was found to be moderately resistant with injury rating of 3.

Apart from these, 41 high oil/oleic selections were evaluated for their reaction to aphids. Three of these high oleic selections: Sel-35 (BC_2F_6-38-1-7-OL), Sel-36 (BC_2F_6-38-9-4-OL) and Sel-37 (BC_2F_6-38-14-5-OL) were found resistant to aphids with an injury rating of 2 on a 0-5 scale. Susceptible check, CO-1 was found highly susceptible with an injury rating of 5.

Reaction of sub-core to aphids

Reaction of high oil/oleic selections to aphids

Reaction of F_7-RILs (CO-1 x EC523368-2) to aphids

During *rabi* 2017-18, F_7-RILs of cross CO-1 X EC-523368-2 were evaluated for their reaction to aphids. Aphids were artificially released in the screening block at elongation stage. Phenotypic data of a set of 183 F_7-RILs based on reaction to aphid (days-to-wilt after infestation) has been obtained. The days-to-wilt data of F_7-RILs ranged from 21 to beyond 43 and showed quantitative nature of variation for resistance to aphid in the population. The parents of mapping population, CO-1 had 26 days to wilt while the EC-523368-2 did not wilt at 43 days, which was the point of termination of the screening experiment.

Differential reaction of F_7- RILs to aphids

SOCIAL SCIENCES

A mobile app was developed for safflower researchers, developmental agencies, students, industry professionals, NGOs and farmers. This provides the information on management practices, cultivars, pests and diseases and their management, the details of AICRP centres on safflower in different states with their addresses to enable end users to contact the nearest research centre for additional information specific to that region. The information of major Agriculture Produce Market Committees (APMCs) in the states of Karnataka, Maharashtra and Telangana are provided to supplement the end user with the information of nearby markets to sell the produce.

A total of 100 demonstrations were conducted through cluster approach in collaboration with KH Patil KVK, Hulkoti in Karamudi village of Ron Block, Gadag district of Karnataka. These were conducted to showcase the technologies such as high yielding variety PBNS-12, seed priming with $CaCl_2$ (2%), soil application of sulphur @ 12 kg/acre. $ZnSO_4$ @ 6 kg/acre, foliar spray of Imidacloprid @ 0.3 ml/l against sucking pests; foliar spray of Propiconazole @ 1ml/l against foliar diseases and mechanized harvesting.

Productivity potential of improved technologies

Village	Area (acre)	Seed yield (q/ha)		% increase in seed yield
		IT	FP	
Asuti	4	8.93	6.85	30.48
Karamudi	92	10.32	8.11	27.63
Menasagi	4	10.33	7.71	34.16

The results suggest that the productivity enhancement of the technology demonstrated over the farmers' practice was of the order of 27.63, 30.48 and 34.16% in Karamudi, Asuti and Menasagi villages, respectively. The demonstrations resulted in additional net returns of Rs.4013, 4499 and 5237/ha in Asuti, Karamudi and Menasagi, respectively indicating the profitability of the technologies demonstrated.

Profitability of improved technologies

Village	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	B:C ratio	
	IT	FP	IT	FP		IT	FP
Asuti	18626	15999	28560	21920	4013	1.53	1.37
Karamudi	18551	15974	33046	25970	4499	1.78	1.62
Menasagi	18865	15702	33056	24656	5237	1.75	1.57

Screen shot of Safflower mobile app

SESAME

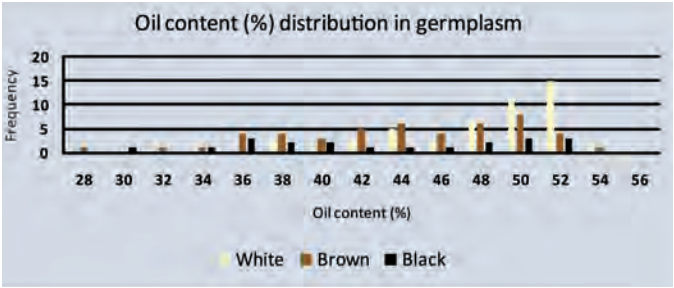
CROP IMPROVEMENT

Maintenance and evaluation of germplasm

A total of 1936 germplasm accessions were multiplied and maintained during summer 2017 and 250 germplasm accessions were maintained and multiplied and characterized during *kharif*-2017. Four hundred and thirty germplasm lines were multiplied, characterized and deposited in national gene bank of NBPGR, New Delhi. Ten high yielding entries (IC-500514, IC-500674, IC-500675, IC-500472, IC-500757, IC-500341, IC-500691, IC-500663, IC-500671, IC-500476) better than checks GT-10 and TKG-22 and three entries IC-500657 (4.2 g), IC-500475 (4.1 g) IC-500362 (4.1 g) which showed more than 4 g of test weight were also identified. Eight wild sesame accessions were augmented from different AICRP centres and maintained.

Trait	Minimum	Maximum
Plant height cm)	35.6	142.2 (EC-346207)
No. of branches/plant	3	6 (EC-334971
No. of capsules/plant	17	121 (EC-334963)
Capsule length (cm)	1.7	3.3 (EC-346232)
Days to flower initiation	28 (EC-346195, EC-0334956, EC-346286)	43 (EC-335003)
Maturity	86 (EC-346195, EC-0334956)	95 (EC-335001, EC-335003)
Test weight (g)	2.1	4.1(EC-132830, EC-343404, EC-346203)
Oil content (%)	28.6	52.7 (EC-343408)
Seed yield (g)	2.2	29.1 (EC-335013, EC-346192)

A set of 200 germplasm accessions, which included 62, 108 and 30 accessions of white, brown and black seed coats, respectively, were evaluated for yield and other components during *kharif* 2017. Plant height ranged from 83 to 127 cm and number of capsules per plant ranged from 56 to 272. Highest seed yield of 21 g/plant was recorded in accession IC-205312, which had 54.12% of oil content. Test weight ranged from 2.1 to 4.1 g and the highest test weight was observed in accession IC-500352. Oil content ranged from 37-54.12% in white, 23.5-52.8% in brown and 29.5 to 51.2% in black seed coat accessions. Variation for oil content was high in black seeded accessions than brown and white seeded ones.



Distribution of oil content (%) in germplasm accessions

Development of mapping populations: In order to develop mapping population the most important and critical requirement is a pair of contrasting and genetically stable genotypes. In this direction, selfed progeny of 106 genotypes were raised under field condition and were evaluated for the stability of the traits for which those lines were selected. Wide variability was seen for the traits; number of branches ranged from 0-18, number of capsules per axil exhibited the range of 1-6, number of locules per capsule varied from 4-8, internodal length ranged from 3-16 cm, plant height was

in the range of 41-117 cm, the basal bearing was recorded in the range of 4-74 cm with 25-65 days taken to 50% flowering and 93-128 days to physiological maturity, seed weight ranged from 1.2-32 g/plant and seed oil percentage (NMR based) was in the range of 25-45.

Evaluation of germplasm accessions and cultivars against *Macrophomina* root rot

A set of 100 sesame germplasm accessions was evaluated against root rot by sick pot method of which 34 accessions showed susceptible to highly susceptible reaction with >30% root rot incidence. Fourteen accessions *viz*., NIC-13598, IC-205797, SI-3299-A, EC-203304-A, NIC-16190-A, VCR-/82 /NO/101/NS, B-201, SI-250-A, Julang salame, IC-025790, S-0335, IC-205788, S-0994 and IS-245 recorded resistance reaction with <10% root rot while 27 exhibited moderately resistant reaction to root rot. Among 20 sesame varieties screened against root rot, Krishna, N-32, YCM-4, YLM-17, Savithri showed moderately resistant reaction while susceptible check, NIC-8316 showed 80% root rot incidence.

Breeding

A hybridization programme was initiated in a full diallel mating design. There were four sets of F_1 hybrids from diallel design as follows.

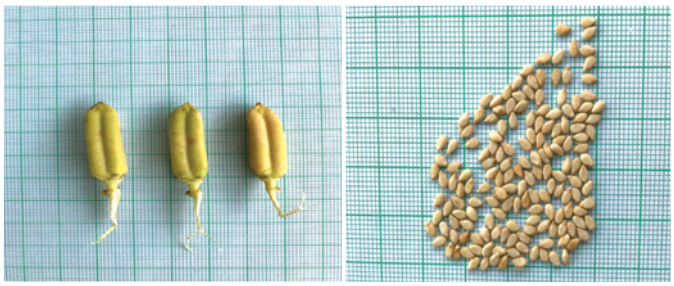
Accessions used in hybridization programme in full diallel design

White diallel set-1	White diallel set-2	White diallel set-3	Brown diallel set-1
IC-132201	MT-75	RAJESHWARI	IC-14136
IC-500472	E-8	SWETHA TIL	IC-204300
IC-204613	RT-351	E-8	IC-204444
IC-204618	HT-1	HIMA	IC-205776
IC-96160	PHULE TIL	TSS-6	EC-118591
IC-96227	TKG-22	VRI-3	EC-343403
	GT-2		
	VRI-3		

Wide hybridization: Five interspecific crosses *viz*., Swetha Til x *S. mulayanum (*IC-43144-1), GT-10 x *S. mulayanum (*IC-43144-1), IC-204444 x *S. mulayanum (*IC-43144-1), IC-132035 X *S. mulayanum* and its reciprocal, and *S. mulayanum* (IC-43144-1) x *S. malabaricum* were attempted for widening the genetic base of sesame.

Evaluation of experimental hybrids: One hundred F_1 hybrids were evaluated under late *kharif* in 2017. Two F_1s, H-33 x GOURI and KMR-48-B x VRI-2 recorded highest plant yield of 66.3 g/plant and 55 g/plant with 49 and 51.1% of oil content, respectively.

Development of high oil line: A high oil line IOS-1101 was developed by pureline selection from IC-205312. Oil content was improved from 48 to 54% after six rounds of single plant selections. Seed yield/plant improved from 14.5 to 20 g with 178 effective capsules per plant and 115-138 cm of plant height. Seed number per capsule was also increased to 80. Seed multiplication of IOC-1101 is in progress for nominating it for multi-location trials.



Capsule length and seeds per capsule of IOS-1101

Development of stable cytoplasmic genetic male sterile lines: As part of the programme on development of CGMS system in sesame, crosses were made with *Sesamum malabaricum* and male sterility was observed in different backcross generations.

Backcross generation	Range of pollen sterility (%)	Mean sterility (%)
BC_3F_1(ISMB-2 x GT-10) F_1 x GT-10 -1-1-1-2	72.1-74.6	73.4
BC_3F_1(ISMB-3 x GT-10) F_1 x GT-10 -1-1-1-2	72.3-76.5	74.6
BC_3F_1 (ISMB-7 x GT-10) F_1 x GT-10-1-1	80.0-83.3	81.8
F_1- G-3 x TKG-22-1	80.5-86.8	82.8
BC_1F_1(G-3 x TKG-22) F_1 x TKG-22-1-1	82.4-87.1	84.3

Generation advancement of different crosses: Advanced the selected progenies of 41 crosses from F_7 to F_8 generations and of 151 crosses from F_5 to F_6 generations. A line IOS-MC-17 from the cross SP-2 x TKG-22 was less branched (1-2), with basal bearing capsules from ground level at 10 cm height, 5.5 cm long capsules, bold, white seeded with 100 seeds per capsule, synchronous maturity with average of 50-70 capsules per plant. This line is particularly suitable for high density

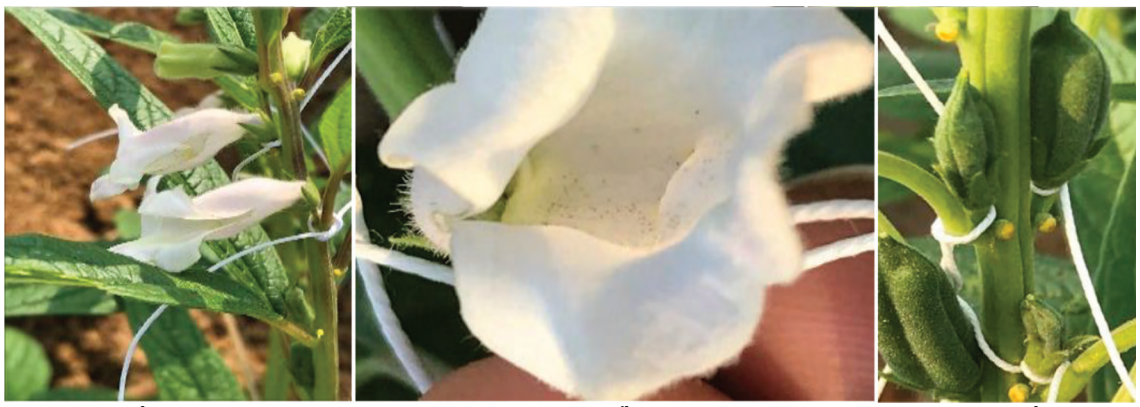
planting and intercropping systems. Apart from this four multicapsular monoculm lines were developed for high density planting.

IOS-17: A promising line with basal bearing capsules

Some of the crosses identified for high seed yield

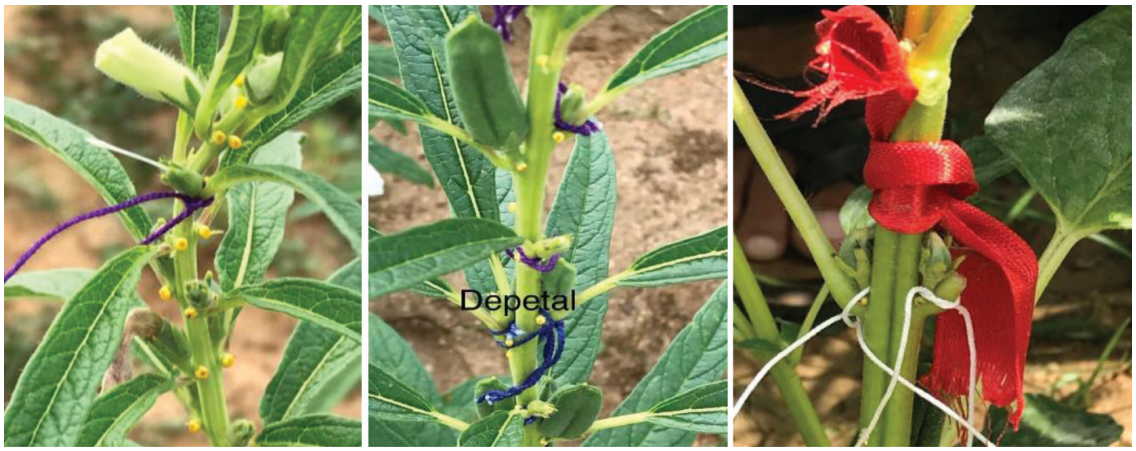
Cross	No. of branches	Capsules/ plant	Oil content (%)	Yield/ plant (g)
DS-5 X DS-10	5	64.9	46.8	8.1
DS-5 X Madhavi	5	63.2	46.7	10.8
DS-5 X Nirmala	6	61.0	48.4	12.4
DSS-9 X Madhavi	7	76.8	48.1	17.0
DSS-9 X JLS 05-03	5	69.9	50.2	11.5
DSS-9 X Hawari	4	46.0	48.1	9.7
DSS-9 X TKG-22	5	64.1	46.3	15.2
DSS-9 X Prachi	5	43.7	48.6	8.4
DSS-9 X VS-07-023	6	59.7	46.2	10.7
DSS-9 X Nirmala	5	44.0	47.3	9.5
DSS-9 X CST-2001-1	4	44.4	46.1	8.1
DS-1 X TKG-87	4	45.7	47.3	6.4

Role of honey bee in seed production: An experiment was conducted to study the role of honey bees in seed production of sesame. The experiment was laid out in 600 m^2 area with variety Swetha Til and YLM-66 in border during summer 2018. An active honey bee hive was set up during flowering period. Eighty seven plants were selected and labelled, in which anthers from mature flower buds were removed carefully without damaging the flower and keeping the corolla intact on previous evening before flower opening. A thread was tied on these buds for identification. These emasculated buds (only anthers removed) opened in the next morning to attract honey bees. A total of 3896 buds were emasculated by removing only anthers but not corolla over a span of 3 weeks of flowering. Similarly, a different set of 85 plants were selected and mature flower buds were emasculated by removing anthers along with corolla. A total of 3767 flowers were emasculated in this fashion and left for pollination. Capsule setting was observed and recorded after 20 days of emasculation and at physiological maturity. Out of 3896 'only anther removed' flowers, 1645 (45%) capsules were obtained. Similarly, among 3767 flowers where anthers were removed along with corolla, 256 (7%) capsules were produced. This experiment clearly proved that honey bees could bring about pollination in sesame if the corolla is present and thus it has provided a clear indication that in case male sterile lines are developed in sesame and if enough bee activity is ensured, seed production throughout crossing may not be an issue. This also proves that honey bees could play a significant role in seed setting in male sterile flowers and help in hybrid seed production. The experiment also shows the prominent role of corolla for attracting honey bees for pollination. The seeds produced by honey bee pollination were of good quality and on par with the seed produced by natural pollination.



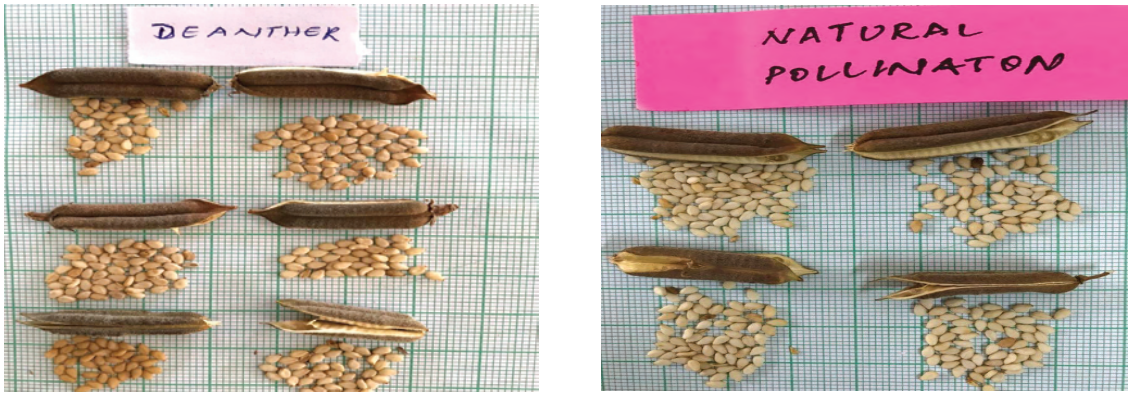
87 plants **3896 flowers** **1645 capsules (42%)**

Emasculated flower in which only anthers were removed the previous evening and capsule set in such an emasculated flower



85 plants 3767 flowers 256 capsules set (7%)

An emasculated flower by removing corolla along with anthers and capsule set

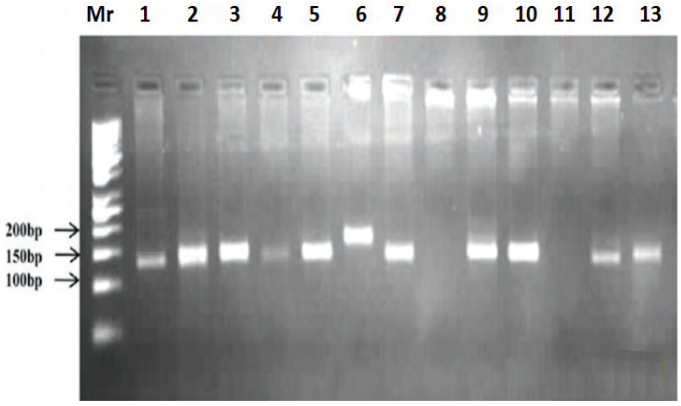


Seeds produced in honey bee pollinated capsules and natural pollinated capsules

Development of superior varieties/hybrids with wider adaptation: Experimental hybrids were evaluated in three sets each in *kharif* and *rabi* seasons. In *kharif* each set had 100 hybrids while in *rabi* each set had 150 hybrids. A total of 100 new crosses involving 60 diverse parents was effected. Promising types were selected based on basal capsule bearing, less internodal length, more total productive capsules, branching, duration, tolerance to diseases, besides seed yield and oil content.

Development of genomic resources in Indian sesame

An additional set of 400 SSR markers were optimized for their PCR-amplification in Indian sesame and were tested for their amplifiability in a panel of 100 Indian genotypes. Polymerase chain reaction (PCR) conditions were optimized with respect to annealing temperature and magnesium chloride concentration. Out of 400 SSRs, 74 were polymorphic with the chosen panel of genotypes. Polymorphic information content (PIC) varied from 0.18 to 0.43. Publicly available 100 SSR markers were assigned to linkage groups based on *in silico* analysis using publicly available sesame genome sequence information. This information helps selection of set of SSR markers, with genome-wide coverage. In addition to polymorphic information (PIC), information on genome wide distribution is highly useful in assessing utility of a given set SSR markers in a given set of genotypes.



Electrophoregram showing polymorphism of sesame markers

Mr: marker; SSR markers: SIM030, **2**. SIM034, **3**. SIM051, **4**. SIM055, **5**. SIM059, **6**. SIM065, **7**. SIM072, **8**. SIM077, **9**. SIM101, **10**. SIM105, **11**. SIM107, **12**. SIM109 and **13**. SIM112 amplifying their respective loci in a IIOR sesame genotype NIC-16426-IS

CROP PRODUCTION

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

Improvement of drought tolerance genotypes is one of the major objectives of sesame breeding programs for recommendation to marginal and arid regions of its cultivation. The Indian sesame core set consisting of 313 accessions was used in this study along with 42 released varieties and breeding lines. The core set consists of indigenous landraces from different agro-ecological zones in India with five accessions of wild sesame (*S. mulayanum*). Intermittent drought was imposed by reducing the amount of irrigation using water flow meters. Different traits such as the number of primary branches per plant, plant height, number of capsules per plant, number of seeds per capsule, seed weight and harvest index (HI) were recorded under both conditions. Seed yield and biological yield were also determined. The leaf weight, total biomass, number of capsules, capsule weight, seed weight per capsule and seed weight were reduced under drought condition compared to irrigated condition, which indicated that intermittent drought has its effect on the dry matter partitioning and reproductive process that ultimately reflect on seed yield. A total of 83 accessions were selected from core set based on cluster analysis and their seed yield, stress tolerance index responses under both drought and irrigated conditions for identification of source material with traits associated for intermittent drought tolerance.

Root traits

The variation in root traits *viz*., root depth, root volume, root length density and root mass at different soil depths and their relationship with the seed yield and shoot biomass was determined in experiments conducted in root structures (1.2 m height x 2 m width x 30 m length) using high yielding selected germplasm accessions from Indian core collection- IC-204300, IC-205471, IC-43036, IC-132300, IC-132186, IC-205649, IC-204090, IC-204622, IC-132171 and selected varieties adapted to dry environment- RT-346, RT-135, Swetha Til, JCS DT-26 with national checks TKG-22 and GT-10. The genotype IC-205649 had maximum and IC-132300 had minimum root depths. The root volume and root length density varied from 0.29 to 0.47 cm^3 and the maximum root volume in terms of more lateral and profuse root system was found in JCSDT-26, IC-204090, IC-204622 compared to the other varieties and national checks. The positive relationship (R^2: 0.34) between seed yield and root length density was observed along with shoot growth (R^2: 42) indicating that the genotypes with profuse lateral root system can explore more water and nutrients from soil profile thereby contributing to seed yield. The JCS DT-26, IC-204090 and IC-204622 genotypes with potential root traits can be targets for location specific varietal development in sesame breeding programmes.

Oil content and fatty acid analysis of sesame core set

The oil content in sesame core accessions ranged from 40 to 52%. Average palmitic acid; stearic acid; oleic acid; linoleic acid and linolenic acid of the sesame genotypes were 9.61; 5.02; 41.33; 43.58 and 0.44, respectively. IC-203987 recorded maximum linoleic acid (62.31) and minimum oleic acid content (25.55). IC-26304 showed maximum oleic acid (52.68%) and minimum linoleic acid content (32.66). IC-205209 recorded maximum (2.59%) alpha linolenic acid content (ω-3) fatty acid among all accessions tested.

Trait specific accessions identified for drought breeding programme

Leaf and capsule pubescence, cooler leaf temperature, structural root traits, reproductive success (pollen viability), seed yield and oil content are the important traits for intermittent drought tolerance. IC 204622 was identified with high leaf, stem and capsule pubescence, basal branching, high number of capsules (260 maximum), basal capsule bearing, cooler leaf temperature, profuse deeper roots, partially fertile pollen under stress, high seed yield (9 g/ plant) and oil content (48%). JCSDT-26 has profuse root system, cooler leaf temperatures, high relative water content (RWC) chlorophyll content and partially fertile pollen under stress, high seed yield (9 g/ plant) and oil content. These two accessions could be exploited in the drought breeding programmes.

Yield and physiological parameters at seed filling stage

Variety/ Accession	Stem wt. (g)	Capsules wt. (g)	Unfilled capsule wt. (g)	Leaves wt. (g)	Seed wt. (g)*	Total biomass (g)
IC-204622	49.6	45.8	3.4	19.8	42.8	165.2
TKG-22©	29.3	39.3	3.0	10.1	36.6	115.3
JCSDT-26	45.2	58.3	2.2	13.4	42.1	157.0
GT-10 ©	32.0	39.5	2.2	3.4	36.8	91.2
Swetha Til©	40.1	53.8	3.8	9.3	36.9	144.0

Five plants*

IC-204622 with high leaf, stem and capsule pubescence, basal branching, high SPAD, RWC and low CT.

Physiological parameters in IC-204622 compared to checks

Parameter	Irrigated	Stress
RWC (%)	88 ± 3 (IC-204622) 85 ± 3 (JCSDT-26) 83 ± 4 (Swetha Til)	65 ±4 (IC-204622) 64± 4 (JCSDT-26) 60± 3 (Swetha Til)
SPAD	49 ± 2 (IC-204622) 48 ± 5 (JCSDT-26) 46± 4 (Swetha Til)	54 ± 3 (IC-204622) 53± 4 (JCSDT-26) 48± 3 (Swetha Til)
Leaf temperature (°C)	23.2 ± 0.5 24.0 ± 0.8 (JCSDT-26) 26.1 ± 0.7 (Swetha Til)	23.9 ± 0.4 (IC-204622) 25.5 ± 1.2 (JCSDT-26) 27.8 ± 1.4 (Swetha Til)

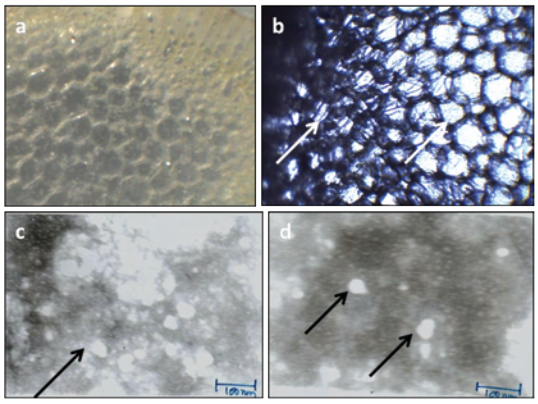
Estimation of lignin content through UPLC

A high throughput UPLC (Ultra Performance Liquid Chromatography) method was standardised for lignan (sesamol, sesamin and sesmolin) estimation from sesame seed oil. Sesamin, sesmolin and sesmol, the major lignans present in the sesame seed are known for their antioxidant properties. A high throughput method was developed for lignan (sesamol, sesamin and sesamolin) content estimation using Waters Acquity H class, Ultra Performance Liquid Chromatography (UPLC) with Photo Diode Array Detector and Acquity UPLC C_{18} 1.7 μm (2.1x100 mm) column. The mobile phase was water-methanol. The chromatographic flow rate was 0.400 mL/min. Injections volumes were 0.1 μ L for UPLC analysis. The analysis was carried out by Waters Empower software at 290 nm. HPLC methods were time consuming (30-60 min.) and uses large quantity of solvents. By using present method, all three lignans content can be estimated within seven minutes with very less solvents. The method was validated for linearity, accuracy, precision, limit of detection and of limit of quantification.

CROP PROTECTION

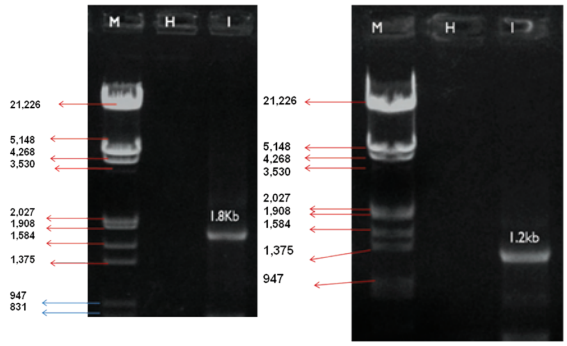
Studies on phyllody disease

Thin hand sections of phyllody infected leaves treated with Diene's stain revealed blue areas in the phloem region under light microscope indicating the presence of phytoplasma in the phyllody. However leaf sections from healthy tissues did not show any blue colour with Diene's stain. The presence of phytoplasma bodies in the ultra thin section of affected tissues like midrib was confirmed by transmission electron microscopy. The electron micrograph revealed typical pleomorphic phytoplasma like bodies inside the phloem cells of infected tissue. These bodies were mostly oval to spherical with opaque colour. Examination of ultrathin sections from diseased sesame leaves revealed the presence of numerous phytoplasma units in sieve tubes of phloem but not in healthy leaves. Phytoplasma were abundant in mature sieve tubes. When present in low concentrations, they were generally restricted to the periphery of sieve tubes.



Light microscopic images of (a) healthy leaves (b) tissue from phyllody infected leaves; Transmission electron microscopic images of (c) healthy leaves (d) tissue from phyllody infected leaves under. Arrows indicate the pleomorphic bodies of phytoplasma

The phytoplasma was identified through nested PCR using DNA extracted from phyllody infected and healthy sesame samples. The phytoplasma universal primer pairs P1/P7 and R16 F2/R 16 R2 were used for the direct and nested PCR, respectively. 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 R16F2n/R 16 R2.



PCR analysis of healthy and phyllody infected sesame samples with P1/P7 primers and R16 F2n/R16 R2 primers. H-Healthy; I- Infected with phyllody. White arrow indicates PCR product of sample

For seed transmission studies, seeds (500 nos.) from phyllody infected sesame plants were collected and sown in earthen pots containing sterilized soil and maintained in insect proof cages. Plants were observed up to 60 days for the expression of symptoms. Plants did not produce any symptoms throughout the period and were confirmed for absence of phytoplasma through nested PCR indicating that the disease is not seed transmitted.

Studies on suitability of alternate hosts for rearing leafhopper (*Orosius albicinctus*)

A pot culture experiment was conducted to study the suitability of host plants of leafhopper *viz*., sunhemp (*Crotalaria juncea*), sesame (*Sesamum indicum*), periwinkle (*Catharanthus roseus*), common bean (*Phaseolus vulgaris*) and mint (*Mentha* sp.) under caged conditions. Two pairs of field collected adult leafhoppers were released on host plants and suitability of the hosts for multiplication of leafhopper was assessed. Among the hosts, multiplication of leafhopper was observed on sesame (8.3 ± 1.1 nymphs/plant), sunhemp (3.5 ± 1.3 nymphs/plant) and periwinkle (2.3 ± 0.3 nymphs/plant) while no multiplication was observed on mint and common bean.

SOCIAL SCIENCES

Frontline demonstrations on sesame were conducted on 60 acres area during summer 2017 in seven villages of Siddipet (Ibrahimpur and Nanganur), Kamareddy (Mothe) Mahabubnagar (Lakkardoddi and Patherched) and Vikarabad (Rampur) districts of Telangana State. The village-wise details and the productivity potential of improved technologies demonstrated in rice-fallows are presented.

Productivity potential of improved technologies of sesame demonstrated during summer 2017

Village	Variety demonstrated	Area (ac.)	Seed yield (kg/ha)		% increase in seed yield
			IT	FP	
Mothe	SwethaTil	15	500	-	-
Ibrahimpur	SwethaTil	10	500	-	-
Nanganur	GT-10	10	438	350	25.0
Lakkardoddi	SwethaTil	10	400	300	33.3
Patherched	SwethaTil	10	438	-	-
Rampur	YLM_66/GT-10	05	438	350	25.0

IT = Improved technology; FP = Farmers practice

Demonstrations were conducted with improved varieties of sesame *viz*., Swetha Til, YLM-66 and GT-10 to show the potential of the crop during summer after harvest of paddy. The farmers' practice of keeping the field fallow after paddy harvest was compared with paddy followed by sesame. Farmers were able to harvest around 400 to 500 kg/ha, which provided an additional net returns of Rs. 3,463 to Rs. 4,400/ha. The details of village-wise cost of cultivation, gross monetary returns and the B:C ratio are presented.

Profitability of improved technologies of sesame demonstrated during summer 2017

Village	CoC (Rs./ha)		GMR (Rs./ha)		ANR (Rs./ha)	B:C ratio	
	IT	FP	IT	FP		IT	FP
Mothe	9000	-	25500	-	-	2.83	-
Ibrahimpur	9000	-	26500	-	-	2.94	-
Nanganur	9500	8500	22313	17850	3463	2.35	2.10
Lakkardoddi	9500	8500	20400	15300	4100	2.15	1.80
Patherched	9500		22313	-	-	2.35	-
Rampur	9500	9000	22750	17850	4400	2.39	1.98

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

Sesame variety YLM-66 demonstrated in Rampur Thanda, Vikarabad

NIGER

Development of improved breeding population

Collection of germplasm: A total of 300 germplasm accessions from PC unit Jabalpur, 18 germplasm accessions from hilly areas of Odisha and seven farmers' varieties from Araku valley of Andhra Pradesh were collected.

Characterization of germplasm: Collected germplasm lines were characterized for different qualitative and quantitative traits for two seasons. Seed yield varied from 2.2 g to 4.8 g/plant, while the oil content ranged between 27.1% and 40.1%. A total of 230 germplasm accessions were multiplied by sibbing under isolation using sibbing nets.

Elite lines for high oil content

Germplasm	Seed yield/ plant (g)	Oil content (%)
N-36	2.5	40.1
N-289	3.2	39.1
N-108	3.0	39.6
N-209	4.1	39.2
N-214	3.0	38.7
N-201	3.9	38.6
N-227	3.3	38.5
N-228	3.1	38.5
N-174	3.3	38.4
N-282	2.7	38.4

Range: Seed yield = 2.2 to 4.8 g/plant; Oil content = 27.1 to 40.1 %

CENTRAL LAB ACTIVITIES

Development of FT-NIR protocol for measuring the oil content of *Arabidopsis* using mustard seeds as reference sample

Nuclear Magnetic Resonance spectroscopy (NMR) is commonly used for oil content estimation in oilseed crops but it requires a minimum of 3-5 g of sample. The very small seeds and less sample size is often a great problem in oil content measurement of the *Arabidopsis* seeds. An FT-NIR protocol was developed for measuring the oil content of *Arabidopsis* seeds (500 mg) using mustard seeds as reference samples. A set of 127 samples of different genotypes of mustard seeds was analysed for oil content by NMR. All samples were ground individually and FT-NIR spectra were generated. A chemometric model was used for analysis in the Thermo FT-NIR (IS-50) system. Partial Least Squares (PLS) analysis was performed using TQ-Analyst software. Oil content of wild type *Arabidopsis* seeds were estimated by soxhlet (solvent extraction) method using hexane as solvent. The model developed enabled the spectra to be correlated to oil content with excellent prediction agreement with measurements and can be used for estimation of oil content of both ground mustard and *Arabidopsis* seeds.

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

Standardization of polymeric films for seed coating

Standardization of physical and chemical parameters, type and concentration of reactant for film forming ability had been assessed. For standardization of these parameters a total of 560 combinations were assessed. Of these, 221 combinations were finalized based on scoring on film forming capacity as per reported studies. These 221 combinations were studied for their seed coating ability on seed germination and vigour index. The films which are formed are in the range of 20-70 μ thickness, colour was white to off white having opacity of transparent to semi-transparent with smooth surface. Seed coating of polymers and its evaluation for seed quality parameters was also done. A total of 212 combinations was tested on sunflower and soybean for its optimum film without affecting seed germination.

Influence of polymer combination on seed germination

Seed germination %	0	10	20	30	40	50	60	70	80	90	100
No. of polymer combination	36	14	12	16	9	2	2	9	15	19	78

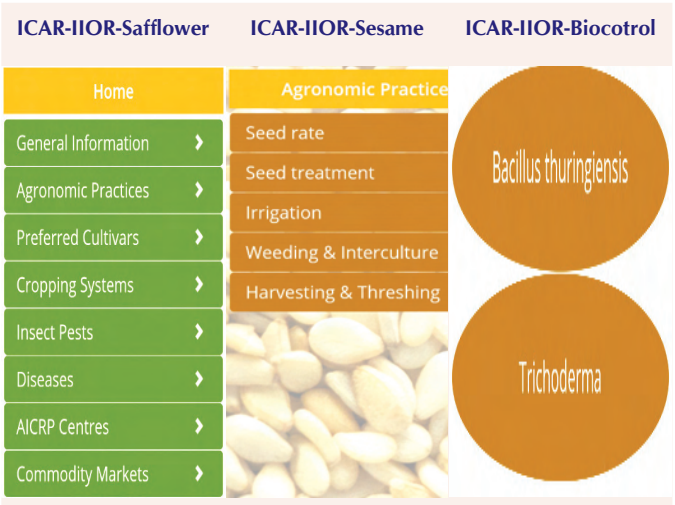
Finally, two films were selected based on the desirable criteria. Polymer 1 is fast release and polymer 2 is a sustained release carrier. Finalized polymers were re-evaluated in all oilseed crops for seed enhancements. The polymers were entrapped with *Trichoderma* for study against biotic stresses along with shelf life of the bio-agent.

SOCIAL SCIENCES

Mobile Apps developed

Mobile apps for safflower, sesame and biocontrol agents were developed for the benefit of researchers, students, industry professionals, NGOs, farmers and other stake holders. The Mobile Apps on safflower and sesame provides the information on management practices, cultivars, pests and diseases, information on AICRP centres, market prices from major Agriculture Produce Market Committees (APMCs) to facilitate the end users to have the information on the nearby markets.

An app on IIOR biocontrol agents was developed for *Bacillus thuringiensis* (Bt) (gram positive ubiquitous soil bacterium producing an insecticidal toxin that is active against several economically important lepidopteran insect pests) and *Trichoderma harzianum* (a farmer friendly fungus). The app is enriched with information about Bt, the advantages of DOR Bt formulations and the sources from where the formulation can be obtained. The benefits of *T. harzianum*, seed treatment method, dosages and contact details are provided.



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

Frontline demonstrations on oilseeds were conducted in 7445 acres by the oilseed Institutions/Directorates/Project Coordinating Units and Indian Institute of Farming Systems Research in various agro-ecological regions of the country.

Trainings: Since input dealers are the primary source of information on agriculture for the farmers, improving the knowledge of the input dealers on the latest oilseed production technologies for increasing productivity and income of the farming community, 49 trainings were conducted for input dealers, agricultural officers and extension workers.

Frontline demonstrations conducted: The details of FLDs on oilseeds and oilseed based cropping systems conducted during the year 2017-18 are presented below.

Frontline demonstrations and trainings conducted by the AICRPs/Directorate/Institutes during 2017-18

Institute/AICRP/Directorate	FLDs		Total	Trainings organized
	Kharif	*Rabi*		
ICAR-Indian Institute of Soybean Research, Indore	1142	0	1142	4
ICAR-Directorate of Rapeseed-Mustard, Bharatpur	0	1750	1750	12
ICAR-Directorate of Groundnut Research, Junagadh	293	280	573	5
ICAR-Indian Institute of Oilseeds Research, Hyderabad				
Castor	550	85	635	-
Safflower	0	755	755	-
Sunflower	100	620	720	-
Sesame	0	200	200	-
Niger	50	0	50	
ICAR-IIOR, Rajendranagar, Hyderabad	**700**	**1660**	**2360**	**10**
Project Coordinator (Sesame), Jabalpur	230	70	300	10
Niger	155	0	135	0
PC (Linseed), Kanpur	0	1000	1000	2
ICAR-Indian Institute of Farming Systems Research (IIFSR), Modipuram	15	170	185	6
Grand total	**2535**	**4930**	**7445**	**49**

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

This project was implemented in Vikarabad district of Telangana with a total farm families of 1022 spanning 1672 ha.

NRM component: Under the above project based on the need assessment of the study area, 400 soil health cards under NRM component were prepared for 12 major, micro and secondary nutrients. The soil health cards enabled farmers in taking up the fertilizer application for the respective crops in accordance with the fertility status of the soil. Skill development on soil sampling was imparted to the farmers in the villages. This enabled farmers to reduce the cost of cultivation in redgram by Rs. 2,000-2,025 /ha and in groundnut by Rs. 2,625-2,750/ha, respectively. The cost towards phosphatic fertilizers were reduced considerably especially in soils with medium and high P status and through advocacy of PSB and application of SSP instead of DAP. In *rabi* groundnut cultivation, application of gypsum added to increasing the yield by 15-20% through better seed development (15-20 q/ha as against 10-14 q/ha before interventions from IIOR). To safeguard against the prevailing soil borne diseases application of *Trichoderma harzianum* as seed treatment @8-10 g/kg seed was practiced in 250 acres in redgram crop. The soil conservation measures *viz*., opening of dead furrow, ridge and furrow method of planting was practiced in 125 ha and enrichment of the soil texture through application of tank silt was taken up in approximately 160 ha. These interventions were readily accepted by the farming community and have now become perpetual with the farming activities in those villages where these were popularized.

Under the crops and cropping pattern module: Inter cropping with redgram (PRG 176) + castor (DCH-519) intercropping (3:1) and (1:1) *vs* sole redgram (local variety) in 40 ha through complete technology assemblage common to inter crop and sole crop plots resulted in 2.5 q/ha of redgram and 2.5 q/ha of castor *vis-à-vis* 3.75-4.00 q/ha of redgram resulting to additional net returns of Rs. 6,250/ha due to inter cropping.

The cropping sequence of mungbean-castor (late *kharif*) with castor hybrid DCH-519 resulted in productivity of 2.5 q/ha of mungbean and 18 q/ha of castor crop resulting in net returns for the system to the tune of Rs.48,000/ha on paid out costs. This intervention has vintage value considering the low water requirement through irrigation for castor crop, less labour requirement and reduction of wild boar menace.

The castor production technology through DCH-519 hybrid was implemented in 30 ha. This resulted in productivity of 3-5 q/ha despite the severe gray mold disease due to unprecedented weather conditions during November-December.

Seed production of groundnut (K-6) with complete technology backstopping resulted in productivity of 12-14 q/ha during *kharif* and 18-22 q/ha during *rabi* 2017. This enabled farmers to sell the seeds to the neighbouring villages @ Rs. 7,500/q. The storing of seeds for sowing for the next season would avoid the drudgery of travelling 200 km for procurement of the seeds besides incurring cost towards seed.

Complete adoption of technology package in commercial groundnut cultivation inclusive of plant population of 30 x 10 cm, seed treatment with Mancozeb @ 2 g/kg of seed + *Trichoderma* @10 g/kg seed, SSP-150 kg/ha, gypsum-250 kg/ha, need based plant protection at 45 days with flubendamide @ 100 ml/ha; 500 ml monocrotophos + 2.5 litre neem oil + 2.5 kg surf resulted in productivity of 18-24 q/ha as against 10-14 q/ha. The farmers were educated on storing the seeds from the harvested produce after sufficient drying for the, next season.

With a view to increase farmers' income, seed production of paddy (RNR-15048), a relatively low GI variety was initiated on a pilot scale during summer, 2017-2018 in one acre.

Under the horticulture component, the vegetables *viz*., tomato (Arka Rakshak), chilli (Arka Kyathi) and okra (Arka Anamika) were sown in 6 ha during summer 2018.

Under the marketing and value addition, initiated marketing of locally processed Tur dal on pilot basis (6 FF) @ Rs.85/kg after negotiations through the local site committee.

HRD component: Training was imparted on vermicompost production technology for improved soil health in oilseeds based production system to 30 farmers and mushroom production technology for enhanced nutritional security and income generation to 50 farmers.

Farmer scientist interface meetings

During the year 2017-18, 73 interface meetings were conducted with the farming community. The list of the topics/ subject matter in the interface meetings include: soil testing and skill development on soil sampling; focused group discussions on importance of NRM; inter cropping; INM; BMP's; Importance of seed treatment; Role and importance of bio controls, PSB and Rhizobium; importance of soil health cards and soil test based INM; role of gypsum and its importance in oilseed crops; capacity building programmes on improved production technologies of oilseed crops, paddy, redgram, maize; advocacy of using PSB in soils with high P fixation; entrepreneurship development programme (EDP) on backyard poultry; EDP on seed production of oilseeds and paddy (low GI); exposure visits to oilseed

demonstration plots; awareness on the price information system at APMC's (max, min and modal price); EDP on the potential of bold seeded groundnut for table purpose; EDP on the value addition of oilseeds; importance of IFS and the role of sheep and goat farming on integration with the farm/ family; Swacch Bharat for better quality of life.

Interaction meetings with farmers

OTHER SCIENTIFIC ACTIVITIES

Agricultural Knowledge Management Unit

Developed an exclusive website for Oilseeds Analytical Instruments Facility for instruments available at IIOR as per the guidelines received from ICAR and linked up with IIOR website, and subsequently uploading the information to knowledge portal of ICAR website; regular updation of the web site through pertinent database on prices and arrivals of the major APMC's trading concerning IIOR mandate crops; regular uploading of budget releases to AICRP, FLDs and TSP centres, uploading of photographs of the various events; press gleanings, tender documents, employment opportunities. Updated the contact details of staff of IIOR, AICRP centres in the ICAR telephone directory.

Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell has facilitated to review the progress of all the ongoing projects by Research Advisory Committee (RAC). It has also facilitated to review the experiments carried out under 21 institute projects and 17 external funded projects in field as well as in IRC meetings both in *kharif* and *rabi*. RPPs of 21 institute research projects were reviewed as per the IRC recommendations and submitted to Director for approval. The database on publications was updated and maintained. Ten new institute research project proposals were evaluated and discussed in IRC and 5 new project proposals were reviewed and recommended for external funding sources. Six monthly reports on targets and achievements in HYPM have been uploaded. Under Institute Technology Management Unit (ITMU), database of commercialisable technologies, and IP assets were updated. One MoA was made for licensing Th4d bio-pesticide formulation to one private company. Facilitated for the agreement with NBA for taking the approval for obtaining Indian Patent on 4 applications. The replies to the different queries of CIB&RC on Bt-1 and *B. bassiana* data were sent to the respective licensee. One proposal of the scientist for data generating for licensing and one patent application were processed. Besides, the proposals for 10 PG students for doing M.Sc Project work at IIOR and 2 Ph.D students were processed and finalized to work at this Institute.

Field evaluation of Bt-127 SC formulation against major lepidopteran pests of soybean

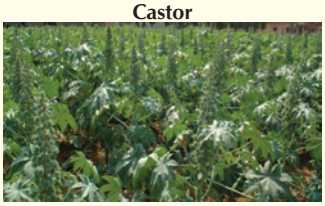
Evaluation of Bt-127 SC formulation as a component of IPM was undertaken in soybean in farmers' fields at Hegdoli village, Nizamabad district, Telangana. Soil application of Phorate 10CG @ 10 kg/ha was undertaken at the time of sowing for management of stemfly. *S. litura* was monitored with pheromone traps (4/acre) and yellow mosaic virus (YMV) infected plants were uprooted and destroyed. ETL based application of DOR Bt-127 SC formulation @ 3 ml/l against defoliators was undertaken (ETL - 2 larvae of semilooper or 4 larvae of *S. litura* /m row length). Application of emamectin benzoate and coragen was undertaken for management of lepidopteran pests in farmers' practice. Incidence of *S. litura* and semiloopers was lowered by 93 and 99.5% with the first spray of Bt-127 SC formulation at 60 days after sowing (DAS) while their incidence was lowered by 97.3 and 99.6%, respectively in farmers' practice with spray of emamectin benzoate. At 75 DAS, with the second spray of Bt-127 SC formulation, incidence of *S. litura* was lowered by 92%, on par with 91.5% lowering from spray of coragen in farmers' practice. The formulation was not phytotoxic and was safe to the predators like spiders and *Chrysoperla carnea*. Incidence of natural enemies in IPM field after first and second spray was higher at 0.84 and 0.72 per meter row length in comparison to 0.12 and 0.4, respectively in farmers' practice. The IPM trial resulted in net returns of Rs. 12,312/acre with a CBR of 1:2.36 over net returns of Rs. 5195/acre with a CBR of 1:1.61 in farmers' practice. A farmers' day was organized on August 22, 2017 to demonstrate the potential of Bt-127 in management of lepidopteran insect pests of soybean.

A: Soybean IPM field, B, C: Participants visit to the IPM soybean field during the field day at Hegdoli

SEED PRODUCTION

A total quantity of 694.35 q. of variety/parent/hybrid of various oilseeds were produced during the year 2017-18.

Seed production of Variety/ Parent/ Hybrid of mandate crops

Crop	Variety/ Parent/ Hybrid	Seed production (q)
Castor 	DCS-107 (Variety)	2.20
	DPC-9 (Parental line)	3.15
	M-574 (Parental line)	5.15
	DCS-9 (Parental line)	2.00
	DCS-78 (Parental line)	1.50
	DCH-519* (Hybrid)	450.00
	DCH-177* (Hybrid)	105.00
	Total	**568.50**
Sunflower 	DRSF -113 (Variety)	1.00
	DRSF-108 (Variety)	0.05
	243 A (Female Parent)	0.80
	243 B (Female maintainer line)	0.50
	6 D-1 (Male Parent)	0.50
	DRSH-1 (Hybrid)	7.00
	Total	**9.85**
Sesame 	YLM -66 (Variety)	0.90
	Shweta Til (Variety)	13.00
	CUMS-17 (Variety)	3.00
	GT-10 (Variety)	0.80
	Total	**17.70**
Safflower 	PBNS-12	25.00
	ISF-764	69.00
	DSH-185	2.40
	Total	**92.40**
Grand total		**694.35**

* = Participatory seed production

Information regarding varietal replacement rate

Crop	New variety popularized	Prerelease year of release or notification	Quantity of seed Produced (q)	Old variety replaced	Remarks
Safflower	ISF 764 (Variety)	Prerelease	69	A1 Bhima	Promising variety
	DSH 185 (Hybrid)	2018	2.4	PBNS-12 A-1 Bhima	CMS based hybrid

TSP progress report under ICAR seed project

Trainings (No.)	FLDs (No.)	Exhibitions (No.)	Exposure visit (No.)	Beneficiaries (No.)	Village & District	Supply of inputs		Asset created (Type & Number)	
						Type	Units kg	Type	Units
2	90	4	2	90	Arsada village, Chintapalle	Niger seed: KGN-2	200	Seed bins	90
								Tarpaulins	90
					Domriguda, Killoguda, Aruku			Push hoe	25
								Bee hives	25



Field day at Aruku

Tribal Sub Plan


Line sowing vs Broadcast Sowing of Niger variety KGN-2


DAC & FW-NMOOP Project

Andhra Pradesh and Haryana are the potential states and *rabi* is the season for achieving crop expansion with high productivity. Seed is the major limitation besides ecological limitations in Telangana state and southern India. Poor quality seed from Gujarat and Rajasthan are being used by the farmers of Haryana. Seed of hybrid DCH-177 was sent from Hyderabad and it was a big success in Haryana and Rajasthan with growing demand for seed. Best technologies for *rabi* castor cultivation with micro-irrigation have been developed from IIOR and AICRP system resulting in realizing high yield and profits. Thus the DAC-NMOOP project entitled "Area expansion and productivity enhancement of castor through quality seed production and adoption of BMPs" for 2017-18 with budget outlay of Rs. 20.03 lakhs was initiated to strengthen the efforts of IIOR, SPAC and AICRP with the support of MM-I NMOOP, DAC, GoI.

Collaborators: HLRDC, Hisar; AICRP (Castor), TCRS, TNAU, Yethapur; RDT, NGO, Anantapuramu

Objectives

- Undertaking seed production of castor hybrids (DCH-519 and DCH-177) in farmers' fields in Telangana and Haryana states.
- Organising FLDs for realizing higher seed yield of *rabi* castor with adoption of BMPs.

Critical BMPs/inputs provided (Telangana, Andhra Pradesh, Tamil Nadu and Haryana): quality parental seed for seed production and hybrid seed of YRCH-1 and DCH-519 for FLDs; seed treatment chemicals; water soluble fertilizers for drip fertigation; yellow sticky traps; plant protection chemicals for sucking pests; secatures for harvesting.

Seed production of castor hybrids in farmers' field in Telangana and Haryana states

Hybrid	Region	State	Number of farmers	Number of acres
DCH-519	Palem, Nagarkurnool distict,	Telangana	12	70
DCH-177	Veldanda, Nagarkurnool	Telangana	10	30
DCH-177	Hisar	Haryana	HLRDC farm + farmers field	25
Total				125

Seed production at Haryana was not successful due to extreme low temperatures that prevailed from December to February resulting in high males and ISFs despite very good crop growth and spike length.

A total of 519q of DCH-519 and 107.3q of DCH-177 hybrid was produced and procured after grow out test. The average yield realised by farmers in Telangana state was about 7q/acre.

FLDs for realizing higher seed yield of *rabi* castor with adoption of BMPs

Region	State	Number of farmers	Number of acres
Yethapur, Salem and Namakkal districts	Tamil Nadu	25	75
Anantapuramu	Andhra Pradesh	20	50
Total		45	125

In Tamil Nadu, the profitability of castor over competing maize and cotton was higher (B:C ratio of 4.1 *vs* 1.25 to 1.6) due to the high cost of production and low productivity due to pink boll worm and loss of quality of lint in cotton and insect pest incidence and low market price for maize.

The demonstrations comparing drip *vs* flood recorded a 43% increase in seed yield (3312 *vs* 2310 kg/ha) and gross returns (Rs.1.325 *vs* 0.92 lakhs). Further, drip fertigation resulted in additional water saving up to 30% + use of poor quality water from deep tube wells.

Demonstrations on intercropping blackgram (VBN-6) with castor rows at 150 cm resulted in additional yield of 1178 kg/ha and additional returns of Rs. 64,797/ha with a B:C ratio of 4.78.

YRCH-1 hybrid performed marginally superior over DCH-519 in the region.

In Anantapuramu district of Andhra Pradesh, castor was intercropped with vegetables – chillies and tomatoes resulting higher monetary returns and withstanding the risk of loss and low markets for vegetables.

Expansion of area under castor in Andhra Pradesh and Tamil Nadu

Castor production in Anantapuramu district of Andhra Pradesh was highly promising with clear surge in

demand for castor expansion and seed requirement. A clear trend of crop diversification from groundnut was possible with castor. Scope for castor + groundnut/ vegetables and in interspaces of orchards was promising with significant additional returns. Market price of castor is stable and high over vegetables.

In Tamil Nadu, castor is highly profitable over competing cotton and maize crops. With adaptation of BMPs and/under drip system very high yield and profits were realised.

Demonstration of YRCH-1 and DCH-519 with BMPs/drip during *rabi* 2017 at Salem, Periyambur and Namakkal dist. T.N

Demonstration of DCH-519 hybrid with BMPs/drip during *rabi* 2017 at Anantapuramu district, Andhra Pradesh

AICRP ON OILSEEDS (CASTOR, SUNFLOWER AND SAFFLOWER)

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

CASTOR

- 43 new accessions were added to castor repository at ICAR-IIOR, Hyderabad.
- RG-4163, an early flowering (46 DAS) accession collected from Odisha has recorded higher seed yield (254 g/plant) than the best check variety, DCS-9 (238 g/plant) under rainfed conditions.
- The drought and salinity tolerant accessions, RG-72 , RG-1826 and RG-1941 recorded higher total seed yield
- Registered RG-2661 (IC-374272; INGR-17049), a leafhopper resistant accession with Plant Germplasm Registration Committee, ICAR-NBPGR.
- JI-454 (5,373 kg/ha), JI-453 (3,779 kg/ha) and JI-456 (3,504 kg/ha) at Junagadh; SKI-430 (2398 kg/ha), SKI-427 (2363 kg/ha) and SKI-421 (2298 kg/ha) at S.K Nagar and ICS-151 (1924 kg/ha), ICS-152 (1982 kg/ha) and ICS-153 (1684 kg/ha) at IIOR were found promising under open pollinated populations.
- A total of 68 new monoecious lines (8 at Anand, 15 at Junagadh, 2 at Palem, 16 at SK Nagar and 27 at IIOR) were isolated from the advanced generations of different cross combinations.
- A new pistillate line, PPL-321 with earliness (11-12 nodes to primary) was developed at Palem. Four pistillate lines *viz*., IPC-3, IPC-4, IPC-5 and IPC-6 were stabilized for their pistillate expression at IIOR.
- A total of 400 (60 at Anand, 65 at Junagadh, 50 at Mandor, 26 at Palem, 46 at SK Nagar, 75 at Yethapur and 78 at IIOR) new experimental hybrids were generated. 26 hybrids at Anand; JHB-1074, JHB-1076, JHB-1086, JHB-1081 and JHB-1078 at Junagadh; four hybrids (SKP 120 x SKI 406 [4425 kg/ha], SKP 121 x SKI 401 [4358 kg/ha], SKP 121 x SKI 406 [4295 kg/ha] and JP 104 x SKI 399 [3468 kg/ha]) at S. K. Nagar; YRCH-17035 (2858 kg/ha), YRCH-16108 (2327 kg/ha) and YRCH-16007 (2074 kg/ha) at Yethapur; ICH-182, ICH-261, ICH-859, ICH-278, ICH-138 (rainfed)and ICH-859 (55%), ICH-225 (40%) and ICH-266 (32%) at IIOR found superior to checks.
- DCH-1715 recorded 7-10 per cent higher seed yield than the best check, DCH-177 at Bhawanipatna (1302 kg/ha) and Kanpur (1960 kg/ha) and can be proposed for state level identification at Odisha and Uttar Pradesh.
- ICH-66 reported superior in terms of seed yield in AHT than the best check GCH-7 (1523 kg/ha) for rainfed condition.
- National average over nine locations indicated that JHB-1018 (2764 kg/ha) was numerically superior to the best check, GCH-7 (2661 kg/ha).
- Among the best performing hybrids, ICH-66 and JHB-1018 are resistant to wilt in sick plots at IIOR and S.K. Nagar.
- A total of 37.17 q of breeder seed of varieties and parental lines of castor was produced against the DAC indent of 35.32 q.
- Application of pendimethalin @ 1 kg/ha (pre-emergence) + IC *fb* HW at 40 & 60 DAS (T2) and, pendimethalin @ 1 kg/ha (pre-emergence) + quizalofop ethyl 0.05 kg/ha (post – emergence at 25 DAS) + hand weeding at 60 DAS were equally effective and resulted in higher seed yield and profitability (B:C ratio 2.33-2.48) at S.K. Nagar.
- At Yethapur, selective mechanization *viz*., tractor drawn seed drill sowing; inter cultural operation with power weeders; spraying plant protection chemicals with boom sprayer; harvesting, threshing and shelling by secateurs and castor thresher, respectively rainfed conditions resulted in saving in labour utilization (90 man days/ha) with time consumption of 782 hr/ ha.
- Planting on 25th July found better to save the crop from frost damage at Bawal.
- Application of 20 kg P_2O_5/ha along with seed treatment either with PSB (5064 kg/ha) or bio-phos (4919 kg/ha) was found to be at par with application of 40 kg P_2O_5/ha at Mandor.
- In artificial screening of accessions, genotypes RG-3795, RG-2787-89-20, RG-2787-181-12 showed resistant reaction to wilt at Hyderabad, Palem, S.K. Nagar and RG -2661, ICI- RG-2787-152-9, ICI- RG-2787-181-12, ICI-RG-2787-192-12, ICI- RG-2661-7-5-2 showed resistant reaction to root rot at Junagadh.
- Among the entries from coordinated trials, SHB-1002, ICH-86 showed resistant reaction to wilt disease at Hyderabad, Palem and S.K. Nagar. Entries ICH-515, JI-444, PCH-555, RHC-428, SHB-1021,SHB-1028, ICH-68, JHB-1018, ICH-66, PHT-14-44 were resistant to root rot. Entries PCH-555 and SHB-974 were moderately resistant to reniform nematode.

- Seed treatment and soil application of *Trichoderma harzianum*, Th 4d WP and seed treatment with carbendazim were on par with each other and recorded low wilt incidence with higher seed yield at Yethapur. Pooled analysis for three years (2015-16 to 2017-18) at Junagadh, indicated that root rot incidence was lowest and seed yield was high in seed treatment and soil application of *Trichoderma* local isolate. It was statistically on par with other two treatments *viz*., seed treatment with carbendazim and seed treatment and soil application of *T. harzianum* Th4d WP.
- On farm demonstration of management of gray mold of castor revealed that spraying of propiconazole two times recorded low gray mold disease with high seed yield in farmers fields at Mahabubnagar district of Telangana and Yethapur as compared to untreated control**.**
- Combination of trifloxystrobin + tebuconazole recorded lowest gray mold disease severity followed by carbendazim, tebuconazole, triflumizole and propiconazole under glass house conditions.
- Seven entries (RG-435, RG-1814, RG-3037, RG-3079, RG-3080, RG-3095 and RG-3132) confirmed resistant to moderate resistant reaction to leafhopper (hopper burn grade 1 to 2 on 0-4 scale) at Palem, Yethapur and ICAR-IIOR, Hyderabad.
- The newer insecticides *viz*., buprofezin 25SC (1.5 ml/l) and flonicamid 50WG (0.2g/l) were superior in reducing the whitefly infestation and resulted in higher yields at Yethapur (1831 and 1651 kg/ha, respectively as compared to 807 kg/ha in untreated control).
- DOR Bt-127 SC formulation @ 3ml/l effected 59.0 to 84.5% reduction in semilooper and 58.9 to 81.8% reduction in *S. litura* population and was superior over commercial *Btk* formulation @ 1g/l (54.0 to 80.8% and 56.7 to 74.0% reduction in semilooper and *S. litura*, respectively) under field conditions at Palem and Yethapur.
- Clothianidin 50WDG @ 0.1g/l and acetamiprid 20SP @ 0.2g/l) found better against sucking pests (leafhopper and thrips).
- Rs 445.30 lakh was released to castor centers besides release of Rs 4.39 lakh as need based research fund.

Major Recommendations

- GNCH-1, a high yielding wilt resistant hybrid suitable for late-*kharif* and *rabi* season for South and Middle-Gujarat; YRCH-2 for castor growing areas of Tamil Nadu and GCH-8 for all castor growing areas of the country were released.
- Application of clothianidin 50WDG @ 0.1g/l or acetamiprid 20SP @ 0.2g/l for management of sucking insect pests (leafhopper and thrips) in Telangana

SUNFLOWER

- One hundred and twelve germplasam were identified promising for agro-economic traits at different locations.
- Open populated populations , AKSFI-17-8 (1471 kg/ha) of Akola and SS-1316 (1728 kg/ha), SS-1508 (1613 kg/ha), SS-1319 (1576 kg/ha) of Solapur reported superior to checks in terms of seed yield.
- New experimental hybrids developed at Akola (26), Bengaluru (160), Coimbatore (438), Hisar (56), Latur (360), Ludhiana (81), Nandyal (44), Nimpith (130), Raichur (66) and Savalvihir (106) were evaluated in replicated trials with large plot size.
- PKVSH-964 (2329 kg/ha), PKVSH-970 (2239 kg/ha) and PKVSH-968 (2019 kg/ha at Akola; SMLHT-Kh-17-02 (2802 kg/ha) and SMLHT-Kh-17-01 (2679 kg/ha) at Raichur (IOSH-15-10) (2509 kg/ha) at IIOR; KBSH 79 at Bengaluru.
- CSFH-16510 (1979 kg/ha), CSFH-16413 (1967 kg/ha), CSFH-15020 (1935 kg/ha), CSFH-15020 (2079 kg/ha), CSFH-12205 (2068 kg/ha) and CSFH-12205 (2068 kg/ha) at Coimbatore; HSFH-1549 (2640 kg/ha) at Hissar; LSFH-3470 (1832 kg/ha), SVSH-488 (1771 kg/ha), PKVSH-971 (1736 kg/ha) and SVSH-454 (1708 kg/ha) at Latur; SH-1032 (2826 kg/ha) and SH-1034 (2411 kg/ha) at Nandyal and SMLHT-Kh-17-5 (2301 kg/ha) followed by SMLHT-Kh-17-9 (2270 kg/ha) and SMLHT-Kh-17-7 (2145 kg/ha) at Raichur were found superior to the checks in terms of seed yield.
- Selected lines of 26 interspecific cross combinations with *Helianthus* species *petiolaris, praecox,* and *debilis,* were advanced to next generation at IIOR, Hyderabad, Ludhiana and Raichur.
- IIOSH-2, PSH-2080, PSH-2091,BLSFH-15004, IIOSH-14-02, NSFH-639 were promoted to the next level of testing in *rabi* 2017 and IIOSH-15-10,

LSFH-1751, BLSFH-15005, IIOSH-2 and LSFH-4951 BLSFH-15005, IIOSH-2 and LSFH-4951 were promoted to further testing in *kharif* 2018.

- A total of 20 q of breeder seed is expected against an indent of 2.9 q.
- Maize (fodder) as an intercrop in sunflower was remunerative at Hisar.
- Zero tillage was successful for rice *fallow* sunflower in black soils at Nandyal.
- Ridge and furrow sowing at 60 x 30 cm or broad bed and furrow - paired row planting at 45 x 40 cm over flatbed sowing were found effective in increasing sunflower yield at Akola, Latur, Nandyal and Raichur.
- Pendimethalin @ 1.0 kg a.i./ha as pre-emergence spray + Fenoxoprop ethyl (Whip super) @ 37.5 g a.i./ha at 15-20 DAS as direct post emergence spray (Nandyal), Pendimethalin @ 1.0 kg a.i./ha (PE) + Quizalofop-ethyl 10 EC @ 37.5 g a.i./ha at 15–20 DAS (POE) (Latur) were effective in weed management and increased sunflower yield.
- One hand weeding followed by inter-cultivation at 35 DAS or application of pendimethalin @ 1.0 kg a.i./ha as pre-emergence spray + Propaquizofop @ 62 g a.i./ha at 15-20 DAS as post-emergence spray (Raichur) and Pendimethalin @ 1.0 kg a.i./ha as pre emergence spray followed by power weeder weeding at 30 DAS (Coimbatore) were found promising in weed management and realizing higher sunflower yield.
- The combination of 125% RDF, sulphur, zinc sulphate, FYM 5 t/ha and a spacing of 45 × 30 cm was profitable than a spacing of 60 x 30 cm at Nandyal.
- The frontline demonstrations on sunflower conducted during *rabi*/spring showed that the mean seed yield increased by 25.6% with improved technology (1671 kg/ha) as compared to farmers' practice (1331 kg/ha).
- During *kharif* 2017, the improved technology showed 11.8% increase (1586 kg/ha) in mean seed yield as compared to farmers' practice (1118 kg/ha) indicating the limitations of yield improvement in rainfed areas during *kharif*.
- It is estimated that sunflower production in the country during *rabi*/spring season can be increased from 2.01 lakh tonnes to 3.45 lakh tonnes and *kharif* from 0.77 lakh tonnes to 2.03 lakh tonnes by bridging the yield II (yield gap between improved technology and state average yield) with the adoption of available improved technologies in the current area under sunflower.
- All the root traits (root length, weight and volume) showed strong significant correlation between control and stress conditions. Therefore, screening for root traits in control condition holds good for stress situation as well.
- RSFH-1887, KBSH-1, K-618 and NDSH-1012 were found tolerant to drought (mild stress) whereas SH-416 and DRSH-1 are best suited to moderate drought conditionsnce
- During spring 2017, traces to low incidence of downy mildew and low to medium incidence of charcoal rot, head rot, collar rot and Alternaria were recorded at Ludhiana.
- During *rabi* 2016-17, low to moderate incidence of powdery mildew was recorded at Bengaluru, Coimbatore, Nandyal and high sporadic incidence of powdery mildew (up to 80%) was recorded at Bagalkote and Raichur.
- During *kharif* 2017, low to moderate incidence of Alternaria and low incidence of necrosis were recorded at Akola, Bengaluru, Coimbatore, Latur, Nandyal and Raichur centers. Moderate to low incidence of SuLCV was recorded at Raichur and Nandyal centres.
- *In rabi,* the entries that showed less disease incidence for Alternaria are KBSH-78, NSFH-1001; for necrosis: PSH-2091, LG-55-01; for powdery mildew: BLSFH-15004, KBSH-73; for charcoal rot: IIOSH-14-2, BLSFH-15004, NSFH-639, LG-55-01, IIOSH-2. Four IHT entries *viz.*, KBSH-77, BLSFH-15004, IIOSH-2 and KBSH-78 and all the seven test entries in AHT, were with no ('0') downy mildew disease incidence.
- In *kharif*, the entries that showed less disease incidence for Alternaria are LSFH 1751, IIOSH- 2; necrosis: IOSH-15-10, LSFH 4951; powdery mildew: IIOSH-15-10, SVSH-475, IIOSH-2, RSFH 130. Five IHT test entries *viz.*, NCSH-2431, BLSFH-15005, SVSH-498, SVSH-475, LSFH-1751 and in AHT, IIOSH-2 and BLSFH-15001 showed downy mildew disease incidence.
- For the management of collar rot at Ludhiana, seed treatment with *T. viride* (0.4%) + *P. fluorescens* (0.4%) and soil application of *T. viride* @ 2.5 kg/ha) gave maximum disease reduction over control (66.3%).
- Among the different screening techniques tested for charcoal rot disease, the method using 30 g of inoculum

as soil inoculation with water stress of 60% field capacity, induced maximum disease incidence of 71.6 percent.

- For the effective management of Alternaria leaf spot using combi-product fungicides, seed treatment with carbendazim 12% + mancozeb 63% WP (SAAF 75WP) @ 2 g/kg seed followed by two foliar sprays with zineb 68% + hexaconazole 4% WP (Avatar) @ 2.5 g/l (at 45 and 60 DAS) was found to be the most effective.
- For the management of multiple diseases of sunflower using plant growth promoting rhizobacteria (PGPR), seed treatment with *P. fluorescens* @ 10 g/kg seed + soil application of 2.5 kg *P. fluorescens* @ 2.5 kg fortified with 250 kg FYM + three foliar sprays of *Pf* at 30, 45 and 60 DAS was effective with less incidence of Alternaria and necrosis diseases with highest yield and B:C ratio compared to six other treatments tested.
- In coordinated trial entries, BLSFH-15004 (IHT), and KBSH-79 (AHT) recorded the lowest injury grade of 1 and 2, respectively at multi-locations against leafhoppers.
- The entries, 6D-I, HA-430A and GMU-440, that were found resistant to diseases in previous years were found promising against leafhopper as well with an injury grade of 1 or 2 at least in 3 locations each.
- In a multi-location evaluation, sunflower germplasm lines, GMU-504, GMU-669, GMU-696, GMU-1029 and AKSF-1-46.2 were found promising against leafhoppers with injury grade of 1 or 2.
- Incidence of sucking pests like leafhoppers, thrips and whiteflies was higher during *rabi* season in Maharashtra and Karnataka compared to *kharif* season. Higher sucking pest population was recorded during 47-51 standard meteorological week (SMW) in Akola; 3-7 SMW at Latur and 14-17 SMW in Bengaluru. Lepidopteran pests (defoliators and head borer) infestation was more in *kharif* or summer season compared to *rabi* season. In both the seasons, the pest infestation was low in Bengaluru.
- For management of head borer, *H. armigera*, profenofos 50 EC @1 ml/l was found effective followed by Bt-127 at Latur and Bengaluru.
- Insecticide, diafenthiuron 50WP was found effective (8.1/6 leaves/plant) against whiteflies compared to other insecticides and untreated control (39.9/6 leaves/plant) at 10 days after spray at Raichur.
- Rs 614.86 lakh was released to sunflower centers besides the release of Rs 7.35 lakh as need based research fund. Rs. 7.49 lakhs towards testing fee was also released.

Major Recommendations

- Released LSFH-171 for Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana and Eastern India; Prabhat for Andhra Pradesh and PDKV-SH-952 for Maharashtra.
- Application of Pendimethalin @1.0 kg a.i./ha (PE) + Fenoxyprop ethyl (whip super) @ 37.5 g a.i./ha at 15-20 DAS as directed PE is recommended for realising higher sunflower seed yield and higher weed control efficiency and economics in Vertisols at Andhra Pradesh.
- Dibbling of hybrid sunflower seed at 30 cm distance in the center of both sides of ridges open at 4 feet distance along with 100% RDF (N-60, P_2O_5-90, K_2O-60 kg/ha) is recommended for *kharif* rainfed condition of western Maharashtra by advantage of 40% seed saving, conservation of soil moisture and 14% higher seed yield.
- Seed treatment with SAAF (carbendazim 12% + mancozeb 63%) @ 2 g/kg seeds + weekly irrigation is effective in reduction of charcoal rot in Punjab and increase in seed yield.

SAFFLOWER

- Based on the evaluation at four locations, 19 accessions were confirmed for stable oil content >40% at 2-3 locations. The accessions with the highest oil content included EC-736500-1 (48.44%), EC-736501-1 (48.0%) at IIOR, Hyderabad, EC-736511 (48.37%) at Indore, EC-736495 (44.88%) at Parbhani and EC-736496 (41.46 %) at Phaltan. High seed yield was recorded for the accession GMU 1182 (EC-181423) at Parbhani and Indore, whereas GMU 6663 was promising for seed yield at Parbhani and IIOR, Hyderabad.
- Short duration variety, NARI-SD-38 developed at Phaltan has recorded 8.4% higher seed yield (998 kg/ha) than short duration check, JSI-99 (920 kg/ha) in multilocation evaluation trial. It flowered in 68 days and matured in 103 days after planting. Two short duration varieties, ISF-866 and ISF-867 developed at ICAR-IIOR, Hyderabad have recorded much higher seed yields (2213 kg/ha, 2313 kg/ha) than short duration check, JSI-99 (408 kg/ha), and were at par with the best normal duration check, A1 (2179 kg/ha).
- PYT-I-201 developed at Parbhani gave the highest seed yield (3054 kg/ha) with 69% superiority over the best check, PBNS-12 (1812 kg/ha).
- ICAR-IIOR, Hyderabad has developed 42 high oil lines (35-43.8%) of which, 36 lines have recorded 10-49%

higher seed yields (2542-3445 kg/ha) than the best check, A1 (2305 kg/ha).

- The CMS lines developed at Akola (AKS CMS 2A, AKS CMS 3A) and ICAR-IIOR, Hyderabad (ICMS-133-IA, ICMS-133-IIA) have maintained stability for high male sterility per cent (98.8-99.5%).
- Total 105 new CMS-based hybrids were developed at Akola, Indore and ICAR-IIOR, Hyderabad.
- Two populations *viz.*, PBNS-140 and PBNS-142 developed at Parbhani gave 18.49 and 25.37 % higher seed yields (1807kg/ha, 1912 kg/ha) than check, PBNS-12 (1525 kg/ha) and 29-36% higher than A1 (1405 kg/ha).
- In IVT, the non-spiny entry, ISF-1258-15 recorded 10.3% higher seed yield (1570 kg/ha) than the check, NARI-6 (1423 kg/ha) at national level. SSF-13-71 recorded 12.6% higher seed yield (1683 kg/ha) and 21.1% higher oil yield (523 kg/ha) than the best check, A1 (1494 kg/ha seed yield; 432 kg/ha oil yield) in Zone-I under rainfed conditions. NARI-120 exhibited 9.8% superiority in oil yield (739 kg/ha) over A1 (673 kg/ha) with the highest mean oil content (35.4%) at national level but recorded 9.7% lower seed yield (2070 kg/ha) than A1 (2293 kg/ha).
- In AVT, the non-spiny variety, SPP-70 recorded 14.7% higher seed yield (1601 kg/ha) than non-spiny check, NARI-6 (1395 kg/ha) and ISF-764 gave 10.4% higher oil yield (673 kg/ha) and 4.6% higher seed yield (2193 kg/ha) than A1 (609 kg/ha oil yield; 2096 kg/ha seed yield) at national level.
- Hybrid, ISH-388 in IHT recorded 13.6% higher oil yield (692 kg/ha) than A1 (609kg/ha) at national level. It showed 19.5% increase in seed yield (2080 kg/ha) than hybrid check, NARI-H-23 (1741 kg/ha) but could not out yield A1.
- A total of 304.78q of breeder seed of nine varieties was produced against the assigned target of 11.41 q breeder seed.
- Recommended plant spacing (45 x 20 cm) and 100% RDF were better in fallow-safflower (Akola), fallow-safflower and blackgram-safflower (Solapur), wider plant spacing (60 x 20 cm) and 100% RDF were better in fallow-safflower (Tandur).
- Application of fertilizer based on STCR equation along with Zn (5 kg/ha) and S (10 kg/ha) enhanced the seed yield (1793 kg/ha) over 100% RDF (1293 kg/ha) at Tandur.
- Intercropping of one row of leafy vegetable either coriander or fenugreek (as additive series) in safflower generated higher income than sole safflower.
- The demonstrations conducted across the varied agro-ecological situations of the country under rainfed conditions, revealed yield advantage of 21.2 and 33.3% over the farmers' practice in the traditional states of Karnataka and Maharashtra. In the non-traditional states *viz.*, Chhattisgarh and Madhya Pradesh, the yield advantage was 26.7 and 18.02% *vis-à-vis* farmers' practice.
- Across the country, the demonstrations evidenced yield advantage of 11.4% over farmers' practice resulting to additional net returns of Rs. 6209 / ha with B:C ratios of 2.21 and 1.88 on IT and FP farms, respectively.
- In UDN trial, the entries *viz.*, DSI-101, 116, and 118, NARI-P1, P5 and P7 were moderately resistant to *Fusarium* wilt in all locations. The highest seed yield of 735 kg/ha was recorded by DSI-116 followed by NARI-P5 (687 kg/ha).
- Fusaric acid at 15 to 20 ppm concentration could be used for confirmation of resistance to Fusarium wilt in laboratory (Solapur). At Phaltan, soil/sand cup method was found effective for screening safflower genotypes against Fusarium wilt. Agar culture bit inoculation technique was effective for identifying resistant sources to Phytophthora seedling blight (IIOR, Hyderabad).
- Seed treatment with *T. harzianum* Th4d SC @ 2ml/kg and *T. harzianum* Th4d WP @10g/kg were found to be the more effective recording low Fusarium wilt, Macrophomina root rot (*Rhizoctonia bataticola)* and Phytophthora seedling blight and recorded highest seed yield at Parbhani centre. Seed treatment with cymoxanil 8% + mancozeb 64% @ 0.2% and *T. harzianum* Th4d WP @10g/kg were found to be the most effective recording significantly low incidence of Fusarium wilt at Tandur.
- Carbendazim 12% + mancozeb 63% @ 0.2% was most effective against Alternaria leaf spot and highest seed yield was also recorded in same treatment at Solapur. At Phaltan, mancozeb 75 WP @ 0.25% was effective in management of Alternaria leaf spot.
- Out of 138 entries of early breeding material screened, 2 entries *viz.*, SAF-1518, and SAF-1674 from Solapur and 7 entries from Hyderabad *viz.*, ISF-36-15, ISF-19-15, ISF-20-15, ISF-22-15, ISF-23-15, ISF-25-15 and ISF-28-15 were found resistant to aphids.
- Safflower genotypes, SF-1506, SAF-1511 were found resistant at multi-locations under UPN, while resistant reaction of SAF-13-40 was consistent at 3 locations.

- Seed treatment with thiamethoxam 30FS @ 10 ml/kg seed or imidacloprid 70WG @ 8 ml/kg followed by foliar sprays of pymetrozine 50WG @ 300 g/ha or difenthiuron 50WP @ 600 g/ha effectively reduced the aphids by 92% over control.

Major Recommendations

- For scarcity zone of Maharashtra, for blackgram-safflower system, it is possible to substitute 50% P of blackgram with PSB and 50% NP of safflower with *Azospirillum* and PSB without any adverse effect on system productivity
- For Telangana, greengram-safflower system, it is possible to substitute 50% P of greengram with PSB and 50% NP of safflower with *Azospirillum* and PSB without any adverse effect on system productivity
- For sufficient rainfall zone of Maharashtra, in soybean-safflower system, application of safflower residues along with 2.5 t FYM/ha could save 50% NPK of soybean; soybean residues along with 2.5 t FYM/ha could save 50% NPK of safflower.

ICAR-IIOR

Annual Report 2017-18

Institutional Activities

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

EXTENSION AND OTHER ACTIVITIES

Tribal Sub-Plan

Tribal sub-plan programme was implemented in 43 villages of 8 districts spanning over 6 states *viz*., Andhra Pradesh, Telangana, Tamil Nadu, West Bengal, Gujarat and Chattisgarh with the objective of reducing poverty among the scheduled tribe population and creation of productive assets for them. Under this programme, 463 scheduled tribe farmers were benefited through demonstrations of latest released varieties/hybrids of castor, sunflower and safflower with improved technologies conducted in association with NGOs such as, Viksit Rythu Sankshema Samstha (VRSS), Ekalavya Foundation (EF) and REEDS and AICRP centres such as Nimpith, Yethapur, Raipur and Navasari. These farmers were trained on the improved cultural practices to cultivate these crops. The farmers were given all the inputs such as seed, fertilizer and pesticides. Besides, the farmers of Prakasam district in Andhra Pradesh were given secatures, hand sprayer and manual weeder. Periodically, the programmes were monitored by the scientists concerned by visiting the fields.

Demonstration of castor and safflower under Tribal Sub-Plan

Organization	State	District	Villages	No. of beneficiaries	Crop/variety/hybrid demonstrated
ICAR-IIOR through VRSS, Ekalavya Foundation and REEDS	Andhra Pradesh & Telangana	Prakasam Nalgonda, Vikarabad	11	191	Castor –DCH-519, DCH-177, Safflower- PBNS-12
TCRS, Yethapur	Tamil Nadu	Salem	10	50	Castor- YRCH-1
RMKVK, Nimpith	West Bengal	Bankura Purulia	12	152	
CoA, Raipur	Chattisgarh	Rajnandgaon	1	40	Safflower- PBNS-12
NAU, Navsari	Gujarat	Narmada	9	30	Castor- GNCH-1
Total	**6**	**8**	**43**	**463**	

North-East Hill (NEH) Region

In order to exploit the NEH region for expanding area of the mandate crops, a programme was launched with an objective to identify suitable variety/ hybrid through evaluation for yield performance at SASRD, Nagaland University, Medziphema; ICAR-Research Complex for NEH region, Nagaland; ICAR-NOFRI, Tadong, Gangtok, Sikkim; College of Agriculture, Lembuchera, Tripura; ICAR-Research complex for NEH region, Basar, Arunachal Pradesh. Latest released varieties/hybrids of sunflower, niger and sesame were evaluated. The yield of sunflower hybrids ranged from 1.65 t/ ha (KBSH-53) to 2.48 t/ha (KBSH-41) at ICAR-NOFRI, Gangtok, Sikkim. In Medziphema, Nagaland the yield varied from 762 kg/ha (LSFH-171) to 1072 kg/ha (KBSH-53).

The research work carried out during 2017-18 in the NEH region was reviewed and a field day on sunflower was also organized by College of Agriculture, Lembucherra, in Tripura on April 09, 2018. A total of 100 farmers, farm women and rural youth from four districts of Tripura participated in the programme. Seven member team of different subject matter specialists from ICAR-IIOR, Hyderabad, Dr. S.P. Das, Principal Scientist from ICAR-NEHR Lembucherra centre, Assistant Directors, ATMA-Lembucherra, Govt. of Tripura, team of scientists of CAT, Lembucherra and subject matter specialists from ICAR-KVK, Lembucherra interacted with the 100 progressive farmers for production and possibility of sunflower and sesame. At Lembucherra, KBSH-53 appeared to be better than the other hybrids evaluated. Early maturing (85-90 days) sunflower hybrids may be suitable to the area.

Reviewed the research work carried out during 2017-18 on niger and sesame in NEH region and a field day on niger and sesame was organized by ICAR-NEH complex Basar centre, Arunachal Pradesh on April 12, 2018. A total of 80 farmers attended the field day along with line department officers, scientists from host Institute and subject matter specialists from ICAR-KVK, Basar. A fruitful interaction with farmers took place in the field and discussed various aspects of niger and sesame cultivation. At Basar, as the sowings were much delayed (done in January & February, 2018), the results of the evaluation are not conclusive. Though some varieties flowered, the seed yield may not reflect the actual potential since, the rainy season already started in the region. The committee felt that 85-90 days duration sesame and niger varieties may be evaluated for their suitability. The sowing of the crop may be done immediately after harvest of rice crop in the month of November to facilitate the crop to be harvested before last week of March.

Sunflower field day at College of Agriculture Tripura, Lembucherra, West Tripura on April 9, 2018

Niger-sesame field day at ICAR-NEHR complex Basar, Arunachal Pradesh on April 12, 2018

Sunflower crop at ICAR-NOFRI, Gangtok

Mera Goan Mera Gaurav (MGMG)

Mera Goan Mera Gaurav programme as launched by the Honourable Prime Minister of India was initiated with objectives: to identify a village and strengthen interface with farmers, periodically update farmers about agricultural activities through phone and mobile messages, provide technology handout as per the agro-ecological conditions of the village, provide information to farmers about agricultural inputs, seed, fertilizer, chemical, agricultural machinery, climate, market, etc., educate farmers through newspapers, community radio, etc., create awareness among farmers about the programmes being implemented by various organizations and institutions working at local level e.g. voluntary organizations, farmers' organisation, ATMA, other government departments, make farmers aware of the sensitive issues of national importance *viz*., Swachh Bharat Abhiyaan, climate change, water conservation, soil fertility, etc., organise farmer's meet by visiting the selected villages as per need and facilitate the participation of specialists of the concerned institutes, identify technical problems at village level and make use of those in prospective research programmes and generate technical, social and economic data related to a village and to submit quarterly report of work done.

During the period under report, 10 teams were formed and each team selected five villages in Ranga Reddy, Mahabubnagar, Nalgonda and Vikarabad districts of Telangana. The following were the activities undertaken under the MGMG programme.

- Collected the farmers' resource base and examined the existing cropping pattern for facilitating the technical aspects and increase income through cost reduction as well as increased productivity.
- Awareness on Swachh Bharat and conducted activities on Swachhatha.
- Awareness on importance of soil testing and skill development in soil sampling for soil testing.
- Awareness on the importance of resource conservation technologies for better soil and moisture conservation.
- Conducted field days and interactive meetings on important occasions *viz*., World Soil Day, Jai Jawan Jai Kisan.
- Conducted a special field day cum interactive meeting on the occasion of Webcasting of Honourable Prime Minister's address to the nation on March 17, 2018.
- In connection with Krishi Unnati Mela from March 16-18, 2018, organized at ICAR-IIOR, Hyderabad. Farmers from all MGMG villages participated in the programme.
- Created the awareness on the importance of crop diversification in the context of changing climate and weather conditions.
- Created awareness on important government programmes and their relevance to doubling farmers income.
- Importance of bio-control in management of seed and soil borne diseases.
- Importance of Integrated Pest Management in cotton, maize and vegetables.
- Distributed soil health cards to 210 farmers
- Demonstration of hybrid castor production technology and intercropping with redgram for risk mitigation.
- Demonstration of K-6 groundnut production technology for seed production for increasing the farmers income
- Awareness on the use of micronutrients.
- Conducted entrepreneur development programme on mushroom production in the context of doubling farmers income.
- Provided *Trichoderma* for seed treatment for combating the seed and soil borne diseases.
- Demonstration of sesame, sorghum and paddy (low Glycemic Index) production technology.
- Organised field days and visited demonstration plots for creating awareness of the latest production technologies on IIOR mandate crops.
- Awareness on market information system and providing information on market prices of the APMC's in the vicinity.
- Conducted training programme on vermicomposting.
- Dissemination of mobile based crop wise information from time to time to the selected farmers.
- Liasioned with Line Departments (Agriculture, Horticulture, Animal Husbandry, Forestry, Revenue) ICAR Institutes (IIMR, IIRR, DPR) PJTSAU etc. for implementing technologies as well as other government programmes.
- Conducted an interactive session with a group of 20 farmers involved in horticultural crops along with the Horticultural officer, Mr. Jayaraj on Mar 28, 2018 at Jukal village, Ranga Reddy District.

National Agricultural Innovation Fund Activities

Activity	Theme / Area	Place	Date of Conduction	No. of farmers / stakeholders participated
Exhibition	Agri Business Development of bio-controls	ICAR-IIOR	Sep. 10-11, 2017	325
Capacity building / Training	Seed production of groundnut	Rampur Thanda, Vikarabad district	Oct. 7, 2017	15
Capacity building / Training	Value addition of groundnut	Aampally, Vikarabad district	Oct. 11, 2017	12
Exhibition	World Food day	MoFP and CII, New Delhi	Nov. 3-5, 2017	530
Capacity building / Training	*Trichoderma harzianum* 4d SC formulation	ICAR-IIOR	Nov. 13-20, 2017	2
Capacity building / Training	EDP on production of bio-controls	ICAR-IIOR	Nov. 16, 2017	40
Capacity building / Training	EDP on value addition of safflower	Grameen Mall Inc.	Jan. 6, 2018	75
Exhibition	Farmers' Rights and Agro-Biodiversity	PJTSAU	Jan. 27, 2018	65
Capacity building / Training	EDP on value addition of safflower	KH Patil KVK, Hulkoti Aat Karamudi village, Gadag district	Feb. 2, 2018	35
Capacity building / Training	Production process of bio-controls	ICAR-IIOR	Mar. 20-24, 2018	11
Exhibition	Enriching soils for sustainable agriculture	Ekalavya Foundation	Mar. 24-25, 2018	385
Capacity building / Training	EDP on production of bio-controls	ICAR-IIOR	Mar. 26, 2018	13

EDUCATION AND TRAINING

Details of students working for Ph.D. (2017-18)

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

Dissertations submitted and Ph.D. awarded

Supervisor	Ph.D Scholar	University	Title of the dissertation
Dr. M. Sujatha	P. Sai Sudha	Andhra University, Visakhapatnam	Tissue culture studies and identification of candidate gene(s) responsible for organogenesis in castor (*Ricinus communis* L.)
Dr. M. Sujatha	M. Tarakeswari	Osmania University, Hyderabad	Development and characterization of transgenic events in castor *(Ricinus communis* L.) through deployment of *cry IAa* and *cry IEC* genes
Dr. M. Sujatha	S. Vasavi	Osmania University, Hyderabad	Development and evaluation of sunflower transgenics for resistance to necrosis disease

IIOR Activities

Activity	Theme / Area	Place	Date of Conduction	No. of farmers / stakeholders participated
Field day	Sesame germplasm	ICAR-IIOR and ICAR-NBPGR, Hyderabad	Apr. 4, 2017	28
Field day	Improved sesame production technology	Burujupalli, and Venkatapuram Thanda (REEDS)	Jun. 20, 2017	60
Capacity building / Training	Moisture conservation and nutrient management in castor	Thippaiguda, Telangana	Jul. 5, 2017	20
Capacity building / Training	Nutrient management in castor	Rachakonda village, Mahabubnagar district	Aug. 19, 2017	25
Kisan mela	National Oilseeds Kisan Mela	ICAR-IIOR, Hyderabad	Sep. 10-11, 2017	1525
Capacity building / Training	Improved technologies for increasing the yield of castor	Rural Development Trust, Anantapuram, Andhra Pradesh	Sep. 15, 2017	50
Capacity building / Training	Management of Botrytis in castor	Jangamreddypalle, Mahabubnagar district	Sep. 19, 2017	30
Field day	Profitable technologies of castor	Jangamreddypalle Village, Mahabubnagar	Sep. 21, 2017	125
Capacity building / Training	Management of Botrytis in castor	Meenugovanipalle, Mahabubnagar district	Oct. 6, 2017	30
Kisan mela	Improved production technology of oilseeds	ICAR-IIRR, Hyderabad	Oct. 30, 2017	110
Niger field day	Improved production technologies of niger	Arsada Village, Chintapalle, AP	Nov. 9, 2017	85
Field day	World Soil Day	Rampur thanda, Vikarabad district	Dec. 5, 2017	210
Field day	Castor hybrid seed production	Cherukuru, Veldanda, Nagarkurnool, TS	Dec. 27, 2017	78
Capacity building / Training	Rice production technology	Aampally Village, Vikarabad district	Jan. 5, 2018	85
Exhibition	Gramostavam	Grammen Mall Inc at Zaidupalli, Vikarabad district	Jan. 6, 2018	75
Capacity building / Training	Integrated farming systems for doubling farmers income	Gattepally village, Vikarabad District	Jan. 20, 2018	125
Field day	Safflower production technologies	Karamudi village, Gadag distict KH Patil KVK, Hulkoti	Feb. 1, 2018	85
Field day	Field day-cum-training on improved castor production technologies	Patherched village, Narwa Mandal, Mahabubnagar district	Feb. 2, 2018	500
Capacity building / Training	Vermicomposting production technology for improved soil health in oilseeds based production system	ICAR-IIOR / Agri Biotech Foundation, Hyderabad	Mar. 3, 2018	30
Kisan mela	Krishi Unnathi Mela	ICAR-IARI, New Delhi	Mar. 16-18, 2018	3240
Kisan mela	Krishi Unnathi Mela	ICAR-IIOR Hyderabad	Mar. 17, 2018	426
Capacity building / Training	Mushroom production technology for enhanced nutritional security and income generation	ICAR-IIOR / PJTSAU, Hyderabad	Mar. 21, 2018	50

Farmers exposure visit to ICAR-IIOR, Hyderabad

Place/State	Date	No. of farmers
Burhanpur, M.P.	Apr. 24, 2017	12
West Godavari, A.P.	May 23, 2017	20
Nagapattinam, Tamil Nadu	Jun. 6, 2017	15
Tamil Nadu	Jun. 14, 2017	18
Nagapattinam Tamil Nadu	Jun. 15, 2017	22
Belagavi, Karnataka	Jul. 4, 2017	18
Virudhunagar, Tamil Nadu	Aug. 23, 2017	20
Kanchipuram, Tamil Nadu	Oct. 10, 2017	41
Ramanthapur, Tamil Nadu	Oct. 26, 2017	20
Uttara Kannada, Karnataka	Oct. 27, 2017	17
Gadag, Karnataka	Nov. 16, 2017	40
Dharwad, Karnataka	Dec. 20, 2017	30
Tirunevelli, Tamil Nadu	Dec. 20, 2017	16
Nalgonda, Telangana State	Feb. 16, 2018	30
Maharashtra	Feb. 19, 2018	30
Erode, Tamil Nadu	Mar. 25, 2018	15

Training Programmes organized

Title of the programme	Place	Date(s)
Training on sesame best management practices	Chityal Village, Nirmal District, TS	Apr. 13, 2017
High oleic safflower cultivation training to field level officers	Tirupati	Jul. 28, 2017
Field Day cum training on Niger	Killoguda, Domriguda, Aruku, AP	Nov. 10, 2017
Workshop cum training on productivity enhancement of *rabi* castor through adoption of BMPs	Koklai village, Namakkal, TN	Dec. 29, 2017
On-farm training on seed production of CMS based hybrid and varieties of safflower	ICAR-IIOR, Hyderabad	Feb. 12, 2018
Castor breeders training and hybrid seed production	ICAR-IIOR, Hyderabad	Feb. 15-16, 2018
Workshop-cum-training on BMPs for *rabi* castor	Atmakuru, Ananatapuramu, AP	Mar. 3, 2018

Sunflower Germplasm-cum-Breeders' Day

The Breeders-Cum-Germplasm field day of sunflower was organized on February 17, 2018 at IIOR at its Rajendranagar and Narkhoda farms. More than 100 CMS and B lines supplied by all the AICRP centres, pre-breeding lines along with trait specific germplasm accessions received form USDA-ARS, USA were raised for display. Nine breeders from the AICRP (Sunflower) centres participated in the field day and made selections for utilization in the breeding programmes.

On-farm training on hybrid seed production of castor

An on-farm training on "Parental line development and hybrid seed production of castor" was conducted at Narkhoda farm, ICAR-IIOR, from February 15-16th, 2018 for the benefit of all castor breeders of AICRP (Castor), researchers and seed production officers and field staff of IIOR. Scientists from Palem, Yethapur, Bhawanipatna along with castor team at IIOR participated in the programme. Ten pistillate lines and 30 male lines, raised in a show case trial in addition to those raised in the crossing block were shown to the scientists for selecting the relevant material for their use in breeding. Participants also visited breeder seed production plots of two parental lines, DPC-9 and M-574 and participatory hybrid seed production plots of DCH-519 near Palem, Nagarkurnool district, Telangana.

Visit to parental lines and crossing block (Narkhoda Farm, IIOR, Hyderabad)

Participatory seed production of DCH-519 castor hybrid in farmers' field in Palem, Nagarkurnool Dist., Telangana

Safflower Germplasm-cum-Breeders' Day

The Safflower Germplasm-cum-Breeders Field Day was organised on March 6, 2018 at IIOR-ICRISAT Farm. Five breeders from AICRP (Safflower) centres attended the programme and observed the variability among the fresh collections from Maharashtra, trait specific germplasm and other promising germplasm 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.

Safflower breeders' visit to experimental fields

AWARDS AND RECOGNITIONS

Best Worker Awards

The Best Worker Awards in different categories of IIOR staff were awarded to the following staff on the occasion of IIOR Foundation Day held on August 1, 2017.

Name	Category
Dr. M. Santha Lakshmi Prasad, Dr. M. Sujatha, Dr. K. Alivelu and Dr. K. Sujatha	Best research paper (Certificate and cash – ₹1,000/-)
Shri S. Shamdas	Administration (Certificate and cash – ₹ 3,000/-)
Shri M. Ramulu	Skilled supporting service (Certificate and cash – ₹ 3,000/-)
Shri B. Shankaraiah, Smt. N. Ramulamma and Smt. D. Hamsamma	Temporary status labour (Certificate and cash – ₹ 1,000/- each)

Other Awards

- Dr. Ratnakumar Pasala received Excellence in Research Award-2017 by Samagra Vikas Welfare Society, Lucknow.
- Dr. K. Alivelu and Dr. C. Sarada were awarded with Fellow of ISOR.
- Smt. K.S.V.P. Chandrika received Certificate of Excellence in Reviewing the Journal "International Journal of Plant and Soil Science".
- Shri Kumaraswamy, H.H., was awarded "Best Scientist in Biotechnology" by International Multidisciplinary Research Foundation (IMRF) during the inaugural function of International Conference on "Recent Trends in Agricultural, Environmental and Biosciences-2017" held at Chandigarh during April 27-29, 2017.
- Shri Kumaraswamy, H.H., received "Best Oral Presentation Award" for the paper "Comprehensive Knowledge of Genetic Diversity of Indian Wheat is Key to Sustainable Wheat Production in India", presented during International Conference on "Recent Trends in Agricultural, Environmental and Biosciences-2017", organized by International Multidisciplinary Research Foundation at Chandigarh during April 27-29, 2017.
- Dr. P. Duraimurugan, received "Distinguished Scientist Award" for outstanding contribution in the field of Agricultural Entomology during the "National Conference on Technological Challenges in Social, Environmental and Agricultural Reforms" organized by the Green Reap Welfare Society at ICAR-IIRR, Hyderabad during Sept. 9-10, 2017.
- Dr. P. Duraimurugan, received "Best Poster Award – First Prize" for the paper entitled "Evaluation of mating disruption technique with synthetic sex pheromone for the management of *Spodoptera litura* in castor (authored by P. Duraimurugan and M. Sampath Kumar) presented during the National Conference on Technological Challenges in Social, Environmental and Agricultural Reforms organized by the Green Reap Welfare Society at ICAR-IIRR, Hyderabad during Sept. 9-10, 2017.
- Dr. P. Duraimurugan, received "Best Poster Award – First Prize" for the paper entitled "Exploiting pheromone and kairomone blends for trapping *Spodoptera litura* moths in castor (authored by P. Duraimurugan and M. Sampath Kumar)" presented during the 3rd National Conference on Frontiers in Ecobiological Sciences and its Applications organized by School of Life Sciences, Periyar University, Salem, Tamil Nadu during Feb. 7-9, 2018.
- Dr. H.P. Meena, received the Best Poster Award for the poster 'Harnessing the power of crop wild relatives for sunflower (*Helianthus annuus* L.) improvement in India'' by H.P. Meena, M. Sujatha, H.D. Pushpa and A. Vishnuvardhan Reddy in International Conference on "Sustainability of Smallholder Agriculture in Developing Countries under Changing Climatic Scenario" conducted at CSAUAT, Kanpur, Uttar Pradesh during February 14-17, 2018.
- Dr. Sujatha, T.P., received best oral presentation certificate for the paper "Bisexuality precedes unisexuality and alters with temperature in castor (*Ricinus communis* L.) flowers" in 2nd International Conference on Food and Agriculture 2018 held at Dhanbad, Jharkhand during March 29-31, 2018.
- Smt. K.S.V.P. Chandrika received Young Scientist Award in International Conference on Food & Agriculture held at Dhanbad, India, March 29-31, 2018.

Recognitions

- Dr. Ratnakumar Pasala received Elsevier Reviewer Recognition-2017 by Regional Studies in Marine Sciences, Elsevier, The Netherlands.
- Dr. Ratnakumar Pasala has been identified as Member Editor-Journal of Functional and Environmental Botany -2017 (ISSN: 2231-1742; NAAS rating: 4.33).
- Dr. V. Dinesh Kumar has been nominated as IBSC Member of PJTSAU, ICRISAT, DuPont, SNIST and Aegis Agro Chemicals, Hyderabad.
- Dr. V. Dinesh Kumar has been a Member of RAC of IISR, Indore and ABF, Hyderabad.
- Dr. V. Dinesh Kumar had been a Member of IMC of IIRR, Hyderabad and IIMR, Hyderabad.
- Dr. V. Dinesh Kumar has been invited as an external expert for the IRC of crop improvement section at IIRR.
- Dr. J. Jawaharlal has been nominated as Editorial Board member of Journal of International Academic Research for Multidisciplinary.
- Dr. Kadirvel Palchamy has been recognized as mentor to Dr. M. Jegadeeswaran, DST-National Post Doctoral Fellow for two years from April 4, 2017 to March 31, 2019.
- Dr. P.S. Srinivas has been a member of IMC of ICAR-DOGR, Rajgurunagar for a three year term (2015-18).
- Dr. P.S. Srinivas has been recognized as member of Editorial Board of Journal of Allium Research, Indian Society of Alliums.
- Dr. H.P. Meena has been recognized as Editorial Board Member for Journal of Plant Science and Research.
- Dr. Sujatha, T.P, has been selected as Editorial Board member of Journals Acta Scientific Agriculture and Trends in Genetics and Evolution.
- Dr. P. Duraimurugan has been recognized as Editorial Board Member, Journal of Food, Agriculture and Environment, WFL Publisher (Science and Technology), Finland.
- Dr. P. Duraimurugan has been a DBT Nominee in the Institutional Biosafety Committee (IBSC) of M/s. Seed Works International Pvt. Ltd., Medchal Mandal, Telangana.
- Dr. P. Duraimurugan has been recognized as Chief Editor, Editorial Board, Journal of Oilseeds Research, Indian Society of Oilseeds Research, IIOR, Hyderabad.
- Shri Kumaraswamy, H.H. has been recognized as Editorial Member for International Journal of Agricultural Sciences, Published by Bioinfo Publications.
- Shri Kumaraswamy, H.H. has been an external expert in the Institutional Biosafety Committee (IBSC) of M/s Seed Works International Pvt. Ltd., Medchal Mandal, Telangana.

Sports

- During the ICAR Zonal Sports meet held at Coimbatore from 9-13 September 2017, Smt. C. Lalitha, bagged the first prize in carroms (Women) and Dr. M. Sujatha and Smt. D. Swaroopa Rani got the Runners-Up prize in table tennis (Women-Doubles).
- Smt. C. Lalitha bagged the first prize in carroms (Women) during the ICAR National Sports Meet held at Hyderabad from 21-25 February 2018.

IPR

Technology licensing: *Trichoderma harzianum 4d* formulation was licensed to M/S Dhampur Bio-Organics, Dhampur, Bijnor, U.P on 28-08-2017 by ICAR-IIOR.

Registrations

Sunflower Plant Variety: SURYAPRABHA (SSFH-32) was registered.

Castor Germplasm: JP-96 was registered.

ON-GOING RESEARCH PROJECTS

Institute Projects

Sl. No.	Project No.	Project Name	Principal Investigator(s)
1.	101-4 IXX10459	Diversification of CMS and restorer system and development of agronomically superior parental lines in sunflower	Dr. H.P. Meena
2.	101-5 IXX12584	Exploitation of inter and intraspecific genetic resources for development of agronomically superior inbred lines and populations in sunflower	Dr. M. Sujatha
3.	102-7 IXX12633	Exploitation of safflower genetic resources for development of superior breeding lines with high oil yield and adaptation to stresses	Dr. P. Kadirvel
4.	102-8 IXX12568	Development of parental lines with high oil yield and wilt resistance in safflower	Dr. K. Anjani
5.	102-9 IXX12571	Development of genetic and genomic resources and identification of genes/markers for agronomic traits in safflower	Smt. B. Usha Kiran
6.	103-11 IXX09329	Elucidating the molecular mechanisms governing sex expression in castor (*Ricinus communis* L.)	Dr. Sujatha T.P.
7.	103-12 IXX12565	Exploitation of plant genetic resources for development of superior inbred lines in castor	Dr. K. Anjani
8.	103-13 IXX12629	Diversification of pistillate base and development of superior parental lines in castor	Dr. T. Manjunatha
9.	103-14 IXX13518	Development of genomic resources and tools for applications in castor breeding	Dr. S. Senthilvel
10.	103-15 IXX13580	Optimization of regeneration and transformation protocols to realize grey mold resistant transgenic castor (*Ricinus communis* L.)	Dr. V. Dinesh Kumar
11.	104-12 IXX12625	Development of agro-ecological, situation specific, cropping system oriented technologies for different oilseed crops	Dr. S.N. Sudhakara Babu
12.	104-13 IXX12569	Assessing safflower based cropping systems productivity and resource use efficiency under different land configurations, crop geometry and IPNM in different Vertisol types and rainfall patterns	Dr. P. Padmavathi
13.	104-14 IXX13048	Synthesis and evaluation of polymers for seed health and productivity of oilseed crops	Smt. K.S.V.P. Chandrika
14.	104-15 IXX13052	Screening and identification of potential sources of tolerance to abiotic stresses and improved physiological efficiency in sesame	Dr. P. Ratna Kumar
15.	104-16	Fine-tuning of agro-technology of sesame for formulating sesame based cropping systems in AER 6 and 7 in the changing weather scenario	Dr. K. Ramesh
16.	105-11 IXX12566	Development of water dispersible granular (WDG) formulation of *Bacillus thuringiensis* var. *kurstaki* for management of *Spodoptera litura*	Dr. P.S. Vimala Devi
17.	105-12 IXX12570	Screening and identification of durable sources of resistance to diseases of castor and deciphering the associated mechanisms	Dr. M. Santhalakshmi Prasad
18.	105-13 IXX12573	Identification of potential sources of resistance to various biotic stresses and understanding the mechanism of resistance in safflower	Dr. P.S. Srinivas
19.	105-14	Screening and identification of dependable sources of resistance to insect pests of castor and deciphering the associated mechanisms	Dr. P. Duraimurugan
20.	105-15 IXX13577	Screening and identification of dependable/durable sources of resistance to biotic stresses of sesame and deciphering the associated mechanisms	Dr. M. Santha Lakshmi Prasad
21.	105-16 IXX13582	Exploiting the bioefficacy of entomopathogenic nematodes against Tobacco caterpillar (*Spodoptera litura)* and Serpentine leaf miner *(Liriomyza trifolii)* in oilseed crops	Smt. B. Gayatri

22.	106-2 IXX13051	Production and characterization of protein hydrolysates from safflower seed and validation of their utility in animal nutrition	Dr. Praduman Yadav
23.	107-16 IXX12572	ICT mediated knowledge management and dissemination in different oilseed crops	Dr. P. Madhuri
24.	107-17 IXX13053	On-farm demonstrations of improved technologies and impact assessment of the adoption	Dr. S.V. Ramana Rao
25.	107-18 IXX13581	Impact assessment of varieties/hybrids of IIOR mandated crops in varied agro ecological regions of India	Dr. S.V. Ramana Rao
26.	108-1 IXX10783	Development of stable cytoplasmic genetic male sterile system in sesame through wide hybridization	Dr. Jawahar Lal J.
27.	108-2 IXX13579	Exploitation of inter and intra specific genetic resources for development of elite breeding lines in sesame	Dr. K.T. Ramya
28.	108-3 IXX13870	Development of genetic and genomic resources and identification of gene/marker for different agronomic traits in sesame	Shri Kumaraswamy, H.H.
29.	109-1 IXX13629	Exploitation of plant genetic resources for development of improved breeding populations in niger (*Guizotia abyssinica* Cass.)	Dr. Pushpa H.D.

Externally Funded Projects

Sl. No.	Project No.	Project Name	Principal Investigator(s)	Sponsoring organization
1	OXX02627	Deciphering the molecular mechanism of induction of biotic stress tolerance induced by *Trichoderma* spp. in castor (*Ricinus communis* L.)	Dr. V. Dinesh Kumar	ICAR National Fund
2	OXX02640	Mass production of *Bacillus thuringiensis* (Bt) and *Beauveria bassiana*, formulation as oil based suspension concentrates singly and in combination and field evaluation	Dr. P.S. Vimala Devi	ICAR Network-AMAAS
3	OXX02676	Development of practicable technologies for field level exploitation of consortia of microbial agents as ameliorators of biotic and abiotic stresses in crops	Dr. R.D. Prasad	ICAR Network-AMAAS
4	OXX03540	Proactive mitigation of gray mold (*Botryotinia ricini*) disease of castor (*Ricinus communis* L.) crop in Telangana State using dynamical disease forecast	Dr. R.D. Prasad	DST-SSTP
5	OXX03778	Competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana	Dr. S.V. Ramana Rao	KVK Scheme, Extension Division, ICAR
6		Seed Production in Agricultural Crops	Dr. S.N. Sudhakara Babu	ICAR Network
7	OXX03728	Developing high oleic safflower genotypes for Indian conditions and development of protocols for marker assisted selections for high oleic traits in safflower	Dr. K. Anjani Dr. P. Kadirvel	MARICO Pvt. Ltd.
8	OXX03777	Mapping of QTLs associated with resistance to aphid (*Uroleucon compositae* Theobald) in safflower (*Carthamus tinctorius* L.) using genome-wide SNP markers	Dr. P. Kadirvel	DST
9	OXX0412	Area expansion and productivity enhancement of castor through quality seed production and adoption of BMPs	Dr. S.N. Sudhakara Babu and Dr. G. Suresh	NMOOP, DAC&FW, GoI
10		Frontline demonstrations (FLDs) on oilseeds and other extension activities	Dr. G.D. Satish Kumar	NMOOP, DAC&FW, GoI

MEETINGS AND EVENTS

Annual Group Meeting on Sunflower, Sesame and Niger

The Annual Group Meeting of Sunflower, Sesame & Niger was inaugurated with the lighting of lamp by the dignitaries at CCSHAU, Hisar on April 20, 2017. Hon'ble Vice-Chancellor of CCSHAU, Hisar, Professor K.P. Singh as the chief guest graced the occasion. Dr. D.K. Yadava, ADG (Seeds), ICAR was the Guest of Honour. Other dignitaries those graced the occasion were Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR, Hyderabad; Dr. K.R. Naik, In-charge, Project Coordinating Unit, AICRP Sesame & Niger, Jabalpur; Dr. D.R. Sethi, Director of Research, CCSHAU, Hisar; Dr. K.S. Grewal, Dean, CCSHAU, Hisar and Dr. R.K. Sheoran, Head, Genetics and Plant Breeding, CCSHAU, Hisar. Dr. Sethi, welcomed the dignitaries of the Annual Group Meeting. Dr. A.V.V. Reddy presented the salient achievements made in sunflower during 2016-17. Dr. Reddy emphasized on developing a strategy for seed production of newly developed hybrids. He urged to develop sunflower hybrids with productivity of 3000 kg/ha; and also the development of short duration hybrids for sustaining the crop. Dr. Naik, presented achievements made in Sesame & Niger during 2016-17. In sesame, heterosis breeding to increase production and utilization of resistant germplasm and wild species are projected as thrust areas. Dr. Yadava, ADG (Seeds) congratulated the oilseed workers of the Annual Group Meeting as it marks the golden Jubilee year of AICRP on oilseeds. In his address, he advised the scientists for effective utilization of germplasm with strong pre-breeding programmes and distribution among the AICRP centres; development of hybrids through diversified CMS sources; use of MAS in breeding of oilseeds; development of short duration varieties; exploring new areas for expansion of oilseeds with special emphasis on NEH region. In his address, Prof. K.P. Singh, said that the public funded organizations should be involved in innovative technology development while private sector may develop products. He also said that AICRP centres may work in coordination in order to produce quality seed.

Annual Group Meeting on Castor

The Annual Group Meeting of Castor was held at HRS, Yercaud under the supervision of TCRS, Yethapur, TNAU, Tamil Nadu during May 18-20, 2017 to review the results of research conducted under AICRP (Castor) during 2016-17 and formulate the strategies to increase the production and productivity of castor for 2017-18. The Introductory session of the group meeting was chaired by Dr. K. Ramasamy, Vice Chancellor, TNAU, Coimbatore. Dr. M. Maheswaran, Director of Research, TNAU, Coimbatore welcomed the dignitaries and participants. Dr. A. Vishnuvardhan Reddy, Director, IIOR presented the significant achievements made during 2016-17. He assured the house that there will be free flow of germplasm lines, indreds resistant to biotic stresses and drought, pistillates lines developed by IIOR to breeders of different centres. He stressed the need for breeding efforts leading to development of plant types for mechanical harvesting, close planting, short duration types having high photosynthetic efficiency. Dr. Reddy also advised all breeders to screen parental lines for their biotic stress resistance before using them in hybrid development programme. He also said that the FLDs so far conducted have not been able to make any significant improvement in area expansion and also in bridging the gap in yield between improved practices and farmers practice. Dr. Ramasamy, VC, TNAU in his presidential remarks reminded the house of the Prime Minister's call for doubling farmers income by 2020 and the need to carry out dedicated research efforts by the scientific community. He opined that there is a vast scope for value addition to castor oil and exporting value added products would fetch high profits to business people and also there will be scope for farmers realizing higher price for their produce. He also highlighted the ample scope exists for expansion of area under castor in Tamil Nadu by tapping rainfed areas, promoting the crop as shade cover in turmeric field, as trap crop and intercrop.

Institute Research Committee

The Institute Research Committee (IRC) meeting was conducted under the Chairmanship of Dr. A. Vishnuvardhan Reddy, Director during May 3-11, 2017. The results of the research projects undertaken in *kharif* 2016 were reviewed and the technical programme for *kharif* 2017 was discussed and finalized. The project-wise specific recommendations for 25 Institute research projects were made. Research projects pertaining to *rabi* 2017 were taken up at the IRC meeting during July 25-26 and August 3, 2017. Results of 13 Institute research projects were reviewed and the technical programme for 2017-18 was discussed and finalized. Results of 19 externally funded projects were

also reviewed. The concerned investigators were advised to follow the recommendations made by the members.

Consultative Workshop on Short Gestation Non Edible Oil Crops as Feed Stock for Biodiesel

ICAR-IIOR and Ministry of Petroleum and Natural Gas jointly organized a Consultative Workshop on Short Gestation Non Edible Oil Crops as Feed Stock for Biodiesel from June 13-14, 2017. The workshop had around 60 participants representing industry, government organizations and universities. There were about 15 presentations related to the potential of non-edible short gestation oil crops like Camelina, hemp, castor, kenaf, *Saussurea Lappa* as feedstock for biodiesel, co-processing of vegetable oil in the existing refineries and blending. Based on these presentations and deliberations, there was a group discussion on the prioritization of the crops for the said purpose; issues and challenges with regard to the quality planting material; time frame required and locations for trials for the shortlisted non-edible short gestation oil crops; policy recommendations required and supply chain management and the strategies for engaging the farming community in feedstock production.

ICAR- IIOR Foundation Day Celebrations

The Foundation Day of ICAR-IIOR was celebrated along with Golden Jubilee Celebrations of AICRP on Oilseeds on August 1, 2017 at this Institute. These celebrations were graced by Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR); Shri Chhabilendra Roul IAS, Additional Secretary (DARE) & Secretary, ICAR; Prof. E.A. Siddiq, Hon. Chair Professor (Biotech.), PJTSAU & former DDG (CS); Dr. S.K. Chaturvedi, ADG (O&P) Acting, Dr. David Bergvinson, DG, ICRISAT; Smt. G. Jayalakshmi, DG, NIPHM, Directors of local ICAR institutes and several senior officials of PJTSAU were present on this occasion. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR, welcomed the audience and briefed about the achievements of 50 years of AICRPO and achievements of IIOR. Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR), inaugurated the Golden Jubilee Celebrations of All India Coordinated Research Project on Oilseeds (AICRPO) and while launching the year-long celebrations he unveiled the Logo of Golden Jubilee Celebrations. In his message on the occasion, while complimenting the oilseed research workers for significant achievements made in AICRPO during last 50 years, he called for a better convergence of activities of AICRPO and ICAR institutes. The Foundation Day lecture on "Strategies for Increasing Oilseeds Production in India" was delivered by Dr. T. Mohapatra, Secretary (DARE) & Director General (ICAR). He appreciated the efforts of the oilseed scientists who have played a significant role in bringing yellow revolution in India by enhancing production of oilseeds. He expressed concern regarding the huge expenditure of about ₹ 70,000 crores for import of edible oil to meet the domestic demand. He opined that there is a need to improve seed replacement rates in oilseed crops to exploit the benefits of improved cultivars and said that establishing seed hubs for oilseeds by collective efforts of all oilseed research institutes and the AICRP on oilseeds is essential to achieve increased seed multiplication ratio. He also highlighted the importance of developing value added products in oilseeds, especially in castor, to improve the profitability. Further, he said that research efforts must focus on exploiting the available germplasm resources for various traits including nutrient use efficiency and specific yield traits. On this occasion, four publications were released and the best workers in different categories of staff were rewarded by giving certificate and cash. Shri Chhabilendra Roul, IAS, Additional Secretary (DARE) & Secretary, ICAR urged for concerted efforts to bridge the gap between seed yield in the experimental field and farmers' field. The other Guests of Honours, Dr. David Bergivinson, DG, ICRISAT, and Smt. G. Jayalakshmi, DG, NIPHM appreciated the contributions of AICRPO and ICAR-IIOR towards enhancing oilseed production in the country. Dr. E.A. Siddiq, Honorary Chair (Biotechnology), PJTSAU & Former DDG (CS), ICAR presided over the function and in his remarks Dr. Siddiq urged the oilseed workers to meet the growing challenges in the oilseed sector with more commitment and vigour. The newly built Golden Jubilee Central Laboratory Complex and renovated museum were inaugurated by Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR in the presence of Shri Chhabilendra Roul, IAS, Additional Secretary (DARE) & Secretary, ICAR and Dr. S.K. Chaturvedi, ADG (OP), ICAR.



Foundation day and AICRP Golden Jubilee celebrations

Annual Group Meeting on Safflower and Linseed

Annual Group Meeting on Safflower and Linseed was held at College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, during August 17-19, 2017. The inaugural session was chaired by Dr. S.K. Chaturvedi, ADG (O&P). In the welcome address, Dr. Raji Reddy, Director of Research emphasised on the vintage value of safflower and linseed in terms of their value addition and urged the scientific community to focus on value chain of these crops to enable enhancing the area and contribution of these crops to the Indian oilseeds economy. The research highlights on safflower was presented by Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. In his opening remarks, he emphasized that focused approach should be adopted for technology development by the scientific community in the backdrop of low yields and poor net returns. The research highlights on linseed was presented by Dr. P.K. Singh, PC (Linseed). He made an exhaustive presentation on the status of linseed crop and the exports-imports scenario in the country. The Chairman, Dr. S.K. Chaturvedi, ADG (O&P) advised the group to make necessary revamping of the research programmes in tune with proper priority setting. In this direction, he advised to critically review the progress of implementation of the research programmes undertaken during the last decade and prioritise the research requirements accordingly. He emphasised that focus should be on pre-breeding that needs to be high in the research agenda. He also advised that national crossing programme should be introduced and the centres should be identified with unique responsibility to foster the progress in research. He strongly opined that in the process of hybrid development, the base line seed yield should be substantially higher, failing which the outputs with meagre increase in seed and oil yield would not be of much advantage at the farm level. He advised that in the seed chain, the varieties which are less than 10 years old alone should find a place. He further suggested for using off season facility for advancement of generations to reduce the time horizon. He informed that in FLD's there is a need to identify the best demonstrations in each agro-eco system that needs to be scaled up on a large scale. He emphasized that all activities pertaining to FLD's needs to be digitized and advised to use the power of ICT in this regard. He advised the scientists to explore the possibility of bidding for competitive projects to DAC, DST and DBT on priority areas of research.

National Oilseeds Kisan Mela-2017

The National Oilseeds Kisan Mela-2017 was organized on Sep. 10-11, 2017 by ICAR-IIOR, Rajendranagar, Hyderabad, in collaboration with National Mission on Oilseeds and Oil Palm (NMOOP), Department of Agriculture, Cooperation & Farmers Welfare, Government of India.

The programme started with the inauguration of exhibition stalls by Dr. W.R. Reddy, IAS, Director General, National Institute of Rural Development and Panchayat Raj, Hyderabad. Around 100 exhibitors including companies dealing with agricultural inputs, machineries and credits, oilseed extractors and processors, NGOs, Farmers Organizations, Agricultural Research and Extension Institutions participated in the exhibition. It was followed by visit to demonstration plots of recently released hybrids and varieties of oilseed crops *viz*., Castor, Groundnut, Sesame, Soybean, Sunflower and Niger, profitable intercropping systems in different oilseed crops and best management practices including drip irrigation in castor. More than 2000 farmers from 12 states participated in the programme.

Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR, Hyderabad, in his welcome address emphasized the need to use quality seed, soil test based fertilizer application, following all the recommended best management practices, drip irrigation etc. so that yield can be increased by 40-60% as shown in FLDs. He advised the farmers to produce their own seeds especially in self-pollinated crops by forming farmers' association. Farmer's income may be increased by adding value to their produce (ex. oil, cake etc.) and they could become entrepreneurs. Dr. Y.G. Prasad, Director, ATARI (Zone-V), Hyderabad, while addressing the farmers, remembered the role of the unique Krishi Vgyan Kendras (KVKs) in benefiting farming community. Critical technologies suited to the particular areas are being demonstrated by conducting thousands of demonstrations under NMOOP. He said that goal should be to increase farmer's income by increasing production, reducing expenses using latest technologies and practicing climate resilient agriculture.

Dr. Anupam Barik, Additional Commissioner, DAC&FW, GoI, New Delhi in his address as guest of honour, acknowledged the huge participation of farmers and exhibiters from various private and public sectors. He stressed the need for cutting down unhealthy level of 18 kg *per capita* edible oil consumption in the country to healthy level of 12-13 kg. Oilseeds area is slowly expanding to north east states in rice fallows and need to expand in coastal areas. Delivering his presidential address, Dr. V. Praveen Rao, Vice-Chancellor, PJTSAU, Hyderabad, insisted that cropping pattern to be decided based on market demand. He also mentioned about e-NAM where markets are linked and the facility should be used by farmers. By following soil test based fertilizer recommendation, mechanization, quick transfer of technology through mobile apps and with value addition we can overcome the major challenges faced by the oilseed farmers such as non-availability of labour, less price, deterioration in soil fertility and climate change impact. Dr. P.K. Singh, Project Coordinator (Linseed), Dr. P.K. Mathur, Director, Indian Institute of Oil Palm Research (IIOPR), Pedavegi, Andhra Pradesh; Dr. V. Ranga Rao, Chairman, Research Advisory Committee of IIOR were present on the occasion.

During the programme, a total of 29 innovative farmers from different states were felicitated by the dignitaries for their significant achievements in oilseeds production. Farmers from different states shared their experiences on oilseed farming.

Institute Management Committee

The 41st meeting of the Institute Management Committee (IMC) was held on October 25, 2017 under the Chairmanship of Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR. Dr. Farzana Zabeen on behalf of Dr. D. Raji Reddy, Director of Research, PJTSAU, Hyderabad; Dr. Y.G. Prasad, Director, ICAR-ATARI, Hyderabad; Dr. P. Muthuraman, ICAR-IIRR, Hyderabad; Dr. Anupama Singh, Head & PS, ICAR-IARI, New Delhi; Dr. V. Dinesh Kumar, PS, ICAR-IIOR, Hyderabad; Shri Ayyagari Bhumayya, Adilabad, Telangana and Shri Pradeep Singh, SAO I/c, ICAR-IIOR were attended the meeting. The Chairman welcomed the IMC members and presented the research achievement of the institute in the meeting. The Member Secretary apprised the committee about the action taken report on the proceedings of the preceding IMC meeting. The committee appreciated the work being carried out at the Institute. The revenue generated and expenditure incurred in each quarter was also presented to the committee. The proposal for procurement of furniture and fixtures for newly built Central Laboratory Complex was discussed and the committee approved the proposal to make the laboratory functional.

Research Advisory Committee

The 31st RAC meeting of the institute was held during October 5-6, 2017 under the Chairmanship of Dr. V. Ranga Rao, Former Director (DOR) IIOR, Hyderabad. The other RAC members, Dr. Jitender Kumar, Dean, Agriculture, GBPAUT, Pant Nagar; Dr. R. Srinivasan, Retd. Professor and Project Director, NRCPB, IARI, New Delhi; Dr. P. Ananda Kumar, Former Project Director, IIRR, Hyderabad; Dr. D. K. Yadava, Head (SST), IARI and In-charge ADG (Seeds), ICAR, New Delhi; Dr. B.S. Dwivedi, Head (SS and AC), IARI, New Delhi; Dr. Ajay Arora, Principal Scientist, Plant Physiology, IARI, New Delhi; Dr. K. Purna Chandra Rao, Ex-Principal Scientist, ICRISAT, Hyderabad; Shri Ayyagari Bhumayya, Nirmal, Telangana and Dr. Premraj Yadav, Shamshabad, Ranga Reddy District, Telanagana attended the meeting.

Dr. A. Vishnuvardhan Reddy, Director, IIOR welcomed the Chairman and Members of RAC. Presentation on the Action Taken Report on the recommendations of 30th RAC meeting was made by Dr. V. Dinesh Kumar, Member Secretary, RAC. Strategies adopted by the institute to address the researchable issues and the progress made under each of the programmes were presented by the respective programme leaders and crop principal investigators. Also, the members were apprised of the extension activities taken up by the institute to popularise the technologies developed in the mandate crops. The committee visited the IIOR research farm located at Narkhoda village in the forenoon of October 6, 2018 to oversee the field experiments. During the two day meeting Research Advisory Committee reviewed the progress made under different research programmes and other activities and made recommendations to improve the research outputs and deliverables.

Vigilance Awareness Week observed at IIOR

The Vigilance Awareness Week was observed at ICAR-IIOR during October 30 to November 06, 2017. The activity started with administration of the vigilance pledge to the staff on October 30, 2017 at main office and also farms located at Narkhoda and ICRISAT. A seminar was organized on "Accountability Enhancement of the System" wherein Dr. Sudheer Kumar, Registrar, PJTSAU delivered the Chief Guest's address followed by official programmes. There was an interaction on ICAR and SAU system accountability for enhancement of farmers' income and social transformation.

- A debate was organised on the need to be vigilant in the day to day functioning. There was also a panel discussion, wherein Drs. K. Anjani, H.H. Kumaraswamy, K. Ramesh, I.Y.L.N. Murthy, V. Dinesh Kumar, P. Ratnakumar, P.S. Srinivas and Smt. Lalitha participated.
- A sensitisation workshop was organised, wherein Shri J.L.N. Das, SAO I/c, IIOR delivered a lecture on vigilance awareness.
- Vigilance programmes were also conducted at PJTSAU, Campus; Krishi School and Adarsha Vidhylaya High School, Rajendranagar, Jasmine High School, Bhavanicolony. An interaction was organized with the young students on the future prospects for better citizens.
- Gram Sabhas were organised on October 30, 2017 at Zookal, Narkhoda and on October 31, 2017 at Budvel and Premavathipet for sensitization of public on vigilance for better day to day functioning.
- Vigilance programmes were also conducted at Agriculture College on productivity enhancement through breeding and biotechnology at Home Science College on "Oils and fats for good health" and "Agribusiness management for policy issues in agriculture".
- Banners and posters and social media were effectively used at all the places and the same was posted on IIOR website.

Operations and Maintenance (O&M) Reforms

- Land records with boundaries and land utilization were digitalized as per Google Map and submitted to ICAR.
- All the institute buildings are modified with Sugamya Bharat Abhiyan and UJALA compliance.
- Cashless/digital transactions through swipe machines and GST has been implemented.
- Accessible India (ramps for physically challenged people)
- PFMS has been implemented.
- Direct benefit transfer to farmers
- Procurement of items through GeM.
- Office and research management through MIS & FMS
- Activities for Swatch Bharat Mission
- Implementation of ERP
- Observing International Yoga day, Science day, Women day, etc.

HUMAN RESOURCE DEVELOPMENT

Trainings

Name	Training Programme	Venue	Date
Dr. P. Kadirvel, Dr. Praduman Yadav, Smt. K.S.V.P. Chandrika, Smt. B. Usha Kiran, Shri A. Prem Kumar, Shri E.V.R.K. Nagendra Prasad, Shri P. Srinivasa Rao, Shri Rakesh Geeda, Shri G. Chandraiah, Shri B.V. Rao, Smt. P. Swapna	21 days training on *Parangat* (Hindi course) Central Hindi Training Institute.	ICAR-IIOR, Hyderabad	Jun. 1-29, 2017
Shri G. Srinivasa Rao and Shri A. Srinivasa Raju	CEP on soft skills and personality development for Technical staff of ICAR	ICAR-NAARM, Hyderabad	Jun. 15-24, 2017
Smt. R.A. Nalini	Refresher course for Section Officers, AAOs, AFAOs and Assistants of ICAR	ICAR-NAARM, Hyderabad	Jun. 23-29, 2017
Dr. K. Anjani	Practical Application of Agri Genomics principles for understanding genetic basis of biological processes in plants	Chandigarh.	Jul. 22, 2017
Dr. S.N. Sudhakara Babu	XII Annual Review Meeting ICAR Seed Project: Seed Production in Agril. crops	MPKV, Rahuri	Jul. 29-30, 2017
Dr. Lakshmi Prayaga	Short term training course on Phenomics : Perspectives for application in improvement of abiotic stress tolerance in crop plants	ICAR-NIASM, Baramati	Jul. 20-29, 2017
Smt. P. Madhuri	5th National Conference on E-Learning and E-Learning Technologies (ELELTECH) 2017	C-DAC and JNTU, Hyderabad.	Aug. 3-4, 2017
Dr. T. Manjunatha	Analysis of experimental data	ICAR-NAARM, Hyderabad	Aug. 3-9, 2017
Dr. A. Vishnuvardhan Reddy	Research excellence in organisations	ASCI, Hyderabad	Aug. 7-9, 2017
Shri K. Srinivasa Rao	(OSP) on "General Financial Rules 2017"	ISTM, New Delhi	Aug. 9-11, 2017.
Dr. J. Jawaharlal and Shri G. Raghunath	2nd Telangana State Public Relations Conference	Public Relations Society of India, Hyderabad	Aug. 6, 2017
Shri T. Bichanna and Smt. G. Maheswari	Administrative training programme	ICAR-IIMR, Hyderabad	Aug. 16-18, 2017
Smt. R.A. Nalini, Smt. S. Swarupa Rani and Shri G.B. Nagendra Prasad, Smt. S. Swaroopa Rani	Entrepreneur Resource Programme	ICAR-IIMR, Hyderabad	Aug. 30, 2017
Shri P. Gopinath	CEP on motivation and positive thinking for Technical Officers of ICAR	ICAR-NAARM, Hyderabad	Sep. 13-22, 2017.
Shri V. Yadagiri Swamy	Specialized training programme on Automobile maintenance, road safety and behavioural skills for regular drivers in Technical Grades	ICAR-CIAE, Bhopal	Sep. 19-23, 2017
Smt. R. Raji	Enhancing efficiency and personal skills of Stenographers Gr. II	ICAR-NAARM, Hyderabad	Oct. 25-31, 2017

Dr. K. Alivelu	Short course on "Tools on monitoring Evaluation and Impact Assessment of Rainfed Technologies and Agriculture Development Programmes"	ICAR-CRIDA, Hyderabad	Nov. 1-10, 2017
Dr. C. Sarada	Training Program on Financial Inclusion, Agricultural Credit and Crop Insurance	MANAGE, Hyderabad	Nov. 27-29, 2017
Shri G. Ramulu	Automobile maintenance, road safety and behavioral skills for regular drivers of ICAR	ICAR-CIAE, Bhopal	Nov. 27-Dec. 1, 2017
Dr. Mangesh Y. Dudhe and Dr. K.T. Ramya	Multivariate Data Analysis	ICAR-NAARM, Hyderabad	Dec. 14-20, 2017
Dr. P. Lakshmamma	Climate Smart Agriculture for Enhancing Crop and Water Productivity under Abiotic Stress Conditions	ICAR-NIASM, Baramati	Dec. 15-23, 2017
Dr. C. Sarada, Dr. P.S. Srinivas, Dr. K. Ramesh, Dr. S. Senthilvel, Smt. B. Gayatri, Smt. Ch.V. Hari Priya, Shri V. Sambasiva Rao, Shri A. Srinivasa Raju, Shri S. Saida Reddy, Smt. G. Maheswari	21 days training on *Parangat* (Hindi course) Central Hindi Training Institute.	ICAR-IIOR, Hyderabad	Jan. 1-29, 2018
Dr. P. Lakshmamma and Dr. M. Santhalakshmi Prasad	Strengthening Gender Perspective in Agricultural Research & Extension	ICAR-CIWA, Bhubaneswar	Feb. 26-Mar. 3, 2018
Smt. B. Gayatri	Six days training on 'Analysis of Experimental Data'	ICAR-NAARM, Hyderabad	Feb. 19-24, 2018

Training for Employees under SSS Category

ICAR-IIOR has conducted a 5 day training programme on "Personal and Work Excellence for Skilled Support Staff" during 15 -20 November, 2017 for employees under SSS category. Dr. P.S. Srinivas, Principal Scientist (Convener) and team (Sh. Pradeep Singh, AD (OL); Sh. Shoukat Ali, T-5 and Sh. P.R.V.P. Rao, Assistant) has actively involved in conducting the training programme. The topics were selected after discussion with HRD, NAARM, based on the nature of the duties of SSS, performing on daily basis. Twenty employees under SSS category of ICAR-IIOR were imparted training on various aspects such as diary and dispatch, basics of Hindi, communication skills, our organisation, our institute and hierarchy emotional intelligence, role perception, motivation and positive thinking, values and ethics, *etc.*, by resource persons from NAARM and IIOR Hyderabad. The training sessions were comprised of activities, interactions and presentations. Dr. A. Vishnuvardhan Reddy, Director, ICAR-IIOR distributed the certificates to all the trainees during valedictory function.

Physical targets and achievements

Category	No. of employees	No. of trainings planned	Total No. of employees undergone training	% realization of planned trainings	% employees undergone training
Scientists	41	9	9	100	22
Technical	43	9	6	66.7	14
Administrative and finance	24	6	5	83.3	21
SSS	21	9	20	100	95
Total	132	37	40		31

Financial targets and achievements

RE for HRD (Rs in lakhs)	Actual Expenditure for HRD (Rs in lakhs)	% Utilization of allotted budget
2	3**	3*100/2=4
374000	373909	99.98

**Rs.3,00,000 have been paid to Biotech consortium India Limited for payment towards training on institute bio-safety officers during previous years

Category-wise national trainings attended by employees a) Scientists

Name of employee	Designation	Discipline/ Section	Name of training programme attended	Actual Expenditure incurred (₹)
Dr. A. Vishnuvardhan Reddy	Director	RMP	Research excellence in organisations	36816
Dr. Lakshmi Prayaga	Principal Scientist	Plant Physiology	Phenomics: Perspectives for application in improvement of abiotic stress tolerance in crop plants	0
Dr. P. Lakshmamma	Principal Scientist	Plant Physiology	Climate smart agriculture for enhancing crop and water productivity under abiotic stress conditions	9720
Dr. C. Sarada	Principal Scientist	Ag. Statistics	Financial inclusion, agricultural credit and crop insurance	0
Dr. K. Alivelu	Senior Scientist	Ag. Statistics	Tools on monitoring, evaluation, and impact assessment of rainfed technologies and agricultural development programmes	0
Dr. P. Duraimurugan	Senior scientist	Ag. Entomology	Workshop on Agri innovations	0
Dr. K.T. Ramya	Scientist	Plant Breeding	Multi variate data analysis	0
Dr. T. Manjunatha	Scientist	Plant Breeding	Analysis of experimental data	0
Smt. B. Gayatri	Scientist	Nematology		0

Trainings attended include other than ATP 2017-18

b) Technical

Name of employee	Designation	Discipline/ Section	Name of training programme attended	Actual expenditure incurred (₹)
Shri P. Gopinathen	Tech. Officer	Farm	CEP on motivation and positive thinking for technical officers of ICAR	0
Shri A. Srinivasa Raju	Tech. Asst.	Electrician	CEP on soft skills and personality development for technical staff of ICAR	0
Shri G. Srinivasa Rao	Tech. Asst.	Farm	CEP on soft skills and personality development for technical staff of ICAR	0
Shri V.Y. Swamy	Tech. Asst.	Driver	Auto mobile maintenance, road safety and behaviour skills	0
Shri S. Saida Reddy	T-1	Pathology	Microbial identification and preservation	0
Shri G. Ramulu	T-1-3	Driver	Auto mobile maintenance, road safety and behaviour skills	2173

c) Administration & Finance

Name of employee	Designation	Discipline/Section	Name of training programme attended	Actual expenditure incurred (₹)
Smt. R.A. Nalini	Assistant	Stores	Refresher Course for Section Officers, AAOs, AFAOs and Assistants of ICAR	0
Smt. R. Raji	PA	Technical Coordination Cell	Enhancing efficiency and behavioral skills for stenographers	0
Shri T. Bichanna	UDC	Farm	Training on Administrative matters	0
Smt. G. Maheswari	LDC	Admin	Training on Administrative matters	0
Shri K. Srinivasa Rao	FAO	Finance	General Financial Rules 2017	0

d) Skilled Supporting Staff

The following skilled support staff have been trained on personal and work excellence

Name of employee	Section	Actual expenditure incurred (₹)
Shri G. Rajamouli	Administration	1260
Shri G. Mallesh	Administration	1260
Shri D. Narasimha	Farm	1260
Shri M. Venkatesh	Administration	1260
Shri A. Rambabu	Administration	1260
Shri M. Ramulu	Farm	1260
Shri P. Krishna	Crop improvement	1260
Shri D. Balaiah	Farm	1260
Shri B. Narasimha	Farm	1260
Smt. B. Kishtamma	Farm	1260
Shri K. Sanjeeva	Farm	1260
Shri B. Vishnu	Accounts	1260
Smt. G. Bharatamma	Farm	1260
Shri Narasimha	Administration	1260
Shri Gyaneswar	Farm	1260
Shri P. Srinivas	Administration	1260
Smt. K. Kalavathi	Farm	1260
Smt. A. Lalitha	Farm	1260
Smt. Hamsamma	Farm	1260
Smt. Suseela	Farm	1260

Participation in Conference/Seminars/Symposium/Workshops/Meetings

a) National

Name	Programme	Venue / Place	Date
Dr. S.V. Ramana Rao	State level Coordination meeting on Doubling Farmers Income in Andhra Pradesh	Guntur	Apr. 7, 2017
Dr. G.D. Satish Kumar	Review meeting of R&D project under NMOOP	ICAR-CRIDA, Hyderabad	Apr. 8, 2017
Dr. P. Lakshmamma	Farm innovators meet organized by ATARI Zone X	ICAR-CRIDA, Hyderabad	Apr. 14, 2017
Dr. S.N. Sudhakara Babu	Annual 32nd meeting of National Seed Project	SKRAU, Bikaner	Apr. 22-24, 2017
Dr. P. Lakshmamma	National Seminar on "Road Map of Vegetable Oil Production in India"	PJTSAU, Hyderabad	Apr. 28-29, 2017
Dr. S.N. Sudhakara Babu	157th RCGM meeting of DBT	DBT, New Delhi	May 9, 2017
Dr. M. Sujatha	77th CVRC sub-committee meeting of release of varieties and hybrids	ICAR-CPRI, Shimla	May 14-15, 2017
Dr. A. Vishnuvardhan Reddy, Dr. S.N. Sudhakara Babu, Dr. V. Dinesh Kumar, Dr. S.V. Ramana Rao, Dr. D. Pati	Doubling of farmers' income : Oilseeds Sub-Group Meeting on "Enhancing oilseeds production to meet demand and to reduce imports"	ICAR-IIOR, Hyderabad	May 29-30, 2017
Dr. S.V. Ramana Rao	Strategy Workshop on 'Vegetable Oil Economy and Production Problems in India'	NAAS, New Delhi	Jun. 3, 2017
Dr. I.Y.L.N. Murthy and Dr. Praduman Yadav	Monitoring committee meeting on pre-clinical efficacy & safety evaluation of tobacco seed oil (n-6 PUFA rich)	ICMR-National Institute of Nutrition, Hyderabad	Jun. 9, 2017
Dr. I.Y.L.N. Murthy, Dr. M. Sujatha and Dr. Praduman Yadav	Consultative Workshop on Short Gestation Non-Edible Oil Crops As Feed Stock for Biodiesel	ICAR-IIOR, Hyderabad	Jun. 13-14, 2017
Dr. I.Y.L.N. Murthy	Soil health cards and Paramparagat Krishi Vikas Yojana	MANAGE, Hyderabad	Jun. 13, 2017
Dr. Praduman Yadav	Interactive meeting on "Processing characteristics of agricultural produce and animal and fisheries breeds"	Mahatma Jotiba Phule Hall, Krishi Bhawan, New Delhi	Jun. 16, 2017
Dr. S.N. Sudhakara Babu	158th RCGM meeting of DBT	DBT, New Delhi	Jun. 20, 2017
Dr. G. Suresh	Workshop on "Impact of Fertilizer Policy on Soil Health and Balanced application of Nutrients"	Fertilizer Association of India (FAI), Hyderabad	Jun. 27, 2017
Dr. I.Y.L.N. Murthy and Dr. V. Dinesh Kumar	A one day dialogue on "Modern Breeding Strategies for Crop Improvement"	PJTSAU, Hyderabad	Jul. 10, 2017
Dr. S.N. Sudhakara Babu	Annual Seed Workshop of IISS	MAU, Rahuri	Jul. 29-30, 2017
Smt. P. Madhuri	5th National Conference on E-Learning and E-Learning Technologies (ELELTECH) 2017	cDAC & JNTUH, Hyderabad	Aug. 3-4, 2017
Dr. S.V. Ramana Rao	Agri Udan - Food and Agribusiness Accelerator programme	ICAR-NAARM at New Delhi	Aug. 4, 2017

Dr. P. Duraimurugan	Workshop on 'Agri-Innovations'	ICAR-NAARM, Hyderabad	Aug. 17-18, 2017
Dr. P. Duraimurugan	National Conference on Technological Challenges in Social, Environmental and Agricultural Reforms	ICAR-IIRR, Hyderabad	Sep. 9-10, 2017
Dr. A. Vishnuvardhan Reddy, Dr. S.V. Ramana Rao, Dr. G. Suresh, Dr. C. Lavanya, Dr. P. Lakshmamma, Dr. R.D. Prasad, Dr. G.D.S. Kumar, Dr. P. Padmavathi, Dr. S. Senthilvel, Dr. C. Sarada	Castor field day	Jangamreddipalle, Mahabubnagar	Sep. 21, 2017
Dr. I.Y.L.N. Murthy	Brain storming session cum workshop on "Strategies for area expansion and productivity enhancement of oilseeds and oil palm and inclusion of coconut under NMOOP.	ICAR-IIOR, Hyderabad	Sep. 26, 2017
Dr. S.N. Sudhakara Babu	159th RCGM meeting of DBT	DBT, New Delhi	Sep. 26, 2017
Dr. K. Alivelu	National workshop on "Developing a Roadmap for Agricultural Knowledge Management in India	ICAR-DKMA, New Delhi	Sep. 27-28, 2017
Dr. I.Y.L.N. Murthy	National conference on "Seed production quality control & marketing"	TSSDC Ltd., Hyderabad	Oct. 6, 2017
Dr. G.D. Satish Kumar	World Food India-2017	Ministry of Food Processing Industries, GOI, New Delhi	Nov. 3-5, 2017
Dr. I.Y.L.N. Murthy	25th Annual Conference, 2017 (Silver Jubilee Conference) of Agricultural Economics Research Association (India) on "Doubling Farmers' Income: Options and Strategies"	ICAR-NAARM, Hyderabad	Nov. 7-9, 2017
Dr. S.N. Sudhakara Babu	161st RCGM meeting of DBT	DBT, New Delhi	Nov. 14, 2017
Dr. M. Sujatha	BCIL meeting of stakeholders of the National Certification System for Tissue Cultured Plants	BCIL, New Delhi	Nov. 14, 2017
Dr. P. Ratnakumar	National Conference of Plant Physiology.	IGKV, Raipur	Nov. 22-24, 2017
Dr. A. Vishnuvardhan Reddy, Dr. I.Y.L.N. Murthy, Dr. K. Alivelu, Dr. P. Lakshmamma, Dr. S.V. Ramana Rao, Dr. R.D. Prasad	World soil day under the Farmers FIRST Programme	Rampur Thanda, a tribal hamlet in Vikarabad district of Telangana	Dec. 5, 2017
Dr. Mangesh Y. Dudhe	Training programme on Multivariate Data Analysis for Scientific Personnel using R	ICAR-NAARM, Hyderabad	Dec. 14-20, 2017
Dr. S.V. Ramana Rao and Dr. D. Pati	Zonal Technology Management Committee (ZTMC)	ICAR-IIMR, Hyderabad	Dec. 16, 2017
Dr. P.S. Srinivas	Meeting of experts in Entomology in Hyderabad for holding National symposium during 2018	ABF, Rajendranagar, Hyderabad	Dec. 18, 2017.

Dr. S.V. Ramana Rao	National level farmer workshop on Doubling Farmers Income	ICAR-NAARM, Hyderabad	Dec. 22-23, 2017
Dr. I.Y.L.N. Murthy	National level dialogue on 'Let's listen to farmers: A workshop on farmers' feedback' on doubling farm income by 2020. Interaction meeting with all the Directors and Scientists of ICAR Institutes	ICAR-NAARM, Hyderabad	Dec. 23, 2017
Dr. S.N. Sudhakara Babu	162nd RCGM meeting of DBT	DBT, New Delhi	Jan. 9, 2018
Dr. N. Mukta	12th Annual review meeting of DUS centres and projects.	ICAR-IISR, Lucknow	Jan. 15-17, 2018
Dr. I.Y.L.N. Murthy	"Strategies for Enhancement of Farmers Income in Dryland Agriculture" under the program Feed the Future - India Triangular Training (FTF-ITT)	ICAR-CRIDA, Hyderabad	Jan. 16, 2018
Dr. S.N. Sudhakara Babu	KVKs workshop of ATARI, Pune	KVK, Solapur	Jan. 16, 2018
Dr. Kadirvel Palchamy, Dr. Mangesh Y. Dudhe, Dr. H.P. Meena and Dr. Ch. Sarada	Regional Workshop and Agro-Biodiversity Exhibition	PJTSAU, Hyderabad	Jan 27, 2018
Dr. G. Suresh	Telangana State Resource Mobilization (TSRM) second workshop	Commissioner of Agriculture, Hyderabad.	Jan. 30, 2018
Dr. Ch. Sarada and Dr. K. Alivelu	A Training-cum- Field day on castor and sesame	Patherched village, Narwa mandal, Mahabubnagar	Feb. 2, 2018
Dr. H.P. Meena	Foundation day lecture on "Strategies in millets for doubling farmers income"	ICAR-IIMR, Hyderabad	Feb. 7, 2018
Dr. Kadirvel Palchamy and Dr. P. Duraimurugan	Frontiers in Eco-biological Sciences and its Application–FESA 2018": Theme: Water-Food-Energy Nexus	Periyar University, Salem, Tamil Nadu	Feb. 7-9, 2018
Dr. S.N. Sudhakara Babu	On-farm training on seed production of CMS based hybrid and varieties of safflower	ICAR-IIOR, Hyderabad	Feb. 12, 2018
Dr. S.N. Sudhakara Babu	Castor breeders training and hybrid seed production	ICAR-IIOR, Hyderabad	Feb. 15-16, 2018
Dr. R.D. Prasad	National Symposium on 'Plant health management: embracing eco-sustainable paradigm'	Assam Agricultural University, Jorhat	Feb. 15-17, 2018
Dr. S.N. Sudhakara Babu	163rd RCGM meeting of DBT	DBT, New Delhi	Feb. 20, 2018
Dr. S.V. Ramana Rao	Annual Review Workshop of Farmer FIRST Programme	ICAR-IARI, New Delhi	Feb. 21-22, 2018
Dr. P.S. Srinivas	Institute Management Committee of ICAR-DOGR	ICAR-DOGR, Pune	Mar. 1, 2018
Dr. I.Y.L.N. Murthy, Dr. G. Suresh and Dr. A.R.G. Ranganatha	Workshop on Decentralized Seed System for Climate Resiliance Rainfed Agriculture	MANAGE, Hyderabad	Mar. 8-9, 2018
Dr. A.R.G. Ranganatha	Strategies for seed supply	MANAGE, Hyderabad	Mar. 9, 2018

Smt. K.S.V.P. Chandrika and Smt. B. Gayatri	National workshop on 'Revisiting foundation course for agricultural research service (FOCARS): reflections and feedback of trained scientists'	ICAR-NAARM, Hyderabad	Mar. 15-16, 2018
Dr. I.Y.L.N. Murthy	National Oilseed Kisan Mela on Sunflower	Sri Rama Krishna Ashram, AICRP-Nimpith, West Bengal	Mar. 16-17, 2018
Dr. Mangesh Y. Dudhe	Krishi Unnathi Mela	ICAR-IARI, New Delhi	Mar. 16-18, 2018
Dr. I.Y.L.N. Murthy, Dr. G. Suresh, Dr. G.D.S. Satish Kumar, Dr. P. Lakshmamma, Dr. P. Ratna Kumar, Dr. P. Padmavathi and Smt. K.S.V.P. Chandrika	National conference on *Bhumi suposhan*- Approach and practices to enrich soil for sustainable agriculture	CSIR-IICT, Hyderabad	Mar. 24-25, 2018
Dr. P. Duraimurugan	National Seminar on Awareness, Motivation and Technology Transfer for Development of Scientific Beekeeping in the Country	JAISAL Vocational Training Centre, Pedavegi (AP)	Mar. 24-25, 2018
Dr. C. Sarada	User's Training Workshop on "Geospatial Applications in Data Enrichment of ICAR KRISHI Geoportal"	ICAR-NBSS&LUP, Nagpur	Mar. 26-27, 2018

b) International

Name	Programme	Venue	Date
Dr. M. Sujatha, Shri H.H. Kumaraswamy	Fifth Annual South Asia Biosafety Conference	Ministry of Environment, Forest and Climate Changes, Govt. of India, ICAR, BCIL, ILSI and South Asia Biosafety Programme, Bengaluru.	Sep. 11-13, 2017
Dr. P.S. Vimala Devi, Dr. P. Duraimurugan, Smt. B. Usha Kiran and Smt. K.S.V.P. Chandrika	India International Science Festival	Anna University, Chennai	Oct. 13-16, 2017
Dr. P.S. Vimala Devi and Dr. Duraimurugan	International Science Festival 2017 (Industry-Academia Interaction Meet; Women Scientists & Entrepreneurs Conclave)	Anna University, Chennai	Oct. 13-16, 2017
Dr. S. Senthilvel, Dr. Kadirvel Palchamy	VI NGGIBCI Conference on Crop Genomics: Present & Future	ICRISAT, Hyderabad	Dec. 6-8, 2017
Dr. M. Santhalakshmi Prasad, Dr. P. Duraimurugan, Smt. B. Gayatri	International Workshop on Integrated Management of Root-lesion nematodes	NIPHM, Hyderabad	Dec. 11, 2017
Dr. H.P. Meena	Sustainability of Smallholder Agriculture in Developing Countries under Changing Climatic Scenario	CSAUAT, Kanpur	Feb. 14-17, 2018
Smt. B. Usha Kiran, Dr. Sujatha, T.P. and Smt. K.S.V.P. Chandrika	2nd International Conference on Food and Agriculture	Dhanbad, Jarkhand	Mar. 29-31, 2018

राजभाषा कार्यान्वयन

राजभाषा पुरस्कार:- भारतीय कृषि अनुसंधान परिषद के स्थापना दिवस के अवसर पर 16 जुलाई, 2017 को दिल्ली में आयोजित कार्यक्रम में संस्थान को राजभाषा के उत्कृष्ट कार्यान्वयन के लिए राजर्षि टंडन राजभाषा पुरस्कार से सम्मानित किया गया। जिसे केंद्रीय कृषि मंत्री श्री. राधा मोहन सिंह जी ने प्रदान किया तथा संस्थान के निदेशक डॉ. ए. विष्णुवर्धन रेड्डी तथा सहा. निदेशक (रा.भा) श्री. प्रदीप सिंह ने प्राप्त किया।

राजभाषा कार्यान्वयन समिति की बैठक:- नियमानुसार प्रत्येक तिमाही में राजभाषा कार्यान्वयन समिति की बैठके क्रमशः जून 29, 2017; सितंबर 25, 2017 ,दिसंबर 28, 2017 और मार्च 24, 2018 को आयोजित की गई। बैठक में लिए गए निर्णयों का कार्यान्वयन सुनिश्चित किया।

तिमाही प्रगति रिपोर्ट:- प्रत्येक तिमाही की समाप्ति पर विभिन्न अनुभागों से आंकडे एकत्रित कर इसकी समग्र रिपोर्ट तैयार की गई। इस रिपोर्ट पर संस्थान के निदेशक के हस्ताक्षर के पश्चात समय पर मुख्यालय, क्षेत्रीय कार्यान्वयन कार्यालय और नगर राजभाषा कार्यान्वयन समिति को प्रेषित की गई।

प्रकाशन:- संस्थान के वार्षिक प्रतिवेदन तथा तिमाही समाचार पत्र को द्विभाषिक प्रकाशित किया गया।

कार्याशाला आयोजन:- संस्थान के हिन्दी का कार्यसाधक ज्ञान प्राप्त अधिकारी तथा कर्मचारियों के लिए प्रत्येक तिमाही में कार्यशालाएँ क्रमशः जून 27, 2017; सितंबर 17, 2017, नवंबर 24-25, 2017 तथा जनवरी 25, 2018 को आयोजन किया गया।

नगर राजभाषा कार्यान्वयन समिति:- राष्ट्रीय ग्रामीण विकास एवं पंचायती राज संस्थान में 21 सितंबर, 2017 को आयोजित नगर राजभाषा कार्यान्वयन समिति की बैठक में भाग लिया।

पारंगत पाठ्यक्रम का आयोजन:- वर्ष के दौरान जून, 2017 तथा जनवरी, 2018 में पारंगत के पाठ्यक्रम हिन्दी शिक्षण योजना, हैदराबाद के सहा. निदेशक श्री. जयशंकर प्रसाद तिवारी की सहायता से आयोजित किया गया।

हिन्दी पखवाडा समारोह

भारतीय तिलहन अनुसंधान संस्थान (आईआईओआर) में हिन्दी पखवाड़ा 11-25 सितंबर, 2017 तक आयोजित किया गया। इस पखवाडे के दौरान विभिन्न प्रतियोगिताएँ जैसे शब्दानुवाद, सामान्य ज्ञान, एक मिनट और स्मरण का आयोजन किया गया। सभी प्रतियोगिताओं में संस्थान के वैज्ञानिक, अधिकारी एवं कर्मचारियों ने काफी उत्साह से भाग लिया। सभी प्रतियोगिताओं के लिए प्रथम, द्वितीय, तृतीय एवं प्रोत्साहन पुरस्कार प्रदान किए गए।

इस पखवाड़े का समापन समारोह 25 सितंबर, 2017 को आयोजित किया गया। कार्यक्रम का शुभारंभ डॉ. मुक्ता, उपाध्यक्ष राजभाषा कार्यान्वयन समिति के स्वागत भाषण से हुआ। मुक्ता जी ने राजभाषा प्रगति रिपोर्ट में कहा कि पिछले एक वर्ष में संस्थान के हिन्दी कार्य में काफी प्रगति हुई है। हमने राजभाषा विभाग के वार्षिक कार्यक्रम का अनुपालन करते हुए। प्रत्येक तिमाही में संस्थान के अधिकारियों व कर्मचारियों के लिए एक कार्यशाला आयोजन किया है। इसके अलावा राजभाषा कार्यान्वयन समिति की नियमपूर्वक प्रत्येक तिमाही में बैठक का आयोजन किया तथा बैठक में लिए गए निर्णयों का अनुपालन भी किया है। तिमाही समाचार पत्र एवं वार्षिक रिपोर्ट को द्विभाषिक प्रकाशित किया गया। संस्थान के राजभाषा प्रगति का मुख्यालय द्वारा निरीक्षण किया गया जिसमें संस्थान के कार्य पर संतुष्टी प्रकट की गई। जून, 2017 में हमने संस्थान में पारंगत पाठ्यक्रम का आयोजन किया गया जिसमें 11 अधिकारियों व कर्मचारियों ने परीक्षा दी थी जिसमें सभी 70 प्रतिशत से अधिक अंक लेकर पास हुए हैं। कार्यक्रम के अध्यक्ष रंगनाथा जी ने अपने अध्यक्षीय संबोधन में कहा कि हिन्दी में कार्य करना सभी कर्माचारियों का संवैधानकि दायित्व है। इसका निर्वाह सभी को करना चाहिए। उन्होंने पखवाडे के दौरान आयोजित प्रतियोगिताओ एवं हिन्दी प्रोत्साहन योजना के विजेताओं को नगद पुरस्कार तथा इसके साथ ही हिन्दी पारंगत पाठ्यक्रम में उत्तीर्ण सभी वैज्ञानिक, अधिकारी एवं कर्मचारियों को प्रमाणपत्र प्रदान किए। अंत में श्री. प्रदीप सिंह, सहा. निदेशक (रा.भा) ने धन्यवाद ज्ञापित किया।

PUBLICATIONS

Research Papers

Abhinav Kumar, Vandana Bharti, Vinod Kumar, Meena, P.D. and Suresh, G. 2017. Hyperspectral Imaging Applications in Rapeseed and Mustard Farming. *Journal of Oilseeds Research*, 34 (1) 1-8.

Ajay, B.C., Kambiranda, D., Bera, S.K., Narendra Kumar, Gangadhar, K., Abdul Fiyaz, R. and Ramya, K.T. 2018. Low phytic acid peanut: a potential tool to overcome mineral malnutrition in humans. *Current Science*, 114(6), 1165-1166.

Anjani, K. and Praduman Yadav. 2017. High yielding-high oleic non-genetically modified Indian safflower cultivars. *Industrial Crops and Products,* 104:7-12.

Anjani, K., Raoof, M.A., Santhalakshmi Prasad, M., Duraimurugan, P., Lucose, C., Praduman Yadav, Prasad, R.D., Jawharlal, J. and Sarada, C. 2018. Trait-specific accessions in global castor (*Ricinus communis* L.) germplasm core set for utilization in castor improvement. *Industrial Crops and Products*, 112: 766-764.

Arbind K. Choudhary, Rafat Sultana, M., Isabel Vales, Kul Bhushan Saxena, Ravi Ranjan Kumar and Pasala Ratnakumar. 2017. Integrated physiological and molecular approaches to improvement of abiotic stress tolerance in two pulse crops of the semi-arid tropics. *Crop Journal* (Japan), doi.org/10.1016/j.cj.2017.11.002.

Aziz Qureshi, Prasad, R.D., Kulkarni, A., Navaneeta, T., Lakshmamma, P., Varaprasad, K.S. and Vishnuvardhan Reddy, A. 2017. Selection of *Trichoderma* strains for salinity stress and evaluation for imparting salinity tolerance in sunflower. *Journal of Oilseeds Research*, 34(4):205-208.

Aziz Qureshi, Singh, R.K., Sen, D., Baishya, L.K., Singh, A.P., Vishnuvardhan Reddy, A. and Pati, D. 2018. Evaluation of sunflower hybrids for their suitability in North Eastern Hill Regions of India. *Journal of Oilseeds Research*. 35(1):45-47.

Bal, S.K., Minhas, P.S., Singh, Y., Kumar, M., Patel, D.P., Rane, J., Sureshkumar, P., Ratnakumar, P., Choudary, B.U. and Singh, N.P. 2017. Coping with hailstorm in vulnerable Deccan Plateau region of India: Technological interventions for crop recovery. *Current Science,* 2021-2027.

Dudhe, M.Y., Rajguru, A.B., Bhoite, K.D. and Madhuri, P. 2017. Genetic evaluation and identification of stable sunflower genotypes under semi-arid dryland conditions of Telangana and Maharashtra state. *SABRAO Journal of Breeding and Genetics*, 49 (1) 83-93, 2017.

Duraimurugan, P. 2018. Effect of weather parameters on the seasonal dynamics of tobacco caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae) in castor in Telangana State. *Journal of Agrometeorology*, 20(2): 139-143.

Duraimurugan, P. and Alivelu, K. 2017. Development and evaluation of integrated pest management module for castor. *Journal of Experimental Zoology*, 20 (Supplement 1): 1389-1393.

Duraimurugan, P. and Alivelu, K. 2017. Field efficacy of newer insecticides against sucking insect pests in castor. *Indian Journal of Plant Protection*, 45(3): 246-250.

Duraimurugan, P. and Lakshminarayana M. 2018. Effect of novel insecticides to *Trichogramma chilonis* and *Snellenius maculipennis*, the potential parasitoids of castor semilooper. *Journal of Environmental Biology*, 39(5/6): 1-5.

Duraimurugan, P. and Srinivas, P.S. 2017. Evaluation of poison baits against tobacco caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae) in castor. *Journal of Experimental Zoology*, 20(2): 745-749.

Duraimurugan, P., Sampathkumar, M. and Srinivas, P.S. 2017. Field evaluation of synthetic kairomonal attractants against major lepidopteran pests of castor. *Journal of Environmental Biology*, 38(6): 1421-1427.

Geetha, A., Sivasankar, A., Saidiah, P. and Lakshmi Prayaga. 2017. Antioxidant enzyme response in water stress sunflower genotypes. *International Journal of Current Microbiology and Applied Sciences*, 6 (5) : 138-146

Geetha, A., Sivasankar, A., Saidiah, P. and Lakshmi Prayaga. 2017. Effect of moisture stress on key physiological parameters in sunflower genotypes. *International Journal of Current Microbiology and Applied Sciences*, 6 (5) : 147-159.

George F., Oliver, J. and Sujatha, M. 2017. High yielding and trait specific genotypes and genetic associations among yield and yield contributing traits in *Jatropha curcas* L. *Agroforestry Systems,* DOI 10.1007/s10457-017-0089-2.

Jawahar Lal Jatothu, Anil Kumar, A., Choudhary, S.B., Sharma, H.K., Maruthi, R.T., Kar, C.S. and Mitra, J. 2018. Genetic diversity analysis in tossa jute (*Corchorus olitorius* L.) germplasm Lines. *Journal of Applied and Natural Science,* 10 (1): 1-3.

Kadirvel, P., Praduman Yadav and Mukta, N. 2017. Oil quality of exotic safflower (*Carthamus tinctorius* L.) cultivars in India. *Journal of Oilseeds Research*, 34(2): 76-80.

Krishna Teja, I., Ramana Rao, S.V., Vishnu Sankar Rao, D. and Ravindra Reddy, B. 2017. Performance of oilseeds in India-a temporal analysis. *Journal of Oilseeds Research*, 34(1) : 26-31.

Kumaraswamy, H.H., Singh, G.P. and Singh, N.K. 2017. High Kernel Weight Genotypes of Indian Bread Wheat (*Triticum aestivum* L.). *Indian Journal of Plant Genetic Resources,* 30(1): 80- 83.

Lakshmamma, P., Lakshmi Prayaga and Alivelu, K. 2017. Selection of castor germplasm with important traits for drought tolerance under field conditions. *Indian Journal of Plant Physiology,* 22 (3), 295-303.

Lakshmamma, P., Lakshmi Prayaga and Sarada, C. 2016. Response of contrasting root genotypes of castor (*Ricinus communis* L.) to water stress. *Journal of Oilseeds Research,* 33(4): 212-215.

Lakshmi, S., Durga, K.K., Ranganatha, A.R.G., Bharathi, V. and Ankaiah, R. 2016. Influence of different pollen storage methods on seed quality parameters in sunflower. *Progressive Research*, (Spl. Issue), 11; 3980-85.

Lakshmi Prayaga, Sarada, C. and Lakshmamma, P. 2017. Germination of sunflower (*Helianthus annuus* L.) at low temperature with different methods of seed treatment. *Journal of Oilseeds Research*, 34(2): 93-97.

Mahalakshmi, K.P., Lokesha, R., Savitha, Naik, M.K. and Ranganatha, A.R.G. 2017. Genotypic differences of mutant lines for resistance in natural pathogen load to *Alternaria*, Powdery mildew and selected lines in pathogenic load to powdery mildew in sesame. *Bulletin of Environment, Pharmacology and Life Sciences,* 6 (4) 534-541

Manjunatha, T., Chandran, K., Mahesh, P., Mohanraj, K. and Appunu. 2018. Characterization of *Saccharum spontaneum* accessions from North-Eastern India. *Electronic Journal of Plant Breeding*, 9(1): 38-50.

Meena, H.P. and Prabakaran, A.J. 2017. Evaluation of new inbreds for fertility restoring and maintaining behaviours in two diverse CMS sources of sunflower (*Helianthus annuus* L.). *Journal of Oilseeds Research*, 34(3): 125-132.

Meena, H.P., Pushpa, H.D. and Sujatha, M. 2017. Interspecific hybrid between silver leaf sunflower (*Helianthus argophyllus* T. & G.) and cultivated sunflower: Cytomorphological characterization of F_1 hybrid. *Journal of Oilseeds Research*, 34(2): 81-88.

Meena, H.P., Sujatha, M. and Prashant Kumar Soni. 2017. Interspecific hybrid between cultivated sunflower (*Helianthus annuus* L.) and silver leaf sunflower *H. argophyllus* T. & G.: Cytomorphological and molecular characterization. *The Indian Journal of Genetics and Plant Breeding*, 77(4): 547-555.

Naresh, N., Santhalakshmi Prasad, M. and Prasad, R.D. 2017. Morphological and genetic variability of *Alternaria alternata* isolates of sunflower. *International Journal of Current Research*, 9 (7): 54393-54398.

Padmavathi, P., Murthy, I.Y.L.N. and Alivelu, K. 2017. Oilseed based cropping systems productivity in response to land configuration practices in Vertisols under rainfed conditions. *Journal of Oilseeds Research*, 34 (3): 179-181.

Pandey, A.K., Rajani, B., Roshni, S. and Ranganatha, A.R.G. 2017. Efficacy of seed treatment and their combinations with foliar sprays of insecticides for management of *Antigastra* in sesame. *Journal of Entom. Zoology Studies,* 5(5);1216-20.

Pandey, A.K., Rajani, R., Surabhi, J. and Ranganatha, A.R.G. 2018. Efficacy and economics of different insecticidal treatments for management of sucking pests in sesame. *Journal of Entomology and Zoology Studies,* 6(2):1247-52.

Praduman Yadav and Anjani, K. 2017. Assessment of variation in castor genetic resources for oil characteristics. *Journal of The American Oil Chemist's Society*, 94:611–617.

Rajamanickan Elanchezhian, Dameshwar Kumar, Kulasekaran Ramesh, Ashish Kumar Biswas and Ashok Kumar Patra. 2017. Morpho-physiological and biochemical response of maize (*Zea mays*) plants fertilized with nano-iron (Fe_3O_4) micronutrient. *Journal of Plant Nutrition*, 40(14): 1969-1977.

Rajender, J., Pushpavathi, B. and Santhalakshmi Prasad, M. 2016. Molecular characterization of isolates of *Alternariaster helianthi* causing sunflower blight. *Indian Phytopathology*, 69(4s) : 134-137.

Rakesh, P., Prasad, R.D., Uma Devi, G. and Bharati, N.B. 2017. *In vitro* assessment of seedling growth and management of castor wilt and groundnut collar rot through the combination of seed coat polymers, fungicides and bioagents. *Bulletin of Environment, Pharmacology and Life Sciences*, (6) Special issue [1]: 147-153.

Ramesh, K., Ashok, K. Patra and Ashis K. Biswas. 2017. Best management practices for soybean under soybean-wheat system in the changing climate scenario. *Indian Journal of Fertilizers*, 13(2): 42-55.

Ramesh, Kulasekaran, Amar Matloob, Farhena Aslam, Singarayer K. Florentine and Bhagirath S. Chauhan. 2017. Weeds in a changing climate: vulnerabilities, consequences, and implications for future weed management. *Frontiers in Plant Science,* doi: 10.3389/fpls.2017.00095.

Ramprasad, E., Senthilvel, S., Jawarharlal, J., Yamini, K.N., Dangi, K.S., Ranganatha, A.R.G. and Varaprasad, K.S. 2017, An insight into morphological and molecular diversity in Indian sesame cultivars. *The Indian Journal of Genetics and Plant Breeding,* 77 (2), 271-277

Ramya, K.T., Mukesh Patel, Manjunatha, T. and Lavanya, C. 2018. Identification of best combiners for development of castor hybrids under irrigated conditions. *Electronic Journal of Plant Breeding,* 9 (1): 387-391.

Ravi Yugandhar, P., Suneetha, K. and Usha Kiran, B. 2018. Principal component analysis for agro-morphological and quality characters in germplasm of rice. *International Journal of Advanced and Biological Research*, 8(2):1-5.

Saisanthosh, K., Joseph Raju, T., Kadirvel, P., Keshavalu, K., Razia Sultana, Praduman Yadav and Mukta, N. 2018. Correlations among seed traits: implications for breeding high oil yield in safflower. *Journal of Oilseeds Research,* 35(1): 13-19.

Sammi Reddy, K., Gopinath, K.A., Kumari Visha, V. and Ramesh, K. 2018. Weed nutrient interactions in agricultural systems. *Indian Journal of Fertilisers*, 14(2): 50-58.

Santosh, B., Narender Reddy, S. and Lakshmi Prayaga. 2017. Physiological attributes of sunflower as influenced by moisture regimes. *Green Farming*, 8 (3): 680-683.

Santosh, B., Narender Reddy, S., Lakshmi Prayaga and Dayakar Reddy, T. 2017. Effect of moisture stress on sunflower genotypes at seedling stage. *Environment and Ecology*, 15 (1): 16-20.

Siddiqua, M., Sharma, S.H.K., Aziz Qureshi, A. and Laxminarayana, P. (2018). Assessment of potassium supplying capacity of soils of Nalgonda district of Telangana state through Neubauer seedling technique. *International Journal of Pure and Applied Bioscience,* 6(1): 551-555.

Sreekanth, P.D. and Madhuri, P. 2017. Rice bran oil, a hitherto untapped source to meet the edible oil deficit in India. *Journal of Oilseeds Research*, 34(3) : 187-190.

Srinivas, A., Kumar, G.D.S. and Padmaiah, M. 2017. Evaluation of mobile based agro-advisory services-A case of e-kapas and reliance information services. *Journal of Oilseeds Research,* 34 (3): 161-165.

Sujatha, K., Santhalakshmi Prasad, M., Usha, D., Naresh, N. and Prasad, R.D. 2017. Assessment of fungicides, botanicals and biocontrol agents for integrated management of *Alternariaster* leaf blight of sunflower. *Environment and Ecology*, 35 (1):113-121.

Sujatha, M., Ulaganathan, K., Divya Bhanu, B. and Soni, P.K. 2018. RNA-Seq data of control and powdery mildew pathogen (*Golovinomyces orontii*) treated transcriptomes of *Helianthus niveus*. *Data in Brief* (Elsevier) 17: 210-217.

Sujatha Thankeswaran Parvathy. 2018. Versatile roles of ubiquitous Calcium-dependent protein kinases (CDPKs) in plants. *Journal of Oilseeds Research,* 35 (1): 1-11.

Sujatha. T. Parvathy, Raoof, M.A., Jagadesh, P. and Jayakrishna, T. 2018. *In vitro* sporulation, cultural characterisation, identification and phylogeny of gray mold fungus (*Botryotinia ricini* (Godfrey) Whetzel.) of castor. *Applied Biological Research,* 20 (2): 105-117.

Usha Kiran, B., Shivakula Sekara Paandian and Lavanya, C. 2017. Diagnostic set of SSR markers for molecular fingerprinting of parental lines and hybrid purity testing in castor (*Ricinus communis* L.). *International Journal of Pure and Applied Biosciences*, 5(6):1608-1615.

Books/Book Chapters

Abdul Fiyaz, R., Ramya, K.T. and Subba Rao, L.V. 2017. Development of mapping populations in crop plants. In: *Traditional and Modern Breeding Approaches for Development of High Quality Rice Varieties* (LV Subba Rao *et al*., 2017) sponsored by Vietnam Academy of

Agricultural Sciences (VAAS), Vietnam and conducted at ICAR-Indian Institute of Rice Research, Hyderabad, India. Training Manual No. PB-1/2017-18. ICAR-IIRR, Hyderabad, India, pp 351-354.

Basappa, H. and Duraimurugan, P. 2018. Management of Pests of Oilseed Crops. In: *Pests and their Management*. Omkar (Ed.), Springer Nature, Singapore, pp. 162-171. (ISBN 978-981-10-8687-8).

Desai, S., Prasad, R.D., Dinesh Kumar, V., Sowmya, P., Aziz Qureshi, A., Lakshmamma, P., Navaneetha, T. and Meenakshi, T. 2017. *Trichoderma* mediated abiotic stress management – A novel approach to sustain crop productivity. In: *Biological Control of Crop Diseases: Recent advances & Perspectives*, 65-84, Eds. Dinesh Singh, B. N. Chakraborty, R. N. Pandey and Pratibha Sharma. Today & Tomorrow's Printers and Publishers, New Delhi, India.

Elanchezhian, R., Biswas, A.K., Ramesh, K. and Patra, A.K. (ed.) 2017. *Advances in soil-plant system for enhancing nutrient sue efficiency*. New India Publishing Agency. p.1-404.

Kulasekaran Ramesh, Ashish Kumar Biswas, Brijlal Lakaria, Sanjay Srivastava and Ashok Kumar Patra. (ed.) 2017. *Enhancing nutrient use efficiency: concepts, methods and management interventions*. New India Publishing Agency. p.1-483.

Kumar, G.D.S. 2017. Assessment of frontline demonstration on oilseeds. In: *Compendium of lectures on "Tools on monitoring, evaluation and impact assessment of rainfed technologies and development programmes"*. Eds. G. Nirmala, K. Ravi Shankar, R. Nagarjuna Kumar, P.K. Pankaj, D.B.V. Ramana, Pushpanjali, Jagriti Rohit, Anshida Beevi, G. Venkatesh, B. Narsimlu and K. Sammi Reddy. ICAR-CRIDA, Hyderabad.

Meena, B.P., Ramesh, K., Neenu, S., Pramod Jha and Rashmi. I. 2017. Controlled release fertilizers for improving nitrogen use efficiency. In: *Enhancing nutrient use efficiency concept, method and management interventions*. K. Ramesh, A.K. Biswas, B.L. Lakaria, Sanjay Srivastva and Ashok Kumar Patra (Eds.), New India Publishing Agency, New Delhi. pp.59–79.

Minhas, P.S., Rane, J. and Ratnakumar, P. 2017. *Abiotic Stress Management for Resilience Agriculture*. Springer Nature Publishers, India, pp.01- 517.

Minhas, P.S., Rane, J. and Ratnakumar, P. 2017. Abiotic stresses in Agriculture. In: *Abiotic Stress Management for Resilience Agriculture*. Minhas *et al*. (Eds), Springer Nature Publishers, India, pp.03-08.

Mukta, N. and Varaprasad, K.S. 2018. Tree Borne Oilseeds for Agroforestry. In: *Agroforestry Opportunities for enhancing resilience to climate change in rainfed areas*. G.R. Rao. M. Prabhakar, G. Venkatesh, I. Srinivas and K. Sammi Reddy (Eds.), ICAR-CRIDA, Hyderabad. Pp.43-49.

Prasad, R. D. and Srinivas, A. 2017. Biological control of diseases of castor, safflower and sunflower, In: *Biological Control of Crop Diseases: Recent advances & Perspectives*, 495-507, Eds. Dinesh Singh, B. N. Chakraborty, R. N. Pandey and Pratibha Sharma. Today & Tomorrow's Printers and Publishers, New Delhi, India.

Ratnakumar, P., Minhas, P.S. and Wakchaure, G.C. 2017. Plant bioregulators : A mitigation strategies for resilient agriculture. In: Minhas *et al.,* 2017. *Abiotic Stress Management for Resilience Agriculture*. Springer Nature Publishers, India, pp. 221- 235.

Sujatha, M. and Reddy, T.P. 2017. Current status and genomics and genomic resources in select group of oilseed crops. In: *Insights on Global Challenges and Opportunities for the Century Ahead*. V. Dashvantha Reddy, K. Venkateswara Rao and K. Ramakrishna (eds) BS Publications, Hyderabad, pp.327-330.

Varaprasad, K.S. and Duraimurugan, P. 2018. Integrated Pest Management - Minor Oilseeds Crops. In: *Handbook of Integrated Pest Management*, Chattopadhyay, C., Tanwar, R.K., Sehgal, M., Birah, A., Bhagat, S., Ahmad, N. and Mehta, N. (eds). Indian Council of Agricultural Research, New Delhi, pp. 557-577. (ISBN: 978-8171641796).

Vimala Devi, P.S. 2018. Mass production of *Bacillus thuringiensis* and *Nomuraea rileyi*. In: Chattopadhyay, C.; Tanwar, R.K.; Sehgal, M.; Birah, A.; Bhagat, S.; Ahmad, N.; Mehta, N. (eds), *Handbook of Integrated Pest Management*. Indian Council of Agricultural Research, pp. 353-357.

Abstracts in Seminars/Symposia/Workshops

Duraimurugan, P. 2017. Compatibility of insecticides and fungicides on castor (*Ricinus communis* L.). In: Proceedings of National Conference on Technological Challenges in Social, Environmental and Agricultural Reforms, 9-10 September 2017 organized by the Green Reap Welfare Society, ICAR-IIRR, Hyderabad, India. pp. 294-295.

Duraimurugan, P. and Sampath Kumar, M. 2017. Evaluation of mating disruption technique with synthetic sex

pheromone for the management of *Spodoptera litura* in castor. In: Proceedings of National Conference on Technological Challenges in Social, Environmental and Agricultural Reforms, 9-10 September 2017 organized by the Green Reap Welfare Society, ICAR-IIRR, Hyderabad, India. pp. 294.

Duraimurugan, P. and Sampath Kumar, M. 2018. Exploiting pheromone and kairomone blends for trapping *Spodoptera litura* moths in castor. In: Proceedings of 3rd National Conference on Frontiers in Ecobiological Sciences and its Applications, 7-9 February 2018, School of Life Sciences, Periyar University, Salem, Tamil Nadu, India, pp.5.

Duraimurugan, P., Anjani, K. and Sampath Kumar, M. 2018. Studies on behavioural response and associated allelochemicals in relation to differential susceptibility of castor germplasms to capsule borer (*Conogethes punctiferalis*). In: Proceedings of 3rd National Conference on Frontiers in Ecobiological Sciences and its Applications, 7-9 February 2018, School of Life Sciences, Periyar University, Salem, Tamil Nadu, India. pp. 4.

Kadirvel, P., Veerraju, C.H., Senthilvel, S., Usha Kiran, B., Srinivas, P.S., Mukta, N., Praduman Yadav, Raju, J., Saisanthosh, K., Joseph Raju, T., Shaw, R., Mobeen, S.K. and Jegadeeswaran, M. 2017. Towards marker-assisted breeding for higher productivity in safflower. In: Proceedings of VI NGGIBCI Conference on Crop Genomics: Present & Future, ICRISAT, Hyderabad, India, pp. 87.

Prasad, R.D., Dinesh Kumar, V. and Vishnuvardhan Reddy, A. 2017. "Trichoderma: Critical Issues in Research and Commercialization" in National Symposium on 'Plant health management: embracing eco-sustainable paradigm' organized by the Indian Phytopathological Society (IPS) at Assam Agricultural University, Jorhat from 15-17 February, 2018, pp.80-81.

Ratnakumar, P., Jawaharlal, J., Praduman Yadav, Ramya, K.T., Ranganatha, A.R.G., Murthy, I.Y.L.N. and Vishnuvardhan Reddy, A. 2017. Foliage variations effect on transpiration, transpiration efficiency and their relationship with seed yield in sesame under drought. Presented at National Conference of Plant Physiology "Emerging Role of Plant Physiology for Food Security and Climate Resilient Agriculture" held at November 23-25, 2017, IGKV, Raipur.

Selvaraj, V.M., Bhavani, D., Sarada, C. and Dinesh Kumar, V. 2018. Genome-wide transcriptome expands the published gene repertoire of castor bean (*Ricinus communis*. L). International Conference on Integrative Biology & Applied Genetics held at CSIR-IICT between March 15-17, 2018 by the Department of Genetics, Osmania University.

Sujatha Thankeswaran Parvathy, Prabhakaran, A.J. and Vishnuvardhan Reddy, A. 2018. Abstracts of bisexuality precedes unisexuality and alters with temperature in castor (*Ricinus communis* L) flowers" in 2nd International conference on Food and Agriculture 2018, Dhanbad, Jharkhand.

Suresh, G. and Vishnuvardhan Reddy, A. 2018. Phosphate solubilizing microorganisms for enhancing castor productivity and sustaining soil health under rainfed and irrigated conditions. National Conference on Approach and Practices to enrich soil for Sustainable Agriculture- *Bhumisuposhan*. Organized by Ekalavya Foundation at IICT, Hyderabad on 24-25 March, 2018.

Technical Bulletins and Popular Articles

Anjani, K., Raoof, M.A., Santhalakshmi Prasad, M., Lakshminarayana, M., Duraimurugan, P., Praduman Yadav, Lakshmamma, P., Jawaharlal, J. and Vishnuvardhan Reddy, A. 2017. *Castor Genetic Resources : Status and Utilization in Castor Genetic Improvement*. ICAR-IIOR, Hyderabad, pp. 34.

Jawaharlal, J., Meena, H.P., Ratnakumar Pasala, Praduman Yadav and Vishnuvardhan Reddy, A. 2017. *Til mei prabhandan kriyaye* (Hindi) –Extension folder-20.

Jawaharlal, J., Duraimurugan, P., Santhalakshmi Prasad, M., Satish Kumar, G.D., Suresh, G., Ranganatha, A.R.G. and Vishnuvardhan Reddy, A. 2017. *Nuvvula saagu yaajamanyam* (Telugu)-Extension folder-19.

Jawaharlal, J., Ratnakumar, P., Duraimurugan, P., Santhalakshmi Prasad, M., Ranganatha, A.R.G. and Vishnuvardhan Reddy, A. 2017. *Sesame Management Practices*. (English) Extension Folder-18.

Meena, B.P., Biswas, A.K., Shirale, A.O., Ramesh, K., Jha, P. and Lakaria, B.L. 2017. Eco-friendly neem coated urea: a boon for farmers. *Indian Farming,* 67 (06): 11-14.

Mukta, N., Praduman Yadav, Prasad, R.D., Srinivas, P.S., Madhuri, P., Kadirvel, P., Padmavathi, P., Murthy, I.Y.L.N., Alivelu, K., Meena, H.P. and Vishnuvardhan

Reddy, A. 2017. 'विशिष्ट गुण वाले कुसुम जर्मप्लाज्म' Promising Trait Specific Safflower Germplasm, Bilingual Technical Bulletin, ICAR-IIOR, Hyderabad, pp. 1-26

Padmavathi, P., Alivelu, P., Srinivas, P.S., Prasad, R.D., Anjani, K., Mukta, N., Satish Kumar, G.D., Praduman Yadav, Meena, H.P. and Padmaiah, M. 2017. Safflower (*Carthamus tinctorius* L.) pamphlet in Hindi. pp 1-5.

Ravi Yugandhar, P. and Usha Kiran, B. 2018. *Kusuma upayogalu*. Agriclinic. 8 (11): 29-30.

Ravi Yugandhar, P. and Usha Kiran, B. 2018. *Manushulake kadhu pantaluku melu chese pedda tulasi*. Agriclinic. 8 (11): 55-56.

Sarada, C., Padmaiah, M., Suresh, G., Satish Kumar, G.D., Duraimurgan, P., Santhalakshmi, M., Lavanya, C., Prabakaran, A.J., Meena, H.P., Praduman Yadav, Alivelu, K. and Ramana Rao, S.V. 2017. Castor (*Ricinus communis* L.) pamphlet in Hindi. pp 1-5.

Satish Kumar, G.D., Suresh, G., Basappa, H., Chander Rao, S., Meena, H.P., Praduman Yadav and Madhuri, P. 2017. Sunflower (*Helianthus annuus* L.) pamphlet in Hindi. pp. 1-5.

Sujatha, M., Chander Rao, S. and Vishnuvardhan Reddy, A. 2017. *Significant Achievements of 50 years of AICRP on Oilseeds*. ICAR-IIOR, Hyderabad. Pp.46.

Technical Folders by IIOR on (1) BMPs for castor cultivation – Leaflet in seed packets; (2) Outreach of IIOR; (3) Pocket Book: Rogues identification in DCH-177 castor hybrid seed production and (4) Pocket Book: Rouges identification in DCH-519 castor hybrid seed production.

Mobile Apps

- ICAR-IIOR Biocontrol agents
- ICAR-IIOR Sesame
- ICAR-IIOR Safflower

Presentations in Conference/Symposia/Trainings

Name of the scientist	Title/Conference/Place/Date(s)
Smt. P. Madhuri	Hands on training to all the staff of IIOR on Supply Chain Management Module of MIS-FMS during February 6-8, 2018
	Delivered a lecture to the Skilled Supporting Staff of NAARM on the Implementation of MIS-FMS & AEBAS at IIOR
Dr. P. Ratnakumar	Foliage variations effect on transpiration, efficiency and their relationship with seed yield in sesame under drought. National Conference of Plant Physiology held at IGKV, Raipur during Nov -22-24, 2017
	Delivered lecture on " Climate Smart Agriculture for Enhancing Crop and Water Productivity under Abiotic Stress Condition" in Model Training Course Sponsored by DoE, MoAFW, held at ICAR-NIASM, Baramati, Pune Dec. 16-23, 2017
	Delivered lecture on topic 'Diagnosis and management of nutrient deficiencies of plants' held at NIPHM, Hyderabad on Dec. 22, 2017
	Delivered lecture in Summer School on "Recent advances in Abiotic Stress Management for Climate Smart Agriculture" at ICAR- NIASM, Baramati, Pune, 8 - 28 September, 2017
Smt. K.S.V.P. Chandrika	Oral presentation of the paper "Enhancing seed quality and germination of oilseed crops through climate smart-value Added biopolymeric films" In: 2nd International conference on Food and Agriculture during Mar. 29-31, 2018 at Dhanbad, Jharkhand.
Dr. V. Dinesh Kumar	Delivered a lecture on "RNA seq and its applications" on Sept. 18, 2017 in National Seminar on Applications of Bioinformatics in Agricultural Research and Education held at NAARM, Hyderabad during Sep. 14-23, 2017.
	Delivered a lecture on 'Introduction to gene cloning and applications' on March 12, 2018 in DBT sponsored training programme on 'Techniques in molecular biology'
	Delivered an invited lecture on 'Genomics of Trichoderma mediated Induced Systemic Resistance in castor' in the National Conference on "Plant Breeding in Genomics Era" held at UAS, Bengaluru on Sept. 15, 2017
Dr. S.N. Sudhakara Babu	Presentation of lecture on "Prospects and strategies for organic oilseeds crop production" in ICAR Winter school on "Sustainable organic production practices – an approach to mitigate climate change and livelihood security" at UAS, Bengaluru on Dec. 12, 2017
	Lead paper presentation on "Technologies for increasing oilseeds production in Maharashtra' at KVKs workshop of ATARI, Pune, at KVK, Solapur on January 16, 2018
Dr. P. Kadirvel	Presented a lead paper on Tailoring Plants for Better Harvest and More Profits. In: Proceedings of National Conference on "Frontiers in Eco-biological Sciences and its Application-FESA 2018": Theme: Water-Food-Energy Nexus during February 7-9, 2018 at Periyar University, Salem, Tamil Nadu
Dr. H.P. Meena	Poster presentation of the paper 'Harnessing the power of crop wild relatives for sunflower (*Helianthus annuus* L.) improvement in India' organised at C.S. Azad University of Agriculture & Technology, Kanpur from 14-17 February, 2018.

Dr. Praduman Yadav	Delivered lecture on "Chemical Composition and Suitability of Short Gestation Non-Edible Oil Crops for Biofuels". In A Consultative Workshop on Short Gestation Non Edible Oil Crops as Feed Stock for Biodiesel organized by ICAR-IIOR and working group on biofuels, Ministry of Petroleum & Natural Gas at Hyderabad, India on June 13-14, 2017
Dr. Md. A. Aziz Qureshi	Paper presented on studies on potassium release characteristics in selected soils of Nalgonda district of Telangana. In: National Seminar on Developments in Soil Science during 82nd Annual Convention, December 11-14, 2017, Amity University, Kolkata.
Dr. S. Senthilvel	Delivered a lecture on "Tools for identification of marker-trait associations" in the training programme on 'Application of Bioinformatics in Agricultural Research and Education' organized by NAARM at Hyderabad during September 14-23, 2017
Dr. M. Sujatha	Perspectives of castor crop as a feedstock for biodiesel. Presented during the Consultative Workshop on Short Gestation Non Edible Oil Crops as Feed Stock for Biodiesel organized at ICAR-IIOR, Hyderabad from 13-14 June 2017. Delivered a lecture on Prebreeding and Genetic Enhancement in Oilseed Crops at the Third National Workshop on TILLING and Genome Editing in Crop Plants organized at University of Hyderabad on January 25, 2018
Dr. Sujatha, T.P.	Oral presentation on Bisexuality precedes unisexuality and alters with temperature in castor *(Ricinus communis* L) flowers in 2nd International conference on Food and Agriculture held from March 29-31, 2018 at Dhanbad, Jharkhand.
Dr. G. Suresh	Phosphate solubilizing microorganisms for enhancing castor productivity and sustaining soil health under rainfed and irrigated conditions. National Conference on Approach and Practices to enrich soil for Sustainable Agriculture- *Bhumisuposhan* held from 24-25 March, 2018 at IICT, Hyderabad. Delivered a talk on "Biological control of weeds" during a training course on "Advances in weed management "organized at NIPHM, Hyderabad during Sept. 18-20, 2017
Smt. B. Usha Kiran	Oral presentation on "Construction of safflower germplasm mapping panel suitable for association mapping of seed traits" In: 2nd International conference on Food and Agriculture during March 29-31st, 2018 at Dhanbad, Jharkhand.
Dr. A.R.G. Ranganatha	Lead lecture on improved technologies of sesame, sunflower, safflower, castor, linseed and niger at KVK, Berhampur during November 24-26, 2017.
Dr. C. Lavanya	Presented paper in Brainstorming Workshop-cum-Discussion Meeting on "Opportunities and Potential of Value Addition in Castor : Technical Needs and Requirements and the Way Forward organised by TIFAC, DST, New Delhi on March 15, 2018.
Shri H.H. Kumaraswamy	Delivered an invited lectures on "Importance of Signal Transduction" and "Mechanism of Signal Transduction" for the postgraduate students of Institute of Biotechnology of PJTSAU, Hyderabad, on April 22, 2017

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 ₹ 8,00,000/- was spent during the period under report to acquire 75 books and for subscription to 43 periodicals, A total of 85 publications were received on gratis, besides newsletters and annual reports from different organizations. New records of books were added to the computerized library catalogue database.

The KOHA Integrated Library Management Software has been in operation at IIOR. Four issues of " IIOR Newsletter" and 380 electronic article delivery though e-mails have been brought out and circulated to all scientists working in AICRP (sunflower, safflower, castor and sesame & niger) centres across different states and at IIOR. Literature searches have been carried out in the mandate crops using in-house database, CROP CD, AGRIS on CD. AGRICOLA, Indian Patents.

Civil Works

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

Work/Repairs	Cost (₹ in Lakhs)
Construction of Central Laboratory Complex including Furniture & Fixtures	342.00
Repairs and renovation of garden guard walls	5.00
Ramps at main and annex buildings and hostel	1.68
Minor repairs and re-carpeting of BT roads at Rajendranagar Farm	4.90
Minor repairs and re-carpeting of BT roads at Narkhoda Farm	4.98
Minor repairs in soil science laboratory and digestion room	2.36
Minor repairs in safflower germplasm field lab, Director Cell, Accounts, etc.	2.88
Repairs and renovation of cattle shed to use as physiology lab at Narkhoda Farm	3.14
Repairs and maintenance of Residential Quarter Type-IV No. 1	3.97
Repairs/Renovation of plant breeding laboratory	4.46

VISITORS

During the year under report, about 364 farmers from Andhra Pradesh, Tamil Nadu, Karnataka, Telangana, Maharashtra and Madhya Pradesh and nearly 3000 students from SAUs, Colleges and schools belonging to Telangana, Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Karnataka, Kerala and Meghalaya visited this Institute and interacted with the scientists.

Dr. T. Mohapatra, Secretary, DARE & Director General, Indian Council of Agricultural Research, New Delhi visited ICAR-IIOR on August 1, 2017 to inaugurate (1) Central Laboratory Complex; (2) Newly renovated Museum; (3) Foundation Day Celebrations and (4) Golden Jubilee Celebrations of AICRP on Oilseeds.

Shri Sudhir Singh, IIS, Spokesperson, Krishi Bhawan, New Delhi visited ICAR-IIOR on September 16, 2017.

PROBATION / PROMOTIONS / TRANSFERS / SUPERANNUATIONS

Probation

Name	Designation	Date of cleared
Shri P. Srinivas	Skilled Support Staff	14.03.2016
Dr. H.D. Pushpa	Scientist	31.12.2016
Smt. K.S.V.P. Chandrika	Scientist	31.12.2016
Smt. B. Gayatri	Scientist	31.12.2016

Promotion

Name	From	To	Date
Dr. K. Alivelu	Sr. Scientist	Principal Scientist	09.12.2016
Dr. Sentilvel Senapathy	Sr. Scientist	Principal Scientist	01.04.2017
Smt. P. Madhuri,	Scientist (Computer Application)	Higher grade with RGP Rs.9000/- Scientist (Computer Application)	19.01.2015
Shri M. Bhaskara Reddy	ACTO (T-7/8)(F/F)	Chief Technical Officer (T-9)	01.01.2017
Shri G.Balakishan	ACTO (T-7/8)(F/F)	Chief Technical Officer (T-9)	01.01.2017
Shri B.V. Rao	Tech. Officer (T-5)	Sr. Tech. Officer (T-6)	01.07.2013
Shri G. Srinivasa Rao	Technical Assistant (F/F)	Sr. Technical Assistant (T-4)	01.01.2009
Smt. D. Hamsamma	TSCL	Skilled Supporting Staff	08.09.2017
Smt. K. Suseela	TSCL	Skilled Supporting Staff	08.09.2017

Transfers/Joinings

Name	Post	From	To	Date
Smt. B. Swarna Kumari	Sr. Admn. Officer	ICAR-IIOR, Hyderabad	ICAR-CTRI, Rajahmundry	15.04.2017
Shri H. Ganesha	Finance & Accounts Officer	ICAR-IIOR, Hyderabad	ICAR-CMFRI, Cochin	24.04.2017
Shri K. Srinivasa Rao	Finance & Accounts Officer	ICAR-IIRR, Hyderabad	ICAR-IIOR, Hyderabad	29.04.2017
Dr. K. Ramesh	Pr. Sci. (Agronomy)	ICAR-IISS, Bhopal	ICAR-IIOR, Hyderabad	27.06.2017
Shri Shitanshu Kumar	Sr. Admn. Officer	ICAR-DOGR, Pune	ICAR-IIOR, Hyderabad	30.12.2017

Superannuation

Name	Post	Date
Shri M. Ramulu	Technical Officer	31.05.2017
Dr. M. Lakshminarayana	Pr. Scientist (Ag. Entomology)	30.06.2017
Shri B. Krishna	Technical Officer	31.07.2017
Shri B. Kistaiah	Technical Officer	31.08.2017
Shri S. Jagadishwer	Technical Assistant	31.08.2017
Shri D. Mallesha	Technical Officer	30.11.2017
Shri Ch. Balaiah	Skilled Supporting Staff	02.02.2018 (VRS)
Shri Shaik Shoukat Ali	Technical Officer	31.03.2018
Smt. D. Hamsamma	Skilled Supporting Staff	31.03.2018

The resignation of Dr. N.V.P.R. Ganga Rao, Senior Scientist (Plant Breeding) from the Council service has been accepted vide Council Lr.F.No.3-11/2017-DA&A, dated.12.09.2017 and he has been relieved from the Council/ICAR Service w.e.f.22.01.2013.

PERSONNEL

(as on March 31, 2018)

Dr. A. Vishnuvardhan Reddy	Director

Director's Cell

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

Research Section

Crop Improvement

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

Crop Production

Dr. I.Y.L.N. Murthy	Head & Principal Scientist (Soil Science)
Dr. S.N. Sudhakara Babu	Principal Scientist (Agronomy)

Dr. P. Padmavathi	Principal Scientist (Agronomy)
Dr. P. Lakshmamma	Principal Scientist (Plant Physiology)
Dr. Lakshmi Prayaga	Principal Scientist (Plant Physiology)
Dr. G. Suresh	Principal Scientist (Agronomy)
Dr. Md.A. Aziz Qureshi	Principal Scientist (Soil Science)
Dr. K. Ramesh	Principal Scientist (Agronomy)
Dr. Ratna Kumar Pasala	Senior Scientist (Plant Physiology)
Dr. Praduman Yadav	Scientist (Biochemistry)
Smt. K.S.V.P. Chandrika	Scientist (Agricultural Chemicals)
Smt. Ch.V. Haripriya	Sr. Tech. Officer (F/F)
Shri P. Ashok	Tech. Officer (T-5)
Shri L. Krupakar	Tech. Officer (T-5)
Shri S. Narsimha	Tech. Officer (T-5)

Crop Protection

Dr. P.S. Vimala Devi	Head & Principal Scientist (Agricultural Entomology)
Dr. H. Basappa	Principal Scientist (Ag. Ento.) (Deputation with UAS, Dharwad)
Dr. R.D. Prasad	Principal Scientist (Plant Pathology)
Dr. S. Chander Rao	Principal Scientist (Plant Pathology)
Dr. M. Santhalakshmi Prasad	Principal Scientist (Plant Pathology)
Dr. P. Satya Srinivas	Principal Scientist (Agricultural Entomology)
Dr. P. Duraimurugan	Senior Scientist (Agricultural Entomology)
Smt. B. Gayatri	Scientist (Nematology)
Shri Ch. Anjaiah	Sr. Technician (F/F)
Shri S. Saida Reddy	Sr. Technician (F/F)

Social Sciences

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

Support Services

AKMU Cell

Shri P. Srinivasa Rao	Senior Technical Officer

Library & Documentation

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

Art & Photography

Shri B.V. Rao	Sr. Tech. Officer
Shri B.V. Noble	Sr. Tech. Officer

Technical Coordination Cell

Smt. R. Raji	Personal Assistant

Farm Section

Shri M. Bhaskar Reddy	Head (FOM) & Chief Technical Officer (F/F)
Shri G. Balakishan	Chief Technical Officer (FF)
Shri Y. Rama Govinda Reddy	Sr. Tech. Officer (F/F)
Shri G.Y. Prabhakar	Tech. Officer (T-5)
Shri C. Prabhudas	DMO
Shri Surender Prasad	Technical Officer (Workshop)
Shri A. Srinivasa Raju	Tech. Asst. (AC Mech.-cum-Operator)
Shri N. Vasanth	Tech. Asst. (Fitter)
Shri K. Srinivas	Tech. Asst. (Generator Operator)
Shri M. Indrasena Reddy	Tech. Asst. (Tractor driver)
Shri Y. Venkateshwar Rao	Tech. Asst. (Tractor driver)
Shri T. Bichanna	UDC

Seed Section

Shri M. Panduranga Rao	Technical Officer (F/F)
Shri T. Veeraiah	Technical Officer (F/F)

Administration

Shri Shitanshu Kumar	Sr. Administrative Officer
Shri Pradeep Singh	Assistant Director (OL)
Shri S. Shamdas	Asst. Admn. Officer
Dr. G. Annapurna	Sr. Tech. Officer
Smt. C. Lalitha	Personal Assistant
Smt. R.A. Nalini	Assistant
Shri P.R. Varaprasada Rao	Assistant
Shri E.V.R.K. Nagendra Prasad	Assistant
Shri B. Giri	UDC
Smt. P. Swapna	LDC

Stores

Shri Rakesh Geeda	Assistant
Shri G.B. Nagendra Prasad	UDC
Smt. G. Maheshwari	LDC
Shri G. Raghava Kiran Kumar	Jr. Stenographer

Drivers

Shri V. Yadagiri Swamy	Sr. Tech. Asst.
Shri G. Ramulu	Tech. Asst.
Shri G. Pardhasaradhi	Sr. Tech. Asst.
Shri E. Ravi Kumar	Tech. Asst.

Audit & Accounts

Shri K. Srinivasa Rao	Finance & Accounts Officer
Shri A. Prem Kumar	Jr. Accounts Officer
Shri G. Srinivasa Rao	Assistant
Smt. S. Swarupa Rani	Assistant
Smt. B. Gyaneshwari	UDC

Skilled Supporting Staff

Shri G. Rajamouli
Shri G. Mallesh
Shri D. Narasimha
Shri M. Venkatesh
Shri A. Rambabu
Shri M. Ramulu
Shri P. Krishna
Shri D. Balaiah
Shri B. Narasimha
Smt. B. Kistamma
Shri K. Sanjeeva
Shri B. Vishnu
Smt. G. Bharathamma
Shri Narsimha
Shri B. Gyaneshwar
Shri P. Srinivas
Smt. K. Kalavathi
Smt. A. Lalitha
Smt. K. Suseela
Smt. D. Hamsamma

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान

ICAR-Indian Institute of Oilseeds Research

राजेंद्रनगर, हैदराबाद / Rajendranagar, Hyderabad-500 030

Phone: +91-040-24015222; **Fax**: 040-24017969; **E-mail**: director.iior@icar.gov.in; **Web site**: http://www.icar-iior.org.in