ICAR-IIOR
Annual Report

वार्षिक प्रतिवेदन
Annual Report
2021

भाकृअनुप-भारतीय तिलहन अनुसंधान संस्थान
ICAR-Indian Institute of Oilseeds Research
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ICAR-IIOR Annual Report

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Preface

It gives me immense pleasure to present the ICAR-IIOR Annual Report 2021 that highlights the significant achievements made under research, extension and training programmes pursued during 2021. The institute is striving to strengthen the government's goal to achieve self-reliance in oilseed production through developing and promoting innovative technologies in the mandate oilseed crops *viz*., castor, sunflower, safflower, sesame, niger and linseed.

Crop improvement research focussed on various fronts including germplasm management, pre-breeding, parental line development, cultivar development, and molecular breeding and biotechnology. Extensive efforts were made on germplasm evaluation and generation of breeding materials/populations for exercising superior plant selections towards cultivar development. To support the breeding efforts, 474 exotic germplasm accessions, mainly in sunflower, sesame and niger, were augmented from USA and Ethiopia. Two hybrids (TilhanTec-SUNH-1in sunflower and ICH-5 in castor) were notified by the Central Variety Release Committee. Five genetic stocks (HOSuS-1 in sunflower; RG-3060, M-571, ICS-200, IPC-21 in castor) were registered with PGRC, ICAR-NBPGR, New Delhi. Four major genetic loci for resistance to *Fusarium* wilt in castor were identified and tagged with SNP markers to facilitate marker-assisted selection, which is globally the first attempt. A major QTL for tolerance to aphid in safflower was validated. A robust *in vitro* regeneration protocol for castor using the hypocotyls was developed, which would help expediting transgenic cultivar development. Furthermore, a total of 697 q seeds (breeder, foundation, certified and truthfully labelled) of castor, sunflower, sesame and safflower were produced, which significantly enhanced the availability of good quality seeds to the farmers and contributed to improving seed replacement rate in the mandate crops.

Crop production research focussed on conservation agriculture, cropping system research, efficient nutrient management, best management practices, abiotic stress tolerance and quality/value addition. Experiments on conservation agricultural practices showed that reduced or zero tillage was equally effective as that of conventional tillage in castor. In safflower, soybean (normal duration)-safflower cropping system showed higher productivity under different crop geometry and IPNM in broad bed and furrow configuration. A combination of Fe and Zn nanocitrates improved plant growth and nutrient uptake. Efforts were made to develop best management practices for cultivating sesame under organic and rice-sesame situations. Screening germplasm for tolerance to abiotic stresses, especially drought and temperature in castor, sunflower, safflower and sesame led to identification of genotypes with potential stress tolerance for further validation and use in breeding pogrammes. Efficacy testing of safflower seed protein concentrates in broiler chicken diet and rats provided encouraging results suggesting their potential value in animal nutrition.

In crop protection research, major emphases were given towards understanding host plant resistance to pests and diseases, biological control, population dynamics of insect pests/pollinators and management of stored grain pests. Sources of resistance to important pests and diseases in castor (*Fusarium* wilt, capsule borer, leafhopper, thrips and whitefly), sunflower (leafhopper), safflower (*Fusarium* wilt, root rot and aphid) and sesame (root rot, phyllody, leafhopper) were identified for further confirmation and utilization in breeding. DOR Bt-127 SC formulation was promising against lepidopteran pests in castor and groundnut under multi-location field testing. Promising isolates of chitinolytic bacteria for biological control of Fusarium wilt and root rot were identified. Microbiome profiling of sesame phyllosphere and endosphere was done towards understanding and managing phyllody disease. Biopolymer-based seed coating of microbials showed a great promise for disease management; efforts are underway for upscaling the technology.

In social sciences, major emphases were made in the areas of developing statistical models to predict yield responses to climate change, impact assessment of technology, developing online resources by the application of ICT and AI tools, analysis of yield gaps for developing suitable extension strategies, FLDs and value

chain management. Digital platforms, Castor Knowledge Management Portal, Oilseeds Pests and Disease Image Repository system, Oilseeds Statistics Information System and AICRP (Linseed) Information System were developed for effective technology management and dissemination. A total of 494 FLDs on castor, sunflower, sesame and niger were successfully conducted in collaboration with State Departments of Agriculture and NGOs.

Licensing agreements were signed with private firms namely M/s. PJ Margo Pvt. Ltd., Bengaluru and M/s Gujarat Eco Microbial Technologies Pvt. Ltd., Vadodara for commercialization of DOR Bt-1 technology. A patent entitled "Identification of Thermo-Tolerant Trichoderma for Use as Bio-Control Agent under Heat Stress Condition" was granted. Permanent registration of *Bacillus thuringiensis* var. *kurstaki* 0.5% WP, *Beauveria bassiana* 30% SC and Th4d WP formulations was pursued with Central Insecticides Board and Registration Committee, Department of Agriculture and Farmers Welfare, Govt. of India. The institute assisted the formation and promotion of two FPOs in Siddipet district of Telangana. In order to strengthen research training and outreach programmes, the institute signed MoUs with Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani and NGOs: Koneru Lakshmaiah Education Foundation (KLEF) and Grameen Mall Foundation, Hyderabad. In addition, the institute implemented various capacity building and outreach activities under the Farmer First Programme, Tribal Sub Plan, Scheduled Caste Sub Plan, MGMG and NEH Region. Sixteen training programmes were conducted in the areas of seed production, crop diversification, value addition, beekeeping, mass production of microbials, FPOs *etc*., which benefited more than 1000 personnel including scientists, entrepreneurs, farmers and school children. Furthermore, the institute celebrated the National Science Day, International Women's Day, World Water Day, International Yoga Day, Parthenium Awareness Week, *Swachhta Pakhwada*, *Azadi Ka Amrut Mahotsav*, Hindi *Pakhwada etc*. as a part of the national schemes.

I place on record my sincere gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR; Dr. T.R. Sharma, DDG (CS), ICAR; Dr. Sanjeev Gupta, ADG (O&P), ICAR; Dr. D.K. Yadava, ADG (Seeds), ICAR for their guidance and unstinted support in executing the mandate of the institute. I express my gratefulness to the Chairman and the Members of Research Advisory Committee for critical assessment and guidance in improving the research programmes of the institute. I also express my gratitude to the Members of Institute Management Committee for facilitating smooth functioning and budget utilization of the institute. My sincere thanks to all the Heads of Sections, Drs. V. Dinesh Kumar, S.N. Sudhakara Babu, R.D. Prasad, S.V. Ramana Rao; Shri Shitanshu Kumar, SAO; Shri K. Srinivasa Rao, FAO, Shri Vinod Kumar Sahoo, SFAO, Dr. A.L. Rathnakumar, OiC, PME Cell and Dr. T. Boopathi, OiC, TIC for their inputs in compiling the information of their respective sections. I appreciate the efforts of the editorial team of the Annual Report for bringing out the publication. The contribution of Smt. J. Gnana Prasuna, STA for typesetting; Shri P. Srinivasa Rao, PS and Smt. C. Lalitha, PS for secretarial assistance and Shri Pradeep Singh, Assistant Director (OL) for translation of the Annual Report in Hindi is greatly acknowledged.

(M. Sujatha)
Director (A)

Hyderabad
May 16, 2022

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Executive Summary

Executive Summary

Major Achievements (2021)

- Two hybrids (TilhanTec-SUNH-1in sunflower and ICH-5 in castor) were notified by Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops.
- Five genetic stocks (HOSuS-1 in sunflower; RG-3060, M-571, ICS-200, IPC-21 in castor) were registered with PGRC, ICAR-NBPGR, New Delhi.
- Four major genetic loci (*for-1*, *For-2*, *For-3* and *For-4*) conferring resistance to *Fusarium* wilt in castor were identified and tagged with SNP markers to facilitate marker-assisted selection.
- A major QTL (*QUc-Ct3.1*) associated with tolerance to aphid in safflower was validated.
- A robust *in vitro* regeneration protocol for castor was optimized and the rooted plants could be acclimatized successfully.
- In rice fallow–sesame cropping system, conventional tillage was superior over the other tillage practices across regions.
- A process for bioploymer-based multilayer seed coating with bioagents and other crop inputs was developed.
- Digital platforms *viz*., Castor Knowledge Management Portal, an Interactive Oilseeds Statistical Information System and AICRP (Linseed) Information System were developed for effective technology management and dissemination.

Crop Improvement

Germplasm Maintenance, Evaluation and Enhancement

- **Castor**: A total of 625 accessions were multiplied and 446 accessions were supplied to different AICRP centres.
- **Sunflower**: A total of 126 accessions were multiplied; 381 accessions were supplied to different AICRP centres, and 224 accessions were augmented from USDA, USA.
- **Safflower**: A total of 893 accessions were rejuvenated, 350 promising accessions were multiplied and 247 accessions were supplied to various AICRP centres. Seventy accessions of *Carthamus oxyacanthus* and 18 accessions of *C. lanatus* were multiplied.
- **Sesame**: A total of 230 exotic accessions were augmented from USDA, USA; 287 accessions were multiplied; 328 accessions were evaluated for agronomic traits; 3 accessions of *Sesamum radiatum* and 1 accession of *S. alatum* were augmented.
- **Niger**: A total of 3420 accessions were augmented (from ICAR-NBPGR, New Delhi, PC Unit-Sesame & Niger, Jabalpur and Niger Research Station, Vanarasi, Gujarat), multiplied and characterized.
- **Linseed**: A total of 3088 accessions were multiplied.

Pre-breeding

- **Sunflower**: A total of 450 pre-bred lines derived from interspecific crosses involving wild *Helianthus annuus*, *H. debilis* and *H. praecox* were advanced and a set of 110 promising lines were supplied to four AICRP centres; nine lines promising for yield and yield related traits under heat stress were identified from the pre-bred lines supplied by University of British Columbia, Canada through USDA, USA.
- **Safflower**: Twenty interspecific crosses were made between *C. tinctorius* and *C. oxyacanthus* accessions towards improvement of seed yield, oil content and tolerance to biotic stresses.
- **Sesame**: An F_3 population of the interspecific cross of Swetha Til x *S. mulayanum* was advanced to F_4 generation.

Parental Line Development

Castor

- A total of 229 pistillate selections were made from segregating populations involving genepool developed through random mating, MAGIC and bi-parental crosses.

- Eight promising monoecious lines with higher seed yield (36-142%) than the best check DCS-78 (700 kg/ha) were identified.
- Twenty diverse wilt resistant monoecious lines were developed.
- A set of 10 S_3 families derived from a genepool showed promise for gray mold resistance in field and in controlled screening.
- A total of 63 single plant F_3 selections were made from the cross between JM-6 (no basal branching) x JI-273 (complete branching type) towards designing new plant types suitable for machine harvesting.

Sunflower

- A total of 165 CMS lines were characterized for 24 qualitative traits and evaluated for 15 quantitative traits. A subset of 46 lines showed promise for various traits including test weight (7.1-9.3 g), volume weight (46-50 g/100 ml), early flowering (51-55 days), seed yield (31.6-41.0 g/plant), oil content (38.0-39.8%) and oleic acid content (79.6-86.2%).
- A total of 185 newly developed inbred lines derived from restorer genepool were characterized for 24 qualitative traits and evaluated for 9 quantitative traits. A set of 95 restorer lines with desirable traits including oil content (>37%), seed yield (>25 g/plant), late flowering (>70 days), oleic acid content (>75%) and resistance to downy mildew were identified. A set of 32 restorer lines resistant to biotic stresses, including downy mildew (17), powdery mildew (12) and leafhopper (3) were confirmed.

Varietal Development

Safflower

- A total of 62 promising progenies with high seed yield, high oil content, high test weight or short duration were selected from RIPE population.
- Two varieties *viz*., ISF-123-sel-15 (AVT-II) and ISF-300 (AVT-I) with higher oil yield of 13% and 19%, respectively over the checks, A-1 or PBNS-12 are in pipeline.

Sesame

- A total of 3587 progenies from MAGIC populations (involving eight parents) and a double cross population were developed for making desirable selections with high seed yield potential.
- A total of 34 high yielding selections were made from bi-parental crosses during *kharif* and summer seasons.
- Four breeding lines with high seed yield potential (950-1110 kg/ha) were identified. Two varieties *viz*., IIOS-1102 and IIOS-3101 were nominated for AICRP trials.

Niger

- A total of 151 selections were made from third cycle random mating population based on seed yield.

Hybrid Development

Castor

- A total of 281 new experimental hybrids were generated, 157 hybrids were evaluated, 28 promising experimental hybrids were re-evaluated and seven hybrids with superior seed yield potential (1267-1606 kg/ha) were identified.
- Two early maturing hybrids *viz*., ICH-1146, ICH-440 and one medium maturing hybrid ICH-277 were promising for higher seed yield (12-22%) over the checks, GCH-4 or GCH-8 in AICRP trials.

Sunflower

- Seven hybrids were promising for higher seed yield (2166-2500 kg/ha) and oil yield (805-887 kg/ha) with oil yield superiority of 22 to 40%.
- Three hybrids *viz*., IIOSH-460 (AHT-I), IIOSH-566 (IHT) and IIOSH-434 (IHT) were under AICRP testing. IIOSH-460 recorded 18% and 26% higher seed yield and oil yield, respectively over the checks, DRSH-1 and KBSH-44, respectively.

Molecular Breeding and Biotechnology

Castor

- Four major genetic loci (*for*-1, *For*-2, *For*-3 and *For*-4) conferring resistance to *Fusarium* wilt were identified through allelism tests and marker based linkage analysis. The loci, *for*-1 and *For*-2, and *For*-3 were mapped on linkage group 7 and 8, respectively using SNP markers.
- An *in vitro* regeneration protocol has been optimized using the hypocotyls obtained from embryo axes derived plantlets. The rooted plants could be acclimatized and successfully established in growth chamber.
- Spray induced gene silencing (SIGS) was explored to control gray mold using five selected genes *viz*.. *ERG27*, *CHS1*, *EF2*, *DCL1* and *DCL2*. This preliminary experiment indicated that dsRNA spray delayed the progression of disease as the appearance of disease symptoms was delayed till 48 h post inoculation.

Safflower

- Allelic variation in the candidate genes *viz*., *CtDGAT-1*, *CtPDAT*, *CtFATB*, *CtOleosin*-4 and *CtOleosin*-9 showed strong association with oil content. Real time PCR analysis showed elevated expression for *DGAT-1* in high oil lines compared to low oil lines.
- A set of 48 polymoprhic SNPs have been identified and are being used in genetic diversity and mapping work in safflower.
- A total of 1940 lines representing six mapping populations from bi-parental and multi-parent crosses were advanced towards identification of QTLs associated with agro-morphological traits including yield components, oil content and tolerance to aphid in safflower.

- Putative QTLs associated with yield related traits and oil content were detected.
- A major QTL (*QUc-Ct3.1*) associated with tolerance to aphid was validated in F_8, F_{10} and BC_1F_3 populations of CO-1 x EC-523368-2 cross.

Registrations, Notifications and DUS Testing

- Five genetic stocks (HOSuS-1 in sunflower; RG-3060, M-571, ICS-200 and IPC-21 in castor) were registered with PGRC, ICAR-NBPGR, New Delhi.
- Two hybrids (TilhanTec-SUNH-1in sunflower and ICH-5 in castor) were notified by Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops.
- DUS testing of one new candidate variety of safflower, one new candidate hybrid of sunflower, comparative DUS testing for two candidate hybrids of sunflower during *rabi* and one farmers variety of castor during *kharif* was undertaken under the Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority.
- A total of 20 niger varieties were multiplied under nets through sibbing and observations were recorded on 32 traits for the development of DUS testing guidelines for niger.

Seed Production

- A total of 696.7 q of breeder, foundation, certified and truthfully labelled seeds of castor, sunflower, sesame and safflower were produced.

Crop Production

Conservation Agriculture

- The seed yield of castor due to different tillage systems were statistically at par indicating reduced tillage (RT) and zero tillage (ZT) had no negative influence on seed yield and castor equivalent yield was equally effective as that of conventional tillage (CT). The highest seed yield and equivalent yield of castor was realized under CT (2538; 3151 kg/ha) followed by RT (2355; 2989 kg/ha) and ZT (2073; 2814 kg/ha). Among intercropping systems, the highest castor equivalent yield was recorded in castor + green gram (3215 kg/ha), followed by castor + redgram (3165 kg/ha) and castor + groundnut (2843 kg/ha).
- High ligno-cellulosic castor stalk is hard to decompose. Utilizing bio-decomposer (Pusa decomposer/ *Madhyam*) for *ex-situ* composting showed promising effect with faster decomposition and higher nutrient composition of the compost (3.6% N; 0.07% P; 0.223% K; 0.026% S and 70 ppm Zn) compared to untreated castor stalk (0.70% N; 0.028% P; 0.092% K; 0.016% S and 24 ppm Zn).

Cropping Systems Research

- Safflower productivity was not significantly influenced by preceding *kharif* crops of greengram and soybean. Seed yield of safflower at 3 rows/BBF with 100% RDF+*Azotobacter*+PSB recorded the highest seed yield (1918 kg/ha). Crop raised without fertilizer with 2 or 3 rows/BBF recorded the lowest seed yield (1300; 1100 kg/ha).

Efficient Nutrient Management and Organic Cultivation

- Evaluation of individual and combined nanocitrates of Fe and Zn micronutrients on soybean and groundnut showed higher nutrient uptake (0.48 mg of Fe/kg; 88.4 μg of Zn/kg) in seedlings with low soil residues compared to the lower uptake (0.02 mg of Fe and 2.05 μg of Zn/kg) of commercially available nano micronutrients.
- Organic sesame in the soybean–sesame cropping system responded well to organic modules with temporal variations. Perceptible difference in the soil health was not yet noticed in terms of soil nutrient status in three years of study.
- Agro-technology for sesame cultivation under paddy fallows indicated superiority of conventional tillage over other tillage practices across locations. Reduced tillage resulted in comparable yields at Mahisapet and Aduthurai with 100% RDF for realising higher yields across the soil types.

Abiotic Stress Tolerance

- In castor, drought tolerant germplasm (RG-1594, RG-1663, RG-2818, RG-2822 and 48-1) and parental lines (ICS-164, ICS-299 and IPC-42) with $\leq$30% reduction in seed yield coupled with $\leq$1.0 DSI, drought and temperature tolerant germplasm (RG-298, RG-2048 and RG-72) with 10-20% reduction in seed yield were identified.
- Significant yield reduction in sunflower to the tune of 57 and 45% was recorded due to water stress in normal and delayed sowing, respectively. Genotypes Phule Bhaskar, KBSH-44, PI-686527 and RHA-6D-1 recorded least susceptibility (<30% yield reduction) due to drought under both normal and late sowing conditions.
- In sesame, total dry matter, total leaf area and stomatal conductance were significantly correlated with seed yield/plant under water stress. Genotypes IC-205776, DT-112, DT-26, IC-205610, IC-132293, DT-97 and IC-204622 recorded higher yield (> 10%) compared with checks GT-10 and Swetha til under water stress condition.

Quality and Value Addition

- The safflower seed protein concentrates (SPC) at 100% replacement to soybean meal in broiler chicken resulted in significantly higher food conversion ratio (FCR: 1.98) compared to soybean meal (FCR: 1.78) at 6 weeks. With SPC, feed intake was reduced with normal serum and slaughter parameters.

Crop Protection

Host Plant Resistance

- Sick pot method was a better artificial inoculation method for screening of castor genotypes against root rot disease than stem tape inoculation method. Sorghum grown inoculum of *Macrophomina phaseolina* @ 35 g/kg soil was standardized in sick pot method.
- Developed *in vivo* and *in vitro* methods to study mechanism of resistance to whitefly (*Trialeurodes ricini*) in castor under controlled conditions. This method was effective in identification of resistance sources among castor genotypes. Resistant genotypes (RG-2800, RG-3428 and DPC-9) exhibited antixenosis for oviposition.
- Studies on influence of wax content in pericarp of castor capsules on gray mold severity revealed that genotypes (RG-1919, RG-1754, RG-1915 and RG-1875) with low quantities of wax content on capsules (0.26 to 0.53 μg/mg) recorded low disease severity (12.5 to 20.0%) as compared to the susceptible check, DCH-519 (wax content of 2.06 μg/mg and disease severity of 95%).
- Leaf epicuticular wax plays a major role in castor-whitefly interaction. Leaf wax content had significant positive correlation with oviposition and negative correlation with developmental period.
- Antixenosis and antibiosis mechanisms are operating in resistant lines of sunflower (GMU-339, GMU-696 and TSG-401) to leafhopper. Antixenosis for nymphal preference, oviposition preference, shelter and feeding; antibiosis in terms of extended larval period, reduced nymphal survival and shortened adult longevity were the major mechanisms of resistance.
- Production of malondialdehyde (MDA) and hydrogen peroxide were higher in susceptible sunflower plants indicating that stress was more in susceptible plants due to leafhopper feeding. Enzyme activity of superoxide dismutase (SOD), catalase (CAT) and peroxidase (POX) was higher in resistant lines.
- Twenty three parental lines and advanced breeding materials of castor (DCS-89, DCS-94, DCS-105, DCS-108, DCS-106, DCS-110, DCS-109, DCS-118, DCS-112, DCS-104, DPC-21, IPC-42, IPC 43, IPC-46, 2061-1, 2160-1, 2180-1, 2202-1, 2203-1, 2255-1, ICS-304, ICS-314 and ICS-315) were resistant to wilt (<20% wilt) in two years of testing under sick plot conditions.
- Resistance reaction of 11 castor inbred lines (ICI-RG 2774-1, ICI-RG 2774-2, ICI-RG 2774-3, ICI-RG2800-1, ICI-RG 2800-2, ICI-RG 2800-3, ICI-RG 2800-4, ICI-RG 2800-5, ICI-RG 2800-6, ICI-RG 2800-7 and ICI-RG 2800-8) to capsule borer were confirmed.
- Resistance reaction of four castor inbred lines (ICI-RG-2800-1, ICI-RG-2800-4, ICI-RG-2800-5 and ICI-RG-2800-8) and a germplasm accession (RG-3428) to whitefly were confirmed.
- Eighteen double bloom castor genotypes (4 germplasm accessions and 14 parental lines) were moderately resistant to leafhopper.
- Seven sunflower lines *viz*., PB1001, PB1003, PB1005, PB1007, PB1008, PB1014 and PB1019 were confirmed for resistance to leafhoppers with an MSI of 1.0.
- Nine safflower germplasm accessions (GMU-6926, GMU-7986, GMU-6891, GMU-6852, GMU-821, GMU-824, GMU-864, GMU-1217 and GMU-3740) were resistant to wilt (<10% disease incidence).
- Six safflower germplasm accessions (GMU-6915, GMU-6854, GMU-1217, GMU-824, GMU-1175 and GMU-4665) were resistant to root rot.
- One safflower accession (GMU-7472) was tolerant (A.I.I., 1.2) and five accessions (GMU-6915, GMU-7985, GMU-4546, GMU-4665 and GMU-4815) were moderately tolerant (A.I.I., 2.4-2.9) to aphid under artificial conditions.
- Five sesame genotypes (SEL-S-18-3002, SEL-S-20-3006, SEL-S-20-2001, IC-500504 and KIC-357) showed moderately resistant reaction (< 20% incidence) to root rot.
- Two sesame genotypes (RT-372 and Lathua local) were highly resistant to leafhopper.
- Two linseed genotypes (LT-113 and LT-114) were promising against leaf miner.

Biological Control

- Three chitinolytic bacterial isolates (IC-RB4, IC-RB5 and NBAIM-2230) were promising against both *Fusarium oxysporum* f. sp. *ricini* and *Macrophomina phaseolina* and inhibited >50% of pathogen under *in vitro* conditions.
- Four chitinolytic bacterial isolates (IC-RB2, IC-RB3, IC-RB8 and UN-RB1) caused >50% mortality of reniform nematode juveniles at 96 h after treatment.
- Culturomics and metagenomics of healthy and phyllody infected sesame were studied for both the phyllosphere and endosphere regions. The metagenomic profiles revealed the presence of *Candidatus phytoplasma* only in endophytic regions of phyllody infected sesame samples.
- Two native isolates of *Bacillus thuringiensis* var. *kurstaki viz*., Bt-154 and Bt-127 were effective against castor capsule borer larvae (*Conogethes punctiferalis*) with LC_{50} value of 1.31 and 1.40 mg/ml, respectively.
- The entomopathogenic fungi, *Beauveria bassiana* was effective against both larvae and pupae of *C. punctiferalis* (LC_{50} of $5.9x10^4$ and $2.6x10^5$ conidia/ml, respectively) over *Metarhizium* (*Nomuraea*) *rileyi* (LC_{50} of $4.4 x10^5$ and $3.8x10^5$ conidia/ml, respectively).
- Safety evaluation of biocontrol agents (Bt-127 SC and *Metarhizium rileyi* isolates) on beneficial organisms (*Trichogramma pretiosum* and *Apis mellifera*) revealed that the microbials are harmless (nil mortality).
- Multi-location field testing of DOR Bt-127 SC formulation @ 3 ml/l revealed that the formulation

was effective against semilooper (*Achaea janata*) and tobacco caterpillar (*Spodoptera litura*) in castor and semilooper (*Thysanoplusia orichalcea*), pod borer (*Helicoverpa armigera*), tobacco caterpillar (*S. litura*), and leafminer (*Aproaerema modicella*) in groundnut.

Bioploymers and Bioagents

- In safflower, soybean and groundnut crops, seed treatment with biopolymer chitosan+*T. harzianum*, Th4d and biopolymer cellulose+*T. harzianum*, Th4d @ 10 ml/kg seed significantly reduced wilt and root rot incidences and improved the seed yield compared to the respective controls.
- In shelf life studies, the biopolymer chitosan+*T. harzianum* Th4d formulation showed an initial log CFU of 10.7 of *T. harzianum* spores and slightly declined to 10.0 by 6 months and to 7.0 by 24 months of storage at 28 ^{0}C and 6.5 by 12 months at 40 ^{0}C.
- Five multilayer seed coating combinations [(cellulose, fungicide, insecticide)+(cellulose, *Bradyrhizobium*, *Trichoderma*); (chitosan, *Bradyrhizobium*, *Trichoderma*)+(cellulose, fungicide, insecticide); (cellulose, fungicide, *Trichoderma*)+(chitosan, *Bradyrhizobium*, insecticide); (cellulose, fungicide) +(chitosan, insecticide)+(cellulose, *Trichoderma*)+ (chitosan, *Bradyrhizobium*); (chitosan, *Bradyrhizobium*) +(cellulose, fungicide)+(cellulose, insecticide)+ (cellulose, *Trichoderma*)] were identified effective in terms of their compatibility, growth promoting parameters and effectiveness against pathogens and insect pests.

Population Dynamics of Insect Pests and Pollinators

- Whitefly and mirid bugs are emerging major insect pests in sesame and the peak incidence of the pests was observed during second fortnight of November. High infestation by major pests of sesame *viz.*, leaf webber and capsule borer, gall midge and leafhopper was observed during October to November.
- Leaf miner, bud fly, pod borer and linseed caterpillar were the major pests on linseed and the peak incidence occurred during January and February.
- Among the various insect visitors of oilseed crops, *Apis cerana indica*, *A. florea*, *A. dorsata*, *Tetragonula iridipennis*, *Syrphus* sp. were both nectar and pollen collectors, while *Nomia* sp. and *Xylocopa tenuiscapa* were the nectar and pollen collectors, respectively.

Management of Stored Grain Pests

- Survey and surveillance of storage insect pests of sesame (48 samples) carried out in Telangana and Madhya Pradesh revealed that the rice moth (*Corcyra cephalonica*) and red flour beetle (*Tribolium castaneum*) were the most dominant species infesting sesame under storage conditions.
- Among hermetic storage methods used to manage storage insect pests, sesame seeds stored in HDPE bag recorded significantly low seed damage as compared to seeds stored in cloth or jute gunny bags.
- Sesame seeds treated with sweet flag rhizome powder @ 10 g/kg or spinosad @ 0.3 ml/kg of seed recorded significantly lower seed damage by rice and red flour beetle compared to untreated control under storage conditions.

Social Sciences

Development of Prediction Models

- Development of models to predict yield responses to climate change in castor crop from Gujarat revealed that Artificial Neural Networks (ANN) was the best fit model in Banaskantha district while Least Absolute Shrinkage Selector Operator (LASSO) in Patan and Mehasana Districts. Weather parameters revealed cyclic variation for all parameters with significant increase over the years across the districts. Trends in district-wise average seasonal rainfall and temperature showed significant positive trend in all seasons. Correlation between yield and weather parameters was significant and positive.

Knowledge Management and Dissemination

- Castor knowledge management portal was designed and developed with five major themes *viz.,* general domain, cultivars, research domain, farmers' domain and extension domain. The information was populated under the respective domain and uploaded to the portal.
- Digital Image Repository System on Oilseeds' Pests and Diseases was created in collaboration with Koneru Lakshmaiah Education Foundation, Hyderabad that enables plant protection specialists to submit digital images online.
- An interactive Oilseeds Statistical Information System (*Tilhantec*:OSIS) was developed by ICAR-IIOR in collaboration with Koneru Lakshmaiah Education Foundation, Hyderabad.
- AICRP (Linseed) information system was developed in collaboration with the KRISHI portal team of ICAR-IASRI, New Delhi. The information system helps in complete automation of experiments conducted under the AICRP system.

Impact Assessment of Oilseed Technologies

- The study on impact assessment of GCH-7 in Banaskantha district of Gujarat revealed that the average productivity of 2.5 t provided additional net returns of Rs. 62,862/ha over operational costs. The highest additional net returns over operational costs was evidenced in cultivation of potato during *rabi* season (Rs. 1,29,990/ha). Gradual shift from castor to taking up two crops or more for increased farm income was evident from the last two years considering the relative profitability of taking two and/or more crops as against one crop of castor (240-270 days duration). This warrants for future research programme orientation towards developing high yielding cultivars of not less than 4.5 t/ha, given the present duration or to evolve cultivars capable of yielding not less than

2.5 t for duration of not exceeding 150-180 days. This could enable for trade off in the net profits realised by the farmers and prevent shrinkage of area under castor.

Analysis of Yield Gaps

- With the objective of reducing the yield gaps in oilseeds and to strengthen the extension strategy for enhancing the productivity, district-wise Relative Spread Index (RSI) and Relative Yield Index (RYI) were estimated and accordingly, the districts were categorised into four groups *viz.,* most efficient, moderately efficient, efficient and inefficient. Appropriate extension strategies will be formulated for each category of district based on the outcome of the field level data and yield gaps observed in FLDs.

Demonstrations of Oilseed Technologies

- A total of 7875 frontline demonstrations (FLDs) on nine oilseed crops and oilseeds-based farming systems were conducted during 2021 with 98.2% implementation rate. As many as 4195 demonstrations were conducted during *rabi*/summer followed by 3680 during *kharif* season.
- The castor hybrid ICH-66 performed better over the prevailing hybrids with additional seed yield of about 28% over the farmers' practice.
- In sunflower, soil application of elemental sulphur @ 25 kg/ha resulted in 15.7% increase over farmers' practice providing additional net returns worth of Rs. 22,250/ha while foliar application of boron @0.2% during ray floret opening stage resulted in 25% higher seed yield.

Value Chain Intervention

- Value chains through introducing apiary in 400 ha of sunflower area in Nizamabad district of Telangana resulted in 5200 kg of honey, providing an additional net income of Rs. 5.6 lakh in three months.
- Two Farmers' Producers Organizations (FPO) *viz.*, "*Chinnakodur Ryhtu Uthpathidarula Paraspara Sahaya Sahakara Sangam Limited*" and "*Sri Bugga Raja Rajeshwara Farmer Producer Mutually Aided Cooperative Society Limited*" were registered with 950 members in two mandals *viz.,* Chinnakodur and Narayanraopet of Siddipet district, Telangana State under the Telangana Mutually Aided Cooperative Societies Act, 1995 as per the operational guidelines of National Cooperative Development Corporation, New Delhi.
- In order to diversify farmers from paddy-paddy system, crop diversification with sunflower was taken up during *rabi* 2021 and around 1000 acres of sunflower was sown by the FPO members. Input aggregation of seed was taken up under the FPO.
- A training programme on "Beekeeping in sunflower crop" was organized to the members of FPO.

Farmer First Programme

- Activities were undertaken in different modules towards improving the farm level profitability and income. A holistic approach was followed for implementing the farm level interventions.
- Soil health cards (25) for major crops (for 12 parameters: major, micro and secondary nutrients) were prepared and distributed to 46 households in tribal hamlet.
- Soil and moisture conservation technologies (contour cultivation/ridge and furrow method) in redgram led to 20.5% increase in productivity resulting in additional net returns of Rs. 16,850/ha.
- Seed treatments with PSB, *Trichoderma* and *Rhizobium* were taken up in redgram, greengram, blackgram and groundnut in both *kharif* and *rabi* seasons with the multi-pronged approach of reduing the usage of inorganic inputs besides improvising the soil health.
- Integrated nutrient management in groundnut (*rabi* 2020-21) resulted in average productivity of 14.3 q/ha as against the traditional practice of 11.2 q/ha. The additional net returns accrued were Rs. 18,437/ha.
- Seed treatment in greengram with PSB, *Rhizobium* and *Trichoderma* coupled with soil test based fertilizer application led to increase in productivity by 31.4% providing additional net returns of Rs. 16,076/ha.
- Sorghum cultivation in *Zaid* towards diversification resulted in average productivity of 12.3 q/ha and gross monetary returns of Rs. 21,998/ha.
- Cultivation of paddy KNM-118 with technology assemblage led to productivity enhancement of 11.3%.
- Technology assemblage in greengram–castor cropping sequence (2020-21) realized the system net returns of Rs. 19,251/ha.
- Vegetable seed kits were provided to 100 households with the intention of enhancing their health and nutrition status.
- Towards doubling of farmers' income, pilots on marketing and value addition led to additional net returns of Rs. 4,650/q in *tur dal* making and Rs. 2,850/q in groundnut kernel.
- Capacity building/training programmes/interaction meetings on importance of value addition for increasing income; use of bioinoculants as seed treatment; health and nutrition; importance of micro nutrients across crops; soil and moisture conservation; importance of input-output marketing were conducted.

ICAR-IIOR

Annual Report 2021

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 at 32 research centres. Later during 1972, safflower, sunflower and niger were brought under the umbrella of AICORPO and the number of research centres were increased to 40. Realizing the need for a national institute for oilseeds, the AICORPO was elevated to the status of Directorate of Oilseeds Research (DOR) 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 2000, the AICRP on Sesame and Niger, and Linseed were separated from the administrative control of DOR. The DOR was entrusted with the responsibility to plan, coordinate and execute the research programmes to augment the production and productivity of sunflower, safflower and castor crops in the country through All India Coordinated Research Project (AICRP) on Oilseeds at 29 locations across 14 states. The DOR was upgraded to ICAR-Indian Institute of Oilseeds Research (ICAR-IIOR) w.e.f. February 3, 2015 as per the approval of XII Plan EFC. During 2020, the Project Coordination (PC) Unit of AICRP (Linseed) was shifted to ICAR-IIOR from ICAR-IIPR, Kanpur as per recommendations of ICAR, New Delhi. Currently, ICAR-IIOR coordinates the AICRP on Oilseeds-Castor, Sunflower, Safflower and Linseed operating at 40 locations across 21 states. The ICAR-IIOR is a premier national institute under the aegis of the Crop Science Division of Indian Council of Agricultural Research, New Delhi.

Vision

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

Mission

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

Mandate

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

Staff position as on December 31, 2021

Category	Sanctioned	Filled	Vacant
Scientific	43*	39	4
Technical	43	26	17
Administrative	30	20	10
Skilled supporting	77	77	0
Total	**193**	**162**	**31**

*including one RMP

Financial Statement

Allocation and Expenditure (2021-22)

(Rs. in lakhs)

Head of Account	Allocation					Expenditure*				
	IIOR Unified Budget	SCSP	NEH	TSP	TOTAL	IIOR Unified Budget	SCSP	NEH	TSP	TOTAL
A. GRANT IN AID – CAPITAL										
Works	71.67	3.19			**74.86**	71.67	3.19			**74.86**
Equipment	58.20	30.81	11.9		**100.86**	58.20	30.81	11.85		**100.86**
Information & Technology	14.07		0.35		**14.42**	14.07		0.35		**14.42**
Library	10.51				**10.51**	10.51				**10.51**
Vehicle & Vessels	0.00				**0.00**	0.00				**0.00**
Furniture	1.12				**1.12**	1.12				**1.12**
B. GRANT IN AID – SALARIES										
Establishment Charges	1952.33				**1952.33**	1952.33				**1952.33**
Wages	195.71				**195.71**	195.71				**195.71**
Overtime Allowance	0.00				**0.00**	0.00				**0.00**
Pension	226.97				**226.97**	226.97				**226.97**
C. GRANT IN AID – GENERAL										
TA	2.82				**2.82**	2.82				**2.82**
Res. & Operational Expenses	392.48	37.50	20.00	26.00	**475.98**	392.48	37.50	20.00	26.00	**475.98**
Administrative Expenses	266.23				**266.23**	266.23				**266.23**
Miscellaneous Expenses	0.47				**0.47**	0.47				**0.47**
TOTAL	**3192.58**	**71.50**	**32.20**	**26.00**	3322.28	**3192.6**	**71.50**	**32.20**	**26.00**	3322.28

*Expenditure as on 31.03.2022

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

(Rs. in lakhs)

Head of Account	AICRP on Oilseeds & Linseed		AICRP on Sesame & Niger	
	Allocation	Expenditure*	Allocation	Expenditure*
A. GRANT IN AID – CAPITAL				
Works	0.00	0.00	0.00	0.00
Equipment	49.08	49.08	33.57	33.57
Information & Technology	0.00	0.00	0.00	0.00
Library	0.00	0.00	0.00	0.00
Vehicle & Vessels	0.00	0.00	0.00	0.00
Furniture	0.00	0.00	0.00	0.00
B. GRANT IN AID – SALARIES				
Establishment Charges	1538.04	1538.04	746.92	746.92
Wages	0.00	0.00	0.00	0.00
Overtime Allowance	0.00	0.00	0.00	0.00
Pension	0.00	0.00	0.00	0.00
C. GRANT IN AID – GENERAL				
TA	0.00	0.00	0.00	0.00
Res. & Operational Expenses	318.2	318.2	87	87
Administrative Expenses	0.00	0.00	0.00	0.00
Miscellaneous Expenses	0.00	0.00	0.00	0.00
TOTAL	**1905.32**	**1905.32**	**867.49**	**867.49**

*Expenditure as on 31.03.2022

Resource Generation

(Rs. in lakhs)

Particulars	Amount
Sale of farm produce	4.27
Rent (Hostel)	2.20
License fee (Quarters)	1.47
Interest earned on loans & advances	0.80
Analytical testing charges	3.51
Interest earned on STDR	14.76
Miscellaneous receipts	2.57
Training	0.15
Sale of technology	3.44
Contract research	6.23
Other Internal resource generation	19.55
Recoveries of loans	1.02
Total	**59.96**

Funds Received for Externally Sponsored Projects

(Rs. in lakhs)

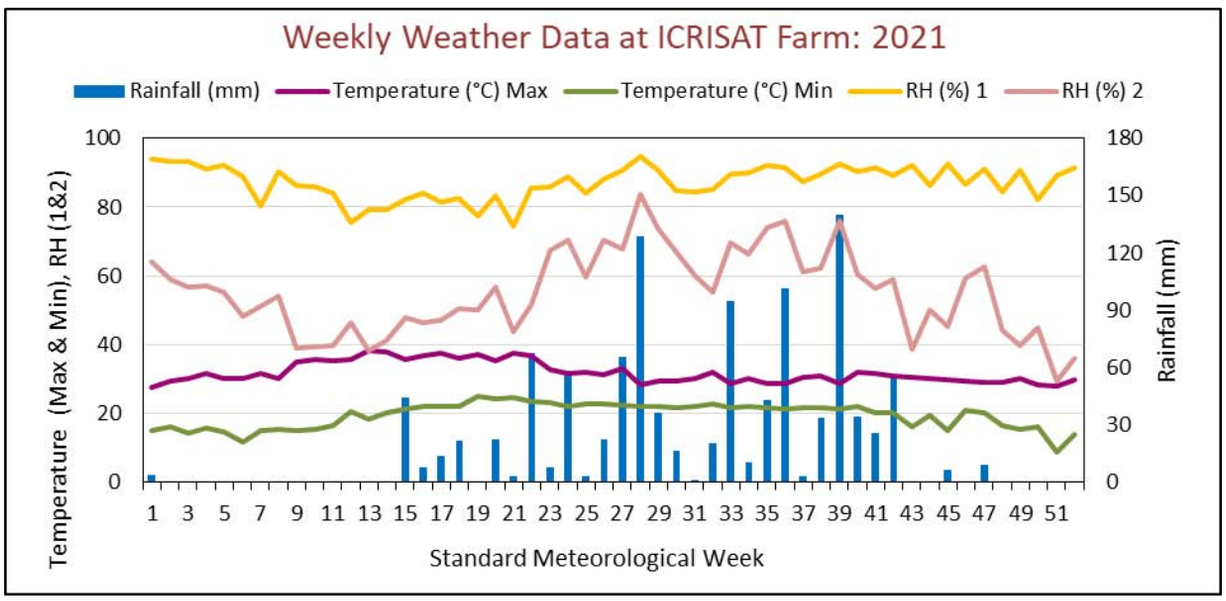
Name of the Scheme	Opening Balance as on 01.04.2021	Receipt	Expenditure
ICAR	1.29242	90.54143	87.43921
DUS	13.10075	10.43457	17.92758
DST	2.03984	34.53655	0.00
DAC	394.79942	253.68812	523.59346
DBT	145.70625	425.63813	486.46707
Others (Licensing, training, testing fee etc.	106.56735	25.50000	45.32437
Total	**663.50603**	**840.3388**	**1160.75169**

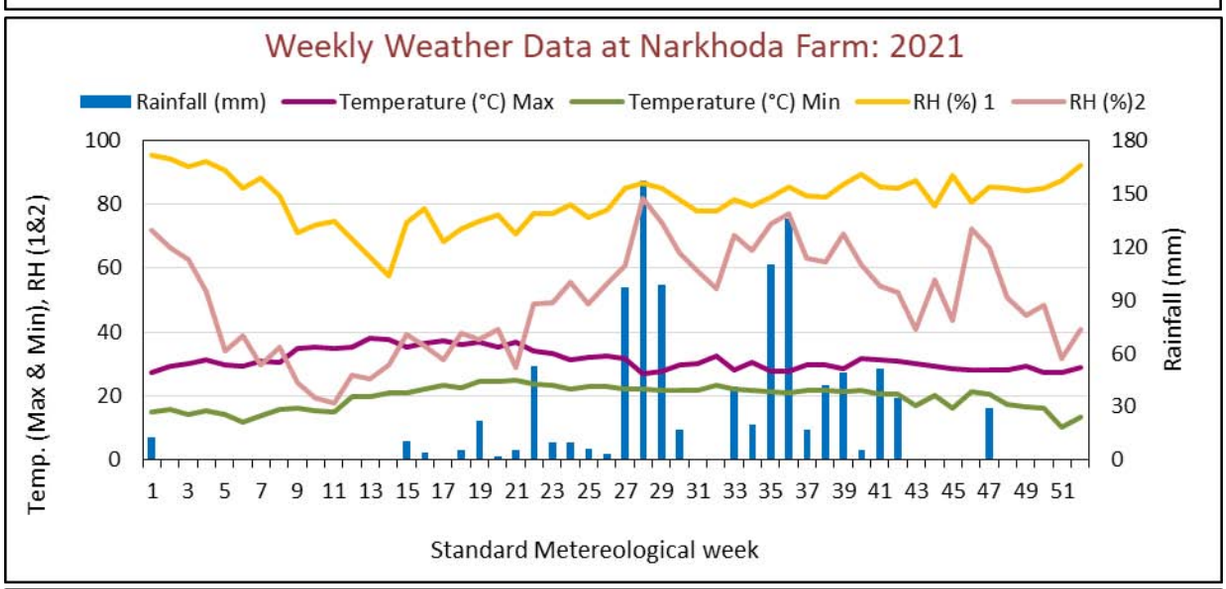
ICAR-IIOR

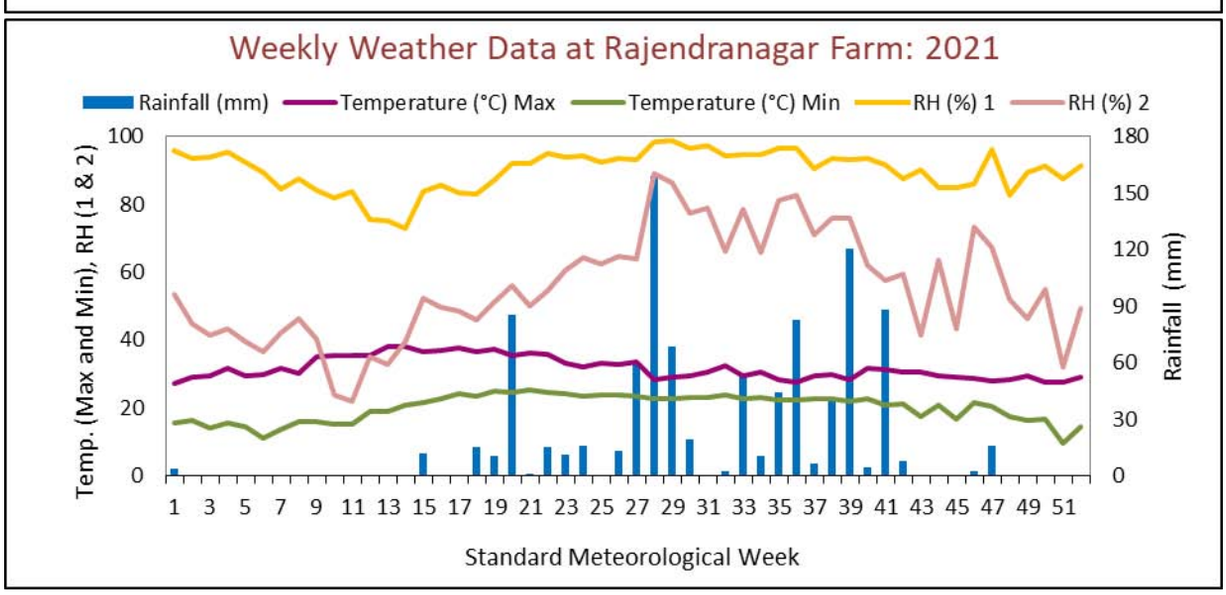
Annual Report
2021

Research Achievements

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


Weekly Weather Data at ICRISAT Farm: 2021
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%) 2
Temperature (Max & Min), RH (1&2)
Rainfall (mm)
Standard Meteorological Week


Weekly Weather Data at Narkhoda Farm: 2021
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%)2
Temp. (Max & Min), RH (1&2)
Rainfall (mm)
Standard Metereological week


Weekly Weather Data at Rajendranagar Farm: 2021
Rainfall (mm)
Temperature (°C) Max
Temperature (°C) Min
RH (%) 1
RH (%) 2
Temp. (Max and Min), RH (1 & 2)
Rainfall (mm)
Standard Meteorological Week

Crop Improvement

Germplasm Maintenance, Evaluation and Enhancement

ICAR-IIOR has the mandate of maintaining, characterizing, evaluating, cataloguing and distributing the germplasm accessions of the oilseed crops *viz*., castor, sunflower, safflower, sesame, niger and linseed for crop improvement research efforts. Concerted attempts were made (1) to augment the germplasm collection by importing exotic accessions of cultivated and wild species, (2) to multiply seeds of germplasm accessions for conservation and distribution, (3) to evaluate germplasm for agronomic traits and oil content/quality, and (4) to identify useful germplasm accessions for utilization in breeding programmes. The activities carried out by the germplasm units are summarized here.

Castor

A total of 3200 accessions are conserved in the medium-term storage (MTS) facility of ICAR-IIOR, Hyderabad. A total of 625 accessions (ICAR-IIOR-317, Ananthapuramu-159 and Palem-149) were multiplied and 446 accessions were supplied to different AICRP centres (S.K. Nagar, Palem and Yethapur) for seed multiplication as well as screening and confirmation against major diseases (wilt, root rot, gray mold) and pests (leafhopper, whitefly and thrips).

Sunflower

A total of 3400 accessions are conserved at MTS of ICAR-IIOR, Hyderabad; 268 accessions were deposited in the MTS of ICAR-NBPGR, New Delhi, 126 accessions were multiplied and 381 accessions were supplied for research use. Augmented 224 accessions from the United States Department of Agriculture (USDA), USA for specific traits like early maturity, high seed yield, high oil content, dwarf plant stature, high oleic acid content and tolerance to different races of downy mildew.

Safflower

A total of 7022 accessions are conserved in the MTS of ICAR-IIOR, Hyderabad. Viability testing was undertaken for 1763 accessions after six years of conservation and 58.2% of the accessions recorded germination of >85%. Sowing was taken up for 893 accessions for rejuvenation and 350 promising accessions for multiplication during *rabi* 2021-22. A total of 436 samples of 247 germplasm accessions were supplied for multilocation, evaluation and utilization in breeding.

Preliminary characterization of fresh exotic accessions/selections: A total of 57 trait-specific accessions were augmented from USDA during 2018, for which sufficient seed was multiplied during two seasons along with initial purification based on morphological traits. A total of 163 accessions/selections were characterized and wide range of variability for important traits was observed as follows: days to 50% flowering (71-117), plant height (38.2-142.0 cm), number of branches/plant (4-13), number of capitula/plant (6-93), diameter of main capitulum (13.3-29.6 cm), 100 seed weight (2.1-8.2 g), seed yield/plant (1.1-36.5 g) and oil content (13.4-36.7%). A total of 36 promising accessions were identified for different traits including early flowering (71-75 days), short plant height (38-60 cm), high seed yield (25-37 g/plant), high oil content (35-37%) and non/few spiny bracts and orange/red petal colour.

Sesame

A total of 2000 accessions are being maintained at ICAR-IIOR, Hyderabad. A total of 328 accessions were evaluated for agronomic performance during *kharif* season. Variability observed in the germplasm set is described as follows: plant height (range: 45-195 cm; mean: 90.3 cm); height of first capsule node (10-43 cm; 22.4 cm), capsule length (2-4 cm; 2.7 cm), capsule circumference (2-3.6 cm; 2.5 cm), number of capsules/plant (25-310; 97) and internodal length (2.5-13.5 cm; 5.3 cm). A total of 230 exotic accessions were augmented from USDA, USA for useful traits like tall plant types, non-branching types, early maturity, black seeded types, large seeded types, large capsule size, multi-capsules per leaf axil and multi-locules. Of these, 154 accessions were rejuvenated in summer 2021. In addition, 287 diverse accessions obtained from ICAR-NBPGR, New Delhi were multiplied.

Exotic sesame accessions

Augmentation of wild species: Three accessions of *Sesamum radiatum* (African origin) and one accession of *S. alatum* (from farmers' fields in the Kolar district of Karnataka state) were augmented.

S. radiatum

S. alatum

Waterlogging-tolerant lines in sesame: Among 120 sesame genotypes, exposed to natural waterlogging situation, during the *kharif* season of 2021, six lines exhibited waterlogging tolerance. The extent of tolerance was quantified in terms of maximum values of agronomic traits: average plant height (98.9 cm; IC-204843), average number of primary branches per plant (3.8; TMV-7), average effective capsules per plant (39.8; IC-131943), average capsule length (2.3 cm; IC-96226), average capsule width (1.3 cm; IC-131936), and average seed yield per plant (13.4 g; IC-132300).

Niger

A total of 3420 accessions were augmented from ICAR-NBPGR, New Delhi; PC Unit-Sesame and Niger, Jabalpur and Niger Research Station, Vanarasi, Gujarat for seed multiplication, preliminary characterization and evaluation. A wide range of variability was observed for traits including duration (days to 50% flowering: 28-85 days), number of capitula (12-62), seed yield (2.1-18.5 g/plant) and oil content (11.5-45.2%). Preliminary evaluation resulted in the identification of eight early maturing accessions (85 days to maturity), 20 self-compatible lines, two male sterile accessions and 27 high yielding (>10 g/plant) accessions. In addition, exotic germplasm accessions were imported from USDA (15) and Ethiopia (5). The exotic accessions are of late duration (120-130 days to maturity) and tall with a high number of capitula (195).

Evaluation of niger germplasm

Comparison of Ethiopian and Indian niger varieties

Linseed

Based on the recommendations of the Council, a total of 2885 accessions, including local land races, exotic accessions, and released varieties, which were maintained by the erstwhile PC Unit at ICAR-IIPR, Kanpur were multiplied at UAS, Raichur and conserved. In addition, 203 diverse breeding lines/accessions received from PC Unit, Kanpur were multiplied at ICAR-IIOR, Hyderabad during *rabi* 2020-21. Several lines with varied oil quality traits were identified including high oleic acid content [LT-181 (64.2%), LT-144 (61.6%)], high linoleic acid content [LT-65 (45.7%), LT-66 (44.0%), LT-142 (43.2%)], high alpha linolenic acid (ALA, omega-3) content [LT-122 (59.1%), LT-10 (58.9%), LT-11 (58.2%), LT-29 (58.4%), LT-40 (58.9%), LT-42 (58.3%), LT-71 (58.2%)] and low ALA content [LT-66 (1.9%), LT-86 (5.7%), LT-89 (4.9%), LT-181 (9.7%)].

Pre-Breeding

Narrow genetic base of the germplasm is a major concern in breeding of the oilseed crops. There is an urgent need to diversify the germplasm base through wide hybridization involving secondary gene pool. Major emphasis is laid on improving seed yield potential, resistance/tolerance to biotic and abiotic stresses by exploiting cross compatible, annual diploid wild species. Pre-breeding activities have been taken up in sunflower, safflower and sesame. The results obtained in the pre-breeding work in the mandate crops are summarized here.

Sunflower

Generation advancement of pre-bred lines: A total of 450 BC_2F_4 families of different wild species like wild *Helianthus annuus*, *H. debilis* and *H. praecox* were advanced from BC_2F_4 to BC_2F_5 generation through selfing during late *rabi* 2020-21. Wider variability was observed for morphological traits like days to flowering, plant height, leaf shape, leaf colour, head diameter, etc.

Evaluation of pre-bred lines for heat stress: Pre-bred lines obtained from University of British Columbia, Canada through USDA, USA were evaluated for tolerance to heat stress based on yield. Nine pre-bred lines (PI-686669, PI-686767, PI-686535, PI-686746, PI-686542, PI-686753, PI-686606, PI-686778 and PI-686808) were promising for yield and yield related traits under heat stress. Seed yield under heat stress ranged from 2.1 to 20.1 g/plant with an average of 10.7 g/plant. Oil content ranged from 32.5 to 41.3% with an average of 39.3%. PI-686669 recorded the highest oil content of 41.3% coupled with seed yield of 8.2 g/plant.

Supply of pre-bred material to different AICRP centres: A total of 110 pre-bred lines derived using different accessions of diploid annual compatible wild species including *H. debilis, H. argophyllus* and wild *H. annuus* were supplied to AICRP centres *viz.*, Coimbatore, Tornala, Hisar and Nandyal for seed multiplication, characterization, evaluation, selection and utilization in breeding programmes.

Safflower

Seed multiplication and characterization of safflower wild species: Seventy accessions of *Carthamus oxyacanthus* (16 of ICAR-IIOR and 54 of ICAR-NBPGR) and 18 accessions of *C. lanatus* (4 of ICAR-IIOR and 14 of ICAR-NBPGR) were multiplied. Variability observed for quantitative traits in the collection of 16 *C. oxyacanthus* accessions were as follows: days to 50% rosette termination (71-89), days to 50% flowering (107-117), days to maturity (176-189), plant height (29-46 cm), number of branches/plant (8-12), number of capitula/plant (64-85), diameter of main capitulum (8.3-9.5 mm), 100 seed weight (1.0-1.5 g), seed yield/plant (1.1-12.9 g) and oil content (19.1-22.5%).

C. oxyacanthus

C. lanatus

Synthesis of interspecific crosses: A total of 20 interspecific crosses were made involving six genotypes of *C. tinctorius* (A-1, EC-755684, EC-755669, EC-736494, EC-736517-1 and EC-755673) as female and five accessions of *C. oxyacanthus* (IC-344875, IC-344883, IC-0218911, IC-0218915 and IC-0344900) as male towards improvement of seed yield, oil content and tolerance to biotic stress through pre-breeding. A-1 was used as source of high seed yield whereas the accessions *viz.*, EC-755684, EC-755669, EC-736494, EC-736517-1 and EC-755673 were used as sources of high oil content (35.3-40.2%).

Sesame

An F_3 population (129 plants) of the interspecific cross of Swetha Til x *S. mulayanum* (IC-43144-1) was advanced to F_4 generation (106 plants) by the single capsule selection.

S. mulayanum

Parental Line Development

Continuous efforts are needed in developing improved parental lines, especially in case of hybrid programmes. As the coordinating and nodal agency of the AICRP on the mandate crops, ICAR-IIOR plays the pivotal role in developing and sharing the improved parental lines to the centres. Major emphasis on the development of parental lines is given in castor and sunflower, which are cross pollinated crops and predominantly hybrids are cultivated. In castor, new pistillate lines (female) with dwarf plant type and earliness were developed through various breeding strategies. Similarly, monoecious (male) lines with high seed yield potential, resistance to wilt and gray mold were developed. In addition, potential of castor parental lines for tolerance to drought were studied and promising genotypes were identified based on physiological evaluation. In sunflower, the focus has been on identifying promising trait specific CMS and restorer lines for agronomic traits, oil quality, resistance to downy mildew and leafhoppers. The promising parental lines are included in hybrid development programmes. The results obtained under different activities carried out during the year are presented.

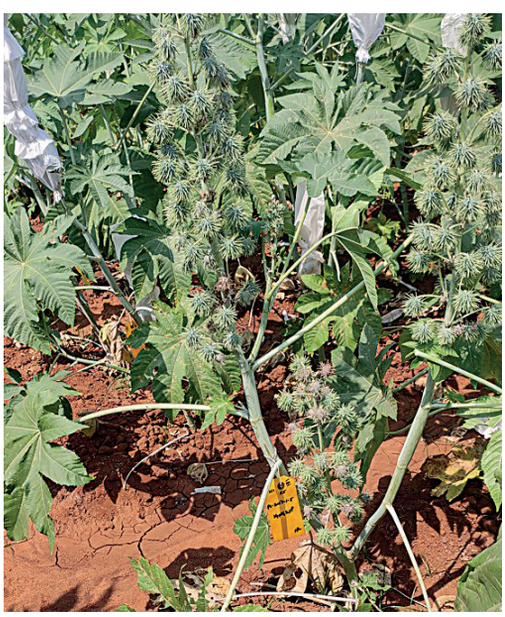
Castor

Development of pistillate lines: Development of improved pistillate lines in castor was attempted through various strategies including gene pool, multi-parent crosses and recombination breeding.

Development of genepool: A genepool for pistillate trait generated involving Rb-1854 (female) and bulk ISF pollen from four pistillate parents [(DPC-9, SKP-84, SL (ISF) and JP-86)] was grown under random mating in isolation (Cycle 1) at ICAR-IIOR, Hyderabad and Junagadh. A total of 114 single plant selections were made, which are being evaluated at ICAR-IIOR.

Development of multiparent advanced generation intercross (MAGIC) population: A MAGIC population is being developed using eight pistillate parents as founders. Four-way cross population was made between ICH-1304 (DPC-16 x M-571) x (Rb-1854 x DPC-25) and ICH-1305 (DPC-23 x DPC-21) x (DPC-9 x DPC-14), which is being evaluated. In addition, 18 selections were advanced to F_3 generation from eight parental crosses involving [(DPC 25 x Rb-1854) x (CNES-1) x NES-6)] and [(DPC-21 x DCS-106) x (JP-77-1 x DPC-21)].

Recombination breeding: A total of 97 promising pistillate selections [primarily with early maturing (<10 nodes) to medium-maturing (12-14 nodes) with short stature] were made from various crosses, which included 13 F_2 progenies from four parental crosses [(DPC 25 x Rb-1854) x (CNES-1 x NES-6)] and [(DPC 21 x DCS-106) x (JP-77-1 x DPC-21)], 37 F_4 single plant selections from DPC-23 x DPC-21 cross, nine selections from three BC_1F_3 populations *viz.*, [(CNES-1 x FC-8) x CNES-1], [(CNES-1 x PMC-36) x CNES-1] and [(M-619 x FC-8) x M619] and 38 F_4 progenies from five bi-parental crosses, *viz.*, Rb 13-1854 x DPC-25, CNES-1 x NES-6, DPC-21 x DCS-106, JP-77-1 x DPC-21 and DPC-25 x Rb-1854.



Pistillate selection of castor with earliness

Development of monoecious lines

Monoecious lines with wilt resistance: A total of 36 F_2 and BC_1F_1 populations were generated to develop elite monoecious lines with wilt resistance in the background of male lines with good combining ability (ICS-156, ICS-159, ICS-169, ICS-171, ICS-177, ICS-182, ICS-185, ICS-186, ICS-210, ICS-216 and ICS-217) using germplasm accessions (RG-1354, RG-2874 and RG-2944) possessing dominant trait of wilt resistance. Furthermore, 20 diverse wilt resistant monoecious lines (ICS series from 406 to 425) were evaluated for agro-morphological traits and reaction to wilt. Seed yield and wilt incidence (at 150 DAS) of these lines ranged from 881 to 2714 kg/ha and 0 to 20%, respectively.

Agronomic evaluation of male lines: Seven promising male lines with higher seed yield (36-142%) than the best check DCS-78 (700 kg/ha) were identified.

Promising male lines for seed yield and yield components in castor (2020-21)

Entry	Plant height up to primary spike (cm)	Number of nodes to primary spike	Total primary spike length (cm)	Effective primary spike length (cm)	100 seed weight (g)	Total seed yield (kg/ha)
ICS-384	113	17	38	38	28	1694
ICS-388	124	15	40	40	30	1177
ICS-362	101	17	40	38	27	1058
ICS-375	92	14	45	45	28	1031
ICS-366	89	15	50	50	25	1020
ICS-371	89	14	39	39	26	994
ICS-374	111	17	41	41	24	992
DCS-78 (C)	73	13	42	42	24	700
48-1 (C)	104	16	31	31	25	504
DCS-9 (C)	52	12	34	34	22	422
CD ($p<0.05$)	21.4	2.3	7.3	8.1	6.8	241.8
CV (%)	11.1	7.4	9.3	10.4	13.3	18.2

Breeding for gray mold resistance: A set of 78 S_3 families derived from the genepool for gray mold resistance were evaluated for reaction to gray mold in the field under natural epiphytotic conditions during *kharif* 2021 and through artificial screening using the detached capsule technique. The screening resulted in the identification of 10 S_3 families (GMM-3, GMM-8, GMM-15, GMM-22, GMM-30, GMM-43, GMM-67-1, GMM-73, GMM-76 and GMM-81) showing promise for gray mold resistance with disease severity in field and reaction in growth chamber ranging from 15 to 35% and 1 to 2 scale, respectively while checks, ICS-324 (resistant) and DCH-519 (susceptible) showed 10 and 80%, and scale of 1 and 4, respectively. The plants from each of the selected families were selfed for further generation advancement.

Designing new plant types suitable for mechanical harvesting: Junagadh Masalio-6 (JM-6) possessing a monospike plant type is used as a donor for developing wilt resistant, early maturing, dwarf male lines through recombination and mutation breeding approaches. An F_2 population (300 plants) of JM-6 (no basal branching) x JI-273 (complete branching type) cross generated at Junagadh was evaluated at ICAR-IIOR, Hyderabad along with the parents during *rabi* 2020-21 with a close spacing of 60 x 60 cm. Four types of branching, *viz.,* i) no basal branching + top branching, ii) basal branching + no top branching, iii) both basal + top branching, and iv) no basal + no top branching (monospike) were observed. Branching nature (i + ii + iii) was dominant over monospike and segregated in 3:1 ratio. Sixty-three single plant F_3 selections were sown in *kharif* 2021 for generation advancement. In addition, JM-6 was used as a male parent to develop four single crosses (DPC-15 x JM-6; IPC-33 x JM-6; IPC-39 x JM-6; VP-1 x JM-6) and a three way cross [DPC-21 x ICS-133) x JM-6] in *rabi* 2020-21. To generate recombinants for early to late flowering and maturity, IPC-15, an early maturing (30 days to primary flowering) pistillate line, was crossed with Ytp-1, a perennial plant type variety (>70 days to primary spike flowering). All six F_1s were evaluated in *kharif* and *rabi* 2021 at a spacing of 90 x 60 cm and simultaneously selfed and backcrossed with both the parents to generate recombinants for maturity and plant type.

Castor parental genotype, JM-6

More than 1000 seeds of JM-6 were treated at BARC, Mumbai with 55 Kr gamma rays and the M_1 population was raised in *kharif* season at ICAR-IIOR, Hyderabad and Junagadh at a wider spacing of 90 x 90 cm. Mutagenic effects like chlorotic patches, yellowing, distorted, overlapping leaf margins were observed in addition to a few early basal branching segregants with no primaries. During the *kharif* season, nearly 600 plants were selfed for raising M_2 generation.

Physiological evaluation of inbred lines: Twenty inbred lines (ICS-237, ICS-238, ICS-240, ICS-241, ICS-242, ICS-243, ICS-244, ICS-245, ICS-246, M-574, ICS-297, ICS-298, ICS-299, ICS-305, ICS-308, ICS-316, ICS-321, PMC-50, DPC-22 and IPC-46) along with checks (RG-1826, 48-1 and ICS-345) were evaluated for total seed yield, total dry matter at harvest and harvest index during *rabi* 2020-21 in order to identify physiologically efficient inbred lines for use in breeding programs. Total seed yield ranged from 96.3 to 228.1 g/plant (checks: 114.5-288.2 g/plant), total dry matter at harvest from 281.6 to 502.1 g/plant (checks: 217.8-501.6 g/plant) and harvest index from 28.5 to 65 (checks: 38.4-57.4). Overall, M-574, ICS-244, DPC-22, ICS-321, ICS-316, ICS-305, PMC-50, ICS-297 and 48-1 recorded high seed yield, which can be used in breeding for increased productivity.

Sunflower

Characterization and evaluation of CMS lines: A total of 165 CMS lines developed by AICRP centres and ICAR-IIOR, Hyderabad were characterized for 24 qualitative traits and evaluated for 15 quantitative traits along with three checks, *viz.,* ARM-243B, CMS-234B and CMS-17B. A total of 46 promising CMS lines including 15 for high oil content (38-39.8%) (CBE COSF-2B, CBE COSF-7B, HA-89B, BLR CMS-300B, CBE COSF-3B, CBE IMS-1B, BLR CMS-103B, CBE COSF-6B, BLR CMS-112B, BLR CMS-851B, BLR CMS-3102B, BLR CMS-3162B, HA-292B, HA-302B and BLR CMS-240B), 7 for high test weight (7.1-9.3 g) (BLR ARM-248B, CMS-17B, HA-286B, BLR CMS-144B, HIS CMS-91B, BLR CMS-102B and BLR CMS-2B), 6 for high volume weight (46-50 g/100 ml) (RCR CMS-70B, LUD CMS-70B, BLR CMS-3102B, BLR CMS-108B, BLR CMS-850B and HA-64B), 6 for early flowering (51-55 days) (BLR CMS-338B, LAT CMS-2023B, LUD CMS-48B, LUD CMS-73B, LUD CMS-67B and HA-302B), 6 for high seed yield (31.6-41 g/plant) (BLR ARM-248B, BLR CMS-3102B, NDL CMS-11B, BLR CMS-243B, LAT CMS-2B and NDL CMS-30B) and 6 for high oleic acid content (79.6-86.2%) (BLR CMS-103B, CMS-1103B, CMS-58B, BLR CMS-901, CMS-59B and RCR CMS-103B) were identified.

Characterization and evaluation of restorer lines: A total of 185 newly developed restorer genepool inbred lines were characterized for 24 qualitative traits and evaluated for 9 quantitative traits along with three checks, *viz.,* RHA-6D-1, RHA-1-1 and RHA-95C-1. Variability observed for quantitative traits was as follows: days to 50% flowering (60-86), plant height (38.0-157.8 cm), number of leaves/plant (15.6-32.0), stem girth (10.5-31.1 mm), head diameter (5-15 cm), 100 seed weight (3.1-7.0 g), seed yield/plant (3.6-35.0 g), oil content (27.1-41.3%) and volume weight (23-51 g/100 ml). A total of 95 restorer lines promising for desirable traits were identified, which included 24 for high oil content (>37%), 5 for seed yield (>25 g/plant), 45 for late flowering (>70 days), 4 for high oleic acid content (>75%) and 17 for resistance to downy mildew.

Confirmation of resistance to downy mildew in restorer lines: Seventeen inbreds (RGP-125, RGP-134, RGP-137, RGP-147, RGP-151, RGP-154, TSG-350, RGP-172, RGP-178, RGP-184, RGP-189, RGP-191, RGP-195, RGP-201, RGP-223, RGP-238 and RGP-303) were confirmed for resistance to downy mildew (0% incidence) consecutively for two seasons: *rabi* 2020-21 and *kharif* 2021 in the downy mildew sick plot at Oilseeds Research Station, Latur, Maharashtra. The downy mildew incidence in checks LSFH-171 (resistant) and Morden (susceptible) were 0% and 83.5%, respectively.

Downy mildew resistant inbred lines of sunflower

Confirmation of restorer lines for resistance to powdery mildew: Twelve lines (RGP-138, RGP-140, RGP-161, RGP-163, RGP-183, RGP-186, RGP-236, RGP-200, RGP-215, RGP-252, RGP-306 and RGP-307) showed a lower percentage disease index (PDI) (<10%), while the PDI was 6.8% and 72.4% in PM-81 (resistant) and CMS-2023B (susceptible) checks, respectively at 90 DAS.

RGP-183 RGP-161 PM-81 (RC) CMS-2023B (SC)

Powdery mildew resistant inbred lines of sunflower

Confirmation of resistance to leafhoppers in restorer lines: Three lines (RGP-184, RGP-189 and RGP-195) were resistant to leafhoppers with an MSI of 1.0. The MSI in susceptible checks Morden and NDCMS-2B was 3.7 and 4.0, respectively.

RGP-184 RGP-189 RGP-195

Leafhopper resistant inbred lines of sunflower

Varietal Development

Varietal development activities are pursued in safflower, sesame, niger and linseed. In safflower, identifying superior inbred lines with short duration, high seed yield, high seed weight, oil content, high oleic acid content and/or tolerance to aphids has been the focus. In sesame, multi-parent crosses based populations have been evaluated and superior selections with high yield potential were made. In niger, emphasis is being laid on improving seed yield and oil content through population improvement strategy. As a new entrant to ICAR-IIOR, breeding work in linseed has just been initiated. Progress made in varietal development in different crops is summarized.

Safflower

Development of inbred lines from RIPE populations: A total of 50 promising progenies with high seed yield, high oil content and high test weight were selected from RIPE population, which are at various stages. Range of seed yield (g/plant), test weight (g) and oil content (%) of the selections along with checks (A-1 and PBNS-12) were as follows: S_5-1C-RIPE (39.7-153; 4.0-5.7; 33-40.1), S_4-2C-RIPE (38.8-77.4; 3.2-4.1; 32-39.3), S_3-3C-RIPE (39.2-80.7; 3.8-5; 40.3-44.4), S_2-4C-RIPE (22.3-73.4; 3.6-5.7; 39.5-44.8), A-1 (35.4; 6.1; 26.1) and PBNS-12 (34.3; 6.2; 24.5).

Development of short duration varieties: In fourth cycle of the RIPE population (S_2-4C-RIPE), 12 lines with early days to flowering (range: 73-75), high seed yield (15.8-52.9 g/plant), test weight (3.9-6.1 g) and oil content (32.5-41.8%) compared with checks, A-1 (86; 32; 6; 27.4) and PBNS-12 (87; 23.6; 6.1; 28.2) were selected.

Short duration safflower selections from RIPE population

Polycross for creating genetic variability: Polycross was generated as an alternative method to enhance the genetic variability in safflower. In this experiment, the high yielding released variety A-1 was used as the female parent and four early and high oil content germplasm accessions (GMU-7590, GMU-7575, GMU-7608 and GMU-7634) were used as the male parents. Hand emasculation was done in A-1 and an equal quantity of pollen was collected from male lines, bulked and applied on to the female line.

Varieties in pipeline: Two varieties *viz.*, ISF-123-sel-15 and ISF-300 were promoted from AVT-II and AVT-I, respectively. Entry ISF-123-sel-15 was on par in seed yield (1502 kg/ha) and 13.0% higher oil yield (486 kg/ha) over the best check A-1 (seed yield: 1483 kg/ha; oil yield 430 kg/ha). Entry ISF-300 was on par in seed yield (2051 kg/ha) and recorded 18.5% higher oil yield (788 kg/ha) than the best check PBNS-12 (seed yield: 2109 kg/ha; oil yield 642 kg/ha).

Sesame

Generation advancement of multi-parent based populations: Two MAGIC populations from the crosses involving eight parents: MSES*-434: [(Phule Til x RT-351)/(GT-2 x E-8)//(HT-1 x VRI-3)/(TKG-22 x Swetha Til) (1269 plants) and MSES*-435: (HT-1 x RT-351)/(GT-2 x TKG-22)//(Hima x TSS-6)/(Rajeshwari x E-8) (1481 plants)] and a double cross population: DSES*-289: IC-132201 x IC-96160/ Phule Til x VRI-3 (837 plants) were developed, which are in F_5 generation. The populations exhibited excellent variability for plant height (78-212 cm), capsule number on main stem (14-50), capsule number in branches (15-103), total capsule number (40-135), height of the branching point (1-67 cm) and height of first capsule (6-72 cm).

Selections in advanced generations: A total of 34 high yielding selections were made from the crosses *viz.*, IS-49-1A x RT-346, CT-55 x CT-57, EC-30344-1B x TKG-22 and DSTA-1-A x VRI-3 during *kharif* and summer seasons. During *kharif* season, 20 high yielding selections recorded high seed yield (487-1013 kg/ha) and oil content (43.2-54.9%) while checks, GT-10 recorded seed yield of 581 kg/ha with oil content of 45.3%) and Swetha Til recorded seed yield of 424 kg/ha with oil content of 50.5%. During summer season, 14 high yielding selections recorded high seed yield (926-1277 kg/ha) and oil content (38.1-49.4%) while checks, GT-10 recorded seed yield of 463 kg/ha with oil content of 45.5% and Swetha Til recorded seed yield of 670 kg/ha with oil content of 50.2%.

High yielding sesame selection

Evaluation of released varieties: A total of 72 released varieties were evaluated during summer 2021. Among varieties, JLT-7, Savitri, Tilarani and Paiyur were the best yielding (1200-1300 kg/ha), while 11 varieties yielded >1000 kg/ha.

Performance of sesame varieties in summer 2021

Varieties	Days to flowering	Days to maturity	Number of primary branches	Number of capsules/plant	Test weight (g)	Oil content (%)	Seed yield (kg/ha)
JLT-7	44	95	4	61.5	3.6	48.3	1300
Savitri	44	98	7	61.0	3.2	47.4	1250
Tilarani	45	97	6	89.0	3.0	45.7	1212
Paiyur	50	102	6	203.5	3.5	49.7	1200
VRI-2	46	103	6	79.0	3.5	48.9	1137
Usha	47	97	6	158.0	3.1	44.0	1112
TMV-4	47	97	6	81.5	3.3	46.6	1062
Hima	44	98	6	71.5	3.6	49.4	1050
YLM-66	46	99	6	101.5	3.1	46.7	1050
N-32	46	99	6	129.0	3.2	45.0	1012
Swetha Til (LC)	42	103	6	78.0	3.8	49.1	875
GT-10 (NC)	43	92	3	112.0	3.3	47.3	712
General Mean	43.8	95.8	5.2	84.2	3.4	48.0	859
CV (%)	4.1	0.9	11.2	17.9	6.4	1.2	15.1
SEM	1.8	0.9	0.6	15.1	0.2	0.6	12.1
LSD (p<0.05)	3.6	1.8	1.2	30.0	0.3	1.1	70.8

LC-Local check; NC-National check

Development of phyllody tolerant genotypes: Two genotypes, PT-1030 (selection from GT-G-30) and PT-1019 (DS-5 x NIC-16080) were submitted to AICRP centres for multilocation testing against phyllody during *kharif* 2021.

Promising breeding lines: Four lines (IIOS-1103, IIOS-3101, IIOS-1102 and IIOS-3003) with high seed yield potential were identified.

Performance of promising sesame breeding lines (*kharif* 2021)

Entry	Pedigree	SC	DM	PB	PH	CN	SY	OC	TW
IIOS-1103	SI-349 x DS-5	White	85	6	110	105	1110	55	3.5
IIOS-3101	IS-848 x VRI-2	Brown	93	6	185	138	1050	47	3.5
IIOS-1102	KMR-63 x JLT-408	White	90	6	138	96	950	48	3.8
IIOS-3003	H-33 x Gowri	Brown	85	6	120	84	950	50	3.6
GT-10 (C)		Brown	90	6	118	106	426	46	3.5
Swetha Til (C)		White	95	4	126	76	370	50	3.6

SC-Seed colour; DM-Days to maturity; PB-Primary branches; PH-Plant height (cm); CN-Capsule no./plant; SY-Seed yield (kg/ha); OC-Oil content (%); TW-Test weight (g).

Varieties in pipeline: Two lines *viz.*, IIOS-1102 and IIOS-3101 were nominated for AICRP trials for *kharif* 2021.

Niger

Development of gene pool through random mating: A total of 151 selections were made from third cycle of random mating population (RMC-III). Seed yield/plant ranged from 1.7 to 23.2 g with the mean of 5.8 g compared to parents (range: 2.2-5.2 g; mean: 3.4 g). The oil content ranged from 30.2 to 45.9% with the mean of 39.9% compared to parents (range: 27.1-40.1%; mean: 38.3%).

Hybrid Development

At ICAR-IIOR, hybrid development efforts are made mainly in castor and sunflower. Major focus has been hybrid evaluation, developing experimental hybrids, identification of superior hybrids and nomination of hybrid entries to AICRP testing. In castor, a total of 281 new experimental hybrids were synthesized and 185 hybrids were evaluated. Three short duration castor hybrids are under testing in the AICRP system at different stages. In sunflower, a total of 152 experimental hybrids were produced, evaluated and promising hybrids with superior seed yield and oil yield potential were identified. Seven sunflower hybrids are under testing in the AICRP system at different stages. Progress made in hybrid development in the mandate crops are summarized here.

Castor

Development of new experimental hybrids: A total of 281 new experimental hybrids were synthesized during *rabi* 2020-21.

Preliminary yield trial: A total of 157 hybrids were evaluated along with two checks *viz.,* GCH-8 and ICH-66 in *rabi* season. Hybrids derived from the pistillate lines *viz.*, DPC-9, DPC-15, DPC-16, DPC-23, DPC-27, IPC-33, IPC-34 and IPC-39 were mostly early maturing (with 8-10 nodes to the primary raceme) compared to checks (14-16 nodes).

Confirmatory yield trial of selected hybrids: A set of 28 promising experimental hybrids identified in the preliminary evaluation trial were evaluated along with ICH-66, GCH-8, GCH-4 and DCH-177 as checks during *kharif* 2020. Seven hybrids (ICH-1069, ICH-278, ICH-1218, ICH-1024, ICH-1068, ICH-1040 and ICH-1011) were promising with higher seed yield (1267-1606 kg/ha) than checks (849-1476 kg/ha).

Promising hybrids in pipeline: Three short duration hybrids *viz.*, ICH-1146, ICH-440 and ICH-277 were promising in AICRP trials at different stages and their salient features are described below.

ICH-1146 was promoted to AHT-I (2021-22). It recorded 954 kg/ha seed yield at 120 DAS, which was 22% higher than GCH-4 (782 kg/ha) in rainfed conditions (5 locations). It recorded seed yield of 1235 kg/ha at 150 DAS, which was 13.0% higher than GCH-4 (1092 kg/ha) under both rainfed (5 locations) and irrigated (6 locations) conditions. It was resistant to wilt and tolerant to leafhoppers.

ICH-440 was promoted to AHT-I (2021-22). It recorded seed yield of 874 kg/ha at 120 DAS, which was 12.0% higher than GCH-4 (782 kg/ha) in rainfed conditions (5 locations). It recorded 1155 kg/ha seed yield at 150 DAS, which was 6% higher than GCH-4 (1092 kg/ha) under both rainfed (5 locations) and irrigated (6 locations) conditions. It was resistant to wilt and tolerant to leafhoppers.

ICH-277 was promoted from IVHT to AVHT-I. It recorded 1858 kg/ha seed yield, which was 15% and 18% higher than GCH-8 (1615 kg/ha) and ICH-66 (1571 kg/ha), respectively under rainfed conditions (5 locations).

ICH-440

ICH-1146

Sunflower

Development of new experimental hybrids: A total of 152 new experimental hybrids were generated during late *rabi* 2020-21 and *kharif* 2021 using promising CMS lines *viz.,* HA-89A, CMS-234A, ARM-243A and COSF-6A with newly developed restorer gene pool inbreds as well as with trait-specific pre-bred lines.

Evaluation of hybrids for yield performance: A total of 152 new experimental hybrids along with two checks (DRSH-1 and KBSH-44) were evaluated for yield and yield-contributing traits during *rabi* 2020-21 at ICAR-IIOR, Hyderabad. Thirteen hybrids were promising for higher seed yield, which ranged from 21.5 to 41.2 g/plant and the oil content ranged from 37.1 to 42.1% while checks, KBSH-44 and DRSH-1 recorded seed yield of 34.8 and 25.6 g/plant and oil content of 32.2 and 38.9%, respectively.

Promising experimental hybrids in sunflower

Hybrid	Days to 50% flowering	Days to maturity	Head diameter (cm)	Seed yield/ plant (g)	100 seed weight (g)	Volume weight (g/100 ml)	Oil content (%)
IIOSH-174-1	63	94	11.6	29.1	5.2	48.6	42.1
IIOSH-173-2	62	92	12.6	31.5	4.8	47.6	42.0
IIOSH-172-1	61	90	13.4	32.6	5.3	46.7	40.4
IIOSH-160	60	91	14.1	36.4	4.2	42.1	40.7
IIOSH-195	60	92	12.6	21.5	4.0	43.1	40.7
IIOSH-164	59	90	13.1	23.5	3.8	39.8	39.5
IIOSH-123	62	93	13.9	24.1	5.3	42.1	39.6
IIOSH-129	61	93	12.1	23.7	5.1	41.2	39.1
IIOSH-173-1	61	92	13.2	29.6	4.3	40.1	38.7
IIOSH-120	61	90	14.6	34.3	4.2	39.7	38.1
IIOSH-207	67	97	14.2	37.8	5.0	36.8	38.0
IIOSH-178	56	89	13.8	22.8	5.3	38.7	37.4
IIOSH-163	59	88	15.4	41.2	4.6	36.4	37.1
KBSH-44 (C)	62	92	14.1	34.8	6.9	35.4	32.2
DRSH-1 (C)	64	95	13.6	25.6	5.6	39.4	38.9
SEM	3.6	3.8	2.7	12.8	0.8	3.2	2.2
CV (%)	2.1	1.9	3.1	14.6	3.8	4.1	4.8

Another set of 40 hybrids along with three checks *viz.*, DRSH-1, LSFH-171 and KBSH-53 were evaluated for yield performance at ICAR-IIOR, Hyderabad. Seven hybrids were promising for seed yield (kg/ha). The highest seed yield of 2501 kg/ha was recorded in IIOSH-521, followed by IIOSH-623 (2500 kg/ha), IISOH-539 (2499 kg/ha), IIOSH-525 (2469 kg/ha) and IIOSH-563 (2277 kg/ha).

Promising sunflower hybrids at ICAR-IIOR

Hybrid	Days to 50% flowering	Seed yield (kg/ ha)	Seed yield superiority % over			Oil yield (kg/ha)	Oil yield superiority (%) over		
			KBSH-53	LSFH-171	DRSH-1		KBSH-53	LSFH-171	DRSH-1
IIOSH-623	75	2500	25.0	15.4	50.1	887	22.7	21.2	39.5
IIOSH-539	73	2499	25.0	15.3	50.0	879	21.6	20.1	38.2
IIOSH-521	74	2501	25.1	15.5	50.1	870	20.3	18.9	36.8
IIOSH-525	72	2469	23.5	13.9	48.1	880	21.7	20.2	38.4
IIOSH-563	70	2277	13.9	5.2	36.8	851	17.7	16.3	33.8
IIOSH-433	80	2138	6.9	-1.2	28.5	776	7.3	6.0	22.0
IIOSH-476	70	2166	8.3	0.1	30.1	805	11.3	10.0	26.6
KBSH-53 (C)	85	1999	-	-	-	723	-	-	-
LSFH-171 (C)	83	2166	-	-	-	732	-	-	-
DRSH-1 (C)	78	1666	-	-	-	636	-	-	-
SEM	-	24.8	-	-	-	9.1	-	-	-
CD ($p<0.05$)	-	71.2	-	-	-	28.2	-	-	-
CV (%)	-	9.4	-	-	-	9.6	-	-	-

Evaluation of hybrids developed by ICAR-IIOR in other locations: A set of 36 hybrids were evaluated at AICRP centre, Nimpith (West Bengal) during spring 2020-21; of which, three hybrids were promising with significantly higher seed yield. IIOSH-1219 recorded the highest seed as well as oil yield of 2165 kg/ha and 761 kg/ha followed by IIOSH-1346 (1984 kg/ha and 726 kg/ha) and IIOSH-1280 (1970 kg/ha and 678 kg/ha) compared to the best check KBSH-44 (1835 kg/ha and 547 kg/ha).

Hybrids in pipeline: Three entries *viz.*, IIOSH-566 (IHT), IIOSH-460 (AHT-I) and IIOSH-434 (IHT) were under AICRP testing.

Performance of IIOSH-460 in coordinated trials: Based on two years data, entry IIOSH-460 recorded 18.1% and 5.2% higher seed yield and 21.1% and 26.0% higher oil yield over the national check hybrids, DRSH-1 and KBSH-44, respectively in multilocation testing under AICRP. IIOSH-460 recorded 0% downy mildew incidence compared to KBSH-44 (51.6%) and DRSH-1 (65.8%), tolerance to leafhoppers and the lowest thrips incidence (3.4%) during *kharif* 2021.

Performance of IIOSH-460 in coordinated trials over two years

Entry	Overall seed yield (kg/ha)		Mean	Seed yield superiority (%)	Overall oil yield (kg/ha)		Mean	Oil yield superiority (%)	Downy mildew incidence (%)		Mean
	IHT	AHT-I			IHT	AHT-I			IHT	AHT-I	
IIOSH-460	1519	1657	1588	-	599	630	615	-	0	0	0
DRSH-1 (C)	1179	1514	1346	+18.1	443	573	508	+21.1	75.0	56.7	65.8
KBSH-44 (C)	1407	1613	1510	+5.2	440	536	488	+26.0	70.0	33.3	51.6
CD at 5%	67.9	98.0			-	-			-	-	
CV (%)	11.5	15.0			-	-			-	-	

Performance of IIOSH-460 in the state multilocation trial: SMLHT-Kh-20-07 (IIOSH-460) was superior for seed yield (2384 kg/ha), followed by SMLHT-Kh-20-06 (IIOSH-15-20) (2343 kg/ha) compared to the check hybrids, KBSH-44 (2300 kg/ha), RSFH-1887 (2208 kg/ha), KBSH-78 (1630 kg/ha), KBSH-53 (1865 kg/ha) and GK-2002 (2108 kg/ha) in the state multilocation hybrid trial conducted at three locations *viz.*, Bengaluru, Hiriyur and Gunjevu in Karnataka.

Performance of IIOSH-566 in coordinated trials: Entry IIOSH-566 recorded an average of 8.1/15.9; 7.1/10.1 and 3.4/10.0% higher seed and oil yield superiority over best check hybrid, respectively. It recorded 0% downy mildew incidence compared to KBSH-44 (70.0%) and DRSH-1 (60.0%).

Performance of IIOSH-434 in coordinated trials: Entry IIOSH-434 recorded an average of 12.5% and 7.2% higher seed yield and 14.3% and 22.2% higher oil yield than the check hybrids DRSH-1 and KBSH-44, respectively. It recorded 0% downy mildew incidence compared to KBSH-44 (33.3%) and DRSH-1 (60.0%).

Performance of IIOSH-434 in coordinated trials

Entry	Seed yield (kg/ha)	Seed yield superiority (%)	Oil yield (kg/ha)	Oil yield superiority (%)	Downy mildew incidence (%)
	Kharif 2021		*Kharif* 2021		*Kharif* 2021
IIOSH-434	1729	-	655	-	0
DRSH-1 (C)	1514	+12.5	573	+14.3	60.0
KBSH-44(C)	1613	+7.2	536	+22.2	33.3
CD at 5%	98.0		-		-
CV (%)	15.0		-		-

Molecular Breeding and Biotechnology

Major efforts are made in developing genetic and genomic resources, trait mapping and allele mining towards developing marker-assisted selection (MAS) tools to support breeding programmes. In castor, SNP markers linked to diverse major genes conferring Fusarium wilt resistance have been identified, which would eventually lead to gene pyramiding by MAS. In safflower, candidate gene based allele mining has resulted in identification of superior alleles associated with high oil content. Furthermore, efforts are underway to develop genome-wide SNP markers, mapping of QTLs associated with agronomic traits and oil content and validation of major QTL for tolerance to aphid in safflower. In castor, a robust *in vitro* regeneration protocol for castor was optimized; the use of spray induced gene silencing strategy to control gray mold is being explored. In sesame, effector biology of phytoplasma causing phyllody is being studied.

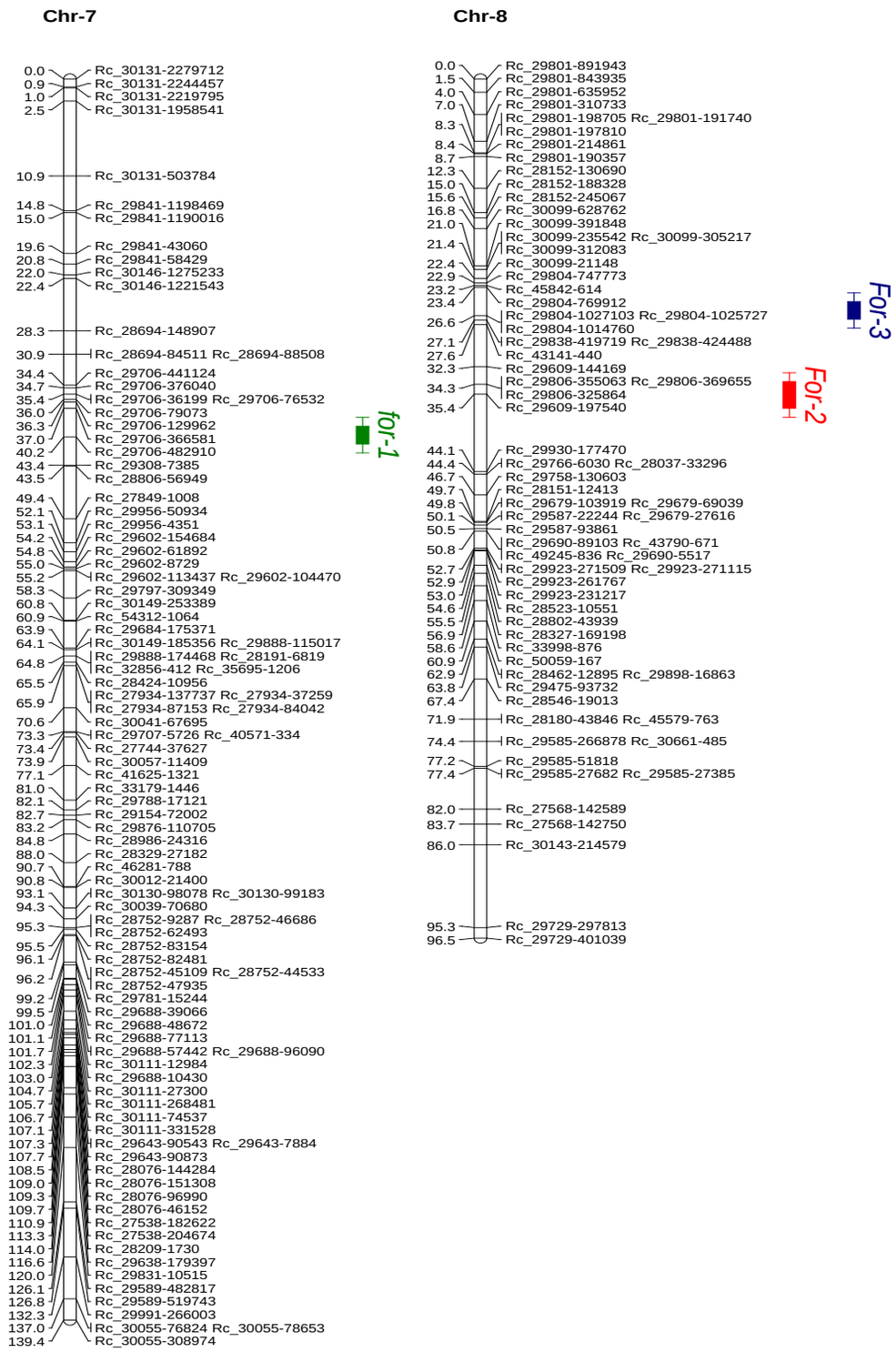
Castor

Marker tool kit for wilt resistance breeding in castor: With the ultimate aim of developing a marker kit that can be used by castor breeders in breeding durable wilt resistant cultivars with high efficiency and effectiveness, eight resistant lines were genetically characterized. The inheritance pattern of wilt resistance in the selected lines was worked out by screening the F_2 and backcross populations generated by crossing the resistant lines with the susceptible line JI-35 in the wilt sick plot. An allelic relationship among the resistance genes showing a similar inheritance pattern was studied by evaluating the F_2 populations generated by crossing the resistant lines. Attempts were also made to tag the resistance loci in the selected resistance lines using SNP markers. On the basis of results obtained from the studies on inheritance, allelism test and SNP markers linked to the wilt resistance loci, gene symbols are proposed for the resistance loci identified in different lines. The overall results of the experiments conducted with regard to wilt resistance in different donors are summarized below.

Inheritance patterns and SNP markers linked to wilt resistance in different castor inbred lines

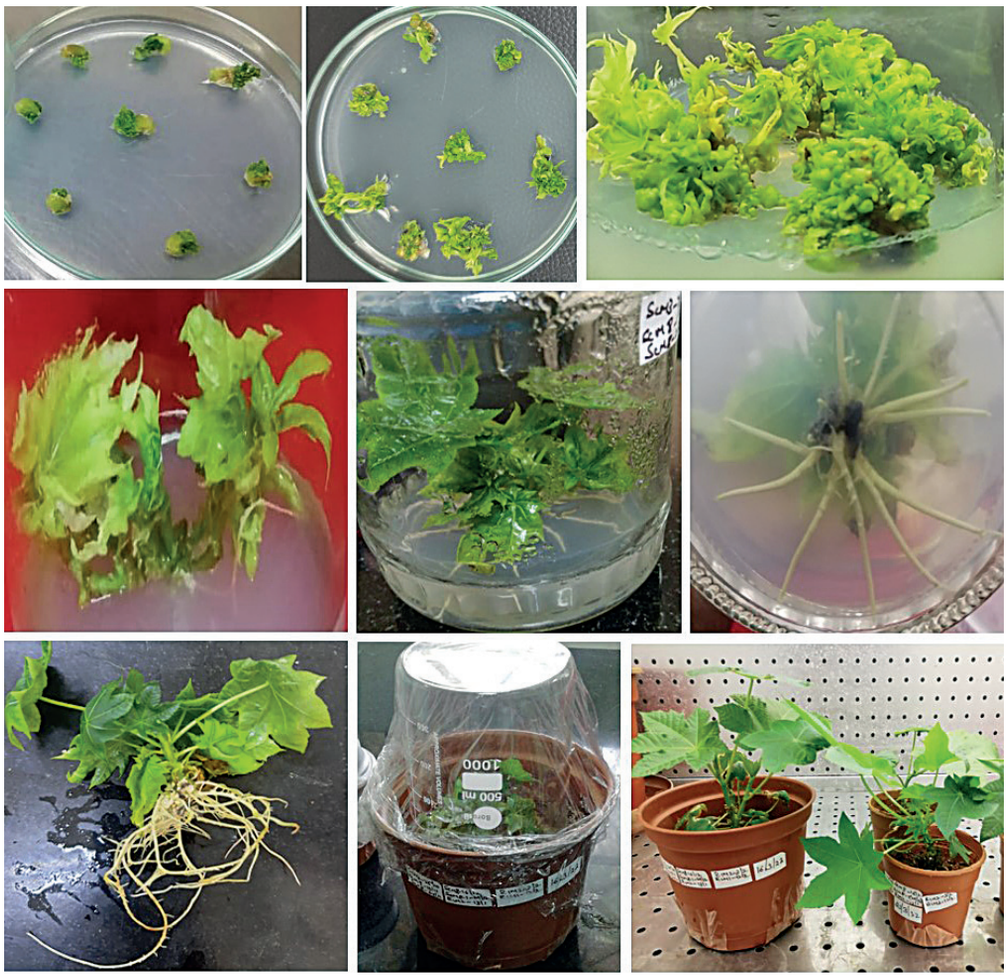
Resistant line	Morphological characters*			Origin/Source	Inheritance pattern	Proposed gene symbol	SNP markers linked to resistance	Location on the genome
48-1 (Jwala)	R	2	NSp	ICAR-IIOR	Recessive	*for-1*	Rc_29706-482910	Chr7: 23089250
AP-156 (RG-1673)	G	1	Sp	-	Recessive	*for-1*	Rc_29706-482910	Chr7: 23089250
AP-48 (RG-1149)	G	3	Sp	Nigeria	Recessive	*for-1*	Rc_29706-482910	Chr7: 23089250
AP-163 (RG-27)	R	3	Sp	USA	Recessive	*for-1*	Rc_29706-482910	Chr7: 23089250
AP-56 (RG-1354)	G	1	Sp	Tamil Nadu	Dominant	*For-2*	Rc_29609-103709	Chr8: 3735223
AP-111 (RG-2685)	G	3	Sp	-	Dominant	*For-2*	Rc_29609-103709	Chr8: 3735223
AP-127 (RG-2944)	R	1	Sp	-	Dominant	*For-2*	Rc_29609-103709	Chr8: 3735223
AP-42 (RG-999)	R	2	Sp	Gujarat	Dominant	*For-3*	Rc_43141-440	Chr8: 2849837
AP-125 (RG-2874)	R	3	Sp	Andhra Pradesh	Dominant	*For-4*	-	-

**R-Red stem; G-Green stem; 1-Single bloom; 2-Double bloom; 3-Triple bloom; Sp-Spiny capsules; NSp-Non-spiny capsules



Genetic map locations of major loci associated with resistance to castor *Fusarium* wilt

Optimization of the tissue culture protocol in castor: An *in vitro* regeneration protocol has been optimized using the hypocotyls obtained from embryo axes derived plantlets. The protocol involves inducing the shoot initials from hypocotyl explants on MS medium supplemented with B5 vitamins and 4.5 mg/l of BAP + 0.5 g/L 2-(N-morpholino) ethane sulfonic acid (MES) + 100 mg/L Adenine hemi sulfate salt (AHS). Explants were sub-cultured onto the same medium after 15 days. Elongation of shoots was achieved by transferring the explants onto MSB medium supplemented with 1 mg/l each of BAP, silver nitrate and GA_3. Rooting of the elongated shoots could be achieved on MSB medium supplemented with 1 or 2 mg/l IBA and activated charcoal. The rooted plants could be acclimatized and successfully established in growth chamber.



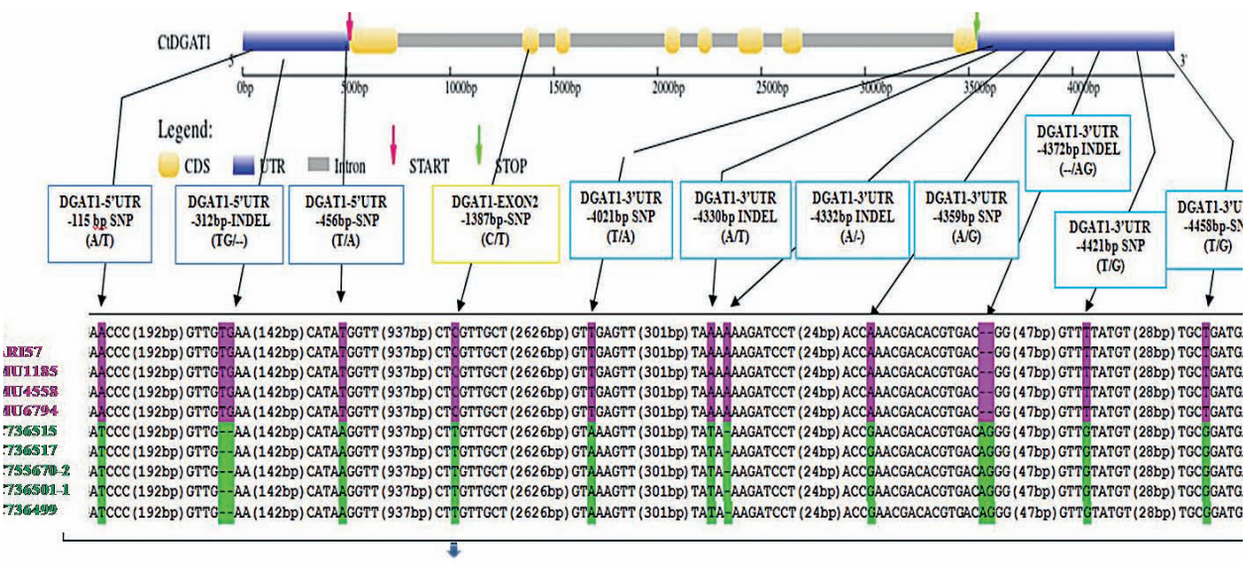
Regeneration of plantlets and their establishment in growth chamber

Exploring the use of spray induced gene silencing strategy to control gray mold: Spray induced gene silencing (SIGS) targeted against essential genes such as *DCL1* (*Dicer like 1*), *DCL2* (*Dicer like 2*), *EF* (*elongation factor*), *ERG27* (*ergosterol synthase*) and *CHS1* (*chitinase synthase*) have been exploited to protect crop plants from *Botrytis cinerea* and other fungal pathogens. Based on this premise, studies were initiated to see the effect of SIGS to control gray mold in castor by targeting the listed essential genes either singly or in combinations. Fragments of the five selected genes, *ERG27*, *CHS1*, *EF2*, *DCL1* and *DCL2*, were amplified from *B. ricini* using the primers with T7 promoters to enable *in vitro* transcription to produce double stranded RNA (dsRNA) and siRNA. The PCR products were used and siRNA was synthesized *in vitro* and the fungicidal activity of the dsRNA was tested through growth inhibition of *B. ricini* in petri plates as well as on the detached castor spikes. Spore suspension with 10^6 conidia/ml was prepared from actively growing fungi on oat meal agar (OMA) plates. Both spore and germ tube assays were carried out. However, clear effect of dsRNA could be observed on the growth of fungus in both the assays was not discernible. In the detached spike assay, 15-day-old spikes from a susceptible cultivar (DCH-519) were inoculated with a fungal spore solution and the spikes were placed inside plastic boxes with moistened germination paper towels at the bottom (to maintain relative humidity). dsRNA of ERG2 + CHS1 (2 μg in 50 ml of sterile distilled water) was sprayed after 36 hrs of incubation on the inoculated spikes. The experiment was done in triplicates. These trays were placed in a growth chamber at 23±2 °C and observations were recorded at 24, 48 and 72 h after spraying. This preliminary experiment indicated that dsRNA spray delayed the progression of disease as the appearance of disease symptoms was delayed till 48 h post inoculation.

Safflower

Candidate gene-based allele mining for oil content in safflower: Candidate gene-based allele mining was done in safflower to detect allelic variation in high and low oil content safflower accessions. From genome sequencing data, candidate genes associated with glycerol lipid metabolism, fatty acid biosynthesis,

and fatty acid elongation were identified and primers were designed for amplification for checking allelic variation. Out of 20 genes studied for variations, PCR based sequencing of eight genes (*CtDGAT1, CtDGAT2, CtPDAT, CtFATB, CtOleosin2, CtOleosin4, CtOleosin5* and *CtOleosin9*) showed nucleotide variation between 20 low and 20 high oil lines in safflower. Two different haplotypes were observed for all the nine genes analyzed. *Ctoleosin* 4, 5, and 9 showed single nucleotide change in the coding region in high oil lines, leading to single amino acid substitutions. Based on the sequence results, allele specific primers were designed for *CtDGAT-1, CtFATB* and *CtPDAT* and all the genotypes in the mapping panel (n = 192) were screened. *CtDGAT-1* and oil content had a strong association with an R^2 value of 0.76, while *CtPDAT* and *CtFATB* had R^2 values of 0.19 and 0.24, respectively. *CtOleosin* 4 and 9 allele specific primers were designed and sequenced for validation in a panel of 96 genotypes. A strong association was also observed with an R^2 value of 0.35 and 0.48, for *CtOleosin* 4 and 9, respectively. Sequencing of cDNA clones of eight genes showed nucleotide variations observed in the 5'UTR, exons and 3'UTR. Expression studies was carried out with 5 low oil (GMU-5701, A-1, NARI-57, GMU-4558 and GMU-6794) and 5 high oil (EC-736496, EC-736497, EC-736499, EC-736495 and EC-736500-1) lines using cDNA prepared from total RNA isolated from developing seeds at different stages (0 DAF, 5 DAF, 10 DAF, 15 DAF and 20 DAF). Real time PCR analysis showed elevated expression for *DGAT-1* in high oil lines compared to low oil lines.



Variations in the transcript of *DGAT-1* between low and high oil lines of safflower

Development of high throughput SNP markers for genotyping applications in safflower

A set of 200 SNP markers discovered using the *de novo* genome sequences of safflower parental genotypes CO-1 and EC-523368-2, were validated in a panel of 23 diverse genotypes representing different species: *C. tinctorius* (8), *C. oxyacanthus* (7), *C. palaestinus* (1) and *C. lanatus* (7) using competitive allele specific PCR assays. A set of 48 polymoprhic SNPs have been identified and are being used in genetic diversity and mapping work in safflower.

Genetic mapping of traits of agronomic value in safflower

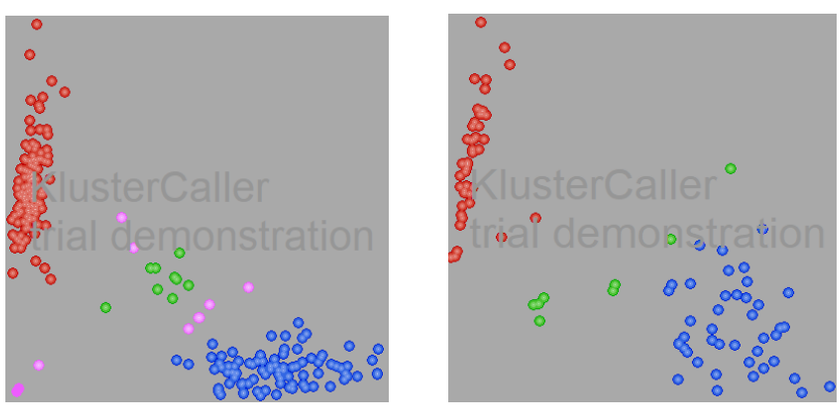
Development of mapping populations: A total of 1940 inbred lines representing six mapping populations from bi-parental and multi-parent crosses [CO-1 x EC-523368-2-F_{11} RILs: 300; CO-1 x EC-523368-2 BC_1F_4: 239; A-1 x Oker-F_4: 296; A-1 x EC-736487- F_4: 299; A-1 x EC-755673-1- $F_{4:}$ 432; MAGIC: 374] were advanced towards identification of QTLs associated with agro-morphological traits including yield components, oil content and aphid tolerance.

Putative QTLs associated with seed traits: A preliminary attempt was made to detect putative QTLs associated with seed traits (seed length, seed breadth, seed thickness, length/breadth ratio, seed length x breadth x thickness product ratio, test weight, oil content and hull content) in the $F_{2:3}$ mapping population derived from the cross between A-1 x EC-755673-1. QTL analysis using the genotypic data of 166 F_2 plants and a linkage map of 135 markers (SNP/SSR) indicated nine QTLs associated with the target traits, particularly a putative QTL for oil content on linkage group 8 (CtDES-81-CtDES-72) with LOD score of 4.9 and R^2 of 14%. These QTLs are being

validated in additional populations.

Validation of QTLs associated with tolerance to aphids: Three different populations of the CO-1 x EC-523368-2 cross were genotyped using five markers (1 SNP: Ampct-131; 4 SSRs: SAFM-290, SAFM-23, CtDES-237 and CAT-85) linked to putative QTLs (*QUc-Ct3.1* and *QUc-Ct-5.1*) reported previously in the F_6 generation of the same cross. Marker-trait association was performed using the phenotypic data for tolerance to aphids based on the parameter, days-to-wilt after aphid infestation. The SNP marker, Ampct-131, linked to the major QTL, *QUc-Ct3.1*, showed strong association with tolerance to aphid in all the three populations with R^2 values of 0.23, 0.47 and 0.23 in F_8-RILs, F_{10}-RILs and BC_1F_3 families, respectively. Fine-mapping of *QUc-Ct3.1* is in progress.

Screening of mapping populations for tolerance to aphids in safflower



Genotyping of F_{10}-RIL and BC_1F_3 populations with QTL linked SNP marker, Ampct131

Evaluation of high oleic lines developed by MAS for reaction to aphid: A set of six high oleic lines has been developed by marker assisted backcrossing involving Bhima as a recurrent parent and Montola-2000 as a donor parent for the high oleic acid content trait. The lines were simultaneously screened for tolerance to aphids at ICAR-IIOR, Hyderabad (from *rabi* 2017-2020) and the AICRP Safflower centre, Solapur (*rabi* 2020) using the standard procedure. The line, BC_2F_6-38-9-4 showed tolerant reaction to aphids for four consecutive years.

Oleic acid content of MAS-derived safflower lines across four years at ICAR-IIOR, Hyderabad

Line	2017-18	2018-19	2019-20	2020-21
BC_1F_6-39-3-3	77.9	78.8	79.1	81.9
BC_2F_6-38-1-7	72.1	78.3	83.8	81.4
BC_2F_6-38-9-4	84.7	78.7	85.2	84.2
BC_2F_6-38-14-15	82.2	81.4	85.3	83.3
BC_3F_4-16-12	79.4	74.8	84.9	83.8
BC_3F_4-16-27	80.6	80.7	83.2	81.9

A-1 (C)	23.1	22.2	17.6	22.1
Bhima (C)	26.2	19.1	23.3	26.5

Reaction of MAS-derived high oleic safflower lines to aphid at ICAR-IIOR, Hyderabad and Solapur

Line	2017-18		2018-19		2019-20		2020-21			
	ICAR-IIOR		ICAR-IIOR		ICAR-IIOR		ICAR-IIOR		Solapur	
	All	Reaction	All	Reaction	All	Reaction	All	Reaction	All	Reaction
BC_2F_6-38-9-4	1.5	T	2.0	T	2.0	T	2.0	T	2.0	T
BC_2F_6-38-14-15	2.0	T	2.0	T	2.0	T	2.0	T	3.0	MT
BC_3F_4-16-12	3.5	S	2.0	T	2.0	T	2.0	T	2.5	MT
A-1 (TC)	3.0	MT	3.0	MT	3.0	MT	3.0	MT	3.0	MT
CO-1 (SC)	5.0	HS	5.0	HS	5.0	HS	5.0	HS	4.5	HS

All-Aphid infestation index; T-Tolerant; MT-Moderately tolerant; S-Susceptible; HS-Highly susceptible; TC-Tolerant check; SC-Susceptible check

CO-1 BC_2F_6-38-9-4

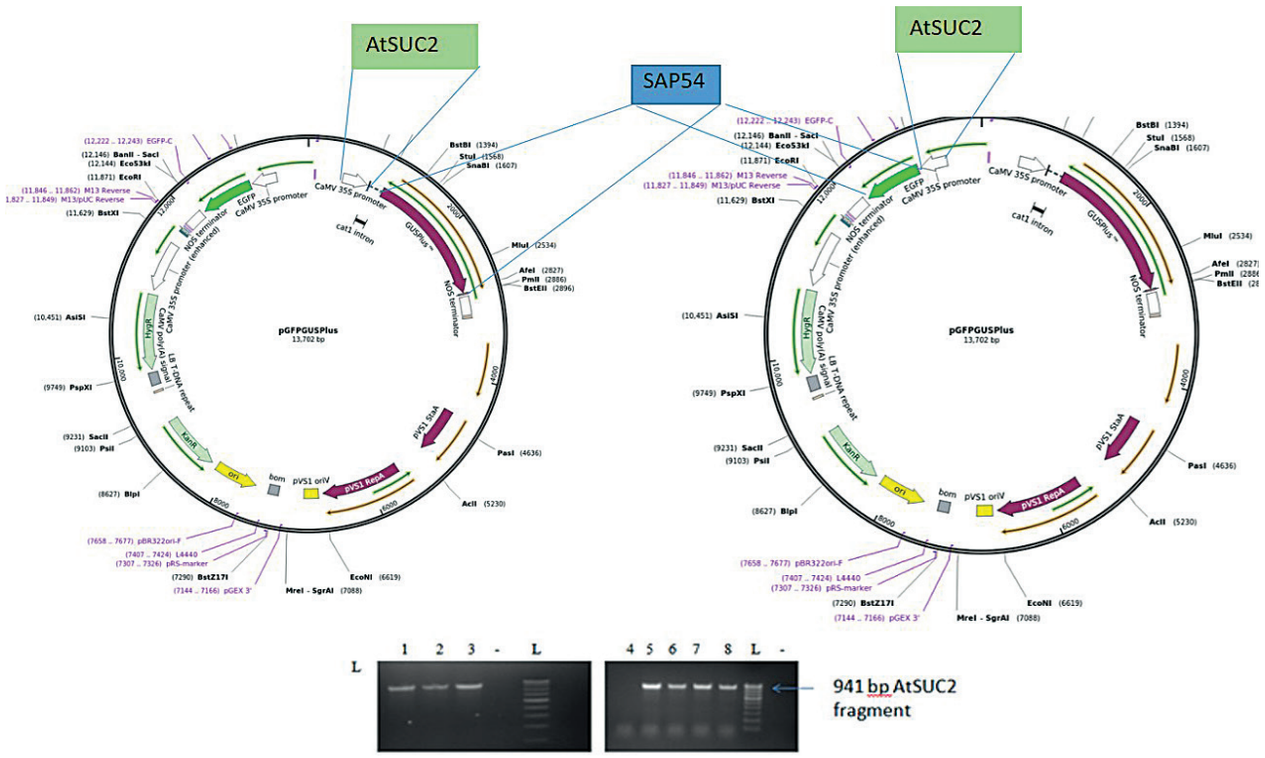
Reaction of high oleic safflower line BC_2F_6-38-9-4 to aphid

Sesame

Delineating the effector biology of phytoplasma causing phyllody: The effector molecules secreted by phytoplasma are known to cause genetic reprogramming of the host plant leading to phyllody in sesame. Identification of its interacting partners in phyllody affected sesame plant will enable not only understanding the molecular events leading to phyllody but also helps in identifying the critical vulnerable points that can form the basis for developing control strategies for phyllody. Interaction studies using Y2H experiments have indicated that the effector molecule, *SAP54* homolog from phyllody causing phytoplasma is known to interact with *RNF5* [*Sesamum indicum* E3 ubiquitin-protein ligase *RNF5* (LOC105167488)], and *NPY4* [*Sesamum indicum BTB/POZ* domain-containing protein *NPY4* (LOC105158596)]. To demonstrate this interaction *in planta*, RNF5 and NPY4 from sesame and *SAP54* from phytoplasma were cloned in *rBiFC* (ratiometric bimolecular fluorescence complementation) vectors. For each pair of proteins being tested eight clones were developed and the confirmed vectors have been mobilized into *Agrobacterium* strain GV3101. These will be used for complementation studies in *Nicotania benthamiana*, *Catharanthus roseus* and sesame plants using agro-infiltration.

Isolation of phloem specific AtSUC2 promoter: To assess the phloem specific expression of effector protein in *N. benthamiana* and *Vinca rosea*, the AtSUC2 promoter was isolated and cloned upstream of the *SAP54* gene fragment in a plant binary vector CAMBIA 1305.2. Also, the promoter along with *S54LP* from phyllody affected sesame plant, was cloned in pGFPGUSPlus vector to

replace either the GFP or GUS gene cassettes to study the phloem specific expression of *S54LP* in test plants.



Phloem specific promoter AtSUC2 isolated from Arabidopsis thaliana and S54LP isolated from infected sesame were cloned in pGFPGUSPlus to replace either the GFP or GUS gene cassettes

Diversity in sesame association panel for microsatellite marker loci

An association panel of 120 lines comprising 108 landraces and 22 varieties showed the presence of considerable diversity among them for microsatellite marker loci. Out of 300 microsatellite markers, 162 showed polymorphisms (distinguishing at least two genotypes of the panel) on 4% agarose gel electrophoresis. Polymorphism information content recorded for the markers ranged from 0.39 to 0.78, with an average of 0.39.

Registrations, Notifications and DUS Testing

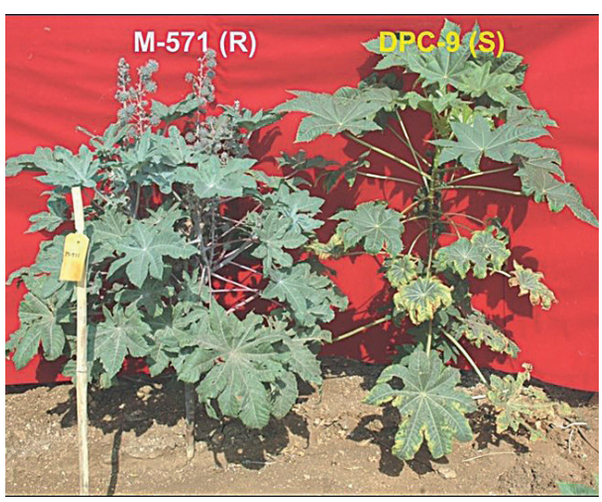
Registrations

During this year, five genetic stocks (1 in sunflower and 4 in castor) were registered with PGRC, ICAR-NBPGR, New Delhi. Two hybrids (1 each in sunflower and castor) were notified. Details are presented below.

Registered genetic stocks in 2021

Crop	Genetic stock	PGRC No.	Developers	Date of registration	Unique features
Sunflower	HOSuS-1	INGR21065	Sujatha M, Dudhe MY, Meena HP, Praduman Yadav	March 18, 2021	A high oil content (41.3%) line with medium maturity selected from the germplasm accession GP4-1424.
Castor	RG-3060	INGR21064	Anjani K, Jawahar Lal J, Duraimurugan P, Santha Lakshmi Prasad M	March 18, 2021	Resistant to leafhopper

Crop	Genetic stock	PGRC No.	Developers	Date of registration	Unique features
Castor	IPC-21	INGR21107	Lavanya C, Balakishan G, Usha Kiran B, Ramya KT, Manjunatha T, Senthilvel S, Duraimurugan P, Santha Lakshmi Prasad M	June 30, 2021	A pistillate line with good combining ability, normal plant type with elongated internodes, divergent branching, flat leaves, green stem, double bloom, spiny capsules, resistant to wilt.
Castor	ICS-200	INGR21157	Manjunatha T, Prabakaran AJ, Lavanya C, Duraimurugan P, Santha Lakshmi Prasad M, Ramya KT	September 21, 2021	Monoecious line resistant against both leafhopper (*Empoasca flavescens*) and thrips (*Scirtothrips dorsalis*).
Castor	M-571	INGR21230	Lavanya C, Santha Lakshmi Prasad M, Duraimurugan P	December 24, 2021	A dwarf pistillate line with red stem, triple bloom, loose spike, spiny capsules, condensed internodes, cup shaped leaves, resistant to wilt and leafhopper.



RG-3060

M-571

ICS-200

IPC-21

Cultivar Notifications in 2021

Cultivar: TilhanTec-SUNH-1 (Sunflower hybrid)

Notification number: S.O.8 (E), December 24, 2021

Date of notification: December 24, 2021

Developers: Meena HP, Sujatha M, Ghodke MK, Ranganatha ARG, Dudhe MY, Praduman Yadav, Madhuri P, Srinivas PS, Chander Rao S, Hegde DM, Varaprasad KS, Vishnuvardhan Reddy A and Mallesh D

Salient features: High seed/oil yield coupled with resistance to downy mildew and moderately resistance to leafhopper

Recommended for: Rainfed conditions of Uttarakhand and Jammu & Kashmir, Gujarat, Maharashtra, Northern Karnataka, Andhra Pradesh, Southern Karnataka, Tamil Nadu and Telangana

Cultivar: ICH-5 (ICH-278) (Castor hybrid)

Notification number: S.O.8 (E), December 24, 2021

Date of notification: December 24, 2021

Developers: Manjunatha T, Lavanya C, Senthilvel S, Ramya KT, Santha Lakshmi Prasad M, Suresh G, Duraimurugan P, Prasad RD, Lakshmamma P, Praduman Yadav, Sarada C, Mukesh Patel, Balakishan G, Prabakaran AJ and Vishnuvardhan Reddy A

Salient features: High seed yield, high oil yield and, resistant to *Fusarium* wilt and *Macrophomina* root rot.

Recommended for: Andhra Pradesh, Telangana, Karnataka, Tamil Nadu, Odisha and Maharashtra

TilhanTec-SUNH-1

ICH-5

DUS testing

Under the Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority, DUS testing trials were conducted for sunflower and safflower during *rabi* 2020-21 and for castor in *kharif* 2021.

Sunflower: DUS testing in sunflower was undertaken for one new candidate hybrid for the first year during *rabi* 2020-21 along with two reference entries and data was recorded for 34 DUS traits. The activity on comparative DUS testing for two candidate hybrids was also undertaken and reports were submitted to PPV & FRA, New Delhi.

Safflower: DUS testing in safflower was undertaken for one new candidate variety in two sets (original and multiplied) for the second year during *rabi* 2020-21 along with two reference entries. Data were recorded for 26 DUS traits. Eleven reference entries of safflower were maintained and multiplied.

Castor: In castor, DUS testing of one farmer's variety was undertaken along with three reference varieties and data were recorded for 30 DUS traits during *kharif* 2021. Nine reference varieties of castor during *rabi* 2020-21 and two reference varieties during *kharif* 2021 were maintained and multiplied.

Niger: Under the project on "Development of Distinctiveness, Uniformity and Stability (DUS) testing guidelines for Niger [*Guizotia abyssinica* (L.f.) Cass.]", 21 niger varieties were obtained from the developing centres and observations were recorded on 32 traits. Twenty varieties were multiplied under nets through sibbing.

Seed Production

Standardization of seed production method for safflower hybrid, ISH-402

Standardization of seed production method for safflower hybrid (ISH-402) was carried out at Rajendranagar farm under isolation by sowing female (A-133-1) and male parent (ISF-855) with row ratios of 4:1 and 5:1. The experiment was carried out with row ratio as the main plot treatment and pollination methods (open pollinated condition and open pollination + hand pollination) as sub plot treatments. Observations on rosette period, elongation period, plant height, number of branches, flowering behaviour of parental lines and pollinator visits were recorded. As per the flowering behaviour, 6-7 days of staggered sowing of female parent was required for synchronization of flowering. In the plot with both row ratios, nearly 17-20% lodging was observed in the female parent. In the female parent, 10% of pollen shedders were observed and removed at the time of flowering. Relatively higher seed yield was observed in a 4:1 row ratio of female and male parent sowing. Though hand pollination improved the seed set, it was laborious and requires further standardization. No difference was observed with respect to seed quality between seed production with both the row ratios.

Seed set under open pollination and hand pollination
(a. Pollinator visit, b. Hand pollination, c. Seed set in open pollination, d. Seed set in hand pollination)

Nucleus Seed Production

Sunflower: Nucleus seed was produced for the parental lines *viz.*, ARM-243A (1.1 kg), ARM-243B (0.5 kg) and RHA-6D-1 (0.4 kg) and populations *viz.*, DRSF-108 (3.0 kg) and DRSF-113 (3.5 kg).

Castor: About 0.5 kg nucleus seed of three pistillate lines (M-574, DPC-9 and SKP-84), five male lines (DCS-9, DCS-78, DCS-107, 48-1 and ICS-164) of released hybrids and five parents (DCP-25, IPC-39, DCP-15, DCS-89 and DCS-94) was produced.

Safflower: Nucleus seeds of A-133-I, B-133-I, A-133-II, B-133-II, ISF-1, ISF-764 and MGMS-7 were produced.

Seed production in different oilseed crops at ICAR-IIOR

A total of 696.7 q of breeder (BS), foundation (FS), certified (CS) and truthfully labelled (TL) seed of castor, sunflower, sesame and safflower were produced, which included 9 varieties (V), 4 hybrids (H) and 9 parental lines.

Seed production in different oilseed crops at ICAR-IIOR

Crop	Variety/Hybrid/Parental line	Seed production (q)
Castor	DCS-107 (V) (BS)	1.7
	ICS-164 (Male Parental line) (BS)	0.2
	ICS-164	1.1
	SKP-84 (Female parental line) (BS)	0.3
	SKP-84 (Female parental line) (FS)	1.2*
	ICH-66 (Hybrid) (CS)	199.8**
	DCH-177 (Hybrid) (CS)	44.3
	Total	**248.6**
Sunflower	ARM-243A (Female parent)	1.1
	ARM-243B (Maintainer line)	0.5
	RHA-6D-1 (Male parent)	0.4
	DRSH-1 (Hybrid) (TL)	17.3
	Total	**19.3**
Sesame	Swetha Til (V) (TL)	8.0
	CUMS-17 (V) (TL)	2.1
	CUMS-17 (V) (BS)	3.1
	GT-10 (V) (TL)	1.0
	Total	**14.2**
Safflower	NARI-96 (V) (BS)	8.0
	ISF-764 (V) (BS)	5.7
	ISF-764 (V) (CS & TL)	395.0
	NARI-57 (V) (BS)	3.2
	DSH-185 (H) (TL)	1.0
	CMS A-133 (Parental line) (BS)	0.8
	B-133 (Parental line) (BS)	0.3
	1705-p22 (R line) (BS)	0.6
	Total	**414.6**
	Grand Total	**696.7**

*Participatory Seed Production under Oilseeds Seed hub
**Participatory certified seed production under Oilseeds Seed hub

Crop Production

Conservation Agriculture

Conservation agriculture (CA) enhances biodiversity and natural processes above and below ground, which contribute to increased water and nutrient use efficiency, improved and sustained crop production, and higher carbon sequestration. CA can be seen as a new way forward for conserving resources and enhancing oilseed productivity. CA practices were evaluated for castor-based cropping systems in shallow Alfisols under rainfed conditions.

Development of conservation agricultural practices for castor-based cropping systems

Tillage (conventional, reduced, zero) and intercropping systems [sole castor, castor+redgram (1:1), castor+greengram (1:3), castor+groundnut (1:3)] were evaluated in a fixed plot in castor-based cropping systems in shallow alfisols under rainfed conditions. During cropping period, 1240 mm of rainfall was received (70% excess of normal). Rainfall received during August-September adversely affected the crops. Rainfall in October (161 mm) had positive influence on castor seed yield but groundnut crop was affected due to heavy rains.

The seed yield of castor due to different tillage systems were statistically at par indicating reduced tillage (RT) and zero tillage (ZT) had no negative influence on seed yield and castor equivalent yield, and equally effective as that of conventional tillage (CT). The highest seed yield and equivalent yield of castor was realized under CT (2538; 3151 kg/ha) followed by RT (2355; 2989 kg/ha) and ZT (2073; 2814 kg/ha).

Castor seed yield was higher under sole cropping (2716 kg/ha) than castor+groundnut (2468 kg/ha), castor+greengram (2243 kg/ha), and castor+redgram (1862 kg/ha) intercropping systems. Among intercropping systems, the highest castor equivalent yield was recorded in castor+greengram (3215 kg/ha) followed by castor +redgram (3165 kg/ha) and castor+groundnut (2843 kg/ha). The interaction effects were not significant. The highest oil yield (1284 kg/ha) was recorded in sole castor.

Stomatal conductance (μ mol $H_2O/m^2/s$) was highest in CT (0.742) followed by ZT (0.61) and RT (0.54). Transpiration rate (μ mol $H_2O/m^2/s$) was the highest in ZT (3.3) followed by RT (2.6) and CT (1.8). Net photosynthesis (μ mol $CO_2/m^2/s$) was the highest in CT (28.6) followed by ZT (25.4) and RT (21.4). Intercellular CO_2 concentration was the highest (670 ppm) in ZT followed by CT (661 ppm) and RT (601 ppm). The leaf temperature across tillage methods and intercropping systems ranged from 29 to 30 ^{0}C. Chlorophyll content through SPAD was the highest in CT followed by RT and ZT (38.7 >37.9 >36.4).

The Rain Water Use Efficiency (RUE) was the highest in CT (2.65 kg/ha/mm) followed by RT and ZT practices. The highest RUE was recorded in castor+greengram (2.7 kg/ha/mm) followed by castor+redgram (2.7 kg/ha/mm) and castor+groundnut (2.4 kg/ha/mm) while the lowest was with sole castor (2.3 kg/ha/mm).

Effect of conservation agriculture practice treatments on soil microbes

Presence of *Azotobacter* was noticed in all three tillage practices; the influence of intercropping system was marked in influencing *Azotobacter*. In CT, the *Azotobacter* population was predominantly noticed in castor +groundnut intercropping system (2.4 x 10^6 cfu/g); in RT; in castor+redgram intercropping system (2.3 x 10^6 cfu/g); whereas in ZT, higher population of *Azotobacter* was noticed under castor+greengram intercropping system (1.9 x 10^6 cfu/g). The highest population of phosphate solubilizing bacteria (PSB) was noticed under castor+groundnut intercropping under CT (5.2 x 10^5 cfu/g) and RT (3.1 x 10^5 cfu/g) systems; while in ZT, castor+greengram intercropping recorded the highest PSB (3.7 x 10^5 cfu/g). The presence of zinc solubilizing bacteria (ZSB) was noticed only in ZT practices across different intercropping systems. Similarly, the population of potassium solubilizing bacteria (KSB) was prominent only in CT system. However, the population of *Trichoderma* spp. was not influenced either due to tillage practices or intercropping systems.

Sole castor Castor+Redgram (1:1) in RT

Performance of castor based intercropping systems in conservation agriculture

Performance of castor hybrids under best management practices

Performance of new hybrids of castor *viz.*, ICH-278 (pre-released) and ICH-66 were assessed with check hybrids *viz.*, GCH-8, DCH-519 and DCH-177 under best management practices in large plots of 2000 m^2 in rainfed conditions. The new hybrid (ICH 278) recorded 12-14% higher yield over ICH-66.

Stalk decomposition through castor shredder and microbials

The potential of high lignin castor stalk for quick decomposition using microbial formulations was assessed. Castor stalks were cut *in-situ* mechanically using castor shredder to which microbial cultures (Pusa decomposer/Madhyam) were added @ 1 kg/t. Treated stalks showed faster decomposition and higher nutrient composition of the compost (3.6% N; 0.07% P; 0.223% K; 0.026% S and 70 ppm Zn) compared to untreated castor stalk (0.70% N; 0.028% P; 0.092% K; 0.016% S and 24 ppm Zn).

Castor stalk decomposition through shredder

Cropping Systems Research

Systems approach to agriculture involving sequential cropping helps in bringing stability to the production through better use of resources, improving soil health, reduced cost of production by utilizing residual fertility and moisture and achieving optimum yields of crops in the system. Short duration legume/cereal/ *kharif* fallow preceding safflower are popular in safflower growing regions in vertisols. Greengram–safflower or fallow safflower are popular in rainfed regions whereas soybean–safflower is popular in irrigated regions. Broad bed and furrow (BBF) method of land configuration ensures moisture conservation and timely sowing of safflower under zero tillage conditions. In this background, safflower-based cropping system productivity under BBF was assessed with greengram–safflower and soybean (short and normal duration variety)–safflower under rainfed conditions.

Safflower-based cropping systems productivity under different crop geometry and IPNM in the BBF background

The field experiment was conducted in broad bed (1.2 m) and furrow (0.3 m) method of land configuration (BBF) in deep vertisols with three safflower-based cropping systems *viz.* greengram (Var. WGG-42)–safflower, soybean (short duration Var. JS-93-05)–safflower and soybean (normal duration Var. JS-335)–safflower. Four rows of *kharif* crop were grown on broad bed with a row to row spacing of 30 cm with 10 cm plant to plant. Greengram and soybean crops received recommended level of fertilizers. P was applied through single super phosphate (SSP) to *kharif* crops to meet sulphur needs of the system. Deficient micronutrient, boron was also applied (1 kg/ha). In each cropping system, safflower (Var. TSF-1) was tested with 6 treatment combinations *viz.*, (2 rows/BBF; 3 rows/BBF) and three integrated plant nutrient management (IPNM) levels (control, 50% RDF+*Azotobacter*+PSB, and 100% RDF+*Azotobacter*+PSB) in split plot design with two replications.

This experiment was conducted for three years. The soil environment was medium deep vertisols in the first year and deep vertisols in the second and third year. The amount of rainfall received during cropping season (June-February) was 537, 789 and 1356 mm during first, second and third year of experimentation, respectively. During the first and third year of experimentation, the crops suffered from moisture stress (low and excess, respectively).

In conclusion, it was found that soybean (normal duration variety, JS-335)–safflower cropping system was superior compared to greengram–safflower and soybean (short duration variety, JS-93-05)–safflower, in all three years of experimentation. With respect to plant geometry x IPNM combination for safflower, zero till sowing at 2 rows/BBF with 50% RDF+*Azotobacter*+PSB was superior under low rainfall (first year). Under normal or excess rainfall years (second and third year), 3 rows/BBF with 100% RDF+*Azotobacter*+PSB combination was found superior.

Effect of cropping system, crop geometry and IPNM on system productivity

Treatments	Safflower seed yield (kg/ha)		Safflower equivalent yield (kg/ha)	
	I year	Mean of II and III year	I year	Mean of II and III year
Cropping system				
Greengram–Safflower	755	1346	755	1946
Soybean (ND)–Safflower	674	1528	1314	2648
Soybean (SD)–Safflower	779	1503	1499	2343
CD at 5%	NS	NS	321	213
Plant geometry x IPNM				
3 rows/BBF x control	528	1264	982	2118
3 rows//BBF x 50% RDF+*Azotobacter*+PSB	884	1535	1337	2388
3 rows//BBF x RDF+*Azotobacter* + PSB	866	1772	1320	2626
2 rows//BBF x control	477	1173	930	2026
2 rows//BBF x 50% RDF+*Azotobacter* + PSB	839	1491	1293	2344
2 rows//BBF x RDF+*Azotobacter* + PSB	820	1521	1273	2375
CD at 5%	736	1459	1189	2313
Mean	253	157	202	185
CD at 5%	NS	NS	NS	NS
Interaction	528	1264	982	2118

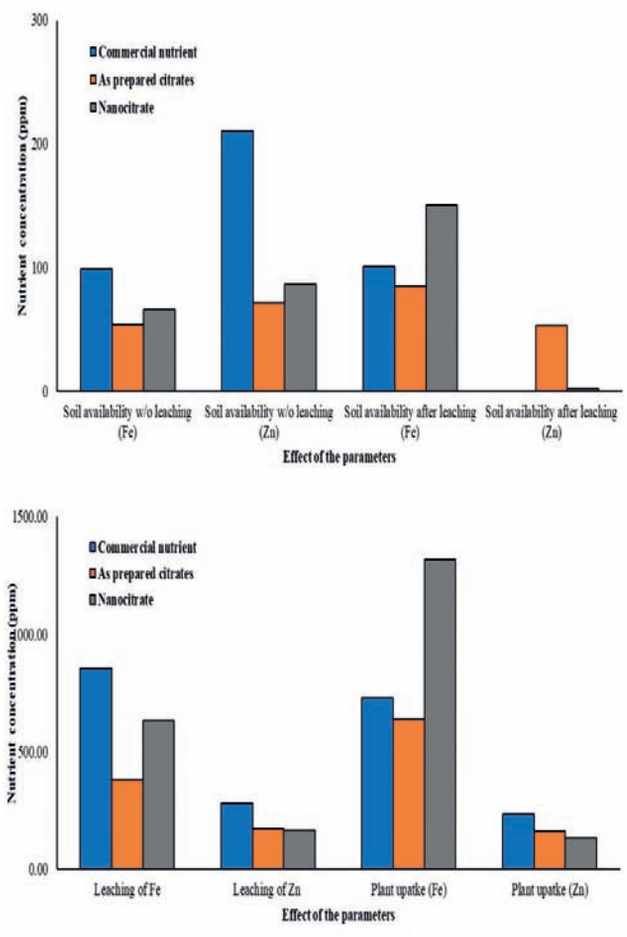
Mean seed yield (kg/ha) of *kharif* crops: 1st year [Soybean (ND), Soybean (SD)]: 800, 900; 2nd and 3rd year (Greengram, Soybean (ND), Soybean (SD)]: 600, 1400, 1050. During 1st year, greengram failed due to heavy rains.

Efficient Nutrient Management and Organic Cultivation

Oilseeds are energy rich crops and demand higher nutrition for achieving higher seed and oil yield. With the growing cost of fertilizers and their negative environmental impact due to unscientific use, avoiding or minimizing the fertilizer use is critical for increasing profitability and environmental safety. In this direction, newly developed Fe and Zn nano systems were evaluated for crop performance under different situations. In addition, organic production system for sesame is being standardized. Crop diversification and expansion into rice fallow situation to favourably exploit residual moisture and fertility for sesame is addressed.

Synthesis of Fe and Zn nanosystems for soil application

Combination of Fe and Zn nanocitrates were formulated using solid state grinding followed by ball milling for different durations and their effects were examined on the 20-day groundnut plant growth and nutrient uptake. Nanosize was confirmed through transmission electron microscopy (TEM) and dynamic light scattering (DLS). A total of 54 treatments (bulk citrate-7; nanocitrates-41; commercial Fe and Zn nutrients-6) were applied to the red soil at a rate of 0.05 gm/kg of soil. Fe uptake was higher in the nanocitrate (0.48 mg of Fe/kg of soil) and Zn uptake was higher in nano zinc (commercial) (88.47 μg of Zn/kg of soil) followed by bulk citrate (82.32 μg of Zn/kg of soil) against the control values of 0.02 mg of Fe and 2.05 μg of Zn per kg of soil. The comparative effect of different treatments for important parameters is depicted in the graph below.

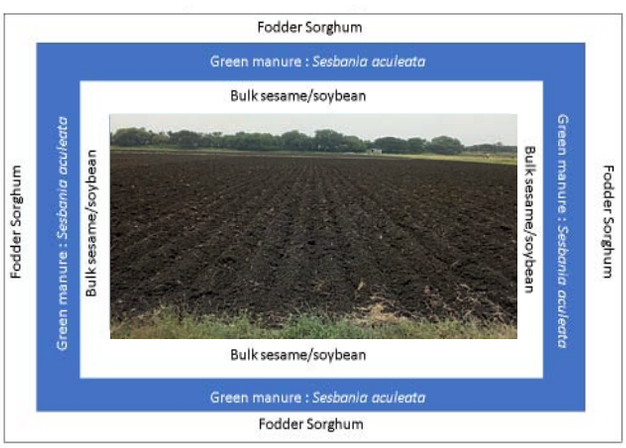


Comparison between commercial and nanocitrate fertilizers for leaching and plant uptake of Fe and Zn

Development of best management practices (BMPs) for organic soybean–sesame cropping system

A field experiment was conducted in vertisols under irrigated conditions (since 2018) in a fixed plot layout with eight nutrient management options to study the comparative performance of sesame under organic, inorganic and integrated management and to study the soil health under organic input conditions for soybean (cv. Basara)–sesame (cv. Swetha Til) cropping system. Organic BMPs followed were: seed treatment with *Trichoderma viride* @ 4 g/kg, cultivation of sorghum and dhaincha along the border, prophylactic spray with neem oil/ neem formulations at fortnightly interval, "T" perch for predation of insect larvae, panchagavya spray @ 3% two times at 15 days interval and nutrient supplementing biofertilizers *viz.*, PSB and Rhizobium for both the crops wherever applicable.

Initial soil nutrient status of the experimental field was: pH: 8.1, EC: 0.57 ds/m, OC: 0.42%, available N: 187 kg/ha, available P: 123 kg/ha, available K: 866 kg/ha, DTPA: Zn: 1.2 ppm, Fe: 7.3 ppm, Cu: 1.6 ppm and Mn: 9.2 ppm.



Field plan of organic experiment in sesame

In the third year of the study, organic sesame in the soybean–sesame cropping system responded well to organic modules with temporal variations. Perceptible difference in the soil health was not yet noticed in terms of soil nutrient status. With regard to soil organic carbon content as indication of the improvement in soil health, inclusion of castor oil cake consistently recorded higher values. However, oil content and fatty acid composition of sesame did not vary significantly.

Nutrient profile of the organic inputs

Manure	N (%)	P (%)	K (%)	S (%)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)
FYM	1.5	0.3	1.1	0.2	184	3040	34.9	212
Vermicompost	1.6	0.2	0.6	0.2	153	3492	36.1	163
Neem cake	1.4	0.1	1.3	0.1	43	2657	17.7	275
Castor cake	4.6	0.3	1.0	0.1	99	534	22.1	268
Glyricidia	3.1	0.1	0.7	0.1	61	1222	11.9	260
Goat manure	2.5	0.3	1.7	0.1	115	1468	30.8	172

Effect of nutrient management options in sesame

Treatment	Yield (kg/ha)	OC (%)
Control	435	0.59
Organic: 100% RDF (FYM*+rock phosphate)+PSB	478	0.67
Organic: 100% RDF (green leaf manure+rock phosphate)+PSB	528	0.69
Organic: 100% RDF (castor oilcake +rock phosphate)+PSB	544	0.81
Organic: 100% RDF (neem oilcake+rock phosphate)+PSB	695	0.57
Organic: 100% RDF (FYM+vermicompost+goat manure)+Rock phosphate)+PSB	823	0.62
Towards organic: 50% inorganic+50% organic (through FYM+Rock phosphate)	770	0.69
Inorganic: 100% RDF (urea, DAP, MOP)	853	0.58
CD ($p<0.05$)	72.5	0.11

*as *Trichoderma viride* compost; OC-Organic carbon

Management practices for enhancing sesame productivity under rice–sesame cropping system

A field experiment was conducted at four locations *viz.*, Hyderabad (Telangana), Ragolu (Andhra Pradesh), Aduthurai (Tamil Nadu) and Mahisapet (Odisha) to find out the optimum tillage and nutrient requirement for rice fallow sesame with tillage management as main factor (Reduced tillage; Conventional tillage and Zero tillage) and nutrient management as sub factor (Control; 25% RDF; 50% RDF; 75% RDF and 100% RDF) with recommended dose of fertilizers (N:P_2O_5:K_2O kg/ha) at different centres: Mahisapet (50:30:20), Aduthurai (35:23:23) and Ragolu (40:40:20). The experiment was conducted in a split plot design with three replications. Across the centres, zero tillage resulted in significantly lowest yield while conventional tillage was superior. However, reduced tillage produced comparable yields at Mahisapet and Aduthurai. With respect to nutrient management, 100% RDF registered the highest yield at Mahisapet albeit on par with 50 and or 75% RDF for Aduthurai and Ragolu.

Effect of tillage and nutrient management on seed yield of rice fallow sesame

Treatment	Mahisapet (Odisha)*	Ragolu (Andhra Pradesh)*	Aduthurai (Tamil Nadu)*
Tillage practices			
Reduced tillage	390	357	425
Conventional tillage	419	506	492
Zero tillage	219	312	343
SEM	17.2	7.5	18.2
CD ($p<0.05$)	64	20.9	73.2

Treatment	Mahisapet (Odisha)*	Ragolu (Andhra Pradesh)*	Aduthurai (Tamil Nadu)*
Fertilizer management			
Control	266	303	363
25% RDF	283	379	408
50% RDF	328	399	424
75% RDF	393	450	440
100% RDF	444	403	465
SEM	21.7	25.9	14.5
CD ($p<0.05$)	63	52	43

*Seed yield in kg/ha

Abiotic Stress Tolerance

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

Castor

Screening germplasm accessions for drought tolerance

Eleven accessions along with checks (48-1 and DCH-519) were screened for tolerance to drought in field under water stress imposed from 30 to 90 days after sowing (DAS) along with irrigated control. Drought stress caused an increase in specific leaf weight (SLW), SPAD chlorophyll meter reading (SCMR), reduction in specific leaf area (SLA), relative water content (RWC), stem, leaf, spike and total plant dry weight (TDM), and primary and secondary spike growth. There was significant reduction in primary, secondary and total seed yield with drought stress. Primary seed yield reduced by 33.6%, secondary seed yield by 43.1% and tertiary seed yield by 4.4% with drought stress. Mean seed yield in control plants ranged from 82 to 193.1 g/plant with a mean of 113.0 g/plant, while stressed plants recorded yield ranging from 45.9 to 119.4 g/plant with a mean of 70.3 g/plant. Reduction in seed yield under drought stress ranged from 16% to 54.6% with the mean of 36.7%. Drought susceptibility Index (DSI) ranged from 0.42 to 1.4. Promising genotypes for drought tolerance were identified *viz.*, RG-1594, RG-1663, RG-2818, RG-2822 and 48-1 with ≤30% reduction in seed yield coupled with ≤0.8 DSI.

Screening of drought tolerant germplasm accessions for temperature tolerance

Eleven selected drought tolerant germplasm accessions along with two checks (48-1 and DCH-519) were evaluated for tolerance to temperature based on two dates of sowing (November and January). Mean maximum and minimum temperatures for November and January sown crops were 32.1 °C and 34.3 °C, and 16.0 °C and 19.4 °C, respectively with an increase in maximum temperature of 2.2 °C and minimum temperature of 3.4 °C. Under delayed sowing, significant reduction in seed yield of different order branches and total seed yield of the genotypes were observed. Overall, an increase of 2.7 °C in mean temperatures showed an average reduction of 30% in seed yield, which indicated that for every 1 °C increase in mean temperature the total seed yield reduction was about 11%. Based on reduction in seed yield up to the secondaries, RG-298 (10%), RG-2048 (10%) and RG-72 (20%) were identified as promising genotypes for temperature tolerance.

Evaluation of castor parental lines for root growth (poly bags)

A set of 12 parental lines were evaluated for root and shoot growth till 90 DAS in poly bags and variability observed among the parental lines for various traits. Strong positive correlations (>0.6) between plant height, stem girth, root length, root volume, root fresh weight, root dry weight and total dry matter (TDM) were recorded. The TDM showed a positive correlation (>0.7) with all shoot and root traits. IPC-41, IPC-43 and DPC-22 were promising with good root and shoot characters.

Evaluation of castor parental lines for drought tolerance in the field

A set of 12 parental lines with two checks (48-1 and DCH-519) were evaluated for tolerance to drought in the field under water stress condition imposed from 30 to 90 DAS along with irrigated control during November, 2020. Seed yield of primaries ranged from 25.0 to 78.5 g/plant (48-1: 47.0; DCH-519: 94.7) under control and 23.3-51.0 g/plant (48-1: 24.3; DCH-519: 42.5) under drought stress. Similarly, for secondaries it ranged from 27.0 to 77.3 g/plant (48-1: 64.5; DCH-519: 47.7) under control and from 11.8 to 36.7 g/plant (48-1: 22.6; DCH-519: 19.7) under drought stress. Total seed yield (g/plant) ranged from 69.2 to 145.8 g/plant (48-1:111.5; DCH-519: 165.7) under control and from 52.2 to 86.9 (48-1: 70; DCH-519-62.3) under drought stress. Promising genotypes for drought tolerance based on ≤30% reduction in seed yield of primaries (1932-1, IPC-42, IPC-46 and DPC-25), secondaries (ICS-164, ICS-200, IPC-42 and DPC-9) and total seed yield (1932-1, ICS-164, ICS-200, ICS-299, ICS-321, IPC-42, DPC-9 and 48-1) were identified.

Sunflower

Evaluation of sunflower inbreds for temperature and combined stress of drought and temperature

A set of 77 genotypes (67 inbreds, 7 hybrids and 3 varieties) were evaluated for combined stress of temperature and drought under field conditions by sowing at two dates, normal (25/01/2021) and delayed (08/03/2021), to expose the crop to high temperatures under stress-free (irrigation) and under water stress by withholding irrigation from 35 DAS to 75 DAS. In delayed sowing, 34.6 mm rain in 3 spells was received 20 days after imposition of stress. Rise in temperature due to delayed sowing was observed during sowing to flowering window [maximum temperature: 33.2-36.8 °C (+3.6 °C); minimum temperature: 15.5-20.2 °C (+4.7 °C); mean temperature: 24.4-28.5 °C (+4.1 °C)] but from flowering to harvest only 2.5 °C rise in minimum temperature and 0.6 °C mean temperature were observed as many days were cloudy days. Delayed sowing received as much as 92.6 mm rain from flowering to harvest and therefore, it was not under water stress post flowering, and the temperature rise during this stage was also negligible, as a result most of the entries recorded higher seed yield in stress compared to normal sowing. Under normal sowing, seed yield ranged from 2.1 to 87.4 g/plant (mean: 19.2 g/plant) under control and from 1.1 to 30 g/plant (mean: 8.1 g/plant) under drought with yield reduction ranging from 19 to 87% (mean: 57%). Under delayed sowing, seed yield ranged from 4.3 to 65.8 g/plant (mean: 19.3 g/plant) under control and from 1.4 to 35 g/plant (mean: 10.6 g/plant) under drought with yield reduction ranging from -43 to 83% (mean: 45%). Effect of temperature stress on yield was not observed. Overall, Phule Bhaskar, KBSH-44, PI 686527 and RHA-6D-1 recorded the least susceptibility (30% yield reduction) due to drought at both sowings.

Effect of temperature on root growth

Fourteen genotypes of sunflower (10 inbreds with 4 hybrid checks) were studied for germination and root growth at six different temperatures *viz.*, 25 °C, 30 °C, 32.5 °C, 35 °C, 37.5 °C and 40 °C in the laboratory. Observations were recorded on 7th day after planting. Significant differences were observed among genotypes. Germination (%), root length (cm), root volume (mm^3), root dry weight (mg) and root surface area (cm^2) decreased with increasing temperature while root diameter (mm) increased. Hybrids: DRSH-1, CSFH-12205 and CMS lines: 127B, 70B, 42B, AKSF-6-3B showed better germination and root traits at high temperatures.

Sesame

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

A total of 35 genotypes of sesame were evaluated for physiological and yield traits under irrigated and moisture stress conditions in shallow alfisols during late *rabi* 2021. Stress was imposed from flowering to physiological maturity and moisture levels were monitored using real-time soil moisture sensors. Phenotypic correlation analysis revealed that total dry matter, total leaf area and stomatal conductance significantly correlated with seed yield/plant under water stress. The genotypes *viz.*, IC-205776, DT-112, DT-26, IC-205610, IC-132293, DT-97 and IC-204622 recorded higher yield (>10%) compared with checks, GT-10 and Swetha til under water stress condition.

Sesame genotypes with high number of capsules under soil moisutre stress

Safflower

Phenotypic evaluation of safflower germplasm for tolerance to moisture stress

A set of 123 germplasm accessions were evaluated under vertisol (residual moisture) and alfisol (stress and irrigated) conditions at Hyderabad for 22 phenotypic traits including physiological and yield components. Data analyses revealed considerable variability for the target traits under vertisol and alfisol conditions. In vertisol, the seed yield ranged from 3.4 to 44.4 g/plant with an average of 20.6 g/plant. In alfisol, about 45.3% reduction in seed yield under stress (range: 6.2-22.2 g/plant; average: 13.1 g/plant) compared to irrigated condition (range: 13.0-38.3 g/plant; average; 23.9 g/plant) was observed. However, harvest index (range: 17.5-40.1; average: 27.1) did not vary appreciably under both the conditions.

Quality and Value Addition

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

Efficacy of safflower seed protein concentrates (meal) in broiler chicken diet

Standardized safflower seed protein concentrates (SPC) were tested for their efficacy in Broiler chicken diet during winter at ICAR-Project Directorate on Poultry (ICAR-PDP), Hyderabad. Along with base diet, two doses of SPC were tried (50 and 100% replacement of soybean meal) with only soybean meal (SBM) as check. Gain in body weight, feed intake, food conversion ratio (FCR) and changes in serum parameters were recorded up to six weeks. Significant increase in FCR and decrease in feed intake was observed at 100% dose. Serum and slaughter parameters in all treatments were in normal range.

Treatment	Week 5 (15/03/21 – 21/03/21)			Week 6 (22/03/21 – 28/03/21)		
	BWG/b (g)	FI/b (g)	FCR	BWG/b (g)	FI/b (g)	FCR
SBM @ 100%	1680^{a}	2640^{a}	1.57^{b}	2037^{a}	3634^{a}	1.78^{b}
SPC @ 50%	1629^{a}	2506^{ab}	1.54^{b}	1976^{a}	3467^{ab}	1.75^{b}
SPC @ 100%	1387^{b}	2415^{b}	1.74^{a}	1688^{b}	3323^{b}	1.97^{a}
SEM	27.96	32.69	0.02	32.84	42.50	0.022

SBM-Soybean meal; SPC-Safflower protein concentrates; BWG/b-Body weight gain/bird; FI/b-Food intake/bird; FCR-Food conversion ratio.
Mean values with different alphabet superscripts varied significantly (at 5%) as per DMRT.

Efficacy of safflower seed protein concentrates on rats

The experiment was conducted for 15 weeks at CSIR-National Institute of Nutrition (NIN), Hyderabad. Histopathology studies were carried out on adults (male and female) and pups. Changes of histological significance were observed only in lungs and liver of both control (casein as a protein source) and treatment (safflower concentrates, isolates and hydrolysates as protein sources) group of adults and other organs were normal. In liver of adults and pups, safflower protein hydrolysates (SPH) group showed the best results compared to the control, with all animals showing normal histology.

Crop Protection

Host Plant Resistance

Host plant resistance is an environmentally safe and cost-effective strategy to manage insect pests and diseases of crops. Standardization of reliable mass screening methods, identification of resistant sources and deciphering the associated mechanism(s) were carried out against major and emerging pests *viz.*, root rot, wilt, gray mold, capsule borer and sucking pests in castor; leafhopper in sunflower; wilt, root rot and aphid in safflower; root rot, phyllody, leafhopper, leaf webber and capsule borer, gall fly in sesame; major foliage feeders and sucking pests in linseed for their utilization in resistance breeding programmes.

Screening methods and mechanism of resistance

Standardization of inoculation method for root rot disease of castor: Different inoculum levels of root rot pathogen (*Macrophomina phaseolina*) grown on autoclaved sorghum were tested with castor genotypes, GCH-4 (susceptible check) and JI-357 (moderately resistant check). In GCH-4, the root rot incidence varied from 45.8 to 100% while in JI-357, the incidence ranged from 5.0 to 20.0% in different inoculum levels of 25 to 50 g/kg soil. Among them, sorghum inoculum of 35 g/kg soil recorded 100% root rot incidence in GCH-4; while 20.0% incidence in JI-357. Hence, sorghum inoculum of *M. phaseolina* @ 35 g/kg soil was standardized for artificial inoculation method of root rot incidence by sick pot method. Castor lines were tested by both stem tape inoculation method (normally followed) and sick pot method. In stem tape inoculation method, the progress of root rot disease after inoculation is very slow and late in the appearance of symptoms while the disease progress was fast with early appearance of root rot symptoms in sick pot method.

GCH-4 (Inoculated)

GCH-4 (Control)

Standardization of inoculation method for screening against root rot disease in castor

Development of *in vivo* and *in vitro* methods to study mechanism of resistance to whitefly in castor: Developed *in vivo* and *in vitro* methods to study mechanism of resistance to whitefly (*Trialeurodes ricini*) in castor under controlled conditions. Cage method using foldable cage (215 cm length x 112 cm width x 102 cm height) was used to study antixenosis (non-preference) mechanism of resistance. Results revealed that the resistant genotypes (RG-2800, RG-3428 and DPC-9) exhibited antixenosis for oviposition (5.8-8.3 eggs/3 cm^2 leaf area and 8.3-9.4 eggs/3 cm^2 leaf area under free-choice and no-choice tests, respectively) as compared to susceptible genotypes (RG-2646, M-574 and DCH-519) (30.5-36.6 and 38.9 48.6 eggs/3 cm^2 leaf area) under free-choice and no-choice tests, respectively. Developmental time (egg to adult emergence) in resistant genotypes (32.8-33.8 days) was prolonged significantly as compared with that on susceptible genotypes (24.3-25.8 days). The resistant genotypes exhibited tolerance mechanism of resistance in terms of leaf damage scale (0-1 on 0-5 scale) as compared to susceptible genotypes (4-5 on 0-5 scale). Similarly, an *in vitro* method using

foldable cage (160 μm mesh aperture; 60 cm length x 60 cm width x 60 cm height) was developed to study mechanism of resistance under laboratory conditions. The results revealed that maximum percentage of adults settled on susceptible genotypes (21.2-31.5%) as compared to resistant genotypes (8.1-9.3%). Significantly lower number of eggs were laid on resistant genotypes (6.2-7.9 eggs/3 cm^2 leaf area as compared to 16.2-23.1 eggs/3 cm^2 leaf area) and exhibited antixenosis (non-preference) mechanism of resistance for oviposition.

Development of *in vivo* and *in vitro* methods to study mechanism of resistance to whitefly in castor

Reaction of resistant and susceptible castor genotypes to whitefly

Role of cuticular waxes of castor to gray mold infection: To unravel the role of cuticular waxes in development of the gray mold disease, 32 castor germplasm lines with low wax content were screened for gray mold infection. Four lines with low gray mold severity *viz.*, RG-1919, RG-1754, RG-1915, and RG-1875 (disease severity: 12.5-20%) recorded significantly lower cuticular wax content on capsules (wax content: 0.26-0.53 μg/mg) as compared to the susceptible check, DCH-519 (wax content: 2.06 μg/mg and disease severity: 95%). The resistant check, ICS-324 recorded a wax content of 0.21 μg/mg and disease severity of 2.0%.

RG-1919 ICS-324 (RC) DCH-519 (SC)

Role of cuticular waxes of castor to gray mold infection

Leaf epicuticular wax as a factor of mechanism of resistance of castor to whitefly: Leaf epicuticular wax content of three whitefly resistant genotypes and three susceptible genotypes was estimated and correlated with whitefly adult settling per cent, oviposition and whitefly developmental period. Significant positive correlation between leaf wax content and whitefly adult settling per cent (r = 0.96**) and oviposition (r = 0.93-0.98**) was observed. However, significant negative correlation between leaf wax content and whitefly developmental period (r = -0.93**) was recorded.

Elucidating the mechanism of resistance in sunflower genotypes against leafhopper: The mechanism of leafhopper (*Amrasca biguttula biguttula*) resistance in the identified resistant genotypes of sunflower was investigated in comparison with susceptible checks. The mechanism of resistance evaluated in terms of settling preference study also revealed less number of nymphs settling on resistant accessions (8.3-17.3 nymphs per plant) compared to susceptible check, Morden (47.1 nymphs per plant). The ovipositional preference by *A. biguttula biguttula* under choice and no-choice tests recorded significantly lowest number of nymphs (4.7-7.3 nymphs per plant under choice test and 4.0-6.2 nymphs per plant under no-choice test) on resistant accessions, compared to susceptible check, Morden (34.0 nymphs per plant under choice test and 12.8 nymphs per plant under no-choice test). This showed that antixenosis/non-preference of leafhopper nymphs might be one of the mechanisms for resistance in those sunflower germplasm accessions that deterred or reduced the colonization of leafhopper nymphs.

Resistant accessions received a smaller number of feeding punctures (24.0-37.5 punctures per leaf) compared to susceptible check, Morden (195.2 punctures per leaf). The lowest number of honeydew spots was also observed on resistant accessions (11.8-15.8 spots/8 h/10 nymphs) compared to susceptible check, Morden which recorded highest number of honeydew spots (62.8 spots/8 h/10 nymphs).

Developmental studies revealed an extended larval period (11.7 days in GMU-339, 11.3 in TSG-401 and 10.9 days in GMU-696), reduced nymphal survival (15.8% in GMU-696, 23.7% in GMU-339 and 32.6% in TSG-401) and shortened adult longevity on resistant accessions (5.4-6.2 days) compared to susceptible check, Morden (10.2 days). The resistant accessions *i.e.,* TSG-401 (13.3 days) and GMU-339 (12.3 days) took a greater number of days for the development of symptoms compared to the susceptible check, Morden (6.6 days).

Various biochemical factors were analyzed to understand their role in resistance/susceptibility of sunflower accessions against leafhopper. Leafhopper feeding causes lipid peroxidation in sunflower. It was more pronounced in susceptible accessions than that of resistant ones. This was indicated by higher MDA and hydrogen peroxide. Enzymes, SOD, CAT, POX and ascorbate peroxidsase (APX) content were more in resistant accessions and removed the stress caused by leafhoppers. Significant differences were observed in mean values of MDA, H_2O_2, SOD, CAT, POX, APX, total phenols, total free amino acids and total sugars between resistant and susceptible accessions, including susceptible check, Morden.

The resistant genotypes *viz.*, GMU-339, GMU-696 and TSG-401 showed antixenosis for nymphal preference, oviposition preference, shelter and feeding; antibiosis in terms of extended larval period, reduced nymphal survival and shortened adult longevity and tolerance in terms of a greater number of days for the development of symptoms.

Sources of resistance

Castor

Wilt: Seventy six parental lines and advanced breeding material were screened against wilt disease under sick plot conditions along with susceptible (JI-35) and resistant (48-1) checks. Among them, DCS-89 (5.6%), DCS-112 (10.0%), ICS-298 (0%), ICS-301 (0%) and ICS-303 (0%) recorded <10% wilt incidence with highly resistant reaction. The parental lines *viz.*, DCS-104, DCS-105, DCS-108, DCS-106, DCS-110, DCS-107, DCS-109, DCS-118, DCS-119, DCS-94, 2061-1, 2160-1, 2180-1, 2202-1, 2203-1, 2255-1, IPC-42, IPC-46, IPC-43, ICS-296, ICS-299, ICS-304, ICS-306, ICS-314, ICS-315, ICS-321, ICS-322, K18-92, K18-101, K18-106, DPC-21, DPC-25 and M-571 recorded <20% wilt incidence. JI-35 (Susceptible check) and 48-1 (Resistant check) recorded 100 and 10% wilt incidence, respectively. The parental lines and advanced breeding materials *viz.*, DCS-89, DCS-94, DCS-105, DCS-108, DCS-106, DCS-110, DCS-107, DCS-109, DCS-118, DCS-112, DCS-104, DPC-21, IPC-42, IPC 43, IPC-46, 2061-1, 2160-1, 2180-1, 2202-1, 2203-1, 2255-1, ICS-304, ICS-314 and ICS-315 showed resistant reaction (<20% wilt incidence) consecutively for two years under sick plot conditions.

Capsule borer: Screened 17 castor inbred lines (six selections from ICI-RG 898, three selections from ICI-RG 2774 and 8 selections from ICI-RG 2800) using the infester row technique. All the selections from ICI-RG 2800 (ICI-RG 2800-1, ICI-RG 2800-2, ICI-RG 2800-3, ICI-RG 2800-4, ICI-RG 2800-5, ICI-RG 2800-6, ICI-RG 2800-7 and ICI-RG 2800-8) and ICI-RG 2774 (ICI-RG 2774-1, ICI-RG 2774-2 and ICI-RG 2774-3) recorded less than 10% capsule damage and confirmed resistant reaction to capsule borer, while susceptible check (DCS-9) recorded 78.1% capsule damage. Selections from ICI-RG 898 recorded less than 25% capsule damage, while the resistant check (48-1) recorded 7.7% capsule damage.

ICI-RG 898 | ICI-RG 2774 | ICI-RG 2800 | 48-1 (RC) | DCS-9 (SC)

Reaction of castor inbred lines to capsule borer

Confirmation of reaction of castor inbred lines against capsule borer

Inbred lines	Capsule damage* (%)	Inbred lines	Capsule damage (%)
ICI-RG 2774-1	5.1 (13.0)	ICI-RG 2800-8	5.8 (13.9)
ICI-RG 2774-2	8.1 (16.4)	ICI-RG 898-1	12.4 (20.6)
ICI-RG 2774-3	4.8 (12.6)	ICI-RG 898-2	7.1 (15.4)
ICI-RG 2800-1	5.1 (13.0)	ICI-RG 898-3	8.9 (17.3)
ICI-RG 2800-2	8.3 (16.7)	ICI-RG 898-4	13.1 (21.2)
ICI-RG 2800-3	6.5 (14.7)	ICI-RG 898-5	6.8 (15.1)
ICI-RG 2800-4	9.2 (17.6)	ICI-RG 898-6	8.3 (16.7)
ICI-RG 2800-5	4.8 (12.6)	48-1 (R)	7.7 (16.0)
ICI-RG 2800-6	9.0 (17.5)	DCS-9 (S)	78.1 (62.2)
ICI-RG 2800-7	7.7 (16.0)	CD ($p<0.05$) = 3.9	

*Figures in parenthesis are arcsine transformation values

Leafhopper: Ninety-five double bloom castor genotypes consisting of 16 germplasm accessions, 72 monoecious lines and 7 pistillate lines were screened against leafhopper along with susceptible and resistant checks under field conditions using the infester row technique. Among 95 double bloom castor genotypes screened, none of the genotypes were found resistant to leafhopper. Four germplasm accessions (RG-1624, RG-155, RG-43 and RG-18), 13 double bloom monoecious lines (ICS-128, ICS-259, ICS-265, ICS-267, ICS-278, ICS-280, ICS-283, ICS-296, ICS-299, ICS-303, ICS-314, ICS-315 and ICS-316) and one pistillate line (IPC-39) were moderately resistant to leafhopper (hopper burn grade 2 on 0-4 scale), while susceptible checks recorded hopper burn grade 4 on 0-4 scale.

Screening of double bloom castor genotypes against leafhopper

Thrips: Among 95 double bloom castor genotypes screened against thrips, 5 germplasm accessions (RG-3445, RG-1624, RG-1621, RG-311 and RG-45), 26 monoecious lines (ICS-121, ICS-125, ICS-141, ICS-239, ICS-240, ICS-242, ICS-252, ICS-253, ICS-255, ICS-258, ICS-259, ICS-261, ICS-265, ICS-267, ICS-269, ICS-271, ICS-273, ICS-275, ICS-283, ICS-288, ICS-296, ICS-303, ICS-316, ICS-319, ICS-320 and ICS-321) and 5 pistillate lines (DPC-18, DPC-19, DPC-20, IPC-39 and IPC-42) were promising against thrips with very low infestation (<10 thrips/spike) as compared to 41.8 thrips/spike in susceptible check, DCS-9.

Whitefly: Twelve promising castor genotypes consisting of six inbred lines (ICI-RG 2800-1, ICI-RG 2800-4, ICI-RG 2800-5, ICI-RG 2800-6, ICI-RG 2800-7 and ICI-RG 2800-8) and six germplasm accessions (RG-3795, RG-3428, RG-3233, RG-2797, RG-2296 and RG-226) were screened against whitefly along with susceptible (M-574 and DCH-519) and resistant checks (DPC-9 and DCH-177). Infester row technique (one infester row of M-574 after every 2 rows in sandwich method) was followed using RBD design with two replications. Four inbred lines (ICI-RG 2800-1, ICI-RG 2800-4, ICI-RG 2800-5 and ICI-RG 2800-8) and one germplasm accession (RG-3428) were highly resistant to whitefly (whitefly grade 0 on 0-5 scale) with significantly low infestation of whitefly (1.4 to 3.9 whiteflies/top leaf/plant), while susceptible checks recorded whitefly nymphs and pupae grade of 4 (on 0-5 scale) with high whitefly adult population of 56.5 to 72.1 whiteflies/top leaf/plant. Two inbred lines (ICI-RG 2800-6 and ICI-RG 2800-7) and one accession (RG-3233) were resistant to whitefly (whitefly grade of 1 on 0-5 scale).

Confirmation of reaction of promising castor genotypes against whitefly

Genotype	Whitefly (No./top leaf/plant)	Whitefly grade (0-5 scale)	Genotype	Whitefly (No./top leaf/plant)	Whitefly grade (0-5 scale)
ICI-RG 2800-1	2.3	0	RG-3428	2.4	0
ICI-RG 2800-4	3.9	0	RG-3233	5.0	1
ICI-RG 2800-5	3.5	0	RG-2797	41.8	3
ICI-RG 2800-6	6.5	1	RG-226	35.8	3
ICI-RG 2800-7	7.2	1	RG-2296	29.9	2
ICI-RG -2800-8	1.4	0	RG-3795	45.3	3
DCH-519 (SC)	56.5	4	DPC-9 (RC)	2.1	0
M-574 (SC)	72.1	4	DCH-177 (SC)	2.4	0

Reaction of resistant and susceptible castor genotypes to whitefly under field conditions

Sunflower

Leafhopper: Fifty-nine lines comprising of accessions from USDA, pre-breeding lines and R gene pool lines of sunflower were evaluated for their reaction to leafhoppers during summer, 2020-21. Among these, 18 lines were resistant to leafhopper while 23 lines were found moderately resistant to leafhoppers. Seven lines *viz.*, PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014, and PB-1019 were confirmed resistant to leafhoppers with MSI of 1.0. Susceptible check, NDCMS-2B and Morden were highly susceptible to leafhoppers.

Reaction of accessions from USDA, pre-breeding lines and R gene pool lines of sunflower to leafhoppers

Entry	LH	MSI	LSI	Category
PI-686681, AMES-31960-6, PI-686489, PI-686651, PI-686521, PI-686550, SEL-1, RGP-195, RGP-189, PI-686504, PI-686739, PI-686808, PI-686800, PI-686490, PI-686833, PI-686598, PI-686808, RGP-184, PB-1001, PB-1003, PB-1005, PB-1007, PB-1008, PB-1014, PB-1019	5.2 - 12.5	1.00	5.2- 12.5	R
PI-686683, PI-686778, PI-686835, PI-686711, RGP-178, RGP-125, PI-686703, PI-686672, RGP-301, RGP-172, PI-686548, PI-686585, PI-686680, PI-686641, PI-686750, PI-686805, PI-686751, PI-686669, PI-686492, PI-686704, PI-686673, PI-686487, PI-686831	4.8 - 13.6	1.17- 2.40	6.3- 32.2	MR
PI-686549, PI-686749, RGP-151, PI-686795, PI- 686792, PI-686775, PI-686499, PI-686746, RGP-137, PI-686689, RGP-147	9.6 - 11.6	2.60- 4.00	25.0- 37.1	S
NDCMS-2B (SC)	20.0	4.00	80.0	S
Morden (SC)	17.3	3.67	63.4	S

LH-Leafhoppers/3 leaves/plant; MSI-Mean scale index 1-4; LSI-Leafhopper susceptibility index; SC-Susceptible check; R-Resistant; MR-Moderately resistant; S-Susceptible

PB-1007

PB-1003

NDCMS-2B

PB-1008

Confirmed sources of resistance to leafhopper in sunflower

PI-686800

PI-686808

PI-686833

RGP-184

Promising sources of resistance to leafhopper in sunflower

Safflower

***Fusarium* wilt:** Twenty five germplasm accessions were screened for confirmation of resistance against wilt under the sick pot method. Nine germplasm lines *viz.*, GMU-6926, GMU-7986, GMU-6891, GMU-6852, GMU-821, GMU-824, GMU-864, GMU-1217 and GMU-3740 were resistant to wilt with <10% disease incidence. The susceptible check (Nira) and the resistant check (TSF-1) recorded 100 and 0% wilt incidence, respectively.

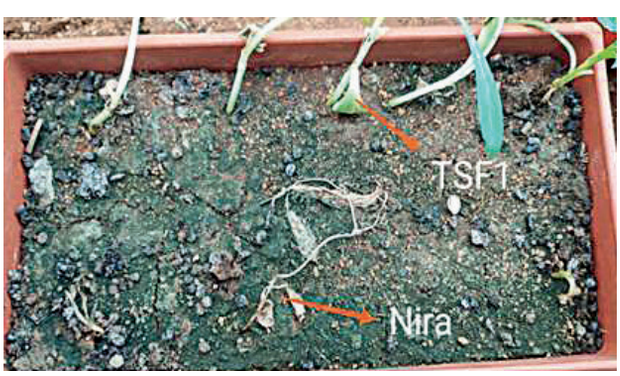
Confirmation of reaction of safflower germplasm accessions to *Fusarium* wilt under sick pot method

Root rot: Twenty five germplasm lines were screened for resistance against root rot using paper towel and sick pot methods. Six germplasm lines *viz.*, GMU-6915, GMU-6854, GMU-1217, GMU-824, GMU-1175 and GMU-4665 were found resistant to root rot, while three lines (GMU-6891, GMU-7472 and GMU-4546) were moderately resistant in both the methods.

GMU-6891 (Moderately resistant)

Nira (Susceptible)

Reaction of safflower accessions to root rot in paper towel method



TSF-1 (Resistant) and Nira (Susceptible)

GMU-6854 (Resistant)

Reaction of safflower accessions to root rot in sick pot method

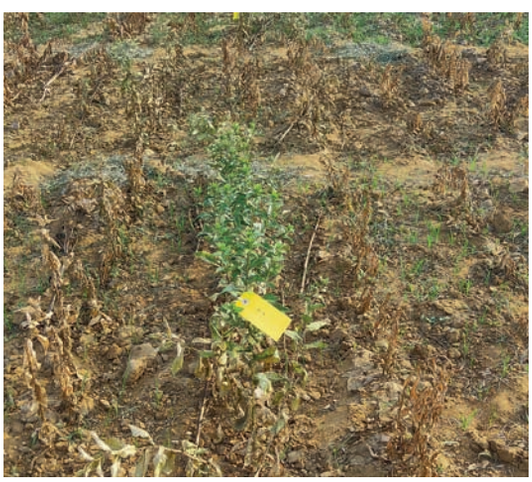
Aphid: A total of 25 wilt tolerant safflower accessions were screened artificially against aphids along with two checks *viz.*, CO-1 (susceptible check) and A-1 (tolerant check) during *rabi* 2020-21. Aphid release was done when plants were around 40-45 days old. The accession, GMU-7472 was found tolerant (A.I.I., 1.2) and five accessions, GMU-6915, GMU-7985, GMU-4546, GMU-4665 and GMU-4815 (A.I.I., 2.4 to 2.9) were found moderately tolerant to aphids. Susceptible check, CO-1 recorded A.I.I. of 5.0.

Reaction of wilt tolerant safflower accessions to aphids

Accession	A.I.I.	Category
GMU-7472	1.2	T
GMU-4546, GMU-4665, GMU-4815, GMU-6915, GMU-7985, A-1 (TC)	2.4-2.9	MT
GMU-3740, GMU-4965, GMU-4983, GMU-5032, GMU-6037, GMU-6854, GMU-6891, GMU-7984, GMU-7986	3.3-3.9	S
GMU-821, GMU-824, GMU-864, GMU-1175, GMU-1217, GMU-4915, GMU-6004, GMU-6852, GMU-6886, GMU-6926, CO-1 (SC)	4.2-5.0	HS

A.I.I.-Aphid infestation index; T-Tolerant; MT-Moderately tolerant; S-Susceptible; HS-Highly susceptible; TC-Tolerant check; SC-Susceptible check

GMU-7472 (Tolerant)



A-1 (Tolerant) and CO-1(Susceptible)

Reaction of wilt tolerant safflower accessions and checks to aphids

Sesame

Root rot: Forty sesame germplasm accessions were screened against root rot by the sick pot method along with susceptible (VRI-1) and resistant checks (Swetha Til). None of the entries showed resistant reaction to root rot (1-10% incidence). Two entries *viz.*, NIC-16129 (13.6%) and S-0248 (17.8%) recorded moderately resistant reaction (11-20% root rot incidence). Rest of the lines showed moderately susceptible to highly susceptible reaction. The susceptible check, VRI-1 recorded 86.7% incidence, while resistant check, Swetha Til recorded 6.7% incidence.

Among 32 advanced breeding material screened against root rot by the sick pot method, four entries *viz.*, SES-S-19-2102 (4.5%), SES-S-20-3003 (2.2%), SES-S-20-2001 (0%) and CUMS-17 (6.7%) recorded resistant reaction to root rot (1–10% incidence). Sesame genotypes GT-10 (18.1%), SES-S-20-1038 (16.7%), SES-S20-1039 (15.8%), SES-K-20-RR-1102 (15.8%) and SES-K-20-RR-1103 (20.0%) showed moderately resistant reaction. The rest of the lines showed moderately susceptible to highly susceptible reaction. The susceptible check, VRI-1 and the resistant check, Swetha Til recorded 64.8% and 8.9% root rot incidence, respectively.

Thirty seven genotypes that showed moderately resistant reaction (<20%) at ICAR-IIOR were tested under sick plot conditions at Vriddhachalam, Tamil Nadu to confirm their resistance to root rot. Six genotypes viz., IIOS-1101, SEL-S-18-3002, SEL-S-20-3006, SEL-S-20-2001, IC-500504 and KIC-357 showed moderately resistant reaction with <20% root rot incidence. Susceptible check, VRI-1 recorded 71.4% root rot incidence.

SES-S-20-2001

SES-S-20-3003

NIC-16129

VRI-1

Evaluation of sesame genotypes to root rot by sick pot method

Phyllody: Sixty three sesame genotypes were screened against phyllody under field conditions. Among the genotypes, none of the genotypes was found highly resistant (no symptoms on any plant). Fourteen genotypes showed resistant reaction to phyllody with 0.1 to 10% phyllody incidence. Twenty genotypes were found as moderately resistant (10.1-20% incidence) and 22 genotypes were found to be tolerant (20.1-30%). Six genotypes showed moderately susceptible reaction (30.1-40% incidence), while one genotype (SES-K-20-2020) showed susceptible reaction (40.1-50% incidence).

Reaction of sesame genotypes to phyllody under open field conditions

Category (Per cent disease incidence)	Genotypes
Resistant (0.1-10)	Lathua Local, SES-K-20-1062, SES-K-20-1063, SES-K-20-1061, CT-51, SES-K-20-1072, SES-K-20-1064, GT 10, SES-K-20-1052, SEL-S-2018-1002, SES-K-20-1045, SES-K-20-1055, SES-S-19-1037, IIOS-1101
Moderately resistant (10.1-20)	SES-K-20-1056, SES-K-20-2008, SES-K-20-1057, Swetha Til, Long Knog-2, SES-K-20-2019, SES-K-20-1050, RT-372, SES-K-20-2012, IIOS-1103, SES-K-20-2009, IIOS-1102, IC-16239, ISWG-20-05, SES-K-20-2027, SES-K-20-3002, SES-K-20-3007, SES-S-19-1013, SES-K-20-1051, SES-K-20-2001

Leafhopper: About 61 sesame genotypes were screened against leafhopper and categorized as highly resistant (2 genotypes), resistant (11 genotypes), moderately resistant (6 genotypes), moderately susceptible (21 genotypes), susceptible (10 genotypes), and highly susceptible (11 genotypes) based on population/incidence.

Reaction of sesame genotypes to leafhopper under open field conditions

Category (No. of leafhoppers/leaf)	Genotypes
Highly resistant (0)	RT-372, Lathua Local
Resistant (1)	Long Knog-2, SEL-S-2018-1010, SES-K-20-1052, IC-16239, SES-K-20-1072, SES-K-20-1063, CT-51, SES-K-20-2016, SEL-S-2018-1003, SES-K-20-2011, SES-K-20-1061
Moderately resistant (2)	IIOS-1101, SES-K-20-2008, SES-K-20-1064, SES-K-20-1060, SES-K-20-2020, CT-55

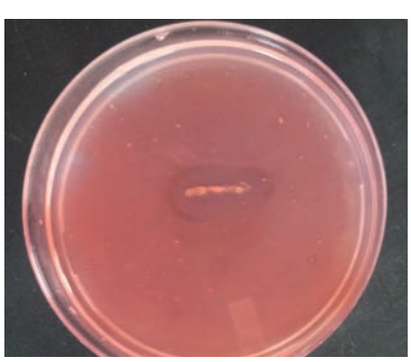
Linseed

Leaf miner, bud fly, sucking pests and chewing pests: A total of 206 genotypes were screened against major insect pests of linseed *viz*., leaf miner, whiteflies, leafhopper, stink bug, mirid bug, bud fly, *Spodoptera litura* and *Helicoverpa armigera*. Among linseed genotypes, percent incidence and population (per 10 plants) of leaf miners varied from 0 (LT-113 and LT-114) to 100.0 (LT-1, LT-51 and LT-63) and 0 to 9.0, respectively. The highest populations of whiteflies and leafhoppers were observed in LT-57 (16 per 10 plants) and LT-74 (12 per 10 plants), respectively. Maximum incidence of stink bug and mirid bug were noticed in LT-157 (29 per 10 plants) and LT-14, LT-115 and T-397, respectively. Maximum *S. litura* population was recorded in LT-56 (6 per 10 plants). Population of *H. armigera* was observed in LT-16, LT-24, LT-77, LT-98 (3 per 10 plants). Bud fly population (per 10 plants) varied between 0 and 4 and maximum was noted in LT-26 (4 per 10 plants).

Biological Control

Biological control is an environmentally amicable agricultural pest management strategy. It is a conservative and dependable pest management method by utilising living organisms to reduce pest populations for sustainable agriculture. Several beneficial microbials have been collected, isolated, and characterised, and their effectiveness against insect pests, diseases, and plant parasitic nematodes in oilseed crops has been investigated.

Collection, isolation and characterization of chitinolytic bacteria: About 62 rhizosphere soil samples were collected from different oilseed crop fields and about 55 rhizobacteria were isolated. The isolated bacteria were characterized for the production of chitinase enzymes *in vitro*. Bacteria which produced halo zones were identified to exhibit chitinolytic activity. Chitinolytic bacteria were sub cultured and tested for their efficacy against the major diseases and nematodes associated with different oilseed crops. The proven seven cultures (*Paenibacillus dentritiformis*, *P. polymyxa*, *Pseudomonas koreensis*, *Bacillus mycoides*, *B. sonorensis*, *B. axarquiensisi* and *Pseudomonas arsenicoxydons*) submitted in the repositories of ICAR-NBAIM, Mau and five effective bacterial isolates from ICAR-IIHR, Bangalore (*Pseudomonas fluorescens*, *P. putida*, *B. pumilis*, *B. megaterium*, *B. liquefaciens*) and 34 Bt isolates from ICAR-IIOR, Hyderabad were also obtained to compare their efficacy with the isolated native bacterial isolates.



Presence of halo zone

Bacteria with chitinase production

Bacteria without chitinase production

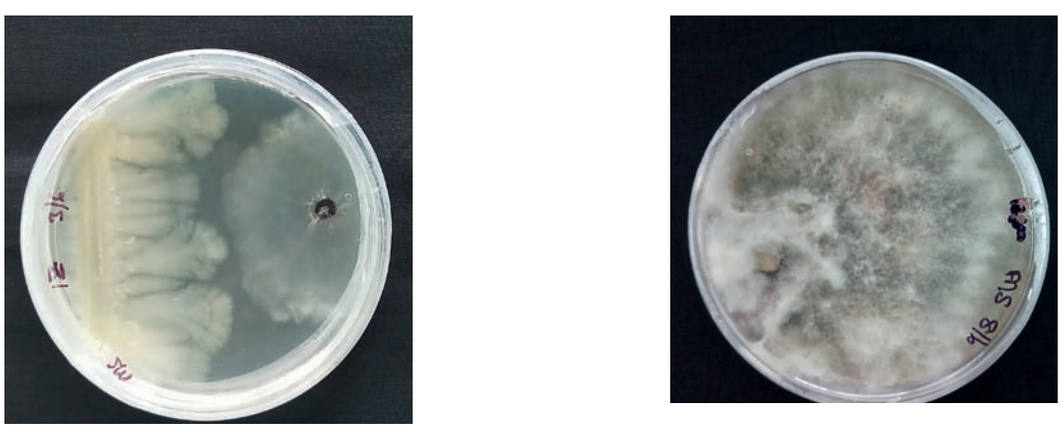
***In vitro* identification of chitinolytic bacteria**

In vitro* efficacy of bacterial isolates against *Fusarium oxysporum* f. sp. *ricini: A total of 34 chitinolytic bacterial isolates were tested for their *in vitro* efficacy against *F. oxysporum* f. sp. *ricini* through dual plate assay along with control (fungus alone). Among 34 isolates evaluated, six isolates *viz*., IC-RB4, IC-RB5, UN-RB1, Bt-145, HD-RB2 and NBAIM 2230 were found promising and inhibited more than 50% of pathogen mycelia over control.

Effective bacteria | Ineffective bacteria | Fungus alone (Control)

In vitro* effect of chitinolytic bacteria against *Fusarium oxysporum* f.sp. *ricini

In vitro* efficacy of bacteria against *Macrophomina phaseolina: Among 34 chitinolytic bacterial isolates tested for their *in vitro* efficacy against *M. phaseolina,* four isolates *viz*., IC-RB4, IC-RB5, NBAIM 2230 and NBAIM 2481 were found promising and inhibited more than 50% of pathogen mycelia over control.



Effective bacteria | Fungus alone (Control)

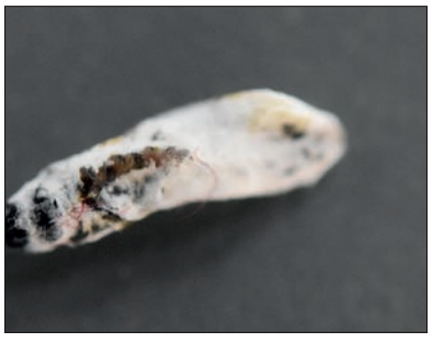
In vitro* effect of chitinolytic bacteria against *Macrophomina phaseolina

In vitro* efficacy of bacterial isolates against reniform nematode, *Rotylenchulus reniformis: About 12 chitinolytic bacterial isolates were tested for their *in vitro* efficacy against reniform nematode (*R. reniformis*). Four isolates *viz*., IC-RB2, IC-RB3, IC-RB8 and UN-RB1 were found promising and recorded more than 50% per cent mortality of nematode juveniles at 96 h after treatment.

Effectiveness of native isolates of entomopathogens against castor capsule borer, *Conogethes punctiferalis*: Among five native isolates of *Bacillus thuringiensis* var. *kurstaki* (DOR Bt-127, 145, 154, 171 and 172) evaluated against larvae of *C. punctiferalis*, Bt-154 and Bt-127 were effective and recorded lower LC_{50} values of 1.31 and 1.40 mg/ml as compared to 1.56 to 1.87 mg/ml in other isolates. Among entomopathogenic fungi evaluated against larvae and pupae, *Beauveria bassiana* was the most effective against both (LC_{50} of $5.9x10^4$ and $2.6x10^5$ conidia/ml, respectively) compared to *Metarhizium* (*Nomuraea*) *rileyi* (LC_{50} of $4.4 x10^5$ and $3.8x10^5$ conidia/ml, respectively).


Healthy larva


Bt infected larva


B. bassiana infected larva

Effectiveness of entomopathogens against larvae of *C. punctiferalis*


Healthy pupa


B. bassiana infected pupa


M. rileyi infected pupa

Effectiveness of entomopathogenic fungi against pupae of *C. punctiferalis*

Multi-location field testing of DOR Bt-127 SC formulation against lepidopteran pests in castor: Field trials were conducted during *kharif* 2021 to evaluate the efficacy of DOR Bt-127 SC formulation against major lepidopteran pests in castor at two locations *viz.*, Yethapur (Tamil Nadu) and SK Nagar (Gujarat) under AICRP on Castor. DOR Bt-127 SC formulation @ 3 ml/l was effective against semilooper (*Achaea janata*) and tobacco caterpillar (*Spodoptera litura*) and was superior to commercial *Btk* @ 1 g/l. Semilooper parasitization by *Snellenius maculipennis* was high in DOR Bt-127SC (18.6%) as compared to chemical insecticides sprayed plots (4.2-8.4%). Higher seed yields, net returns and benefit-cost ratios were recorded with DOR Bt-127 SC (1452-2125 kg/ha; Rs. 51560-60357/ha and 1.31-2.82) as compared to commercial Btk (1374-2070 kg/ha; Rs. 47270-56491/ha and 1.20-2.67).

Multi-location field testing of DOR Bt-127 SC formulation against lepidopteran pests in groundnut: Field trials were conducted to evaluate the efficacy of DOR Bt-127 SC formulation against major lepidopteran pests in groundnut at five locations *viz.*, Latur (Maharashtra), Vriddhachalam (Tamil Nadu), Raichur (Karnataka), Dharwad (Karnataka) and Junagadh (Gujarat) under AICRP on Groundnut during *kharif* 2021. Spraying of DOR Bt-127 SC @ 3 ml/l was effective against lepidopteran pests *viz.*, tobacco caterpillar (*Spodoptera litura*), semilooper (*Thysanoplusia orichalcea*), pod borer (*Helicoverpa armigera*) and leafminer (*Aproaerema modicella*) as compared to untreated control. There was no phytotoxicity observed in DOR Bt-127 SC formulation treated plots. Both the bio-control formulations (DOR Bt-127 SC formulation and commercial Btk) recorded higher number of predators (coccinellids, spiders and green lacewings) as compared to insecticides treated plots. At Vriddhachalam centre, application of DOR Bt-127 SC @ 3 ml/l treatment resulted in pod yield of 1270 kg/ha and comparable to commercial Btk (pod yield of 1380 kg/ha), while untreated control recorded pod yield of 1180 kg/ha.

Safety evaluation of microbial biocontrol agents to beneficial insects: Contact toxicity assays of Bt-127 SC and *Metarhizium rileyi* isolates on *Trichogramma pretiosum* (egg parasitoid of *Spodoptera litura*) revealed that the microbials were harmless (nil mortality) as compared to chemical insecticides (12.2-77.8% mortality). Contact and oral toxicity assays of Bt-127 SC and *M. rileyi* isolates on European honeybee (*Apis mellifera*) revealed that both the microbials were selective and safe (nil mortality) as compared to chemical insecticides (17.8-100% mortality).

Microbiome profiling of sesame phyllosphere and endosphere and its exploitation for suppression of phyllody disease (ICAR-NPDF Project): Phyllosphere and endosphere associated microbiome of healthy and phyllody diseased sesame cultivars were studied using culturable and metagenomics approaches. REP-PCR based genetic fingerprinting classified the total of 89 cultivable bacterial isolates into 72 strains at genus level. The 16S rRNA gene sequence analysis based identification revealed the genus *Pantoea* (39) was more prevalent in cultivable bacteria which was followed by *Pseudomonas* (8), *Kasakonia* (4), and *Klebsiella* (3). Other genera like *Sphingomonas*, *Stenotrophomonas*, *Xanthomonas*, *Ralstonia*, *Acidovorax*, and *Erwinia* were also found in the microbiome. All the 16S rRNA gene sequences of 72 strains were deposited in NCBI and GenBank number MZ501273 to MZ501345 were obtained. Comparative cultivable microbiome analysis of phyllosphere versus endosphere and healthy versus phyllody diseased leaf samples revealed bacterial diversity both at genus and species level and microbiomes were more diverse in phyllosphere/healthy cultivar when compared to endosphere/phyllody diseased sesame cultivar.

Microbiome profiling using mNGS sequencing of cultured phyllosphere microbiome yielded 1091 OTUs. At genus level, *Pantoea* followed by *Pseudomonas* were the dominant cultivable bacterial communities on the phyllosphere of healthy and diseased sesame. Similarly, total phyllosphere microbiome interrogation by mNGS yielded 1092 OTUs. At genus level, *Sphingomonas* followed by *Mucilagini bacter* were the bacterial communities that dominated the phyllosphere of healthy and diseased sesame. Endogenous microbiome analysis showed 945 OTUs. At genus level, *Pantoea* followed by *Pseudomonas* dominated the endosphere of healthy and diseased sesame leaf. The mNGS analysis revealed presence of phytoplasma in the endogenous regions of symptomatic samples and however, not in the healthy endosphere. A total of 12 metagenome data sets were submitted to GenBank and BioSample accessions (SAMN25949320 to SAMN25949331) were obtained.

The comparative validation of microbiome profiling using mNGS sequencing and culturomics revealed that there is abundance of genus *Pantoea* followed by *Pseudomonas* and *Sphingomonas* in both phyllosphere and endospheres of healthy and phyllody susceptible cultivars. Activity screening for *in vitro* PGP traits, revealed that 15 isolates showed potential for phosphorous solubilization, 19 isolates for potassium solubilization, 7 isolates for zinc solubilisation and 24 isolates for sideorophore production. In addition, *in vitro* antifungal efficacy revealed five isolates which could effectively inhibit mycelial growth of sesame root rot pathogen (*M. phaseolina*).

Bioploymers and Bioagents

A tailor-made biopolymer possesses network properties, which provide favourable microenvironment for entrapment/impregnation of inputs for soil, aerial and seed application and also helps in controlled/slow release of the inputs. Biopolymers also improve the distribution and adherence of agrochemicals which leads to improved seed viability and vigour, reduced incidence of pests and diseases and enhanced seed yield. In this context, combined biopolymer and *Trichoderma* were formulated and evaluated for their efficacy against major diseases in different oilseed crops. Attempts have also been made to standardize multilayer seed coating using biopolymers for biotic stress mitigation in oilseed crops.

Management of wilt and root rot incidence in safflower using biopolymer based *Trichoderma* formulations under field conditions: Effect of seed coating with biopolymer based *Trichoderma* formulations along with chemical fungicides was evaluated on seed germination and disease incidence in safflower under field conditions. Seed coating with biopolymer chitosan +*T. harzianum* Th4d and biopolymer cellulose+ *T. harzianum*, Th4d liquid formulation treatments significantly improved seed germination in safflower and recorded low wilt and root rot incidence compared to other treatments. Biopolymer chitosan+*T. harzianum* Th4d treatment recorded significantly low wilt (5.5%) and root rot incidence (2.0%) compared to fungicide (wilt incidence-11.2% and root rot-6.0%) and untreated control (wilt incidence-16.9% and root rot-15.0%). The seed yield recorded was also high (735 kg/ha) in the same treatment compared to a low seed yield of 392 kg/ha in control.

Effect of biopolymer (cellulose/chitosan) based *Trichoderma* liquid formulations on germination, wilt and root rot incidence in safflower

Treatments	Germination (%)*	Wilt incidence (%)*	*Macrophomina* root rot incidence (%)*	Seed yield (kg/ha)
Biopolymer cellulose+*T. harzianum* Th4d @ 10 ml/kg seed	75.5 (60.3)	8.4 (16.8)	4.0 (11.5)	728
Biopolymer chitosan+*T. harzianum* Th4d @ 10 ml/kg seed	79.0 (62.7)	5.5 (13.5)	2.0 (8.1)	735
Carboxin 37.5%+Thiram 37.5% DS @ 2 g/kg	74.2 (59.4)	11.2 (19.5)	6.0 (14.1)	688
T. harzianum Th4d WP 10 g/kg	70.1 (56.8)	9.7 (18.1)	5.0 (12.9)	650
Control	58.3 (49.7)	16.9 (24.2)	15.0 (22.7)	392
CD ($p<0.05$)	6.6	3.4	2.1	59.0
CV (%)	11.1	15.1	16.3	18.5

*Values in parentheses are angular transformations

Effect of biopolymer based seed treatment on disease incidence and yield in groundnut crop under field conditions: Seed treatment with biopolymer cellulose+*T. harzianum,* Th4d @ 10 ml/kg seed significantly improved germination (90.0%) and recorded higher pod yield (2900 kg/ha). Biopolymer chitosan+*T. harzianum* Th4d @ 10 ml/kg seed treatment recorded very low root rot incidence (4.6%) as compared to all other treatments.

Effect of biopolymers (chitosan/cellulose) based *Trichoderma* liquid formulations on seed germination, root rot/collar rot incidence and pod yield in groundnut

Treatments	Germination (%)*	Root rot incidence (%)*	Pod yield (kg/ha)
Biopolymer chitosan+*T. harzianum* Th4d @ 10 ml/kg seed	84.8 (67.1)	4.6 (12.4)	2887
Biopolymer cellulose+*T. harzianum* Th4d @ 10 ml/kg seed	90.0 (71.6)	5.7 (13.9)	2900
Carboxin 37.5%+Thiram 37.5% DS @ 2 g/kg	78.0 (62.0)	9.5 (18.0)	2475
T. harzianum Th4d WP @ 10 g/kg	70.6 (57.2)	6.7 (15.1)	2625
Control	61.2 (51.5)	17.5 (24.7)	1622
CD ($p<0.05$)	1.4 (6.8)	0.9 (5.4)	423
CV (%)	1.2 (6.3)	6.3 (14.5)	10.8

*Values in parentheses are angular transformations

Biopolymer cellulose + Th4d blend

Control

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

Multilocation field evaluation of biopolymer based *Trichoderma* liquid formulations on disease incidence and yield in soybean: Field trials were conducted at different locations *viz*., Adilabad, Amaravathi, Dharwad and Jabalpur to evaluate the effect of seed coating with biopolymer (cellulose/chitosan) based *Trichoderma* formulations against root rot incidence under AICRP on soybean. Seed treatment with biopolymer cellulose+*T. harzianum* Th4d significantly improved seed yield (1684 kg/ha) in field trials conducted at Amaravathi compared to control (1514 kg/ha). Chemical treatment with carboxin+Thiram recorded significantly less root rot incidence (3-11%) compared to control (11-30%) in all the locations.

Effect of biopolymers based *Trichoderma* liquid formulations as seed treatment on disease incidence and yield in soybean

Treatment details	Adilabad		Amaravathi		Dharwad		Jabalpur	
	Root rot (%)	Yield (kg/ha)	Root rot (%)	Yield (kg/ha)	Root rot (%)	Yield (kg/ha)	Root rot (%)	Yield (kg/ha)
Biopolymer chitosan+*T. harzianum* Th4d @ 10 ml/ kg seed	6.3	1450	8.4	1647	8.5	1550	4.5	1213
Biopolymer cellulose+*T. harzianum* Th4d @ 10 ml/ kg seed	11.6	1410	6.9	1684	7.5	1560	4.8	1200
Carboxin 37.5%+Thiram 37.5% DS @ 2 g/kg	5.0	1418	11.7	1514	7.5	1550	3.2	1260
Control	30.0	1225	19.5	1263	22.2	1325	10.9	771
CD ($p<0.05$)	-	259	4.1	NS	2.8	192	0.9	57

Shelf life of *Trichoderma* in chitosan biopolymer liquid formulation: Shelf life of Chitosan+*T. harzianum* Th4d formulation was assessed at room temperature (28 ^{0}C) and at 40 ^{0}C. Viability of spores in the formulation was determined for a period of 24 months from zero day at monthly intervals. Log CFU of *Trichoderma* spores in biopolymer based liquid formulation was 10.70 at zero day. The value showed slight decline to 10.0 by 6 months and then gradually declined from 10.0 to 7.0 by 24 months of storage at 28 ^{0}C and 6.48 by 12 months at 40 ^{0}C.

Multilayer seed coating in oilseeds for amelioration of biotic stresses: Compatibility of biopolymers, microbes and seed treatment agrochemicals as well as the standardization of multilayer seed coating was investigated under laboratory conditions. *Trichoderma* (Tador 7316, Th4d and Th) isolates were compatible with biopolymers (cellulose and chitosan), insecticides (thiamethoxam and imidacloprid) and fungicides (penflufen + trifloxystrobin, mancozeb, carboxin + thiram) while incompatibility was observed with chlorothalonil and tebuconazole. All bacterial bioagents (*Bradyrhizobium arachidis, B. japonicum* and *Bacillus subtilis*) were compatible with insecticides, fungicides and biopolymers. Out of 822 different multilayer combinations, initial 14, 24 double layered combinations and 33 checks (total 71) were evaluated against collar rot and stem rot, insect pests and other growth parameters. Of all, combinations (cellulose, fungicide and insecticide)+(cellulose, *Bradyrhizobium* and *Trichoderma*); (chitosan, *Bradyrhizobium* and *Trichoderma*)+(cellulose, fungicide and insecticide); (cellulose, fungicide and *Trichoderma*)+(chitosan, *Bradyrhizobium* and insecticide); (cellulose and fungicide)+(chitosan and insecticide)+(cellulose and *Trichoderma*)+(chitosan and *Bradyrhizobium*); (chitosan and *Bradyrhizobium*)+(cellulose and fungicide)+(cellulose and insecticide)+(cellulose and *Trichoderma*) were identified as promising for further experimentation and evaluation.

Untreated seed Multilayer coated seed

Population Dynamics of Insect Pests and Pollinators

Insect pest abundance and population dynamics are affected by abiotic and biotic stresses. Monitoring of pest populations and identification of prevailing insects helps farmers to achieve efficient control measures. Similarly, pollinators maintain a healthy ecosystem, ensure plant reproduction, and also increase yields. Hence, the population dynamics of insect pests and pollinators of sesame and linseed were studied.

Population dynamics and seasonal incidence of major and emerging pests of sesame: Major insect pests *viz.*, leaf webber and capsule borer (*Antigastra catalaunalis*), gall midge (*Asphondylia sesami*), and leafhopper (*Orosius albicinctus* and *Hishimonus phycitis*) and emerging insect pests *viz.*, mirid bugs, whiteflies, aphids and stink bug were recorded during *kharif* 2021. Percent leaf, flower and capsule damage of *A. catalaunalis* varied from 0.4 to 4.9, 0.0 to 28.5 and 0.0 to 14.1, respectively. Percent leaf, flower and capsule damage reached maximum during first fortnight of October (4.9%), second fortnight of October (28.5%) and first fortnight of October (14.1%), respectively. Leafhopper population reached highest during second fortnight of November (28.5/10 plants). Gall midge population reached maximum during second fortnight of October (27.8/10 plants).

Leaf webber and capsule borer (*Antigastra catalaunalis*) damage symptoms in sesame

Leafhopper species (*Orosius albicinctus* and *Hishimonus phycitis*) infesting sesame

Gall midge, *Asphondylia sesami* and its damage symptoms

The incidence of whitefly and mirid bug caused significant damage to the sesame crop. Whitefly was observed to suck the cell-sap from the lower surface of leaves and also in the tender leaves. Mirid bug was observed to suck the cell-sap from tender leaves, flowers, and capsules. Population (per 10 plants) of whiteflies and mirid bug ranged from 0 to 9.7 and 0.3 to 5.3, respectively. Population (per 10 plants) of whiteflies and mirid bug reached highest during second fortnight of November (9.7 and 5.3, respectively). Other insect pests such as aphids and stink bug also caused damage to sesame. Population (per 10 plants) of aphids and stink bug varied from 0 to 68.0 and 0 to 2.0, respectively.

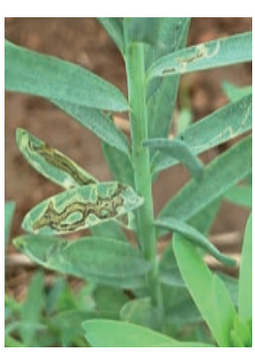
Mirid bug and damage symptoms

Aphids and damage symptoms

Stink bug and damage symptoms

Effect of different dates of sowing on dynamics of insect vectors and phyllody disease incidence in sesame: Insect vector population dynamics and phyllody incidence were assessed in three dates of sowing (second fortnight of July, September, 2020 and January, 2021) using 10 sesame genotypes (Chagatham local, Paiyur, RT 346, GT-G-30, GT-10, G-Til-10-P1-P5-P8, G-Til-10-P1-P5-P6, Swetha, SEL-S-2019-1016 and SEL-S2019-1019). Maximum phyllody incidence and leafhopper population were recorded in July sown crop. Among genotypes, SEL-S-2019-1019, GT-G-30, GT-10 and GT-10-P1-P5-P6 recorded <20% phyllody incidence. The peak incidence of leafhopper (*Orosius albicinctus*) population occurred during 30 to 60 days after sowing (DAS) and then decreased. The leafhopper population among genotypes ranged from 0.2 (GT-10) to 1.4 leafhoppers/3 leaves/plant (Paiyur). Positive correlation (r = 0.06 to 0.51) was observed between leafhopper population at 15, 30 and 45 DAS and phyllody incidence at 47 and 66 DAS.

Population dynamics and seasonal incidence of major and emerging pests of linseed: Incidence of leaf miner, bud fly, tobacco caterpillar, gram pod borer, whitefly, leafhopper, stink bug, mirid bug, pumpkin beetle, flea beetle, looper and tussock caterpillar were recorded on linseed during *rabi* 2020-21. Percent incidence and population (per 10 plants) of leaf miner varied from 43.2 to 69.7 and 0 to 2.8, respectively. Percent incidence and population (per 10 plants) of leaf miner reached highest during first week of February (69.7), first week of January (2.8), respectively. Populations (per 10 plants) of whitefly, leafhopper, stink bug and mirid bug reached maximum during first week of January (22.2), last week of January (13.6), first week of January (2.6) and last week of February (2.2), respectively. Bud fly population (per 10 plants) varied between 0 to 2.2 and reached maximum during second week of February (2.2). Tobacco caterpillar (*Spodoptera litura*) population reached maximum during third week of January (2.0 per 10 plants). Population (per 10 plants) of gram pod borer (*Helicoverpa armigera*) ranged from 0 to 2.6 and reached highest during third week of January (2.6). Other insect pests such as pumpkin beetle, flea beetle, looper and tussock caterpillar also caused damage to linseed.



Leaf miner

Leafhopper

Stink bug

Gram pod borer

Tobacco caterpillar

Incidence of insect pests in linseed

Insect pollinators of oilseed crops: A total of seven insect species (six hymenopterans and one dipteran) visited the niger flowers. Among the various insect flower visitors, *Apis cerana*, *A. florea*, *A. dorsata*, *Tetragonula iridipennis*, *Syrphus* sp. were nectar and pollen collectors. *Nomia* sp. and *Xylocopa tenuiscapa* were nectar and pollen collectors, respectively. In sesame, two insect species (*A. dorsata* and *X. tenuiscapa*) visited the sesame flowers.

Major insect flower visitors and pollinators observed in oilseed crops

Insect pollinators	Family	Order	Collections	Crops visited
Apis cerana indica	Apidae	Hymenoptera	Nectar and pollen	Niger
Tetragonula iridipennis	Apidae	Hymenoptera	Nectar and pollen	Niger, sunflower
Nomia sp.	Halictidae	Hymenoptera	Nectar	Niger
Xylocopa tenuiscopa	Xylocopidae	Hymenoptera	Pollen	Sesame, safflower, niger
Apis florae	Apidae	Hymenoptera	Nectar and pollen	Niger
Apis dorsata	Apidae	Hymenoptera	Nectar and pollen	Sesame, safflower, niger
Syrphus sp.	Syrphidae	Diptera	Nectar and pollen	Safflower, niger

A. dorsata

A. florea

A. cerana indica

T. iridipennis

A. florea

T. iridipennis

A. dorsata

Major insect flower visitors and pollinators of oilseed crops

Management of Stored Grain Pests

Oilseeds are rich in proteins and fats and hence, are vulnerable to stored product insect pest infestation. Insect pests infesting stored grains can result in significant losses, deterioration, and price reductions, as well as grain rejection by buyers. Effective management of stored grain pests necessitates an IPM approach combining sanitation, identification, monitoring, and preventive actions. Survey and identification of insect pests infesting sesame under storage, as well as management of these pests using non-chemical and chemical approaches were investigated due to their export value.

Survey and identification of insect pests infesting sesame under storage: Survey and surveillance of storage insect pests of sesame was carried out in two districts each of Telangana and Madhya Pradesh states. The survey indicated the prevalence of six insect species *viz*., red flour beetle (*Tribolium castaneum*), rice moth (*Corcyra cephalonica*), Indian meal moth (*Plodia interpunctella*), Angoumois grain moth (*Sitotroga cerealella*), cigarette beetle (*Lasioderma serricorne*), tropical warehouse moth (*Ephestia cautella*) and one mite species was observed on sesame under storage conditions. Among them, rice moth and red flour beetle were the most dominant species in both the states.

Rice moth infestation in stored sesame

Red flour beetle infestation in stored sesame

Major insect pests infesting sesame under storage conditions

Management of storage insect pests of sesame through hermetic storage: Four storage bags *viz*., double layered polythene (DLP) bag, high density polyethylene (HDPE) bag, jute gunny bag and cloth bag were evaluated alone and in combination with botanical treatment (sweet flag rhizome powder @ 10 g/kg seed) against rice moth and red flour beetle under storage conditions. In each bag, 50 eggs of rice moth and 50 adults of red flour beetle were released separately. Among the treatments evaluated against rice moth, sesame seeds stored in HDPE bag+sweet flag rhizome powder and HDPE bag recorded significantly low seed damage (4.2-4.8%) as compared to the damage (48.1-50.4%) in sesame stored in cloth and jute gunny bags at 6 months after treatment. HDPE bag + sweet flag rhizome powder and HDPE bag were also found effective against red flour beetle and recorded significantly low seed damage (4.1-4.8%) at 6 months after treatment as compared to the damage (14.4-16.4%) in cloth and jute gunny bags.

HDPE bag

Jute gunny bag

Cloth bag

Infestation of rice moth in sesame stored in different bags

Evaluation of botanical and newer chemical insecticides against storage insect pests of sesame: Among different botanical and newer chemical insecticides evaluated, sesame seeds treated with sweet flag rhizome powder @ 10 g/kg and spinosad @ 0.3 ml/ kg seed recorded significantly lower seed damage due to rice moth (4.9-6.1%) and red flour beetle (8.5-11.7%) as compared to untreated control (19.2-65% seed damage) at 6 months after storage.

Social Sciences

The main focus of the social sciences has been knowledge management, value chain intervention and outreach activities for promoting the improved technologies to the oilseed farmers. Progress made in key areas including development of statistical models to predict yield responses to climate change in castor, development of knowledge management portal of castor, impact assessment of castor hybrid (GCH-7) technology in Gujarat, development of digital image repository system on oilseeds pests and diseases through image analysis and artificial intelligence, frontline demonstrations (FLDs) on oilseeds, formation and promotion of farmer producer organizations (FPOs) and improving farm level profitability and income under the Farmer FIRST Programme are described.

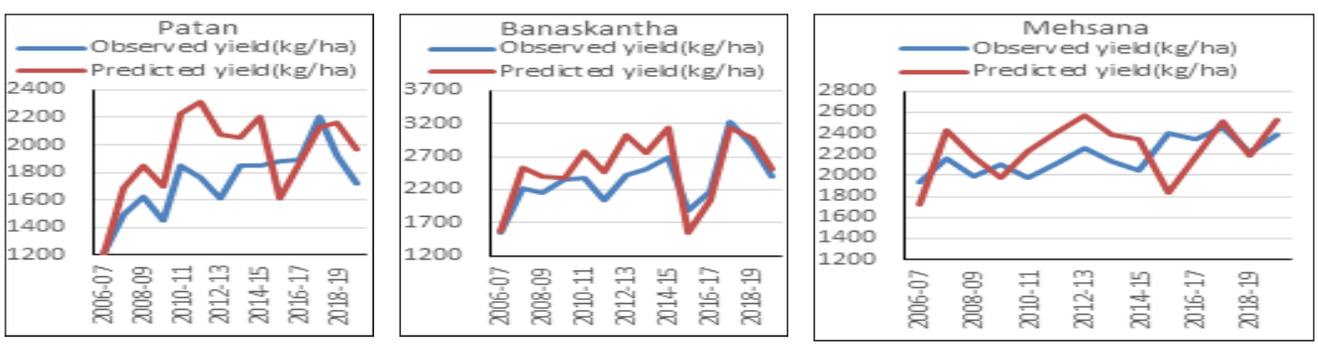
Development of Prediction Models

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

Prediction models namely Least Absolute Shrinkage Selector Operator (LASSO) and Artificial Neural Networks (ANN) were used to predict the yield response to climate change in castor in the major districts (Mehsana, Banaskantha and Patan) of Gujarat. Weather indices and composite weather variable models were fitted to the yield data with weather parameters, which included maximum temperature, minimum temperature, rainfall, RH1 and RH2. Weather parameters of the aforesaid districts revealed cyclic variation with a significant increase over the years. District-wise average seasonal rainfall and temperature showed significant positive trend across seasons. The positive correlation between yield and weather parameters was significant. In Patan and Mehsana districts, ANN was found to be the best fitted model while in Banaskantha district, LASSO regression was the best fitted model based on the evaluation parameters (root mean square error (RMSE), mean squared error (MSE), mean absolute percentage error (MAPE) and R^2). The predicted yield of respective districts based on the best fitted models along with observed yield revealed that there was good agreement with minimal error between observed and predicted yields.

Best fitted models for prediction of castor yield

District	Model	R^2
Patan	Yield = -4690 + 96.32* Max.Temp + 13.56* rainfall + 25.31* RH1	0.76
Banaskantha	Yield = 2131 + 2.63* Max.Temp + 1.75* Min.Temp + 5.61* RH1 + 8.37*Rainfall	0.86
Mehsana	Yield = -11511 + 96.59* Max.Temp + 3.88* Min.Temp + 56.29* RH2	0.78

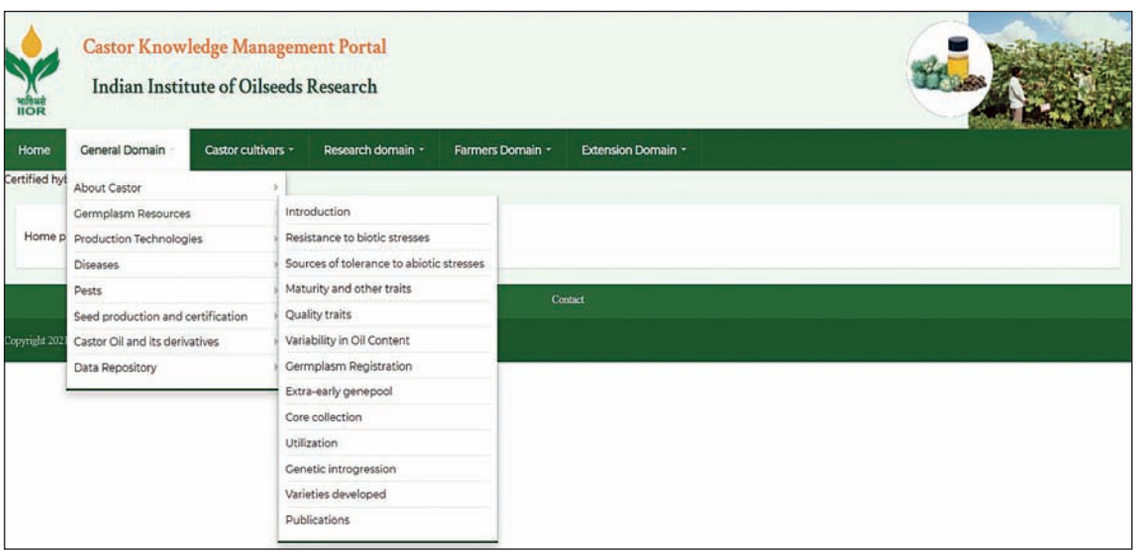


Observed vs predicted yield of castor (kg/ha)

Knowledge Management and Dissemination

Castor Knowledge Management Portal

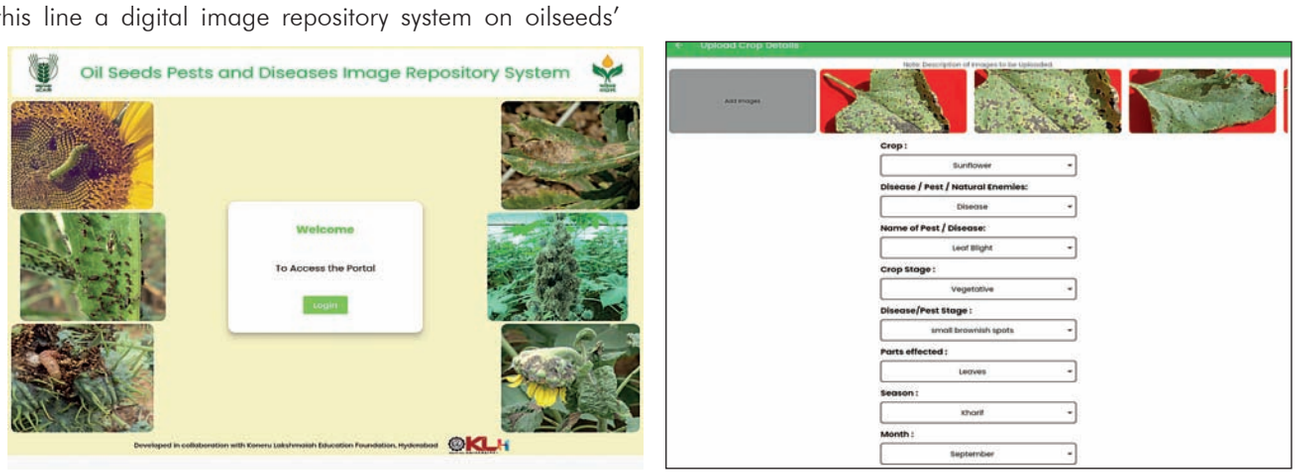
A dynamic castor knowledge management portal was developed with five major themes *viz.*, general domain, cultivars, research domain, farmers' domain, service domain and extension domain. The 'general domain' provides information about the crop, agronomic practices, genetic resources, seed production technologies, pests and diseases and uses of castor. The 'cultivars domain' provides information pertaining to the varieties and hybrids including duration of the crop, average seed yield, oil content and any other specific traits related to the cultivars along with the state-wise recommendations. The 'research domain' provides information on research carried out in breeding, drought resistance, physiological parameters, AICRP centres and directory of oilseed research organizations. The 'farmers' domain' provides information on different government schemes. The 'service domain' provides information on the market prices from major APMCs of trading castor in major growing states and trade knowhow. The 'extension domain' provides information relevant to the extension activities like POPs, contingency plans, FAQs, and FLDs. The portal is useful for castor workers, researchers, academicians, farmers, students, extension workers and NGOs. Information on the portal is updated regularly.



Castor knowledge management portal

Oilseeds Pests and Disease Image Repository System (OPDIRS)

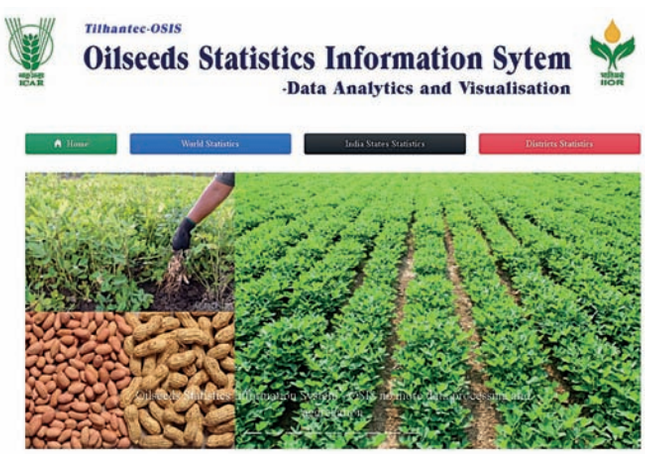
ICAR-IIOR has taken up an initiative to develop a repository of good quality photographs of pests and diseases of oilseed crops for providing identification services. In this line a digital image repository system on oilseeds' pests and diseases was created in collaboration with Koneru Lakshmaiah Education Foundation, Hyderabad. It facilitates pathology and entomology researchers from various parts of India to contribute photographs to the repository remotely through online.

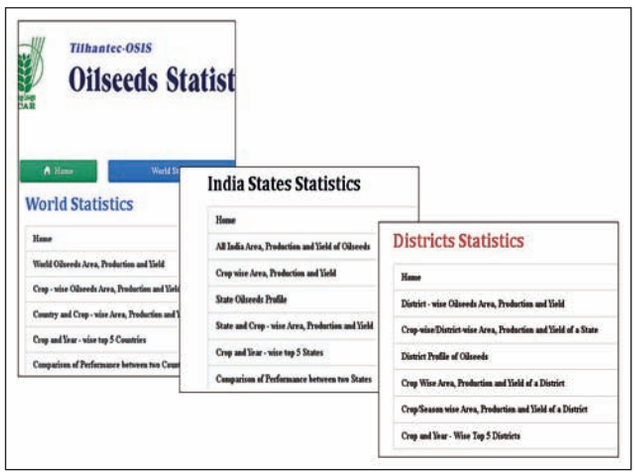


Oilseeds Pests and Disease Image Repository System

Oilseeds Statistics Information System (TilhanTec:OSIS)

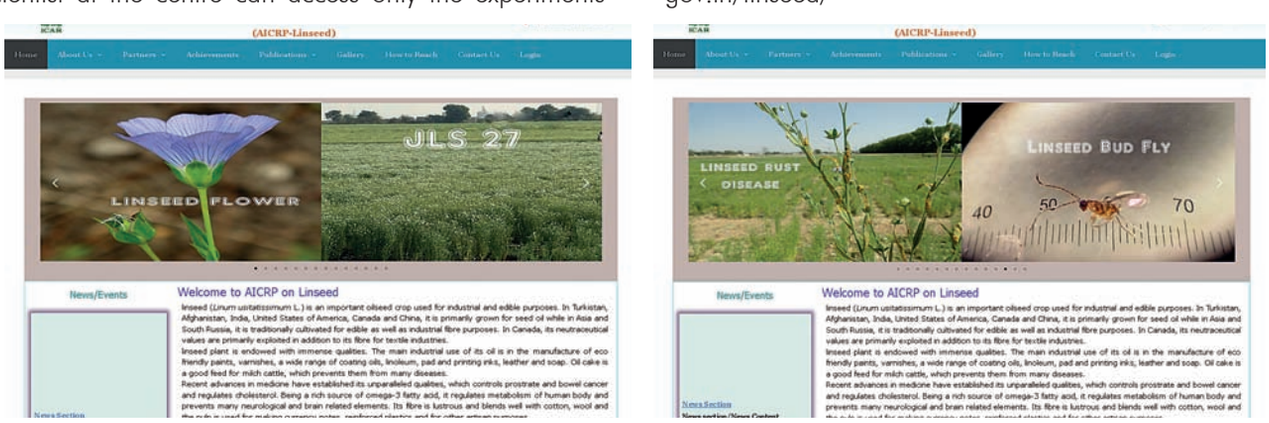
An interactive Oilseeds Statistical Information System (OSIS) was developed by ICAR-IIOR in collaboration with Koneru Lakshmaiah Education Foundation, Hyderabad. The OSIS has been developed using time series data on nine oilseed crops *viz.*, groundnut, soybean, rapeseed and mustard, sesame, castor, sunflower, safflower, linseed and niger. The OSIS provides a comprehensive multi-dimensional analytics and visualisation. Using OSIS one can search and fetch global/national/state/district level information on area, production and yield of nine oilseed crops in various dimensions. Based on the query, tables and graphs will be generated. The tables can readily be downloaded in excel. The interactive graphs generated can be zoomed in and out for better understanding and can be downloaded. The information system can be accessed through the ICAR-IIOR website: https://icar-iior.org.in/tilhantec-osis-comprehensive-oilseeds-data-solution.





AICRP (Linseed) information system

The AICRP (Linseed) information system was launched by Dr. T. R. Sharma, DDG (CS), ICAR through virtual mode on August 18, 2021. The information system was developed in collaboration with the KRISHI portal team of ICAR-IASRI, New Delhi. The information system helps in complete automation of experiments conducted under the AICRP system. The system has been developed in a three tier hierarchy and role-based access of the content. The group head or Director/PI can access the complete information system. The experiment in-charge or Co-PIs of the different disciplines can access the experiments co-ordinated by them and the experimenter or Individual scientist at the centre can access only the experiments handled by them. The Co-PI creates the experiments, randomization layouts and excel data sheets at the initiation of the experiment. These layouts and excel sheets can be remotely downloaded and uploaded by individual centres conducting the experiments through their login ID and passwords. The PI and Co-PIs can monitor the entire experimental system of AICRP. After receiving the data sheets of different experiments from the centres, the statistical analysis and report preparation can also be done automatically by the module developed for the purpose, which saves time in report preparation. The information system can be accessed at https://aicrp.icar.gov.in/linseed/



Home page of AICRP (Linseed) information system

Impact Assessment of Oilseed Technologies

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

Primary data were collected from 60 farmers in five villages across three tehsils (Tarad, Vadgam and Palanpur) of Banaskantha district of Gujarat to examine the relative profitability of castor hybrid (GCH-7) *vis-a-vis* other competing crops in the district. It was observed that diversification is perpetual at the farm level wherein the risk is absorbed. The average productivity of castor was observed as 24.9 q/ha (range: 21.2-29.2 q/ha) with net returns over operational costs being Rs. 62,862/ha and a B:C ratio of 2.7. The competing crops revealed net returns over operational costs varying from Rs.21,226/ha in green gram to as high as Rs. 1,29,990/ha in potato. Variation in the net returns is attributed to the duration of the crop and also to the market and non-market forces in operation. Castor crop in Gujarat is cultivated from late *kharif* (late July-mid August) to April occupying almost 240-270 days. A gradual shift of moving away from castor to take up two crops or more for increased farm income is evident from the last two years as per the opinion survey of the respondent farmers and also signals in shrinkage of area in the district. Shrinkage of area in the high area districts in the country would affect the export earnings from castor. This suggests that future research programmme to sustain castor needs to orient towards developing high yielding cultivars of not less than 4.5 t/ha, given the present duration or to evolve cultivars capable of yielding not less than 2.5 tonnes for a duration of not exceeding 150-180 days. This could enable for trade off in the net profits realised by the farmers and prevent shrinkage of the area under castor.

Economics of castor (GCH-7) and competing crops in Banaskantha district of Gujarat

Crop	Productivity (q/ha)	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Profitability ratio
Castor	24.9	99,953	37,091	62,862	2.7
Mustard	15.9	61,750	31,250	30,500	2.0
Fennel	13.0	1,36,815	41,200	95,615	3.3
Cumin	8.6	95,394	41,865	53,529	2.3
Bajra	24.6	50,882	27,850	23,032	1.8
Groundnut	18.7	90,375	39,870	50,505	2.3
Sesame	6.8	65,980	17,286	48,694	3.8
Wheat	36.8	71,960	37,964	33,996	1.9
Sorghum	12.5	43,131	18,504	24,627	2.3
Potato	210.7	2,13,279	83,289	1,29,990	2.6
Greengram	7.2	41,361	20,135	21,226	2.0

Analysis of Yield Gaps

Analysis of yield gaps and developing suitable extension strategy for reducing yield gaps in sunflower and sesame

District-wise data on area, production and productivity of sunflower and sesame for 10 years (2008-2018) were collected and Relative Spread Index (RSI) and Relative Yield Index (RYI) were estimated. Based on the RSI and RYI values, the districts were categorised into four groups: the most efficient, moderately efficient, efficient and inefficient in order to formulate extension strategies for each category of districts based on the field level data and yield gaps observed in FLDs.

Number of districts identified for sunflower and sesame under different categories

Categorization	Sunflower	Sesame
Most efficient districts	15	26
Efficient districts	121	52
Moderately efficient districts	29	52
Inefficient districts	27	202

Collection, review, standardization, pre-testing and validating the knowledge test were done for measuring the knowledge level of farmers on sunflower and sesame cultivation. An inventory of technologies for measuring adoption index was developed and will be incorporated into a structured interview schedule for pre-testing and field level data collection.

Demonstrations of Oilseed Technologies

Frontline demonstrations (FLDs) on oilseeds

A total of 7875 FLDs on nine oilseed crops and oilseeds based farming systems were conducted during 2021 with 98.2% implementation rate in order to show the productivity potential and profitability of improved technologies. A total of 4195 FLDs were conducted during *rabi*/summer and 3680 FLDs during *kharif* season. The FLDs were coordinated and organized by various oilseed institutes, Directorates and AICRPs and their centres.

Season-wise allotment and conduct of FLDs on oilseeds and oilseeds-based farming systems during 2021

Crop	No. of FLDs allotted			No. of FLDs conducted		
	Kharif	*Rabi*	Total	*Kharif*	*Rabi*	Total
Soybean	2000	-	2000	2000	-	2000
Castor	700	60	760	670	50	720
Sunflower	60	600	660	30	630	660
Linseed	-	500	500	-	500	500
Niger	200	-	200	200	-	200
Niger (ICAR-IIOR)	52	-	52	50	-	50
Groundnut	300	200	500	300	200	500
Rapeseed and Mustard	-	2200	2200	-	2200	2200
Safflower	-	300	300	-	300	300
Sesame	500	200	700	400	200	600
Sesame (ICAR-IIOR)	-	90	-	-	90	90
ICAR-IIFSR	30	25	55	30	25	55
Total	3842	4175	8017	3680	4195	7875

FLDs conducted by ICAR-IIOR

A total of 494 FLDs on castor, sunflower, sesame and niger were conducted successfully during *rabi*/summer and *kharif* seasons in collaboration with different NGOs and State Departments of Agriculture (SDA).

FLDs conducted by ICAR-IIOR during *rabi* 2020-21 and *kharif* 2021

Crop	Season	FLDs allotted (No.)	Vitiated	Conducted successfully
Castor	*Rabi*	50	-	50
	Kharif	65	15	50*
Sunflower	*Rabi*	200	-	200
	Kharif	25	25	-
Sesame	Summer	125	06	119
	Kharif	75	50	25
Niger	*Kharif*	50	-	50
Total		**590**	**96**	**494**

*40 FLDs laid out during *rabi* 2020-21

FLDs conducted during *rabi* 2020-21

Castor: In order to promote *rabi* castor in Telangana, 50 FLDs were conducted in Pullur village, Undavelli mandal of Mahabubnagar district. The demonstrations were conducted with ICH-66 and DCH-519 *vis-a-vis* farmers'

practice (GCH-4 and PCH-111). ICH-66 performed better than GCH-4 and PCH-111 and the seed yield increased by 29 and 28%, while DCH-519 revealed 8.7% seed yield superiority over GCH-4. The additional net returns (ANR) ranged from Rs. 7,400/ha to Rs. 21,400/ha with improved hybrids compared to hybrids used by farmers.

Productivity potential and profitability of castor hybrids during *rabi* 2020-21

Technology in IT vs farmers' practice	FLDs (No.)	Mean seed yield (kg/ha)		% increase in seed yield over FP	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		ANR (Rs./ha)	BCR	
		IT	FP		IT	FP	IT	FP		IT	FP
ICH-66 vs GCH-4	20	2450	1900	28.9	28,500	27,900	98,000	76,000	21,400	3.4	2.7
ICH-66 vs PCH-111	10	2500	2300	8.7	28,000	27,400	1,00,000	92,000	7,400	3.6	3.4
DCH-519 vs GCH-4	20	2500	1950	28.2	28,000	27,000	1,00,000	78,000	21,000	3.6	2.9
Total/mean	**50**	**2480**	**2000**	**24.0**	**28,200**	**27,440**	**99,200**	**80,000**	**18,440**	**3.5**	**3.0**

IT-Improved technology; FP-Farmers' practice; BCR-Benefit cost ratio

Demonstration of ICH-66 at Pullur village, Mahabubnagar, Telangana

Sunflower: Two hundred FLDs on sunflower were conducted during *rabi* 2020-21 in Nizamabad, Khammam and Warangal districts of Telangana State. In Nizamabad district, FLDs on component technologies such as soil application of sulphur, foliar spray of boron, need based pest management and zero tillage were conducted in Hegdoli village. The details of the productivity potential and profitability are presented below.

Productivity potential and profitability of component technologies in sunflower

Technology demonstrated /location	FLDs (No.)	Mean seed yield (kg/ha)		% increase in seed yield over FP	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		ANR (Rs./ha)	BCR	
		IT	FP		IT	FP	IT	FP		IT	FP
Nizamabad											
Soil application of S (25 kg/ha)	50	2500	2160	15.7	28,900	27,500	1,62,500	1,42,333	22,250	5.6	4.1
Foliar spray of B (0.2%)	50	2213	1775	25.1	29,548	28,200	1,43,738	1,15,258	29,112	4.9	3.8
Pest management*	25	2250	1900	18.6	29,000	27,800	1,47,542	1,24,778	23,162	5.5	4.6
Zero tillage	25	2100	1800	16.3	26,750	27,500	1,35,658	1,17,750	18,195	4.9	4.2

Technology demonstrated /location	FLDs (No.)	Mean seed yield (kg/ha)		% increase in seed yield over FP	Cost of cultivation (Rs./ha)		Gross monetary returns (Rs./ha)		ANR (Rs./ha)	BCR	
		IT	FP		IT	FP	IT	FP		IT	FP
Optimum spacing (30 cm x 15 cm)											
Warangal	25	2090	1850	13.0	24,600	25,500	1,29,580	1,14,700	15,780	5.3	4.5
Khammam	25	1600	1400	14.3	22,300	22,800	89,600	78,400	11,700	4.0	3.4
Total/Mean	200	2183	1856	17.6	27,293	27,025	1,39,357	1,18,851	20,238	5.1	4.4

IT-Improved technology; FP-Farmers' practice; BC-Benefit cost ratio; *Seed treatment with imidacloprid 70 WS @ 5 g/kg seed and foliar spray of Profenofos 50 EC @ 1 ml/litre

Soil application of elemental sulphur @ 25 kg/ha resulted in mean seed yield of 2500 kg/ha with higher yield of 15.7% over farmers' practice resulting in additional net returns of Rs. 22,250/ha with B:C ratio of 5.62. Foliar application of boron @ 0.2% during ray floret opening stage resulted in 25% higher seed yield (2213 kg/ha) *vis-à-vis* farmers' practice (1775 kg/ha). Need based management of sucking pests and *Helicoverpa* resulted in 18.6% higher seed yield as compared to farmers' practice. Although the cost of cultivation increased by Rs. 1,200/ha, the ANR accrued was Rs. 23,162/ha. Sunflower under zero tillage after paddy performed better with mean seed yield of 2,100 kg/ha with lower cost of cultivation compared to farmers' practice of conventional tillage. In Warangal and Khammam districts, maintaining optimum spacing in sunflower resulted in 13 and 14.3% higher seed yield, respectively as compared to farmers' practice of maintaining higher plant population.

FLD on foliar spray of boron in sunflower at Hegdoli village, Telangana

FLD on optimum spacing at Kothapalem village, Telangana

FLD on optimum spacing at Mamnoor village, Telangana

Sesame: A total of 125 FLDs were taken up in Adilabad, Nizamabad, Kamareddy, Mahabubnagar and Prakasam districts of Telangana and Andhra Pradesh in Paddy–Fallow and Paddy–Sesame cropping systems in collaboration with Viksith Ryhtu Seva Sangam (VRSS), Research in Environment, Education and Development Society (REEDS) and the State Department of Agriculture. A total of 119 demonstrations were conducted successfully while six demonstrations were vitiated due to severe moisture stress in Mahabubnagar district. Seed yield in the demonstrations ranged from 550 kg/ha to 1050 kg/ha with a mean of 741 kg/ha. The gross returns accrued to farmers ranged from Rs. 33,611/ha to Rs. 78,750/ha with a mean of Rs. 52,730/ha and the net returns ranged from Rs. 17,878 to Rs. 62,250/ha with a mean of Rs. 35,832/ha. The BCR ranged from 2.1 to 4.8 with a mean of 3.6 indicating the profitability of sesame after paddy crop.

Productivity potential and profitability of improved technologies of sesame during summer 2020-21

Organization	District	Village	Situation	FLDs (No.)		Yield (kg/ha)	CoC (Rs./ha)	GMR (Rs./ha)	NR (Rs./ha)	BCR
				C	V					
VRSS	Adilabad	Malkapur	Paddy-fallow	25	-	550	12750	41250	28500	3.2
IIOR	Nizamabad	Chepur	Paddy-sesame	22	-	1050	16500	78750	62250	4.8
	Kamareddy	Mothe		3	-	1000	18100	75000	56900	4.1
	Mahabubnagar	Lankala	Paddy-fallow	25	6	700	14000	52500	38500	3.7
REEDS	Prakasam	Thamballpalle		50	-	560	15733	33611	17878	2.1
Total/Mean				**125**	**06**	**741**	**16897**	**52730**	**35832**	**3.6**

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

FLD on sesame after paddy in Chepur village, Nizamabad, Telangana

FLDs conducted during *kharif* 2021

Castor: Sixty five FLDs were planned during *kharif* 2021, but only 25 FLDs could be sown due to farmers' reluctance to grow castor during *kharif* season. Out of these, 15 FLDs on Bt SC formulation were vitiated as the Bt could not be sprayed due to COVID restrictions and continuous heavy rains. The results of 10 FLDs conducted at Patherched village, Narwa mandal, Mahabubnagar district are presented here. The mean seed yield of castor was 850 kg/ha with ICH-66, improved technologies (IT) whereas, it was 700 kg/ha with GCH-4, farmer's practices (FP). The gross monetary return, additional net returns and BCR were higher in cultivation of ICH-66 (GMR: Rs. 34,850, AR: Rs. 6,450, BCR: 1.8) compared to GCH-4 (GMR: Rs. 28,700, BCR: 1.5).

Sesame: Seventy FLDs were planned in Ranga Reddy and Vikarabad district during *kharif* 2021 in collaboration with Grameen Mall Foundation (GMF) and VRSS; of which, 50 were successfully conducted and 25 were vitiated due to heavy and continuous rains. The seed yield was 500 kg/ha with GMR of Rs. 37,500; net returns of Rs. 24,600/ha and BCR of 2.91.

Niger: A total of 50 FLDs on niger were conducted in Vikarabad and Vishakapatnam districts of Telangana and Andhra Pradesh, respectively to popularize the crop and for area expansion. All the demonstrations were conducted with niger variety JNS-28. The crop was sown during the month of September. In Zaidupally, a rain shadow village in Telangana, farmers were able to harvest around 300 kg/ha. In Paderu of Andhra Pradesh, a predominantly tribal inhabited village, niger was grown on podu lands, where the seed yield recorded was 400 kg/ha. The harvested produce was not sold in the market as the farmers intended to use the same during the next season for seed.

FLD of niger variety JNS-28 at Paderu, Andhra Pradesh

Value Chain Intervention

Beekeeping in sunflower

To realize a complete value chain by strengthening the supply chain through bee keeping that resulted in increasing seed yield of sunflower besides additional monetary returns from honey yield, bee-keepers association was roped in towards introduction of apiary during 2020-21 in Hegdoli village wherein an area of 400 ha was under sunflower cultivation contiguously and more than 3000 ha was spread across the vicinity of villages. As much as 500 kg of pure sunflower honey was harvested in three weeks in the first batch. Observing the potential of the area, bee-keepers association expanded the apiary with 800 bee-hive boxes. Honey was extracted after three weeks and the bee-hives were shifted to an adjacent area, where sunflower crop was at flowering stage in an area of 400 ha and together harvested 5200 kg of honey from various sites. The entire honey was sold out on the spot with word-of-mouth popularity and spread supported by ICAR-IIOR. The on-site extracted pure honey was sold at a modest sale price of Rs. 300/ kg branded as 'Honey Natural' in PET bottles of 0.50 kg and 1.0 kg capacity. The gross income realized was Rs. 15.6 lakhs within a period of 2-3 months. The apiary was a win-win situation for sunflower farmers and the village level entrepreneurs, whereby farmers perceived that the yield of sunflower increased by 20% due to honey bee activity and provided a sustainable livelihood to the local entrepreneur.

Economics of beekeeping in sunflower field at Hegdoli village, Nizamabad

Particulars		Total
Expenditure/box (Rs./kg)	1250	Rs. 10,00,000
Honey yield/box (kg)	6 - 7	5200 kg
Sale price of honey (Rs./kg)	300	Rs. 15,60,000
Net income (Rs.)		Rs. 5,60,000

The fixed cost of each box was Rs. 7500/- which included the wooden box, comb, queen bee, workers bees, extractor and other required items; depreciation of 10% (Rs. 750/- per year) assuming the life of the box is for 10 years and maintenance cost of Rs. 500/- towards transportation, installation, honey extraction, three-stage physical filtration and bottling were considered for calculating the net income.

Honey bee boxes in sunflower field at Hegdoli village, Nizamabad, Telangana

Formation and Promotion of Farmer Producer Organizations (FPOs)

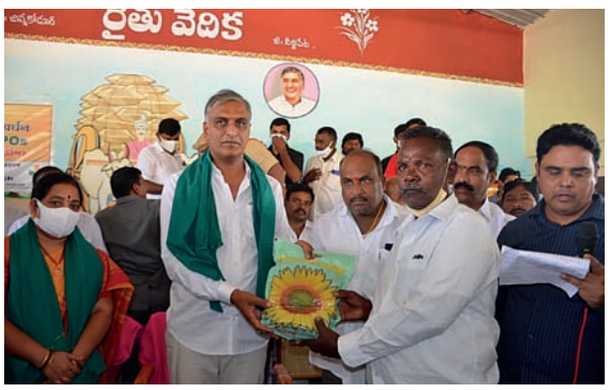
Two FPOs *viz.*, *"Chinnakodur Ryhtu Uthpathidarula Paraspara Sahaya Sahakara Sangam Limited"* and *"Sri Bugga Raja Rajeshwara Farmer Producer Mutually Aided Cooperative Society Limited"* were registered in two mandals *viz.*, Chinnakodur and Narayanraopet of Siddipet district, Telangana State under the Telangana Mutually Aided Cooperative Societies Act, 1995. These FPOs were formed as per the operational guidelines of the National Cooperative Development Corporation, New Delhi. Around 950 farmers have taken membership in the FPOs and adhoc committees have been formed for the FPOs. In order to diversify farmers from Paddy–Paddy

system, crop diversification with sunflower was taken up during *rabi* 2020-21 and around 1000 acres of sunflower was sown by the FPO members.

Aggregation of inputs (sunflower seed) during *rabi*

In order to encourage crop diversification, the FPOs were educated to take up sunflower crop during *rabi* season in the identified villages of Chinnakodur and Narayanraopet blocks. Accordingly, input aggregation (seeds) was done for 1000 acres and the seeds (Siri hybrid, Swathi, DRSH-1 and KBSH-78) were procured directly from seed companies, ICAR-IIOR or UAS, Bengaluru. The seeds were distributed to the members for timely sowing of the crop.

Training of farmers in beekeeping in oilseeds at Chinnakodur, Siddipet, Telangana



Distribution of sunflower seeds by Shri Harish Rao, Minister of Finance, Govt. of Telangana

Pre-season training on beekeeping in sunflower

A training programme on "Co-cultivation of honeybees in sunflower crop" was organized. Around 180 farmers, FPO directors, AEOs, local leaders and private seed company, 'Siri seeds' attended the programme. Awareness was created on the benefits of co-cultivation of honey bees in sunflower during *rabi* season. The scientists of ICAR-IIOR explained about the improved technologies for achieving higher yields in sunflower crop. An exhibition of various hybrids of sunflower was organized for the benefit of the farmers.

Farmer First Programme (FFP)

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

Under the Farmer First Programme, activities were undertaken in different modules towards improving the farm level profitability and income. A holistic approach was followed for implementing the farm level interventions.

Distribution of soil health cards: Twenty five soil health cards were distributed to 46 households in a tribal hamlet.

Interaction meeting and distribution of soil health cards on the World Soil Day

Contour cultivation/soil and moisture conservation in redgram: In redgram, soil and moisture conservation technologies (contour cultivation/ ridge and furrow method) led to 20.48% increase in the productivity resulting in additional net returns of Rs. 16,850/ha.

Use of bioinoculants as seed treatment: Seed treatment

with PSB, *Trichoderma* and *Rhizobium* was taken up in redgram, greengram, blackgram and groundnut under both *kharif* and *rabi* seasons.

Seed treatment with PSB and *Rhizobium* (NC 92 strain) in groundnut

Distribution PSB, *Trichoderma* and *Rhizobium*

Integrated nutrient management (INM): In groundnut, INM resulted in an average productivity of 14.3 q/ha as against the traditional practice (11.2 q/ha). The additional net returns accrued were Rs. 18,437/ha. Seed treatment in greengram with PSB, *Rhizobium* and *Trichoderma* coupled with soil test based fertilizer application led to increase in productivity by 31.43% providing additional net returns of Rs. 16,076/ha.

Crop diversification: During *zaid* 2020-21, cultivation of sorghum towards diversification resulted in an average productivity of 12.3 q/ha with gross monetary returns of Rs. 21,998/ha. Cultivation of paddy variety KNM 118 with technology assemblage led to productivity enhancement of 11.3%. Technology assemblage in greengram–castor cropping sequence (2020-21) realized system net returns of Rs. 19,251/ha.

Technology assemblage towards crop diversification and higher productivity

Nutrition through vegetable seed kits: Vegetable seed kits were distributed to 100 households with the intention of enhancing their health and nutrition status. Eleven types of vegetable seeds including green leafy vegetables were included in the kit.

Marketing and value addition: With the objective of doubling farmers' income, pilot studies on marketing and value addition were initiated.

- Locally processed *tur dal*: (6 households/8 q): Value addition from red gram to dal enabled additional net returns of Rs. 4,650/q
- Paddy to rice: (2 households /10 q): Processing paddy to rice enabled additional net returns of Rs. 2,950/q
- Groundnut pods to kernel: (1 household/3 q): Conversion of groundnut pods to kernel led to an additional income of Rs. 2,850/q

Capacity building/training programmes: Capacity building/training programmes/interaction meetings on importance of value addition for increasing income; use of bio inoculants as seed treatment; health and nutrition; importance of micro nutrients across crops; soil and moisture conservation; importance of input-output marketing were conducted.

Capacity building/training programmes under Farmer First Programme

AICRP on Oilseeds
(Castor, Sunflower, Safflower and Linseed)

Significant achievements made under AICRP on oilseeds are furnished here under:

Castor

- A total of 26 new monoecious lines (12 from Junagadh and 14 from S.K. Nagar) were isolated from advanced generation.
- Two new pistillate lines (SKP-125 and SKP-126) were isolated from advanced generations at S.K. Nagar.
- Forty-two promising selections were made from the genepool for gray mold resistance at Ananthapuramu (2), Bengaluru (5) and Palem (35) centres.
- Out of 69 new inbred lines evaluated in the preliminary trial at four centres, three inbred lines JI-502 (3401 kg/ha) at Junagadh, SKI-463 (2938 kg/ha at 150 DAS), SKI-466 (2662 kg/ha at 150 DAS) at SK Nagar were identified with 19%, 65% and 45% higher seed yield than the check variety, GC-3 (2853 kg/ha) under irrigated conditions.
- At Bhawanipatna, OBCS-4 with 14% higher seed yield than DCS-107 (883 kg/ha) was promising under rainfed conditions.
- Out of 399 new hybrids evaluated in preliminary trials at different centres, 39 hybrids were identified with higher seed yield advantage (10-93%) than the check hybrids.
- Among 11 entries evaluated along with three checks in IVHT (Normal duration) under rainfed (6 centres) and irrigated (8 centres) conditions, ICH-277 was resistant to wilt and recorded 15% higher seed yield (1858 kg/ha) than the best check GCH-8 (1615 kg/ha) under rainfed conditions.
- Among three entries evaluated along with two checks in IVHT (Short duration) under rainfed (5 centres) and irrigated (6 centres) conditions, two entries were promising for early maturity, high seed yield and wilt resistance.
    - ICH-1146 (954 kg/ha) and ICH-440 (874 kg/ha) recorded 22.1 and 11.8% higher seed yield at 120 DAS than the check GCH-4 (782 kg/ha) under rainfed conditions.
    - Across locations, ICH-1146 (1235 kg/ha) and ICH-440 (1155 kg/ha) recorded 13.1 and 5.8% higher seed yield, respectively at 150 DAS compared to the check GCH-4 (1092 kg/ha).
- Among seven genotypes (5 hybrids and 2 varieties) tested along with three checks in AVHT, ICH-278 recorded 10.7% higher seed yield (1771 kg/ha) than the best check ICH-66 (1600 kg/ha), and the variety ICS-164 recorded 24.3% higher seed yield (1306 kg/ha) than the varietal check DCS-107 (1051 kg/ha) under rainfed conditions in six centres. Both the entries were resistant to wilt.
- ICH-277 hybrid was promoted to AHT-Normal Duration (ND); ICH-1146 and ICH-440 hybrids were promoted to AHT-Short Duration (SD); ICS-164 variety was promoted to AVHT-II.
- A total of 31.8 q of breeder seed of varieties and parental lines was produced against the total indent of 18.2 q by various centres.
- Based on frost injury rating score developed, it was found that application of H_2SO_4 (1 l/ha) resulted in lowest damage (514 plants/ha). Application of other chemicals *viz.*, DMSO and thiourea also reduced the mean number of affected plants/ha due to frost over control (water spray application) at Mandor.
- Adoption of best management practices under rainfed conditions resulted in higher seed yield over farmers practice at Ananthapuramu (1564 kg/ha and 657 kg/ha) and at Bengaluru with supplemental irrigation through reuse of runoff water (2154 kg/ha, 812 kg/ha).
- Adoption of BMPs (YRCH 2 castor hybrid; ridges and furrow method of planting; seed treatment with PSB; soil test based fertilization, surveillance based IPM practices; harvesting by secateurs) resulted in higher seed yield (1648 kg/ha), and higher profitability (B:C ratio 3.28) in clay loam soils of Tamil Nadu under rainfed conditions.
- Under irrigated conditions at S.K. Nagar, adoption of BMPs [GCH-8 hybrid; seed treatment with PSB @ 5 ml/kg seeds (*Bacillus coagulans*); plant geometry 150 cm × 120 cm; soil test based nutrient supply; drip irrigation; need based plant protection, harvesting through secateurs] resulted in 26.3% higher seed yield over farmer's practice. Similar trend was followed in Junagadh (GCH-9) and Mandor (DCH-177).

- Conservation agricultural practices under irrigated conditions recorded highest castor seed equivalent yield (3780 kg/ha) at S.K. Nagar with significant influence of intercropping systems on growth, yield attributes and seed yield. Highest castor seed equivalent yield (5065 kg/ha) was recorded in castor + groundnut intercropping system.
- Under high density planting in *rabi* castor trials, highest seed yield at Palem (1961 kg/ha) and Yethapur (1489 kg/ha) was recorded by adopting 90 x 30 cm crop geometry (37,037 plants/ha) and 60 x 30 cm spacing respectively with a significant interaction between castor genotype YRCH-2 and plant densities on seed yield at Yethapur.
- At Junagadh, response of new castor hybrid (GCH-9) to plant geometry and N fertigation through drip irrigation revealed significantly highest seed yield (2677 kg/ha) at 150 cm x 60 cm plant geometry. Application of 120 kg N /ha with 25% as basal; remaining 75% through drip fertigation in form of urea in five equal splits registered highest seed yield (2516 kg/ha).
- Water use efficiency was highest (9.9 kg/ha-mm) by maintaining 150 cm x 60 cm plant geometry and application of 100% N through drip fertigation (8.3 kg/ha-mm).
- Trial on efficacy of bio-inoculants on productivity of castor indicated that application of PGPR-consortium (NPK mobilizers cultures+Trichoderma) recorded highest seed yield (1097 kg/ha) and profitability (B:C ratio 1.86) in Ananthapuramu.
- In Bengaluru, seed inoculation with PSB recorded significantly higher seed yield of castor (1518 kg/ha) and was at par with inoculation with PSB + K solubilizer + N fixer (1383 kg/ha). Significantly higher Partial Factor Productivity of castor was observed when crop was fertilized with 50% of recommended dose of fertilizer (19.21 kg/ha).
- Out of 1153 FLDs, 103 FLDs were conducted during *rabi* 2019-20 in Telangana state, 305 FLDs were conducted on whole package technology, 626 on component technologies and 53 on oilseed based cropping systems during *kharif* 2020 in seven states.
- During *rabi* 2019-20, 20% increase in mean seed yield with improved technology (IT) (2046 kg/ha) as compared to farmers practice (FP) (1704 kg/ha) was observed. The gross monetary returns increased to Rs. 82,046/ha with IT as compared to Rs. 66,144/ha with FP. Farmers could earn an additional net returns (ANR) of Rs. 14,891/ha.
- During *kharif* under irrigated conditions, the FLDs conducted by Bawal centre recorded mean seed yield of 4139 kg/ha with IT as compared to 3745 kg/ha with FP. The ANR accrued were Rs. 17,201/ha.
- The demonstrations conducted under rainfed conditions during *kharif* in Andhra Pradesh and Telangana recorded seed yield of 1352 kg/ha with IT as compared to 867 with FP resulting in 56% increase in seed yield with IT. The ANR accrued with IT were Rs.14,104/ha.
- The demonstrations on improved cultivars increased the seed yield by 24.5% with ICH- 66, 10% with GCH-8 and 35.9% with YRCH-2 as compared to FP. Increase in yield with other component technologies ranged from 10.6% with optimum spacing, 18.4% with soil test based fertilizer application, 12.6% with gray mold management and 8.6% with insect pest management.
- Demonstrations on remunerative castor based intercropping systems conducted by Ananthapuramu (castor + redgram) and Palem (castor + redgram) under rainfed conditions and Bawal (castor + greengram/redgram) and Junagadh (castor + groundnut) under irrigated conditions during *kharif* showed 50% increase in castor equivalent yield in IT (2549 kg/ha) as compared to FP (1693 kg/ha). The ANR accrued were Rs. 24,821/ha.
- During 2020-21, survey of farmer fields at different castor centers indicated severe incidence of *Botryotinia* gray mold at Palem (5-9 scale) and Yethapur (3-7 scale) centers due to prolonged rainy season after spike formation stage during September and October. Incidence of wilt was low to moderate, both under irrigated (0-21%) and rainfed (0-30%) conditions while root rot was low (0-13%) under irrigated conditions. Incidence of seedling blight was up to 15% (*rabi*) to 50% (*kharif*) around Palem.
- Trial on influence of weather parameters on gray mold development at two sowing dates at Palem and Yethapur, indicated that irrespective of sowing time, any increase in relative humidity increased the incidence of gray mold. At Palem in both June and July sowings, the maximum per cent disease index (PDI) was up to 100 with 9 scale during 44th standard week when average minimum temperature of 19.4 °C and relative humidity of 91.1% were recorded.
- Screening of 100 germplasm accessions in sick plots identified three Fusarium wilt resistant accessions *viz*., RG-3860, RG-3940, RG-3932 at Palem and S.K. Nagar; seven Macrophomina root rot resistant accessions RG-3908, RG-3934, RG-3897, RG-3898, RG-3899, RG-3901, RG-3932 at Junagadh.
- Inbred line, ICI-RG-2774-2 was confirmed as a stable source of wilt resistance at Hyderabad, Palem

and S.K. Nagar by sick pot method while RG-3855 showed resistant reaction against root rot by stem tape inoculation method.

- Nine entries *viz.*, ICH-277, SLCH-253, NAUCH-1703 from IVHT-ND, ICH-1146, ICH-440 from IVHT-SD and SHB-1021, SHB-1028, ICS-164, ICH-515 from AVHT-II were resistant to wilt in sick plots of Palem and SK Nagar.
- Two entries *viz.*, SHB-1057, NAUCH-1703 were moderately resistant to gray mold under artificial inoculation conditions at ICAR-IIOR and Yethapur.
- Sixteen entries *viz.*, ICH-277, ICH-239, ANDCH-1702, JI-447, SHB-1057, SLCH-253, NAUCH-1703, JHB-1074, SHB-1061, SHB-1062, SHB-1063, ANDCH-1735 from IVHT-ND, ICH-440 from IVHT-SD and SHB-1021, ICH-278 and SHB-1027 from AVHT-I & II were resistant to wilt in the coordinated trials.
- In national screening nursery of wilt (NSNW), 18 entries were resistant (<20%) at Palem and S.K. Nagar *viz.*, SHB-1071, SHB-1074, SHB-1075, SHB-1077, SHB-1078, ANDCH- 1714, JHB-1098, JHB-1099, JHB-1109, JI-491, YRCS-1904, MP-42-17, MHC-50, ICS- 130, DPC-18, ICH-1050, ICH-1163, ICH-1218.
- Survey and monitoring of castor insect pests at research stations and farmer's fields revealed moderate to heavy infestation of leafhoppers and defoliators (semilooper and *Spodoptera litura*) at Palem and Yethapur. Low to moderate infestation of sucking pests (leafhopper, thrips and whitefly) was reported from S.K. Nagar and Junagadh. Low infestation of capsule borer was recorded at all four locations.
- Among 93 different waxy bloom type castor germplasm accessions screened at Palem and Yethapur, five double bloom accessions (RG-3041, RG-3087, RG-3094, RG-3105 and RG-3427) and five triple bloom accessions (RG-2956, RG-3067, RG-3090, RG-3411 and RG-3421) were resistant to leafhopper. One zero bloom accession (RG-2976), four single bloom accessions (RG-2870, RG-2878, RG-2918 and RG-3020) and one double bloom accession (RG-2991) were promising against whitefly.
- Among several inbred and parental lines screened in multi-location/year trials, ICI-RG-2661-7-3-5-6, ICI-RG-2661-16-2-2 (2 years and 4 locations), IPC-34, IPC-36, IPC-41, ICS-317, 1932-1 (3 locations) were confirmed sources of leafhopper resistance with 0-1 score compared to susceptible check (3-4 score). Eight accessions viz., ICI-RG-2800-1, ICI-RG-2800-4, ICI-RG-2800-5, ICI-RG-2800-6, ICI-RG-2800-7, ICI-RG-2800-8, RG-3233, RG-3428 were confirmed sources of white fly resistance at three locations with a score of 0-1 compared to susceptible check (3-4).
- Three IVHT entries (ICH-277, SHB-1062 and ANDCH-1735) and one AVHT entry (ICH-278) showed resistant reaction to leafhopper (hopper burn grade 0 to 1 on 0-4 scale) at all four locations (Palem, Yethapur, S.K. Nagar and ICAR-IIOR, Hyderabad).
- Effectiveness of DOR Bt-127 SC formulation @ 3 ml/l was superior over commercial Btk formulation @ 1 g/l in reducing the population of semilooper and *S. litura* at Yethapur. DOR Bt-127 SC formulation treated plot yielded 1459 kg/ha and was on par with commercial Btk (1398 kg/ha).
- Among the insecticides evaluated against thrips at S.K. Nagar, flonicamid 50 WG @ 0.2 g/l, profenofos 50 EC @ 1 ml/l and dimethoate 30 EC @ 1.7 ml/l were superior in reducing the thrips infestation and resulted in higher seed yield (1801-1870 kg/ha) as compared to untreated control (1350 kg/ha).
- The new insecticide viz., spinetoram 11.70 SC @ 1 ml/l was superior in reducing the *S. litura* infestation and resulted in higher seed yield at Palem (1075 kg/ha) as compared to untreated control (687 kg/ha). Cyantraniliprole 10.26 OD @ 1 ml/l and thiacloprid 21.70 SC @ 1 ml/l were found effective against leafhopper and resulted in higher cost-benefit ratios at Palem (1: 2.30) and Yethapur (1: 2.82), respectively.
- On-farm demonstration of management of castor whitefly in farmer's fields conducted by Yethapur centre revealed that the new insecticides *viz.*, flonicamid 50 WG @ 0.2 g/l, thiamethoxam 30 FS @ 0.5 g/l and profenofos 50 EC @ 2.0 ml/l were effective against whitefly and resulted in higher seed yields (1304 to 1425 kg/ha) and cost-benefit ratios (1:1.41 to 1: 1.74) over farmer's practice (seed yield of 1085 kg/ha and cost-benefit ratio of 1: 0.98).
- On-farm demonstration of management of lepidopteran pests of castor in farmer's fields conducted by Palem centre revealed that application of DOR Bt-127 SC formulation @ 3 ml/l was at par with commercial Btk formulation @ 1 g/l against *S. litura* and resulted in comparable seed yield (800 and 845 kg/ha in DOR Bt-127 SC and commercial Btk, respectively) in castor.

Recommendations for on-farm trials

- Seed treatment with tebuconazole + trifloxystrobin 75 WG @ 0.4 g/kg, which was effective for low wilt incidence and high seed yield was recommended for on-farm validation at Palem centre based on pooled analysis of three years data.

- Seed treatment with *T. harzianum* Th 4d WP @ 10 g/kg and soil application of neem cake @ 150 kg/h one week before sowing which was effective for low root rot incidence was recommend for on-farm validation at Junagadh based on pooled analysis of three years data.
- Application of flonicamid 50 WG @ 0.2 g/l, profenofos 50 EC @ 1 ml/l and dimethoate 30 EC @ 1.7 ml/l which was effective for management of thrips in castor at S.K. Nagar was recommended for on-farm validation based on pooled analysis of five years data.

Major Recommendations

- At Yethapur, Best Management Practices *viz.,* cultivation of YRCH-2 castor hybrid; ridges and furrow method of planting; seed treatment with PSB; soil test based fertilization, surveillance based IPM practices; harvesting by secateurs is recommended for higher seed yield (1648 kg/ha), and higher profitability (B:C ratio 3.3) in clay loam soils of Tamil Nadu under rainfed conditions.
- Under rainfed centres, Yethapur, Palem, ICAR-IIOR, Hyderabad two sprays of propiconazole 1ml/l at the onset of disease and 15 days after the first spray is recommended for effective management of gray mold resulting in higher seed yield and economic benefits.
- Seed treatment with *Trichoderma harzianum*, Th 4d WP 10 g/kg and soil application of *T. harzianum*, (1 kg *T. harzianum* mixed with 100 kg FYM incubated for a week and applied while seed dibbling) is recommended for management of wilt at Yethapur and root rot at Junagadh.
- At Yethapur, application of flonicamid 50 WG @ 0.2 g/l or thiamethoxam 30 FS @ 0.5 ml/l or profenofos 50 EC @ 2.0 ml/l is recommended for management of whitefly in castor.
- At Palem, application of bioinsecticides *viz*., DOR Bt-127 SC formulation @ 3 ml/l or commercial Btk formulation (Delfin®) @ 1 g/l is recommended for management of semilooper and *Spodoptera litura* in castor.

Sunflower

- Under multilocation evaluation trial at Akola, accessions EC-601635 (42 g), GMU-770 (41 g) recorded highest seed yield/plant over the three checks, Phule Bhaskar (28 g), DRSF 113 (27 g) and DRSF-108 (25 g).
- At Latur, three trait specific germplasm accessions *viz.,* TSG-199-R, TSG-53, TSG-269 and nine exotic accessions EC-198072, EC-399512, EC-512739, EC-276249, EC-198074, EC-278276, EC-276282, EC-276229, EC-68414-S4-21 were identified as downy mildew resistant.
- Raichur centre identified line PM-81 as powdery mildew resistant and registered it with NBPGR (Registration number: INGR20078).
- Forty promising lines (20 RHA lines, 20 inbred lines) were deposited to NBPGR, New Delhi for long term storage.
- Among the inbreds derived from B gene pool, CSFI-32-2-20-1 and CSFI-32-2-29-1 were moderately resistant to Alternaria leaf spot disease and free from powdery mildew disease. CSFI-6-5-1, CSFI-6-91-1, CSFI-6-93-1 and CSFI-6-134-1 were found promising for high seed yield (22-26 g/plant).
- At Raichur, F_5 material *viz.,* RSLP-13, RSLP-87, RSLP-88, RSLP-89, RSLP-90, RSLP-91, RSLP-98, RSLP-99 and RSLP-106 developed through recombination breeding were resistant to powdery mildew with <10% PDS and RSLP-41 was resistant to leafhopper with 1.25 grade.
- New experimental hybrids developed at Akola (27), Bengaluru (86), Coimbatore (57), Hisar (26), Latur (150), Ludhiana (150), Nandyal (25), Nimpith (161) and Raichur (77) were evaluated in preliminary hybrid yield trials.
- Multilocation evaluation of experimental hybrids revealed superiority over the best check hybrids: PKVSH-988 (2224 kg/ha), PKVSH-991 (2131 kg/ha), PKVSH- 984 (2104 kg/ha) and PKVSH-992 (2079 kg/ha) at Akola; SMLHT-Kh-20-07 (IIOSH-460) (2384 kg/ha), SMLHT-Kh-20-06 (IIOSH-15-20) (2343 kg/ha) at Bengaluru; CSFH-18297 (2119 kg/ha), CSFH-18293 (1975 kg/ha) and CSFH-18242 (1925 kg/ha) at Coimbatore; HSFH-1645 (2951 kg/ha) and HSFH-1641 (2893 kg/ha) at Hisar; SHT-04 (1557 kg/ha) and SHT-02 (1543 kg/ha) at Latur; PSH-2704 (2928 kg/ha) and PSH-2703 (2879 kg/ha) at Ludhiana; SH-2199 (2395 kg/ha) at Nandyal; H-10-225 (1880 kg/ha), H-14-148 (1710 kg/ha) and H-14-124 (1690 kg/ha) at Raichur.
- Twenty interspecific derivatives (BC_2F_4) derived from ARM-243B x DEB-691 at ICAR-IIOR were evaluated at Coimbatore centre for yield and yield contributing traits. PB-120 (44.3%), PB-127 (41.0%), PB-128 (42.7%), PB-129 (43.0%) and PB-130 (42.7%)

recorded >40% oil content. The highest seed yield was recorded in PB-129 (33.1 g/plant) followed by PB-127 (32.4 g/plant), PB-122 (31.9 g/plant), PB-132 (30.2 g/plant) and PB-120 (28.3 g/plant).

- KBSH-85 (for zone-II) was promoted to the next level of testing in *rabi* 2020 and KBSH-85 (for zone-V), KBSH-88 and IIOSH-460 were promoted to further testing in *kharif* 2021.
- Pendimethalin 30 EC @ 1.0 kg a.i./ ha as pre-emergence followed by Propaquizafop 10 EC (Agil) @ 62.0 g a.i./ha at 15-20 DAS as post-emergence herbicide was effective in both alfisols and vertisols for weed management in sunflower at modified spacing of 75 cm (row) x 25 cm during k*harif* season (Akola, Bengaluru).
- Application of FYM @ 5 t/ha and sowing of sunflower at half way on the ridges at Raichur was promising with highest yield (1929 kg/ha) over flatbed sowing (1803 kg/ha) under saline soils.
- Oxadiargyl 6 EC @ 125 g a.i./ha as a promising pre-emergence herbicide followed by one hand weeding was a promising option for weed management with high yield (2281 kg/ha) at Coimbatore, Tamil Nadu.
- A minimum of 10-15% higher seed yield was achieved by following good agricultural practices (FYM @ 5 t/ha and STCR based fertilizers and boron spray @ 0.2% at ray floret stage; Pendimethalin 30 EC @1 kg a.i./ha as PE followed by hand weeding on 30 DAS; Need based application of pesticides. Irrigation was given at critical stages. The crop was protected with net for bird damage and thalamus was used as cattle feed) over farmers' practices across the locations.
- Utilisation of Sulphur Oxidizing Bacterial inoculum as seed treatment @ 2 kg/ha + soil application @ 2 kg/ha was promising in terms of yield (2140 kg/ha) at Coimbatore, Tamil Nadu.
- KBSH-44 was the promising sunflower hybrid in terms of seed yield (1890 kg/ha) over DRSH 1 (1792 kg/ha) and MSFH-17 (1602 kg/ha) in sandy loam soils under rice fallow environments of Bhubaneswar, Odisha.
- Zero tillage sunflower after rice was successful in terms of yield (905 kg/ha) in vertisols of Nandyal, Andhra Pradesh over minimum (763 kg/ha), conventional (658 kg/ha) and reduced (637 kg/ha) tillage practices.
- Sunflower–Chickpea was a profitable emerging cropping system at Akola, Maharashtra with a benefit cost ratio of 3.6 while greengram-sunflower could realise only 3.06.
- Groundnut-Sunflower was a profitable emerging cropping system at Latur, Maharashtra with a benefit cost ratio of 2.18 followed by sunflower-groundnut and soybean-sunflower (2.15).
- Maize-sunflower resulted in highest benefit cost ratio at Nandyal, Andhra Pradesh with a benefit cost ratio of 1.88 followed by sunflower-chickpea (1.74). The same system was profitable at Bengaluru as well. Similar trends followed at Raichur, Karnataka.
- Greengram-sunflower was a profitable cropping system at Tornala, Telangana with a benefit cost ratio of 1.36 followed by maize-sunflower at 1.26.
- A spacing of 60 x 30 cm was found optimal to facilitate mechanisation and high productivity for sunflower hybrids PSH-1962 (1915 kg/ha) and PSH-2080 (1956 kg/ha) at Ludhiana.
- One kg boron needs to be applied to sandy soils of Odisha if foliar application is to be skipped at ray floret stage for optimum yield under rice fallow conditions.
- DRSH-1 was a promising hybrid with high yield (2031 kg/ha) over COH-3 (1940 kg/ha), NDSH-1012 (1633 kg/ha), KBSH-53 (1990 kg/ha), KBSH-78 (1976 kg/ha), LSFH-171 (1404 kg/ha), Dhanya-3389 (1549 kg/ha) and RSFH-1887 (1542 kg/ha) for *rabi* conditions of Tornala, Telangana.
- Occurrence of sucking pests like leafhoppers and whiteflies was moderate while no defoliators and head borer damage was observed during *rabi*, 2019 in Kalaburagi, Koppal and Bhagalkot areas of Karnataka. In Latur, Maharashtra, leafhoppers, thrips and whiteflies were the predominant sucking pests observed during both *rabi*, 2019 and k*harif*, 2020 and were moderate in occurrence. During *kharif*, 2019, both sucking and lepidopteran pests were low in occurrence in Chamarajnagar and Chitradurga districts of Karnataka. In Raichur, Kalaburagi, Koppal and Bhagalkot districts, leafhopper, defoliators and head borer infestation were moderate.
- After evaluating over 3 years at multiple locations, one line, GMU-520 was found resistant/moderately resistant at all the centres while GMU-440, GMU-79, GPN-219- 2 and ID-1079 were found moderately resistant to leafhoppers.
- During *rabi* 2019 coordinated entries, one entry, IIOSH-15-20 (IHT) showed resistant reaction at 3 centres and moderately resistant at Akola centre while KBSH-87 was found moderately resistant to leafhoppers at all the locations.

- During *kharif* 2020 coordinated entries, KBSH-88 (IHT) and IIOSH-15-20 (AHT-II) were found resistant to leafhoppers across the locations.
- On-farm trial evaluations conducted at Akola, Latur and Bengaluru showed that foliar sprays of Chlorantraniliprole 18.5 SC@ 0.3 ml/l and DOR Bt-127 SC @ 3.0 ml/l of water were found effective in reducing the head borer larvae and recorded significantly higher yield than the farmer's practice of respective location.
- Foliar spray of insecticide, diafenthiuron 50 WP @ 1 g/l significantly reduced the whiteflies population in sunflower in all 4 locations (Akola, Latur, Raichur).
- Disease survey conducted during *rabi* 2019-20 and *kharif* 2020 indicated that in general the incidence of all major diseases was low to moderate. Alternariaster leaf spot disease was moderate to high in Raichur and Nandyal regions and powdery mildew incidence was moderate to high in few locations in Bengaluru and Coimbatore regions.
- Screening of germplasm, CMS and R lines, and breeding/parental lines against major diseases, the entry CMS-135A showed less than 30% disease severity of Alternariaster leaf blight. Thirteen entries namely HA-4303B1, CMS-135A, NDCMS-2B, RHA-92, RHA-275, CSFI-17008, RCRPM-81, TSG-208, RCR-43, RCR CMS-519-B, KGP-308, CMS-1001-B and RGP-184 showed less than 25% powdery mildew disease severity. The entry CMS-7-1B with minimum lesion length (12.2 cm) of charcoal rot and the entry R-106 with minimum lesion length (10.3 cm) for collar rot were promising.
- Among the coordinated trial entries (IAHT) screened during *rabi* 2019-20, none of the entries showed resistant reaction to leaf spot and powdery mildew disease. At Nandyal centre, the entries RSFH-1887 (R), RSFH-12-705, CSFH-16510, DRSH-1 (NC), KBSH-85 and KBSH-86 were moderately resistant to leaf curl disease. At Ludhiana, none of the entries was free from charcoal rot and collar rot diseases. At Latur, eight entries *viz.,* PAC-334 (PC), LSFH-171 (RC), KBSH-87, RSFH-1887 (RC), RSFH-12-705, KBSH-85, IIOSH-15-20 and IIOSH-15-10 were found free of downy mildew.
- During *kharif* 2020, the IAHT entry IIOSH-15-20 was found to be moderately resistant to powdery mildew and nine entries *viz.,* KBSH-88, RSFH-1887 (C), IIOSH-15-20, CSFH-17078, IIOSH-460, KBSH-85, KBSH-89, NDSH-2335 and PKVSH-978 were free from downy mildew incidence.
- Studies on pathogen variability and host range of the sunflower powdery mildew at Coimbatore centre revealed that two genera of powdery mildew *viz., Golovinomyces orontii* and *Podosphaera xanthii* were found associated with sunflower.
- The results from evaluation of molecules against viral diseases of sunflower revealed no significant differences in performance among the treatments and no single common treatment was found best across the locations tested.
- Seed treatment with the plant defence inducer salicylic acid @ 100 ppm + foliar spray of salicylic acid @ 100 ppm at 30 and 45 days after sowing was effective with less incidence of Alternariaster leaf spot, necrosis and powdery mildew diseases and high seed yield and B:C ratio.
- Among combination of fungicides tested, seed treatment with carbendazim 12% + mancozeb 63% WP (SAAF 75 WP) @ 2 g/kg seed followed by two foliar sprays with difenoconazole 25% + propiconazole 25% (TASPA 500 EC) @ 0.25 ml/l) was found to be effective in management of Alternariaster leaf blight in two locations and no single common treatment was found best across the locations tested.
- Seed treatment with *Pseudomonas fluorescens* (Pf) @ 10 g/kg seed followed by soil application of Pf 2.5 kg/ha fortified with FYM at the time of sowing + three foliar sprays of Pf @ 30, 45 and 60 DAS was effective in management of Alternariaster leaf spot and necrosis diseases with the highest seed yield and B:C ratio.
- In on-farm validation, the seed treatment with carbendazim 12% + mancozeb 63% WP (SAAF 75 WP) @ 2 g/kg seed followed by two foliar sprays with zineb 68% + hexaconazole 4% WP (Avatar) @ 0.25 g/l as first spray at the onset of incidence or 45 days after sowing and second spray 15 days after first spray was considered as the best treatment in managing the Alternariaster leaf blight in sunflower crop at Coimbatore.
- In on-farm validation on management of Alternariaster blight, necrosis and powdery mildew through seed treatment with *P. fluorescens* @ 10 g/kg seed + soil application of *P. fluorescens* @ 2.5 kg fortified with 250 kg FYM + three foliar sprays of Pf1 @ 30, 45 and 60 DAS recorded lowest incidence and severity of necrosis, leaf spot and powdery mildew diseases and recorded higher seed yield in sunflower crop at Coimbatore.

Major Recommendations

- Apply Pendimethalin 30 EC @ 1.0 kg a.i./ha as pre-emergence herbicide followed by power weeder at 30 DAS for managing weeds effectively for widely planted (75 cm) sunflower to obtain high yield (2064 kg/ha) and benefit cost ratio (1.40) in sandy clay loams of Western zone of Tamil Nadu.
- Apply Pendimethalin 30 EC @ 1.0 kg a.i./ha as pre-emergence herbicide followed by power weeder at 30 DAS for managing weeds effectively for widely planted (75 cm) sunflower to obtain high yield (2064 kg/ha) and benefit cost ratio (1.40) in sandy clay loams of Western zone of Tamil Nadu.
- At Coimbatore, seed treatment with carbendazim 12% + mancozeb 63% WP (SAAF 75 WP) @ 2 g/kg seed followed by two foliar sprays with zineb 68% + hexaconazole 4% WP (Avatar) @ 0.25 g/l as first spray at the onset of incidence or 45 days after sowing and second spray 15 days after first spray was considered as the best treatment in managing the Alternariaster leaf blight in sunflower.
- Seed treatment with *P. fluorescens* @ 10 g/kg seed + soil application of *P. fluorescens* @ 2.5 kg fortified with 250 kg FYM + three foliar sprays of Pf1 @ 30, 45 and 60 DAS has recorded lowest incidence and severity of necrosis, leaf spot and powdery mildew diseases and recorded higher seed yield in sunflower at Coimbatore.

Safflower

- Safflower variety SSF-16-02 and hybrid ISH-402 were identified for release at national level (Zone-I and Zone-II). Two varieties *viz.*, SSF-15-65 and Annigeri-2020 (ANG-17-102) for Zone-I and IGKV Kusum (RSS 2016-03) for Zone -II were also identified.
- The germplasm accession, GMU-7943 recorded higher seed yield (1523 kg/ha) and oil yield (443 kg/ha) than the best varietal checks (A-1: seed yield 1515 kg/ha; ISF-764: oil yield 440 kg/ha), based on overall means of six locations.
- GMU-7948 was identified for higher seed (1899 kg/ha and 1586 kg/ha) and oil (549 and 424 kg/ha) yield than the best check A-1 (1299 kg/ha; 370 kg/ha) under rainfed conditions at Solapur and Parbhani, respectively.
- The accessions GMU-7945 (1824 kg/ha), GMU-7948-1 (1739 kg/ha) GMU-7948-2 (1731 kg/ha) and GMU-7938 (1519 kg/ha) recorded highest seed yield at Tandur, Indore, Parbhani and Raipur, respectively.
- A total of 2107 individual plant selections were made from evaluation of progenies at various generations (F_2-F_6), which were produced from a total of 241 crosses. A total of 259 stabilized progenies were evaluated in station trials and 35 entries were promising for higher seed yield at Annigeri, Indore, Parbhani, Raipur, Solapur and Tandur.
- A set of 17 short duration entries were evaluated at Indore and Raipur centres for seed yield and related traits along with five checks. Two entries, GMU-7898 (1914 kg/ha; DM: 111) and GMU-7899 (1824 kg/ha; DM: 117) were significantly superior to the short duration check, JSI-99 (1261 kg/ha; DM: 110) with 52% and 45% higher seed yield, respectively.
- A total of 74 selections with high oil content ranging from 33 to 42% were identified at Indore, Parbhani and Raipur.
- A total of 48 fresh crosses were made involving the parents possessing high seed yield, resistance to Fusarium wilt, and tolerance to Alternaria, aphid and moisture stress.
- A total of 302 advanced generation entries were screened against Fusarium wilt at sick plots; of which 31 entries showed resistance reaction. In addition, a total of 936 progenies promising for high seed yield were also selected.
- A total of 86 CMS based crosses were made at the centres involving two CGMS lines, A-133-I and A-133-II. At Solapur, a total of 16 hybrids were evaluated; of which, four hybrids (A-133-I x GMU-7947, A-133-II x GMU-1626, A-133-I x SSF-708, A-133-I x SSF-1565) recorded higher seed yield than the check, SSF-708.
- In IVHT, the varietal entry, TSF-89 recorded 13% higher seed yield (2372 kg/ha) and 8% higher oil yield (696 kg/ha) than the best check, PBNS-12 (seed yield: 2109 kg/ha; oil yield: 642 kg/ha) at national level. The entry ISF-300 (788 kg/ha) possessing oil content of 38.3%, recorded 23% higher oil yield over the best check, PBNS-12 (642 kg/ha).
- In AVT-I&II, the AVT-I entry ISF-123-sel-15 recorded 10% higher oil yield (584 kg/ha) over the best check A-1 (531 kg/ha) but recorded statistically on par seed yield (1757 kg/ha) with the best check A-1 (1820 kg/ha) at national level. Two AVT-II entries *viz.*, RVS-18-

1 (660 kg/ha) and RVS-18-3 (597 kg/ha) recorded 24% and 13% higher oil yield over the best check, A-1 (531 kg/ha) at national level.

- In AHT-I&II, the AHT-I entry ISH-423 recorded 9% higher seed yield (2055 kg/ha) and 9% higher oil yield (665 kg/ha) over the best check DSH-185 (seed yield: 1886 kg/ha; oil yield: 608 kg/ha). The AHT-II entry ISH-400 recorded 14% higher seed yield (2140 kg/ha) and 14% higher oil yield (694 kg/ha) over the check, DSH-185 (seed yield: 1886 kg/ha; oil yield: 608 kg/ha).
- A total of 33.48 q of breeder seed of 10 varieties and parents of one hybrid was produced against the assigned target of 18.95 q.
- In the assessment of safflower based cropping systems productivity with soil moisture conservation background, the safflower equivalent yield of soybean-safflower cropping system did not change/ decrease when short duration soybean was introduced in the system in place of normal duration at Indore and Parbhani. The safflower equivalent yield of blackgram-safflower was greater (1859 kg/ha) than fallow-safflower (659 kg/ha) at Solapur. The safflower equivalent yield of greengram-safflower was greater than fallow-safflower at Annigeri (27%) and Tandur (52%).
- In the assessment of cropping system oriented plant spacing and IPNM in safflower, at Annigeri, safflower equivalent yield was significantly the highest with 45 x 20 cm spacing + 100% RDF + Azotobacter + PSB (for safflower) in greengram-safflower system. Highest safflower equivalent yield was recorded with the combination of 4 rows/BBF x 100% RDF + Azotobacter + PSB (for safflower), which was on par with 3 rows/BBF x 100% RDF + Azotobacter + PSB in normal/short duration soybean-safflower system at Parbhani. Paired row planting, 60-30-60 cm x 100% RDF + Azotobacter + PSB recorded highest safflower equivalent yield, which was on par with 60-30-60 cm x 50% RDF + Azotobacter + PSB and 60-30-60 cm x no fertilizer in blackgram-safflower system in Solapur. Safflower equivalent yield was the highest with 3 rows/ BBF x 100% RDF + Azotobacter + PSB, which was on par with 3 rows/BBF x 50% RDF + Azotobacter + PSB in greengram-safflower system at Tandur.
- In assessment of comparative performance of safflower cultivation under selective mechanization *vis-a-vis* farmer's practice, at Annigeri, Indore, Solapur and Tandur, increase in seed yield with mechanized conditions was 13-16%, while at Parbhani it was 6% and at Raipur it was meagre. Cost of cultivation was reduced by Rs. 3400/-, 8820/, 2650/-, 1240/- and 4986/- with mechanized conditions at Indore, Parbhani, Raipur, Solapur and Tandur, respectively.
- Seed yield of safflower was 45%, 25% and 13% higher with best management practices than farmer's practice at Parbhani, Tandur and Solapur, respectively.
- A total of 900 FLDs on safflower and three trainings for input dealers, agricultural extension officers and extension workers were conducted by eight AICRP centres, one voluntary centre, one KVK and two other organizations covering seven states. FLDs on whole package technology in non-traditional areas of Andhra Pradesh and Uttar Pradesh under protective irrigation resulted in 30% increase in mean seed yield with improved technology (IT), 1154 kg/ha) as compared to 886 kg/ha with farmer's practice (FP) resulting in additional net returns (ANR) of Rs.13,703/ ha. Whereas, in traditional areas of Maharashtra, 17% increase in seed yield was observed with IT (1042 kg/ ha) as compared to FP (892 kg/ha).
- FLDs on improved variety resulted in productivity improvement to the tune of 21% with ANR of Rs. 6341/ha. The B:C ratios were 2.19 and 1.89 with IT and FP, respectively.
- FLDs on seed treatment with bio-agents/bio-fertilizers increased mean seed yield by 28% in IT (1051 kg/ha) with ANR of Rs. 9648/ha as compared to FP (818 kg/ ha). Demonstrations on thinning and soil test based fertilizer application increased seed yield by 17% each with ANR of Rs. 4232/ha and Rs. 4372/ha, respectively. Fertilizer management increased mean seed yield by 17% in IT (1067 kg/ha) with ANR of Rs. 6462/ha as compared to FP (913 kg/ha). Need based management of pests and diseases resulted in 33% increase in seed yield with IT (1079 kg/ha) as compared to FP (809 kg/ha).
- Demonstrations on remunerative intercropping systems increased safflower equivalent yield (986 kg/ ha) by 19% with ANR of Rs. 7592/ha as compared to sole crop (829 kg/ha).
- In confirmation of reaction to Alternaria leaf spot disease, four entries *viz.*, PBNS-148, SAF-P-1902, SAF-P-1906 and SAF-19-11 were found moderately resistant (disease severity <25%) against Alternaria leaf spot disease at Solapur and Parbhani locations.
- In confirmation of reaction to Fusarium wilt disease, the entry GMU-824 was found free from wilt at ICAR-IIOR, Hyderabad and moderately resistant (wilt incidence between 11 and 20%) at Solapur and Tandur. The entry GMU-5032 was found resistant (wilt incidence <10%) against Fusarium wilt at all three locations (Solapur, ICAR-IIOR, Hyderabad and Tandur).

- In Uniform Disease Nursery Trial for *Alternaria* leaf spot, three entries *viz.*, SAF-P-1507, SSF-1660 and PBNS-137 were found moderately resistant (disease severity <25%) to Alternaria leaf spot at Solapur and tolerant (disease severity <40%) to *Alternaria* leaf spot at Parbhani. The highest seed yield was recorded by SAF-P-1507 at Solapur (996 kg/ha) and SSF-1660 at Parbhani (1717 kg/ha). Therefore, these three entries *viz.*, SAF-P-1507, SSF-1660 and PBNS-137 were identified as the most stable source of resistance to *Alternaria* leaf spot disease of safflower.
- In Uniform Disease Nursery Trial for *Fusarium* wilt, the entry ISF-2342 was resistant to wilt at Solapur and free from wilt at Tandur. Moreover, two safflower entries *viz.*, SAF-P-1706 and SAF-P-1606 were resistant to wilt at Solapur and Tandur. The highest seed yield was recorded by SAF-P-1606 at Solapur (993 kg/ha) and ISF-2342 at Tandur (1555 kg/ha). Therefore, these three entries *viz.*, ISF-2342, SAF-P-1706 and SAF-P-1606 were identified as the most stable source of resistance to *Fusarium* wilt disease of safflower.
- Based on disease reaction of selected differential lines of safflower using *Fusarium* isolates from Solapur, Tandur and ICAR-IIOR, Hyderabad centres under wilt sick pot study, six entries *viz.* SAF-P-1608, PBNS-154, 96-508-2-90, ISF-2258, GMU-3740 and ISF-28-15 showed variable reaction to wilt isolates from three locations indicating prevalence of races in major safflower growing areas of the country.
- After three years of evaluation, seven entries, SAF-1666, SAFG-1859, SAFG-1860, GMU-7868, GMU-7869, GMU-7885 and GMU-7917 were confirmed moderately tolerant to aphids under artificial screening.

Major Recommendations

- Released IGKV Kusum (RSS 2016-03), a spiny safflower variety for cultivation in Zone-II (Chhattisgarh and Madhya Pradesh).
- Released SSF-13-71 (Phule Bhivara), a spiny safflower variety for both rainfed and irrigated conditions in Maharashtra, Karnataka, Telangana and Andhra Pradesh (Zone-I).
- Released Chhattisgarh Kusum-1 (RSS 2012-11), a spiny safflower variety for rice based late sown conditions in Chhattisgarh.
- For effective and economical management of *Phytophthora* seedling blight, *Fusarium* wilt and *Macrophomina* root rot disease, safflower seed biopriming with *Trichoderma harzianum* Th4d WP @ 10 g/litre water for 12 hrs before sowing is recommended.

Linseed

- A total of 250 trait specific accessions were indented for import from USDA for diversification of genetic base of linseed, which include high oil (21); early maturing (23); bold seeded (20); low and high alpha linolenic acid (50); high seed number (32); Mediterranean-Argentinian seed flax (10); winter seed flax type (10) (for cold tolerance); spring seed types (10) (for heat tolerance); spring dual type (1); fibre flax types (10); Ethiopean forage type flax (2); yellow seeded types (32); wilt resistant (30) and six wild species (*Linum catharticum* L., *Linum flavum* L., *Linum bienne* Mill., *Linum tenuifolium* L., *Linum perenne* L., *Linum pallescens* Bunge).
- To diversify the source of low alpha linolenic acid (ALA), 10 germplasm accessions with near zero ALA (0.11-0.22%) were obtained from Plant Genetic Resources of Canada (PGRC), Ontario through ICAR-NBPGR, New Delhi and the seeds have been received and are being multiplied at ICAR-IIOR.
- A total of 203 diverse breeding lines/accessions were analysed for genetic variation for oil content and quality (fatty acid composition). Two lines *viz.,* LT 181 (64.2%) and LT 144 (61.6%) were found to be high oleic breeding lines; three lines *viz.,* LT 65 (45.7%), LT 66 (44.0%) and LT 142 (43.2%) possessed high linoleic types and seven high ALA lines {LT 122 (59.1%), LT 10 (58.9%), LT 11 (58.2%), LT 29 (58.4%), LT 40 (58.9%), LT 42 (58.3%), and LT 71 (58.2%)} were identified. Four genotypes, LT 66 (1.9%), LT 86 (5.7%), LT 89 (4.9%) and LT 181 (9.7%) with low ALA were also identified. Promising stable lines will be utilized in hybridisation programmes aiming at improvement of these oil quality traits in linseed.
- A total of 2885 accessions received from PC Unit, Kanpur were multiplied and evaluated for 17 key traits at three locations *viz.,* IGKV-Raipur, BAU-Ranchi and UAS-Raichur during *rabi* 2020-21 in a Augmented Design with appropriate checks. Promising lines for high capsule number, seeds/capsule, semi-dehiscent types, early maturity, bold seeds (>10 g/1000 seeds) flax types, dual purpose types, lines resistant to *Alternaria*, powdery mildew and wilt have been identified at UAS-Raichur and Raipur. Besides, 5886 accessions were maintained at 10 AICRP-Linseed centres as working collection.
- During 2020-21, a total of 386 crosses including interspecific crosses were made at nine centres. The major breeding objectives included combining early maturity with high seed yield, fibre yield, high oil

content, low linolenic acid and resistance/tolerance to *Alternaria* leaf blight, wilt, powdery mildew diseases and among the insect pests-resistance to bud fly and *Spodoptera* for rainfed, irrigated, and *utera* agro-ecological systems.

- F_1 progenies of 439 crosses, which include 49 double crosses were raised at 10 centres for further advancement. Progenies of 1608 crosses were advanced to next higher filial generation(s) and a large number of single plant selections (6517) in line bulks/progeny bulks (168) were made in different generations which will be raised during ensuing *rabi*-2021-22 for further selection. Ninety-one promising lines were identified with high yield potential from a total of 32 station trials comprising elite advanced breeding lines including checks conducted during *rabi* 2020-21.
- Six evaluation trials (IVT-Rainfed, IVT-Irrigated; AVT-Rainfed, AVT-Irrigated; IVT-Utera, AVT-Utera; IVT-Flax and AVT-Flax) were conducted at different locations and entries were found promising on the basis of their superiority (>10% higher over the best check of the zone) in seed and oil yields.
- In different evaluation trials, seven entries LCK 2037, BRLS 110-7, RL 18106, BAU 2019-13, RLC 184, SLS 134, and LMS 2018-R-6 in rainfed zone-I and four entries SLS 133, RLC 183, LCK 2037, RLC 184 in rainfed zone IIII were promoted to AVT-I on the basis of high seed yield (10% superior over the best check of the zone). Under irrigated conditions, two entries SLS 136, and BRLS 103-1 in zone-I and one BAU 2019-03 in zone III were promoted to AVT-I.
- Two entries, one in zone I (BAU 14-09) and zone III each (SLS 1220 were promoted to next advanced level of evaluation, i.e. AVT-II under rainfed situation. Similarly four entries each in zone-I (SLS 129, LCK 1901, RLC 178, LMS 2013-I-125) and zone-II (BRLS 121, BRLS 119, LMS 2017-I-07) were promoted to AVT-II on the basis of yield and oil yield superiority over the best check.
- Four promising genotypes, RLC 171 for Zone II; RLC 171 and SLS 122 for Zone-III (Rainfed), and BRLS 107-1 (Utera) were proposed and two entries, RLC 171 for Zone-III and BRLS 107-1 (Utera) were identified by the Varietal Identification Committee.
- Seven improved high yielding varieties, Kota Barani Alsi 6, RLC-161, and RLC-164 (for Himachal Pradesh, Punjab, Jammu for rainfed cultivation); RLC-167, Aparna (for cultivation under irrigation in Himachal Pradesh, Punjab, Jammu); and BUAT Alsi 4 (for cultivation under irrigation in Rajasthan, Madhya Pradesh, Maharashtra, Odisha, Chhattisgarh and Karnataka) were released and notified at central level and one high yielding variety Kota Barani Alsi 5 was released and notified for the state of Rajasthan.
- Breeder seed indents of 87.50 q for 26 varieties was received from DAC, GoI, New Delhi and accordingly 84.55 q was assigned as targets to the producing agencies. During *rabi* 2020-21, a total quantity of 120.71 q seed was produced.
- In irrigated linseed crop, for effective weed control efficiency, highest seed yield and economic returns from application of post emergence herbicide, clodinafop + metsulfuron methyl @ 0.06 + 0.004 kg a.i./ha (400 g/ha) at 2-3 leaf stage of weed (20-25 DAS) was found to be the best for controlling weeds.
- Soil application of $ZnSO_4$ @ 25 kg/ha and borax @ 1.5 kg/ha at the time of sowing proved to be beneficial for getting higher yield and net monetary returns in linseed and recommended at Palampur, Mauranipur, Raichur and Shillongani. Whereas soil application of borax @ 1.5 kg/ha + foliar application of borax @ 0.3% at 45 DAS with RDF was found as best treatment for higher economic returns and recommended for Kanke and Raipur.
- In linseed crop, foliar application of $ZnSO_4$ @ 0.5% (5 g/l of water) + borax @ 0.3% at 45 DAS with RDF was proved to be beneficial for higher seed yield and economic returns.
- Nutrient management through exogenous application of two sprays of Urea @ 2.0% + $ZnSO_4$ @ 0.5% at vegetative and reproductive stages was found the best fertilization option for *utera* condition of linseed and recommended for maximum yield and economic returns of linseed at Shillongani. Whereas two sprays of NPK 13:0:45 @1% + $ZnSO_4$ @ 0.5% at vegetative and reproductive stages was recommended for maximum yield and economic returns of linseed at Keonjhar.
- Auxin applied at vegetative and reproductive stages @ 2.0 ppm was found to be best treatment for recording highest seed yield and economic returns of linseed as compared to control and recommended at Raipur, Kanke, Sabour, Mauranipur, Shillongani and Keonjhar.
- In rice-linseed cropping system, sowing of direct seeded rice by conventional tillage with recommended dose of fertilizer + 2 t/ha FYM followed by sowing of linseed by zero tillage with residue by Happy seeder or conventional tillage with 60:30:30 kg NPK/ha + 2 t FYM was recommended for highest system productivity

and profitability of rice-linseed cropping system under conservation agriculture.

- Linseed crop was found to be the best predominant *rabi* crop and economically viable after paddy on economic return basis. Equivalent yield (kg/ha), production efficiency (kg/ha/day) and economic efficiency (net returns Rs/) was maximum in early maturity group of paddy-linseed cropping sequence.
- Six germplasm lines *viz.*, RLC 161, BRLS 112-2, SLS 108, RLC 153, RLC 157 and Padmini showed resistant reaction against wilt disease. Eight promising germplasm accessions (PCL 33, RLMS 11, LC 2279, Mutant-1, Mutant-2, Mutant-3, Mutant-4 and GS-144) were found highly resistant for powdery mildew disease.
- The reaction showed that Two entries, RLC 164 and RLC 157 were immune against *Alternaria* blight whereas NDL 2015-03, LCK 1707, JLS 95, RLC 143, RL 13165, TL 99, RLC 153, T 397 and Padmini showed resistant reaction.
- Seven germplasm accessions namely PKDL 72, Sheela, Nagarkota, BRLS 110-1, LC 2023, LCK 9320 and LC 2002 showed highly resistant reaction against rust disease, whereas 12 accessions (LMS 149-4, LMS 23-6, J 23, RLC 156, NDL 2014-1, RFC 2018-1, RLC 153, SLS 107, RLC 143, RLC 155, RLC 157 and RLC 265) were found to be resistant.
- The mean minimum per cent severity of the powdery mildew was noticed with two sprays of wettable sulphur (0.3%) with maximum yield and B:C ratio at Raichur and Nagpur centres. Two sprays of *P. fluorescens* or NSKE (0.5%) reduced the disease intensity and resulted in higher seed yield of linseed at Raichur and Nagpur centres, respectively.
- In the bud fly screening trial which comprised of 65 promising entries of linseed evaluated at multilocations and sown during second fort night of November to second fortnight of December indicated that bud fly infestation in test entries varied from 0 to 75.9% at different locations as compared to resistant (0 to 12.6%) and susceptible checks (2.0 to 60.4%). Minimum bud fly infestation of 9.6% (DLV-12), 0% (RL18106), (RCRL-20-2), 4.3% (BRLS-105) and 5.7% (RLC 183) was recorded at Nagpur, Raichur, Raipur, Mauranipur and Sabour, respectively.
- Population dynamics of linseed bud fly infestation (%) at different dates of sowing of the crop were conducted at Nagpur, Raipur, Sabour and Mauranipur indicated that at Nagpur, minimum (29.0%) bud fly infestation with a maximum seed yield of 915 kg/ha was recorded when the crop was sown at 15th November 2020. In Raipur, the infestation recorded was 15.7% and 23.1% during dough stage and before harvest when the crop was sown on 15th October.
- An observation trial on seasonal incidence of major insect pests and natural enemies of linseed was conducted at Raipur, Nagpur and Sabour. Linseed bud fly was identified as major insect pest in all the three locations. Bud fly infestation started from 52th SMW (Standard Metrological Week) at Nagpur; 3rd SMW at Raipur and 2nd SMW at Raipur and reached up to 58.1% at Nagpur during 8th SMW; 31.6% at Raipur during 10th SMW and 25.6 at Sabour during 10th SMW in Neelum variety whereas in the varieties, PVKNL260, Kiran and Sabour Tisi-1 in these locations, maximum bud infestation recorded was 26.4%, 20.4% and 8.6% during 8th 10th and 10th SMW.
- Released linseed varieties namely Divya, Garima, TL-99, Shekhar, Padmini and JLS-95 were screened for nutritional parameters for value addition. TL-99 recorded highest levels of protein, ash content, iron, potassium, zinc, MUFA and linoleic acid. Highest α-linolenic acid content was recorded in JLS-95 and lowest in TL-99 among the tested varieties.
- Suitable method of fortification of milk with omega-3 fatty acid along with vitamins and protein was developed maintaining healthy omega-6 to omega-3 ratio i.e. 2:1.
- A total of 418 front line demonstrations were conducted against 440 FLDs allotted. The improved technologies of whole package under irrigated, rainfed/limited irrigation and *utera* situations increased seed yield by 36.9, 36.6 and 39.7% and fetched an additional net income of Rs. 15,528, 9,579 and 5,999/ha, respectively. Under intercropping system, linseed+gram (4:2) increased the LEY by 47.6 % over local practice and had an additional net monetary returns and a IBCR of Rs. 37,180 and 7.71, respectively.
- A total of 385 FLDs each of 0.4 ha were conducted at seven locations spread over seven states *viz.*, Chhattisgarh, Odisha, Assam, Nagaland, Jharkhand, Madhya Pradesh and Maharashtra under TSP of AICRP on Linseed during *rabi* 2020-21. The improved technologies of whole package under rainfed/limited irrigation, irrigated, *utera* and new varietal condition increased the linseed yield by 44.0, 54.0, 28.2 and 38.7% and resulted in an additional net income of Rs. 11,124, 25,460, 4,362 and 27,820/ha with a IBCR of 2.98, 6.63, 3.03 and 7.55, respectively.

Major Recommendations

- Seven improved high yielding varieties, Kota Barani Alsi 6, RLC-161, and RLC-164 (for Himachal Pradesh, Punjab, Jammu for rainfed cultivation); RLC-167, Aparna (for cultivation under irrigation in Himachal Pradesh, Punjab, Jammu); and BUAT Alsi 4 (for cultivation under irrigation in Rajasthan, Madhya Pradesh, Maharashtra, Odisha, Chhattisgarh and Karnataka) were released and notified at central level and one high yielding variety Kota Barani Alsi 5 was released and notified for the state of Rajasthan.
- Application of post emergence herbicide clodinafop+metsulfuron methyl @ 0.06 + 0.004 kg a.i./ha (400 g ha-1) at 2-3 leaf stage of weed (20-25 DAS) is recommended in irrigated linseed crop.
- Foliar application of $ZnSO_4$ @ 0.5 % (5 g/liter of water) + Borax @ 0.3% (3 g/liter of water) at 45 DAS with RDF is recommended in linseed crop. Soil application of $ZnSO_4$ @ 25 kg/ha and borax @ 1.5 kg/ha at the time of sowing is recommended.
- Foliar application of 75 ppm Salicylic acid as plant growth regulator at vegetative and reproductive stage is recommended.
- Application of two sprays of Urea @ 2.0% + $ZnSO_4$ @ 0.5% at vegetative and reproductive stage; and two sprays of NPK 13:0:45 @1% + ZnSO4 @0.5% at vegetative and reproductive stage is recommended for higher yields and net returns.
- In rice-linseed cropping system, sowing of direct seeded rice by conventional tillage with recommended dose of fertilizer + 2 tons FYM followed by sowing of linseed by zero tillage with residue by Happy seeder or conventional tillage with 60:30:30 kg NPK/ha + 2 t FYM resulted in higher yields and net returns.
- Based on functional properties of flour and nutritional, microbial, texture analysis and sensory evaluation of bread, it is recommended that a 5% linseed powder with or without blended linseed oil can be considered for developing the value added bread for fortification of omega-3 fatty acid in bread.

ICAR-IIOR

Annual Report 2021

Institutional Activities

- Committees
- Extension and Other Outreach Activities
- Meetings, Events and Field Days
- Education and Training
- Awards and Recognitions
- Human Resource Development
- Publications
- On-going Research Projects
- Infrastructure Development
- Hindi Activities
- Promotions/Transfers/Superannuations
- Personnel
- Press Coverage

Committees

Research Advisory Committee

Dr. P. Raghava Reddy	Former Vice Chancellor ANGRAU, H.No. 3-1-5/41/G1, Sri Sai Nilayam, Attapur, Hyderabad-500 048	Chairman
Dr. B.B. Singh	Retd. ADG (O&P), ICAR, 281 Utsav 1 Apartment, Flat No. 201, Lakhanpur, Kanpur-208 024	Member
Dr. Sreenath Dixit	Principal Scientist & Head, ICRISAT Development Center (IDC), ICRISAT, Patancheru-502 324, Telangana	Member
Dr. V.G. Malathi	Retd. Principal Scientist, G1 Sree Kumaran Hill Crest Apartment, East GKS Avenue, Thondamuthur Road, Coimbatore-641 046, Tamil Nadu	Member
Dr. D.M. Hegde	Former Director, ICAR-IIOR, C-108, SMR Vinay Galaxy Hoody Junction, CTPL Road, White field, Mahadevapura, Bengaluru-560 048	Member
ADG (O&P)	ICAR, Krishi Bhawan, New Delhi-110 001	Member
Director	ICAR-IIOR, Rajendranagar, Hyderabad-500 030	Member
Dr. P.S. Srinivas	Principal Scientist (Agricultural Entomology), ICAR-IIOR, Rajendranagar, Hyderabad-500 030	Member-Secretary
Shri Kondela Saya Reddy	H.No. 11-1-1815, Maruthi Nagar, Nizamabad-503 002, Telangana	Ex-officio Member
Shri K. Yadagiri Reddy	H. No. 16-2-751/C/14, FF-1, Shreys Apartment, Asmangad, Malakpet, Hyderabad-500 036, Telangana	Ex-officio Member

Institute Management Committee

Director	ICAR-IIOR, Rajendranagar, Hyderabad-500 030	Chairman
ADG (O&P)	ICAR, Krishi Bhavan, New Delhi-110 001	Member
Shri Koti Lingam	Regional Manager, Telangana State Seed Development Corporation Ltd., Jeedimetla, Qutubullapur Mandal, Ranga Reddy-500 055, Telangana	Member
Director of Agriculture	Department of Agriculture, Sheshadri Road, K.R. Circle, Bengaluru-560 001, Karnataka	Member

Dr. R. Jagadeshwar	Director of Research, Prof. Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad-500 030, Telangana	Member
Shri K. Yadagiri Reddy	H.No. 16-2-751/C/14, FF-6, Shreys Apartments, Asmangad Malakpet, Hyderabad-500 036, Telangana	Member (Non-official)
Shri Kondela Saya Reddy	H.No. 11-1-1815, Maruthi Nagar, Nizamabad-503 002, Telangana	Member (Non-official)
Dr. C. Aruna	Principal Scientist (Plant Breeding) ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad-500 030, Telangana	Member
Dr. Pankaj Sharma	Principal Scientist (Plant Pathology) ICAR-Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur-321 303, Rajasthan	Member
Dr. K. Sammi Reddy	Head of the Division I/c, Division of Resource Management, ICAR-Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad-500 059, Telangana	Member
Dr. A.K. Singh	Head (Agricultural Engineering), ICAR-Indian Institute of Sugarcane Research, Rae Bareli Road, Lucknow-226 002, Uttar Pradesh	Member
Finance & Accounts Officer	ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad-500 030, Telangana	Member
Shri Shitanshu Kumar	Senior Administrative Officer, ICAR-IIOR, Rajendranagar, Hyderabad-500 030, Telangana	Member-Secretary

Extension and Other Outreach Activities

Activities under Tribal Sub Plan (TSP)

Tribal sub-plan programme was implemented in 24 aspirational districts in 9 states viz., Telangana, Andhra Pradesh, Assam, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Nagaland and Odisha. A total of 1635 scheduled tribe farmers were benefited. Tribal farmers in aspirational districts were encouraged to take up traditional oilseed crops *viz.*, safflower, sesame, niger and linseed by providing improved seed of safflower (ISF-764), sesame (JCS-1020 and YLM-66), niger (KGN-2) and linseed (NL-260, RLC-92 and RLC-131). In addition, group discussions, training programmes and demonstrations on linseed, safflower, sesame and niger crop production were organized.

Input and literature distribution among beneficiary farmers in Visakhapatnam

Training programmes on sesame cultivation and distribution of sprayers in Vizianagaram

Trainings: Two trainings *viz.*, "On-Farm Training on Post-Harvest Technologies of Safflower Seed Production" at Bamni Thanda, Tanur mandal, Nirmal district, Telangana (March 17, 2021) and "On-farm Training on Sesame Seed Production" at Panduguda village, Sirikonda mandal, Adilabad district, Telangana (March 23, 2021) were conducted. The tribal farmers in Bamni Thanda and Panduguda village took up sesame and safflower seed production in about 20 and 40 acres, respectively as part of seed village concept for maintaining community seed bank at village level. Under the TSP programme, safflower and sesame seeds were distributed with the help of Department of Agriculture, Telangana. Awareness camp and orientation programme on seed production of safflower and sesame were conducted. To support tribal farmers, battery operated sprayers and tarpaulins were distributed.

On-farm training for tribal farmers on post-harvest technologies of safflower seed production

On-farm training for tribal farmers on sesame seed production

Activities under Scheduled Caste Sub Plan (SCSP)

A total of 900 SC farmers were provided with critical inputs for oilseed cultivation such as improved castor hybrid (ICH-66), safflower variety (ISF-764), sesame variety (JCS-1020) and groundnut variety (Kadiri Lepakshi). In order to encourage crop diversification, awareness was created on vegetable crops for SC women and crates were provided for the SC farmers cultivating vegetables. Dragon fruit saplings, poles and rings were provided to farmers to encourage dragon fruit cultivation. The farm labourers and farm women were provided with battery-cum-manual operated sprayers, weeders, gorru (cultivator), tarpaulins, drums, overhead water tanks and carrying pipes. Awareness was created among SC communities on improved cultivars, nutrient management, pest and disease management of oilseed crops as well as on consumption of quality oil in their households, preparation of chikkies, bakery items and oil expelling.

Distribution of critical inputs to SC beneficiaries

Training programmes organized for SC beneficiaries on oilseed production technology

Activities in NEH Region (NEHR)

ICAR-Research Complex for NEHR, Tadong, Sikkim

Sunflower: A field study was carried out to evaluate the seed yield potential of nine sunflower culivars (LSFH-171, PSH-2080, RSFH-1887, COSFV-5, DRSH-1, COH-3, CO-2, PSH-1962 and KBSH-78) under organic cultivation at the Research Farm of ICAR Research Complex for NEHR, Tadong, Sikkim during rabi season of 2019-20. Seed yield of the cultivars ranged from 17 to 25 q/ha. Among cultivars, KBSH-78 (25 q/ha) and LSFH-171 (23 q/ha) were promising for seed yield.

Sunflower crop at station trial at Tadong, Sikkim

Farmers' visit to the sunflower trial at Tadong, Sikkim

Sesame: Performance of 10 sesame varieties (VRI-3, TMV-7, VRI(SV)-1, VRI(SV)-2, Prachi, Amrit, Swetha, DS-5, DSS-9 and GT-10) was tested under organic cultivation at the Research Farm of ICAR Research Complex for NEHR, Tadong, Sikkim. Seed yield of the varieties ranged from 7 to 10 q/ha. Among varieties, GT-10 (10 q/ha), TMV-7 (9 q/ha) and VRI(SV)-2 (9 q/ha) were promising for seed yield.

College of Agriculture, Lembuchera, Tripura

A set of 12 varieties of sesame (TRC-1-8, GT-10, Prachi, TMV-7, VRI(SV)-1, VRI(SV)-2, CUMS-17, Amrit, DS-5, DSS-9, VRI-3 and Swetha) were tested during summer in Lembuchera situation in Tripura. Maturity ranged from 73 to 110 days. Seed yield ranged from 549 to 948 kg/ha; CUMS-17 recorded higher seed yield (948 kg/ha) over the other varieties.

School of Agricultural Science and Rural Development, Medziphema, Nagaland

Sunflower: A set of nine sunflower cultivars (PSH-2080, COH-3, DRSH-1, RSFH-1887, CO-2, COSFV-5, PSH-1962, KBSH-78 and LSFH-171) were evaluated at SASRD, Medziphema in Nagaland during rabi 2020-21 for the purpose of identifying suitable sunflower cultivar for rice fallows during winter. Maturity ranged from 113 to 128 days. Seed yield ranged from 308 kg/ha to 570 kg/ha. The hybrid, LSFH-171 recorded higher seed yield (570 kg/ha) over other cultivars.

Sesame: A set of 11 varieties of sesame (VRI-3, TMV-7, VRI(SV)-1, VRI(SV)-2, Prachi, Amrit, Sweta, DS-5, DSS-9, GT-10 and Suprava) were evaluated at Medziphema in Nagaland for the purpose of identifying suitable variety for summer season. Maturity ranged from 100 to 119 days. Seed yield ranged from 323 to 570 kg/ha. The variety, Suprava recorded higher seed yield (570 kg/ha) over other varieties.

Sesame crop at Lembuchera, Tripura

Sunflower crop at SASRD Medziphema, Nagaland

ICAR-Research Complex for NEHR Basar, Arunachal Pradesh

Sesame: A total of 13 varieties (VRI-3, TMV-7, VRI(SV)-1, VRI(SV)-2, Prachi, Amrit, Swetha, DS-5, DSS-9, GT-10, CUMS-17, Namsai local and Khasi local) were evaluated at the research farm (Gori) of ICAR-RC AP centre, Basar. Maturity ranged from 108 to 161 days. Seed yield ranged from 33 to 1422 kg/ha. The variety, Prachi recorded the highest seed yield (1422 kg/ha) followed by Khasi local (789 kg/ha), Namsai local (649 kg/ha) and Amrit (424 kg/ha).

Sesame trial at Basar centre, Arunachal Pradesh

Mera Gaon Mera Gaurav (MGMG)

A total of 230 activities including awareness creation (21), domonstrations (50), interface meetings (18), literature support (13), visit to village by teams (32) and mobile based advisories (96) were taken up under MGMG programme. Overall, 2479 farmers were benefitted.

Activities under MGMG programme

Capacity Building and Technology Dissemination

Sixteen training programmes were organized by ICAR-IIOR, which benefited more than 1000 personnel including scientists, entrepreneurs, farmers and school children. Details are provided below.

Name of the training programme	Venue	Period	Stakeholders	No. of beneficiaries
Assessment of Irrigation Water Quality for Soil and Plant Health Management under DBT sponsored Biotech-KISAN project	ICAR-IIOR, Hyderabad	January 19-20, 2021	Farmers	15
Safflower Field Day	Gadikeshwar village, Chincholi taluq, Kalaburagi (Gulbarga) district, Karnataka	January 23, 2021	Farmers, KVKs, ATMA, ATARI and Department of Agriculture	400

Name of the training programme	Venue	Period	Stakeholders	No. of beneficiaries
Post-Harvest Technologies of Castor Hybrid Seed Production	Cherukuru village, Veldanda mandal, Nagarkurnool district, Telangana	March 06, 2021	Farmers and Seed growers	70
Safflower Seed Production Technologies	Mariapur village, Pudur mandal, Vikarabad district, Telangana	March 10, 2021	Farmers and Seed growers, Department of Agriculture, KVK, ATMA and Grameen Mall (NGO)	350
Post-Harvest Technologies of Safflower Seed Production	Bamni Thanda, Tanur mandal, Nirmal district, Telangana	March 17, 2021	Farmers, Seed growers, Department of Agriculture and NGO	90
Sesame Seed Production	Panduguda village, Sirikonda mandal, Adilabad district, Telangana	March 23, 2021	Farmers, seed growers, Department of Agriculture and KVKs	100
Promotion of Castor for Crop Diversification and Higher System Productivity in South-West Haryana: Scientific Cultivation of Castor in Haryana	Online	August 25, 2021	Farmers, Department of Agriculture and Seed dealers	190
Promotion of Safflower for Crop Diversification and Higher System Productivity in Chhattisgarh and Madhya Pradesh: Orientation Training Programme on Safflower Cultivation for Higher Productivity and Profitability	Online	September 24, 2021	Farmers, Extension Personnel and KVKs	340
Molecular Breeding Approaches and Tools	Online	September 29-October 01, 2021	Breeders of AICRP-Oilseeds	103
Product Profile Development, Trial Management, Digitization of Plant Breeding Experiments and Variety Release System	Online	October 11, 2021	Scientists of AICRP-Oilseeds	100
Promotion of Safflower Crop Diversification and Higher System Productivity in Maharashtra	Online	November 22, 2021	Farmers, ATMA, KVKs and Department of Agriculture	200
Co-cultivation of Honey Bees with Sunflower Crop	Chinnakodur, Siddipet, Telangana	September 16, 2021	Officials of Department of Agriculture, Representatives of Private Seed Companies, Scientists of ICAR-IIOR, Public Representatives and Farmers	200

Name of the training programme	Venue	Period	Stakeholders	No. of beneficiaries
Awareness on Consumption of Millets and Distribution of Millets to Girls	Government Girls Primary and High Schools, Chinnakodur, Siddipet, Telangana	September 16, 2021	School children	600
Mass Production and Formulation of *Bacillus thuringiensis*	ICAR-IIOR, Hyderabad	September 27-30, 2021	Licensee of DOR Bt-1 technology	3
Management of FPO Activities	Chinnakodur, Siddipet, Telangana	September 29, 2020	Directors of Chinnkodur FPO, Progressive Farmers and Department of Agriculture	20
Development of Business Plan for the FPO	Chinnakodur, Siddipet, Telangana	December 28, 2021	Directors of Chinnakodur and Narayanraopet FPOs, Progressive farmers and Department of Agriculture	35

On-farm training on post-harvest technologies of castor hybrid seed production

Hands-on training on assessment of irrigation water quality for soil and plant health management

Participation in Exhibition/Kisan Melas

ICAR-IIOR participated in the 5th International Agronomy Congress organized by Indian Society of Agronomy, New Delhi and PJTSAU, Hyderabad during November 23-27, 2021. More than 1000 delegates visited ICAR-IIOR stall, which was awarded 3rd prize.

ICAR-IIOR Stall at 5th International Agronomy Congress

National Agricultural Innovation Fund (NAIF) Activities

Technology licensing and commercialization: An amount of Rs. 5.0 lakh was generated through licensing of DOR Bt-1 technology to private firms namely M/s PJ Margo Pvt. Ltd., Bengaluru and M/s Gujarat Eco Microbial Technologies Pvt. Ltd., Vadodara, Gujarat. Licensing agreements were signed on June 25, 2021 through a virtual meeting.

Training of PJ Margo personnel on Bt-1 technology

Intellectual Propperty Rights (IPR)

Patents granted: A patent (No. 359123) entitled "Identification of Thermo-Tolerant Trichoderma for Use as Bio-Control Agent under Heat Stress Condition" was granted on February 23, 2021.

Patents in progress: Patent application entitled "A Novel Composition Comprising Thermo Tolerant and Saline Tolerant *Trichoderma asperellum* 673" hearing was held on August 20, 2021. An application entitled 'A Polymer Composition and a Process for its Preparation' was submitted to the Indian Patent Office on April 01, 2021.

Permanent registration: Application for 9(3) permanent registration of *Bacillus thuringiensis* var. *kurstaki* 0.5% WP, *Beauveria bassiana* 30% SC and Th4d WP formulations to Central Insecticides Board and Registration Committee (CIB & RC), Department of Agriculture and Farmers Welfare, Government of India.

Memorandum of Understandings (MoUs)

ICAR-IIOR signed MoUs with Koneru Lakshmaiah Education Foundation (KLEF), Hyderabad (February 10, 2021), Grameen Mall Foundation, Hyderabad (March 04, 2021) and Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra (March 22, 2021).

MoU with Grameen Mall Foundation

MoU with VNMKV, Parbhani

Agri-Business Incubation Unit

Activities on value addition in oilseeds including (i) capacity building programme on value addition in oilseeds to Agricultural Extension Officers, Vikarabad district (February 16, 2021), (ii) linseed-value addition (July 06, 2021), (iii) training on value addition in oilseeds and pulses towards doubling of farmers' income (December 05, 2021) and (iv) hands on experience in processing of oilseeds (December 28, 2021) were conducted.

Value addition in oilseeds towards doubling of farmers' income

Visit of Shri Narendra Singh Tomarji, Hon'ble Minister for Agriculture and Farmers' Welfare, Govt. India to ICAR-IIOR

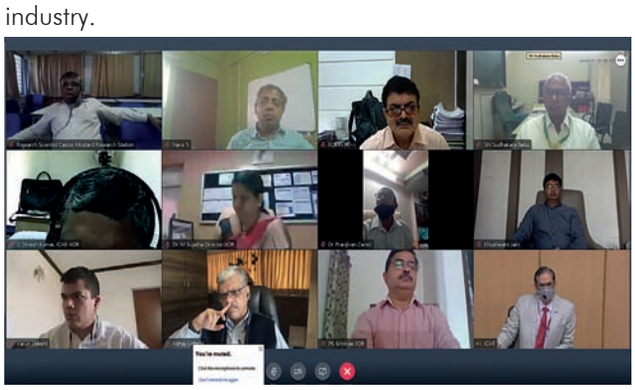
Meetings, Events and Field days

Meetings

Webinar on 'Industry-Academia Interface to Formulate a Roadmap to Increase Domestic Production of Castor Oil Derivatives'

An online webinar on "Industry-Academia Interface to formulate a Roadmap to Increase Domestic Production of Castor Oil Derivatives" was organized on February 23, 2021 in association with Solvent Extractors Association (SEA), Mumbai under the chairmanship of Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR. The meeting was attended by representatives from leading industries involved in production of castor oil and its derivatives (Jayant Agro-Organics, Royal Castor), SEA, scientists from academia and research institutes such as CSIR-IICT, ICAR-IIOR, SAUs, Central Silk Board, Bengaluru, IIT-New Delhi, and Indian Institute of Petroleum, Dehradun, institutions engaged in market mapping such as Indian Oilseeds and Produce Export Promotion Council (IOPEPC), National Institute of Agricultural Marketing (NIAM), Jaipur, Castor Oil India and consumers of derivatives such as IOC, BPCL, *etc*.

Major recommendations of the meeting were (1) support to industry by handholding to compensate for higher costs incurred towards non-tariff barriers, (2) incentivizing exports of higher order derivatives to make India globally competitive, (3) compensating for the higher import tariffs for derivatives imposed by importing countries, (4) speedy environmental clearances for production of new castor-based products and flexibility to switch between products falling within the approved norms of pollution parameters to shift as per the dynamic global demand, (5) regulating imports based on domestic supply and demand gap through quantitative restrictions, (6) higher import duty on sebacic acid to protect and promote absorption of Indian sebacic acid, (7) market creation and promotion for consumption of value-added derivatives and branding for encouraging derivatives industry for "Make in India" compliance, (8) favorable domestic policies for incentivizing the use of green chemistry to give a fillip for using castor oil derivatives in industries, (9) creation of Centre of Excellence for development of demand driven high value derivatives and new applications through public private partnerships and joint ventures, (10) Govt. support for capital and interest on investment, (11) promotion of only green chemistry products, (12) creation of robust database and setting up of Market intelligence-based Decision Support System, (13) stability in castor production through continued technological upgradation of improved varieties, quality seed, best management practices, capacity building and improving resource use efficiency, and (14) ensuring higher profitability through stable markets and higher prices, expansion of value addition through eri-culture and eri-pupae for fashion and food industry; detoxification (ricin and RCA) of castor cake and nutrient rich de-oiled meal for supporting feed industry.



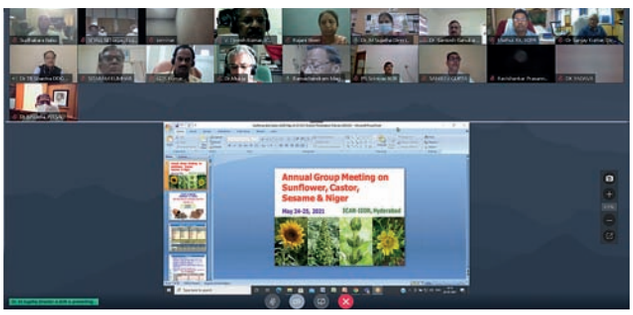
Industry-Academia interface meeting on castor oil derivatives

Annual Group Meeting of AICRP on Sunflower, Castor, Sesame and Niger

The Annual Group Meeting of Sunflower, Castor, Sesame and Niger was organized during May 24-25, 2021 through online. Dr. T. Mohapatra, Secretary, DARE and DG, ICAR was the chief guest. Inaugural session was held on May 24, 2021 under the chairmanship of Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi and co-chaired by Dr. Sanjeev Gupta, ADG (O&P), ICAR, New Delhi. Dr. M. Sujatha, Director, ICAR-IIOR, Hyderabad presented research highlights of AICRP on castor and sunflower. Dr. Rajani Bisen, In-charge, PC Unit, Jabalpur presented significant achievements of AICRP on sesame and niger.

Major recommendations of the meeting were (i) acceleration of utilizing the germplasm resources including those which are imported and integration of innovative breeding methods, (ii) yield targets in the breeding programmes must be revisited, (iii) exploitation of microbial biocontrol agents to tackle pests and diseases of oilseed crops, (iv) designing of appropriate experiments for a better impact on rainfed ecology, (v) area expansion in rice-fallow has to be intelligently designed to supplement/complement pulses and (vi) apiary must become a part of the crop management, which besides increasing yield of the oilseed crops, increases the income of the farmers as well.

Specific recommendations on castor programme were (1) it is important to standardize the expression of pistillate



Annual Group Meeting of AICRP on Sunflower, Castor, Sesame and Niger

character and production of environmentally sensitive interspersed male flowers in pistillate lines so also the extent of male flowers in monoecious lines across the year for all pre-release or identified hybrids. This will facilitate in defining the methods of maintenance and multiplication of parental lines more accurately, (2) intensification of breeding for gray mold resistance, (3) identification of newer and more efficient herbicides for weed management in consultation with ICAR-DWSR, Jabalpur, (4) seed and soil treatment of fungal biocontrol agent, *Trichoderma harzianum* to be included apart from the fungicide treatment in on-farm validation trial for management of castor *Fusarium* wilt, (5) inclusion of pheromone trap catches as a monitoring tool in the insecticide evaluation trials and (6) exploring the possibility of developing whitefly damage scale by combining injury grade on foliage and nymphal counts of whiteflies on the plant.

Specific recommendations on sunflower programme were (1) studies on improvement of fertilizer use efficiency and factor productivity should be made with proper benchmarking and background to assess the changes over the years, (2) an operational research is needed for maximizing production of sunflower under rainfed condition by integrating with *in situ* moisture conservation and supplemental irrigation at critical stages with rainwater harvesting, (3) new developments in soluble fertilizers and nano fertilizer products can be assessed in sunflower nutrition, (4) yield gap and adoption rate of technologies with farmers to be studied using large data in FLDs to identify specific opportunity and policy support for crop expansion, (5) encouragement of staggered cluster planting of sunflower for longer period of honey harvesting, (6) application of PGPR as first spray and combination fungicide as second spray may be tested for management of leaf blight, powdery mildew diseases of sunflower, and (7) identified leafhopper resistant lines may be utilized in breeding programme to develop resistant cultivars.

Specific recommednations on sesame and niger programmes were (1) ICAR-IIOR should initiate major research programmes in sesame and niger, (2) the AICRP must meet the requirements of DAC indents of sesame and niger and (3) biomolecules that would add value must be discovered in these minor oilseed crops and a clear roadmap should be developed for the value addition of these crops.

IRC Meeting

Dr. M. Sujatha, Director (A), ICAR-IIOR chaired the IRC-2021 meeting of kharif season. The sessions were conducted on June 10-14, 22, 26 and July 03, 2021. Ongoing projects and new project proposals were presented and technical programme for 2021-22 was finalized.

Review Meeting on Promotion Criteria in AICRP on Sunflower, Castor, Safflower, Sesame, Niger and Linseed

A meeting to review the existing criteria for promotion/ identification of entries in the AICRP on different oilseed crops was held June 17, 2021 under the chairmanship of Dr. D.M. Hegde, Former, Director, ICAR-IIOR. Dr. M. Ramachandram, PS (Retd.), ICAR-IIOR, Dr. Y.G. Prasad, Director, ICAR-CICR, Nagpur; Dr. G. Uma Devi, Professor and Head, PJTSAU, Hyderabad; Dr. A.J. Prabakaran, PS, ICAR-SBI, Coimbatore and Dr. Rajani Bisen, I/c PC, AICRP (Sesame & Niger), JNKVV, Jabalpur were the members. All the breeders working on AICRP on sunflower, castor, safflower, sesame, niger and linseed participated. Dr. M. Sujatha, Director, ICAR-IIOR and Member Secretary presented the existing criteria for promotion/identification in these crops. Crop-wise discussions and suggestions for revision of criteria were made. Based on the deliberations and recommendations, the revised criteria were finalized.

Stakeholders Meeting on Linseed Value Addition

A stakeholders meeting on linseed value addition was organized (through online and physical mode) on July 06, 2021. About 100 participants including agribusiness start-ups, incubatees, established health food based women entrepreneurs and linseed researchers across the country attended the meeting. A number of linseed based culinary products *viz*., linseed "laddu" fortified with groundnut, sesame dry fruits, and grated copra prepared with jaggery or honey and in combination; dry linseed powder (chutney) prepared by AICRP-Linseed centre, Nagpur; Omega-3 enriched eggs, flax seed oil capsules enriched with natural vitamin, oil emulsions, linseed massage oil from AICRP-Linseed centre, BVDU, Pune were exhibited. A new flax fibre extraction prototype machine, extraction of yarn and fabric from flax, and successful blends optimized with cotton to manufacture linen threads, and linen based fabrics were discussed.

Interface Meeting on Export Quality Sesame Seeds

An interface meeting on export quality of sesame seeds was organized on July 27, 2021 by ICAR-IIOR in association with IOPEPC, Mumbai to boost the export of sesame to harness the opportunity and regain the lost ground in sesame exports. A total of 77 participants (farmers, researchers, industry and certification bodies) from across the country and a few international participants attended the meeting. Dr. Arvind Kumar, Vice Chancellor, RLBCAU, Jhansi was the Chief Guest and Dr. Sanjeev Gupta, ADG (O&P), ICAR, New Delhi chaired the proceedings. Presentations from stakeholders on value chain, production technologies, industry perspective, potential and requirements for export, quality, safe storage and packaging standards, organic certification processes, farmers, traders and aggregators' perspective, *etc*. were discussed. Based on the deliberations, the meeting came up with recommendations on the industry requirements and interventions to be made in research, policy and extension for export promotion of sesame.

Annual Group Meeting of AICRP on Safflower and Linseed

The Annual Group Meeting on Safflower and Linseed was organized on August 18, 2021 under the chairmanship of Dr. T.R. Sharma, DDG (CS), ICAR, New Delhi. Dr. Sanjeev Gupta, ADG (O&P), ICAR, New Delhi co-chaired the session. Dr. M. Sujatha, Director (A), ICAR-IIOR, Hyderabad presented the research highlights of AICRP on Safflower and Linseed during 2020-21. Three technical bulletins *viz.*, 'Diversified Uses of Linseed', 'Value Added Products of Linseed' and 'Value Addition and Diversified Uses of Safflower' were released during the occasion.

Significant acheivements of safflower programme were (i) notification of three new varieties (IGKV Kusum, SSF-13-71 and Chhattisgarh Kusum-1), (ii) development of four varieties and one hybrid in the pipeline and (iii) development of a bio-priming technology for management of *Phytophthora* seedling blight, *Fusarium* wilt and *Macrophomina* root rot disease. Significant achievement of AICRP-Linseed were (i) identification of two varieties *viz.*, RLC 171 for Zone I/II and BRLS 107-1 for *Utera* cultivation and (ii) multiplication of 2885 germplasm accessions at three locations (Raichur, Raipur and Kanke). Major recommendations for safflower and linseed programmes were (i) strengthening institute-industry interface in production and value addition/chain of safflower and linseed, (ii) area expansion of safflower in potential/non-traditional niches especially rice-fallow areas, (iii) speed breeding tools to be exploited for accelerating advancement of materials, and (iv) expediting MAS activities.

Annual Group Meeting of AICRP on Safflower and Linseed

Stakeholders Interaction Meeting on Sunflower Seed Availability

As per the recommendation of ICAR-Regional Committee Meeting of Region VIII held on September 14, 2021 a "Stakeholders Interaction Meeting on Sunflower Seed Availability" was jointly organized by ICAR-IIOR, Hyderabad and UAS, Bengaluru on October 29, 2021 through online. The meeting was chaired by Dr. Sanjeev Gupta, ADG (O&P), ICAR, New Delhi; co-chaired by Dr. Rajendra Prasad, Vice Chancellor, UAS, Bengaluru and coordinated by Dr. M. Sujatha, Director, ICAR-1IOR, Hyderabad. More than 60 participants including sunflower breeders from ICAR-IIOR and AICRP (Sunflower); Vice Chancellors and Directors of Research from SAUs; seed officers, seed hubs, private institutions involved in sunflower hybrid development and seed production; state seed corporations; Directors of Agriculture; FPOs and individual seed growers producing sunflower hybrids, *etc*., participated. Several recommendations with respect to seed availability and policy were made to meet the growing demand of sunflower seeds.

Events

National Science Day

The National Science Day was celebrated on February 27, 2021, as February 28, 2021 was Sunday. The programme was organized in two sessions through video conferencing. Padma Bhushan Dr. (Prof.) P. Balaram, former Director of Indian Institute of Science (IISc), Bengaluru delivered an invited talk on "Chemistry, Biology, the Unity of Nature". Professor Balaram highlighted that one has to take into account the principles and interaction that takes place among physical entities to understand the biological mechanisms in its true sense. Students of Koneru Lakshmaiah Educational Foundation (KLEF), Hyderabad centre showcased their technology during the occassion.

International Women's Day

The International Women's Day was celebrated on March 8, 2021 under the theme of "Women Leadership in Agriculture-Entrepreneurship, Equity and Empowerment" as per the guidelines of ICAR. A series of events were conducted including quiz competition and Just-a-Minute debates. An online interaction meeting with Smt. P. Kondaveeti Satyavati, Director, Bhumika Women's Collective, an NGO, was organized. Three women farmers *viz.*, Smt. G. Rani Pramesh, Smt. Latha Maneppa and Smt. Sujatha Nagesh from Nizamabad district who have contributed immensely to the spread of improved technologies of different oilseed crops like castor and sunflower were felicitated and complimented for their leadership role in inspiring other women farmers towards agriculture. Two eminent retired principal scientists of ICAR-IIOR, Dr. P.S. Vimala Devi and Dr. K. Anjani were also felicitated in recognition of their significant role in entrepreneurship of biopesticides and high oleic safflower variety, respectively.

Felicitating progressive women farmers

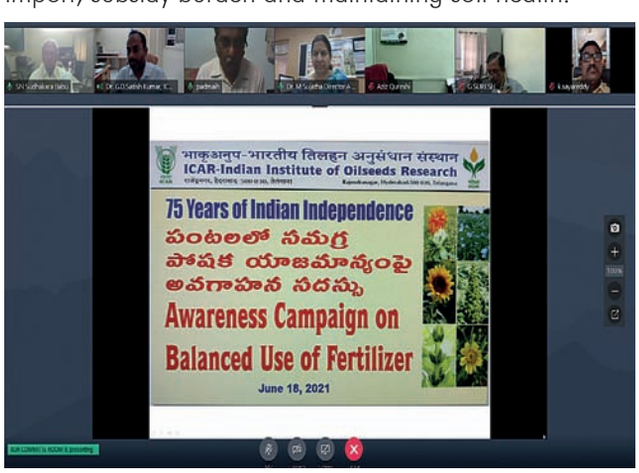
World Water Day

The World Water Day (Theme: Water and Sanitation for all by 2030) was celebrated by hosting interaction meetings with farmers, students and scientists during March 2021. The main event was organized on March 22, 2021 with the lecture of Dr. A.S. Dhawan, Vice-Chancellor, VNMKV, Parbhani on the topic "Optimizing Water Use in Agriculture". Dr. Dhawan deliberated the importance of raising public awareness about the importance of water as a precious natural resource, enacting stringent policy for efficient use and reuse of water in agriculture, urban and industrial needs, adoption of rainwater harvesting, storage and efficient methods of utilization, etc. Prizes were distributed on the day to the winners of quiz competition conducted for school children during the week in connection with the occassion.

Lecture on 'Optimizing Water Use in Agriculture'

Farmers' Awareness Campaign on Balanced Use of Fertilizers

ICAR-IIOR organized an awareness campaign on Balanced Use of Fertilizers on June 18, 2021 through virtual mode to the farming community. Shri K. Saya Reddy, Member, IMC, ICAR-IIOR and All India Secretary, Bharatiya Kisan Sangh, Nizamabad, Telangana was the Chief Guest. Dr M. Sujatha, Director (A), ICAR-IIOR presented the background and relevance of balanced use of fertilizers for increasing crop productivity, reducing import, subsidy burden and maintaining soil health.



Some important issues on the soil nutrient management including (i) soil organic matter and soil test based fertilizer application in increasing crop production, (ii) drip fertigation to achieve higher nutrient and water

use efficiency, (iii) opportunities for efficient recycling of crop residues through *in situ* and *ex situ* composting methods besides alternate uses as biochar, pulp and paper industry, lignins etc., (iv) methods of soil sampling, techniques for assessment of soil pH, organic carbon, major and secondary nutrients and soil quality and the importance of soil health cards and (v) preparation of some organic concoctions for micronutrients and plant protection using available local resources were discussed. Four progressive farmers Shri P. Shekar and Shri Arjun Rao from Telangana, and Shri G.R. Prasad and Shri P. Ramanjaneyulu from Andhra Pradesh were awarded certificates of appreciation for using soil testing kits and aiding the local community. In virtual mode, about 15 farmers groups (85 persons) and scientists/officers participated in the programme.

International Yoga Day

The International Yoga Day was celebrated on June 21, 2021 with the theme "Yoga for Well-Being". The benefits of practising Yoga on health, happiness and well-being were explained and demonstrated through online mode as per the guidelines issued by the Ministry of AYUSH, Govt. of India. The staff members were guided online to perform yoga session by Shri K. Ramakrishna, Yoga Guru, Learn Easy Yoga Center, Attapur, Hyderabad.

ICAR-IIOR Foundation Day

The 44th Foundation Day of ICAR-IIOR (August 01, 2021) was celebrated on August 2, 2021. Dr. Raghava Reddy, former Vice Chancellor and Chairman, RAC, ICAR-IIOR was the chief guest. The Foundation Day Lecture was delivered by Dr. Sekhar Boddupalli, Varenya Bio, USA on the topic "Sustainable Agriculture Innovations" through online. He highlighted how the cutting edge technologies like 'genome editing' provide solutions to agricultural problemes and help improving productivity. Another lecture on "Techniques to Beat the Stress Levels at Work Place" was delivered by Shri Sureh Purini, Heartfulness Institute, Hyderabad. During the occasion, awards to the best workers, research paper etc., were presented and the IIOR staff completing 25 years of service were felicitated.

Parthenium Awareness Week

Parthenium Awareness Week was organized during August 16-22, 2021. Awareness programme cum Interaction meetings on Parthenium were organized at ICAR-IIOR and the villages in Vikarabad district adopted under the Farmers' First programme.

Parthenium awareness activities at ICAR-IIOR farm and villages

Swachhta Pakhwada

Swachhta Pakhwada activities were conducted at ICAR-IIOR from December 16-31, 2021. *Swachhta* pledge and *swacchhta* swareness March was organized followed by cleaning activities at the institute and the schools under MGMG adopted villages. Lectures on "Effect of Weeds on Environment" by Dr. G. Suresh, Principal Scientist, ICAR-IIOR, Hyderabad and "Groundnut Quality and Value Addition" by Dr. Mahesh Mahatma, Principal Scientist, ICAR-NRC on Seed Spices, Ajmer were arranged.

Swachhta pledge

Promoting clean and green technologies for kitchen garden

Azadi Ka Amrut Mahotsav

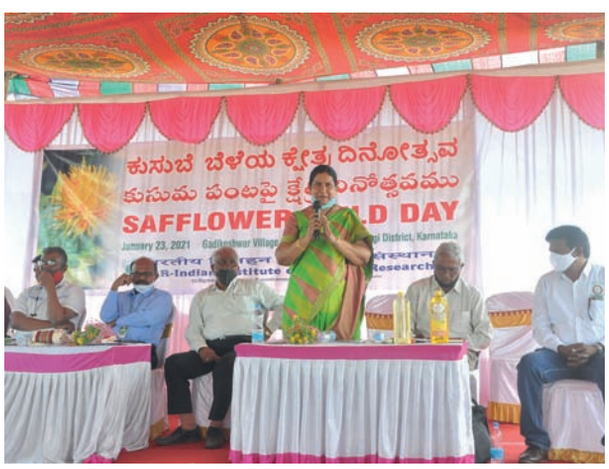
Ten webinars were organized to commemorate 75 years of India's Independence. Scientists of ICAR institutes, agri-business start-ups, women entrepreneurs, *etc*., participated in the webinars.

Topic	Expert(s)	Date
New Farm laws: Misconceptions and Reality	Dr. A. Amarender Reddy, Principal Scientist (Agricultural Economics), ICAR-CRIDA, Hyderabad	July 03, 2021
Linseed Value Addition Meet	Dr. Beena Nair, Linseed Breeder, PDKV, Nagpur Dr. Anand Zanwar, Linseed Value addition Centre of AICRP, BVDU, Pune Dr. D. Payasi, Linseed Breeder, JNKVV, Sagar Dr. Nandan Mehta, Linseed Breeder, IGKVV, Raipur Dr. Suma Mogali, Linseed Breeder, UAS, Dharwad	July 06, 2021
Role of FPOs in Promoting Farmer-Centric and Sustainable Agribusiness Models	Smt. Gijivisha Khattry Shri A. Ravindra, Watershed Support Service and Activities Network (WASSAN), NGO, Hyderabad	July 30, 2021
Food and Nutrition for Farmers	Smt. A. Swetha, Deputy Chief Dietitian, Yashoda Hospitals, Secunderabad	August 26, 2021
Climate Change and Agriculture: Role of Extreme Events	Dr. N.H. Ravindranath, Professor (Retd.), Centre for Sustainable Technologies (CST), IISc, Bangalore	August 31, 2021
Water Security for India - A Reality Check	Dr. D.M. Hegde, former Director, ICAR-IIOR, Hyderabad	September 25, 2021
Sustainable Agricultural Innovation Solutions using Gene Editing	Dr. Sekhar Boddupalli, CEO, Varenya Bio, Sacramento, USA	October 07, 2021
Sustainable Soil Management	Dr. G.V. Ramanjaneyulu, Executive Director, Centre for Sustainable Agriculture (CSA), Hyderabad	November 03, 2021
Plant Genome Sequencing in India and their Utilization in Crop Breeding	Dr. N.K. Singh, National Professor-Dr. B.P. Pal Chair, ICAR-NIPB, New Delhi	November 27, 2021
Reforestation to Combat Desertification and Climate Change	Dr. Malali Gowda, Director, Next-Generation Genomics Lab, C-CAMP, NCBS, G.K.V.K. Campus, Bengaluru, and Founder, Biodiversity Conservation and Research Trust, Anaganalu, Hassan District, Karnataka	December 27, 2021

Field Days

Safflower Field Day

A Safflower Field Day was organized at Gadikeshwar village, Chincholi taluk, Kalaburagi (Gulbarga) district, Karnataka on January 23, 2021. More than 250 farmers including 20 women farmers participated in the field day. Dr. M. Sujatha, Director (A), ICAR-IIOR, Hyderabad; Dr. Basawe Gowda, Special Officer (Seeds), UAS, Raichur; Dr. Raju Teggelli, Senior Scientist & Head, KVK, Kalaburagi; Dr. C. Sudhakar, Principal Scientist, ARS, PJTSAU, Tandur; Shri. Anil Kumar, Assistant Director of Agriculture, Chincholi; Dr. B.T. Pujari, Rtd. Director of Research, UAS, Raichur; Dr. Prabhavati, Scientist (Pathology), ARS, Annigeri, UAS, Dharwad; officers from KVK, Karnataka State Department of Agriculture, UAS-Raichur and UAS-Dharwad; PJTSAU, Tandur, ARS, *etc.*, presented relevant issues and available support and services for safflower promotion in the region. Dr. J. Jawahar Lal, Officer i/c (Seed Section), Dr. S.N. Sudhakara Babu, Principal Scientist (Agronomy), Dr. P.S. Srinivas, Principal Scientist (Agrl. Entomology), Dr. G.D. Satish Kumar, Principal Scientist (Agrl. Extension) and Shri N. Prabhakar Rao, Consultant participated in the technical discussion. Progressive farmer, Shri Javed Pattedar explained his success with the cultivation of ISF-764 after kharif mungbean in vertisols with a wide row spacing of 120 cm against the recommended spacing of 45 cm. This enabled easy intercultural operations and use of combine harvester, which led him to realize high seed yield (7 q/acre).



Safflower field day at Gadikeshwar village, Kalaburagi, Karnataka

Sunflower Field Day

A Sunflower Field Day was organized on March 03, 2021 at Hegdoli village, Kotagiri mandal, Nizamabad district, Telangana to create awareness about improved production technologies in sunflower. About 180 farmers and 20 representatives from various organizations such as Department of Agriculture, NGOs, Bee-keepers association, private companies, scientists of KVK, PJTSAU, Sarpanch of the village and other local leaders and scientists of ICAR-IIOR participated and interacted with the farmers. The participants visited the sunflower fields, where DRSH-1 hybrid was grown and observed the demonstration plots on application of balanced fertilizers based on soil test values, soil application of sulphur (S) and foliar spray of boron (B) and management of pests and diseases of sunflower. The participants also visited the co-cultivation of honey bees arranged in sunflower fields. The scientists explained about the profitability of sunflower in rice-fallow situation with adoption of proper crop management, and pests and diseases management practices. The farmers shared that honey bees have aided in increasing the yield of sunflower by 20% apart from honey yield. Speaking on the occasion, Dr. M. Sujatha, Director (A), ICAR-IIOR urged the farmers to grow sunflower by adopting zero tillage after harvest of paddy, which will significantly reduce the cost of cultivation and save water.

Sunflower field day in Hegdoli village, Nizamabad, Telangana

Field Day cum Training on Safflower Seed Production Technologies

A Field Day cum Training on Safflower Seed Production Technologies was organized on March 10, 2021 at Mariapur village, Pudur mandal, Vikarabad district, Telangana in the certified seed production plot of ISF-764 taken up by the farmer Shri Gnan Reddy. Smt. Pausumi Basu, IAS, Collector and District Magistrate, Vikarabad district, Shri Gopal, DAO, Vikarabad district, Agricultural Officers, local village *Sarpanch*, Scientists and officers from ICAR-IIOR, and safflower farmers (250) from the nearby region of Doma, Parigi, Chevella, Shankerpally, Kulkacherala, Shabad, Patancheru and Vikarabad participated.

Field day cum training on safflower seed production technologies at Mariapur village, Vikarabad, Telangana

Education and Training

Details of students worked at ICAR-IIOR

Name of the student	Degree	Title of the thesis	Advisor(s)	Discipline	University
Tabassum Fatima	Ph.D.	Resistance to leafhopper, *Amrasca bigittula bigittula* Ishida in sunflower: Screening and identification of mechanisms of resistance	Dr. P.S. Srinivas (Co-Major Advisor)	Agricultural Entomology	PJTSAU, Hyderabad
K. Divya	Ph.D.	Molecular mapping and validation of QTLs associated with resistance to aphid (*Uroleucon compositae*) in safflower (*Carthamus tinctorius* L.)	Dr. P. Kadirvel (Co-Major Advisor) Members: Dr. P.S. Srinivas Dr. V. Dinesh Kumar Dr. P. Ratna Kumar	Genetics and Plant Breeding	PJTSAU, Hyderabad
B. Venaktesh	Ph.D.	Yield maximization in hybrid pigeonpea through agronomic management	Dr. Ch. Sarada (Member)	Agronomy	PJTSAU, Hyderabad
Ch. L.N. Manikanta	Ph.D.	Exploitation of the genetic diversity of safflower genotypes for tolerance to deficit soil moisture stress	Dr. Ratna Kumar Pasala (Co-Major Advisor)	Plant Physiology	IGKVV, Raipur
P. Lora Anusha	Ph.D.	Studies on physiological and biochemical characterization of sesame (*Sesamum indicum* L.) genotypes under moisture stress	Dr. Ratna Kumar Pasala (Co-Major Advisor)	Plant Physiology	ANGRAU, Tirupati
Manmode Darpan Mohanrao	Ph.D	Studying allelic relationship and identification of SNP markers linked to specific *Fusarium* wilt resistance genes in castor (*Ricinus communis* L.)	Senthilvel Senapathy (Co Major Advisor)	Genetics and Plant Breeding	PJTSAU, Hyderabad
Kumbha Divya Sravanthi	Ph.D	Mapping of QTL and discovery of candidate genes for *Fusarium* wilt resistance in castor (*Ricinus communis* L.)	Senthilvel Senapathy (Co Major Advisor)	Molecular Biology and Biotechnology	ANGRAU, Guntur
P. Vamshi	M.Sc.	Genetic variability studies in advance breeding lines for yield and Macrophomina rot resistance in sesame (*Sesamum indicum* L.)	Dr. K.T. Ramya (Major advisor) Dr. M. Santha Lakshmi Prasad (Co-Major Advisor)	Genetics and Plant Breeding	ANGRAU, Andhra Pradesh
M. Mukthambika	M.Sc.	Morphological and genetic diversity analysis in sesame (*Sesamum indicum* L.) using microsatellites	Dr. H.H. Kumaraswamy (Co-Major Advisor) Dr. K.T. Ramya (Member)	Genetics and Plant Breeding	JNKVV, Jabalpur

Degree awarded

Name of the student	Degree	Title of the thesis	Advisor(s)	Discipline	University
R. Arutselvan	Ph.D.	Studies on influence of weather parameters in occurrence and development of gray mold disease of castor and its management	Dr. R.D. Prasad (Co-Major Advisor) Dr. Ch. Sarada (Member)	Plant Pathology	PJTSAU, Hyderabad
K. Gopika	M.Sc.	Studies on source and sink relationship of sesame (*Sesamum indicum* L.) genotypes under irrigated and deficit moisture stress condition	Dr. Ratna Kumar Pasala (Co-Major Advisor)	Plant Physiology	IGKVV, Raipur
P. Kusuma Kumari	M.Sc.	Studies on effect of manganese nutrition on growth and yield of sesame (*Sesamum indicum* L.)	Dr. Ratna Kumar Pasala (Co-Major Advisor)	Plant Physiology	PJTSAU, Hyderabad
M. Surya Prakash Reddy	M.Sc.	Studies on root and stem rot of sesame caused by *Macrophomina phaseolina* (Tassi.) Goid and its Management	Dr. M. Santha Lakshmi Prasad (Co-Major Advisor)	Plant Pathology	JNKVV, Jabalpur
R. Madhurima	M.Sc.	PCR analysis of T_4 generation putative transgenic castor (*Ricinus communis* L.) plants to identify positive plants harbouring AtEBP transgene	Dr. V. Dinesh Kumar (Advisor)	Life Sciences (Biotechnology)	GITAM, Vishakapatnam
K. Ummehani	M.Sc.	DNA polymorphism study of cultivated varieties of sesame (*Sesamum indicum* L.)	Dr. H.H. Kumaraswamy (Supervisor)	Biotechnology	University of Mumbai

Internship certificates awarded

Name of the student	Project Title	Discipline	University	Mentor
B. Sumanth T. Sai Chinmay B. Sai Hruthik	Oilseeds Pests and Diseases Image Repository System	CSE	KLEF, Hyderabad	Dr. Ch. Sarada
R. Akash Ch. Nimesh V. Sai Krishna	Oilseeds Statistics Information System (OSIS)-Visualisation and Data Analytics	CSE	KLEF, Hyderabad	Dr. Ch. Sarada

Awards and Recognitions

Awards

- Best research paper award, 2021 of ICAR-IIOR was awarded to the following publications:
  - ✓ Kadirvel, P., Veerraju, Ch., Senthilvel, S., Yadav, P., Usha Kiran, B., Shaik, M., Shaw, R., Velu Mani, S., Reddy, Y.R., Mohanrao, M.D. and Mukta, N. 2020. Marker-assisted selection for fast-track breeding of high oleic lines in safflower (*Carthamus tinctorius* L.). Industrial Crops and Products, 158, https://doi.org/10.1016/j.indcrop.2020.112983.
  - ✓ Devi, P.S.V., Duraimurugan, P., Chandrika, K.S.V.P., Vineela, V. and Hari, P.P. 2020. Novel formulations of *Bacillus thuringiensis* var. *kurstaki*: an eco-friendly approach for management of lepidopteran pests. World Journal of Microbial Biotechnology, 15; 36(5):78. doi: 10.1007/s11274-020-02849-8.
- Dr. H.P. Meena received 'Emerging Scientist Award-2020' for his contribution in the field of Plant Breeding by Agricultural Technology Development Society on the occasion of the "4th International Conference in Global Approaches in Natural Resource Management for Climate Smart Agriculture during the Pandemic Era of Covid 19" held at Shobhit Deemed University, Modipuram, Meerut, Uttar Pradesh during February 26-28, 2021.
- Dr. Praduman Yadav received 'Outstanding Scientist Award' from Agricultural Technology Development Society on the occasion of the "4th International Conference in Global Approaches in Natural Resource Management for Climate Smart Agriculture during the Pandemic Era of Covid 19" held at Shobhit Deemed University, Modipuram, Meerut, Uttar Pradesh during February 26-28, 2021.
- Drs. K.T. Ramya, P. Ratna Kumar and A.L. Rathnakumar received the best oral paper presentation award for 'Development of climate resilient sesame genotypes to enhance production' in the International Virtual Symposium on "Physiological Interventions for Climate Smart Agriculture " held at ICAR-SBI, Coimbatore in collaboration wi th Indian Society of Plant Physiology, New Delhi du ring March 11-12, 2021.
- Mrs. B. Usha Kiran received best oral presentation for the paper entitled, "Candidate gene based allele mining for oil content in safflower (*Carthamus tinctorius* L.) in the International Web Conference (ICAAAS 2021) organized by Innovative and Current Advances in Agriculture & Allied Sciences, Meerut, Uttar Pradesh during July 19-21, 2021.
- Dr. P. Ratna Kumar received 'Outstanding Scientist Award-2021' by VD Good Technologies, Visakapatnam, Andhra Pradesh during August 20-21, 2021.
- Dr. K.T. Ramya was awarded second prize for oral paper presentation on "Development of multi-parent advanced generation intercross (MAGIC) in sesame (*Sesamum indicum* L.)" in the International Conference on Future Challenges & Prospects in Plant Breeding (FCPPB 2021), organized by TNAU, Coimbatore and Indian Society of Plant Breeders during October 6-7, 2021.
- Dr. H.H. Kumaraswamy received the best poster award for the poster titled, "Waterlogging stress tolerant sesame lines: Towards mitigating climate change", in the International Conference on Integrated Agriculture, Natural Farming, Biodiversity Conservation and Rural Bio-Entrepreneurship under Changing Climate Scenario, organized by NAAS Regional Chapter NER, Barapani and International Union of Organic Agriculture, at College of Agriculture, Kyrdemkulai, Meghalaya, India, during December 7-9, 2021.
- Dr. C. Manimurugan received the best poster presentation certificate for the paper entitled "Effect of seed storage with zeolite beads for seed quality maintenance of vegetable crops" authored by C. Manimurugan, Nakul Gupta, Rajesh Kumar, T. Chaubey, Vikas Singh, P.M. Singh, Chandra Sekhar and J. Singh in the International Conference on "Vegetable Research and Innovations for Nutrition, Entrepreneurship and Environment (ICVEG-21)" held at ICAR-IIVR, Varanasi, Uttar Pradesh during December 14-16, 2021.

Chairman/Member of Committee/Panels

- Dr. V. Dinesh Kumar continued as a member of IMC of ICAR-NIPB, IARI Campus, New Delhi; ICAR-IIMR, Hyderabad; ICAR-IIAB, Ranchi; ICAR-IIPR, Kanpur and ICAR-IIOPR, Pedavegi, Andhra Pradesh.
- Dr. V. Dinesh Kumar served as a member in the committee for rationalization of PG seats in ANGRAU for the academic year 2021-22.
- Dr. V. Dinesh Kumar and Dr. S. Senthilvel were nominated as external experts for the State Level Technical Programme meetings of Genetics and Plant Breeding, Molecular Biology and Biotechnology and Seed Science and Technology during May 25-28, 2021 conducted by ANGRAU, Guntur, Andhra Pradesh.
- Dr. V. Dinesh Kumar was nominated for CAS meetings to evaluate scientists of Genetics and Plant Breeding discipline of ICAR-NRRI, Cuttack; Biotechnology discipline of ICAR-IISR, Indore; ICAR-SBI, Coimbatore; ICAR-IIPR, Kanpur; ICAR-CICR, Nagpur and ICAR-IIOPR, Pedavegi.
- Dr. P. Duraimurugan was recognized as scientist expert during the State Level Technical Programme Meetings of Entomology during May 25-28, 2021, ANGRAU, Guntur, Andhra Pradesh.
- Dr. P. Duraimurugan was recognized as expert member for screening the candidates under CAS of Entomology discipline (October 02, 2021), ANGRAU, Guntur, Andhra Pradesh.
- Dr. N. Mukta was nominated to act as an expert in the discipline of Economic Botany for CAS Committee for ARS Scientists of ICAR-SBI, Coimbatore.
- Dr. S. Senthilvel acted as a reviewer for project proposals submitted to Biotechnology Industry Research Assistance Council (BIRAC), New Delhi and Science and Engineering Research Board (SERB), New Delhi.
- Dr. S. Senthilvel was nominated as a member of selection committee for Promotion to Sr. Professor, Professor and Associate Professor in Genetics and Plant Breeding Discipline under CAS of PJTSAU, Hyderabad.
- Dr. M.Y. Dudhe served as a nominated academician for conducting the interviews for the selection of Teaching Faculty under direct recruitment in the Faculty of Veterinary Science in the P.V. Narasimha Rao Telangana Veterinary University, Rajendranagar, Hyderabad during October 8-9, 2021.
- Dr. S.N. Sudhakara Babu acted as a member, Academic Council, ANGRAU, Guntur for 2020-2021.
- Dr. G. Suresh was nominated as an expert, Assessment Committee for consideration of promotion case of Associate Professor/Professor of ANGRAU, Guntur during 2021.
- Dr. P. Lakshmamma acted as a subject expert in the selection committee for promotion of faculty members of Department of Crop Physiology at PJTSAU, Hyderabad on October 22, 2021.
- Dr. K. Ramesh acted as a technical expert for BIRAC BIG 19th Call of a-idea ICAR-NAARM, Hyderabad.
- Dr. P. Ratna Kumar acted as a scientific advisory member for DBT-BIG scheme of BIRAC (2021 to till date).
- Dr. M. Santha Lakshmi Prasad was nominated as a member of selection committee as subject matter specialist for the interview and correction of answer sheets of candidates for the post of Assistant Directors (Plant Health Management, Horticulture & Floriculture) at NIPHM, Hyderabad during September, 2021.
- Dr. Ch. Sarada was appointed as an expert member in selection committee for various awards constituted for faculty members of PJTSAU, Hyderabad during 2021.
- Dr. K. Alivelu was appointed as a subject expert in the selection committee for the faculty members of Department of Agricultural Statistics and Mathematics, PJTSAU, Hyderabad on October 22, 2021.
- Dr. S.V. Ramana Rao served as a member, Institute Technology Management Committee, ICAR-DPR, Hyderabad.
- Dr. P. Kadirvel served as a member, Special STAG Committee Meeting of DBT, Govt. of India to monitor and review the progress of the ongoing phase of the project entitled "DBT-UDSC Partnership Centre on Genetic Manipulation of Brassicas (CGMCP)" on December 13, 2021 (online).

Fellowship of Scientific Societies

- Dr. K. Ramesh was elected as a Fellow of the Indian Society of Agronomy 2020.
- Dr. K. Ramesh was elected as a Fellow of the International Society for Noni Sciences 2021.
- Dr. R.D. Prasad was elected as a Fellow of Indian Phytopathological Society.

National Post-Doctoral Fellowship (NPDF)

- Dr. K. Sakthivel was selected for ICAR-NPDF-2021 on "Microbiome profiling of sesame phyllosphere and endosphere and its exploitation for suppression of phyllody disease" from October 08, 2020 to October 07, 2021.

Editor of Journals

- Dr. S. Senthilvel acted as a member of Editorial Board of Scientific Reports.
- Dr. H.P. Meena was recognized as an Editorial Board Member of International Journal of Agricultural Invention, India.
- Dr. P. Ratnakumar acted as a Guest Associate Editor of Frontiers in Plant Science-Section Plant Abiotic Stress.
- Dr. P. Ratna Kumar acted as a Review Editor in Plant Physiology for Frontiers in Plant Science.
- Dr. J. Jawahar Lal was nominated as an Editorial Board Member of Journal of International Academic Research for Multidisciplinary.
- Dr. P.S. Srinivas was recognized as an Associated Editor of Journal of Allium Research, Indian Society of Alliums, Rajgurunagar, Pune, Maharashtra.
- Dr. P. Duraimurugan was recognized as an Editorial Board Member of Journal of Food, Agriculture and Environment, WFL Publisher (Science and Technology), Finland.
- Dr. P. Duraimurugan was recognized as an Editorial Board Member of The Journal of Research ANGRAU, ANGRAU, Guntur, Andhra Pradesh.
- Dr. H.H. Kumaraswamy was recognized as an Editorial Member for International Journal of Agricultural Sciences, Pune, Maharashtra.
- Dr. H.H. Kumaraswamy was recognized as an Editorial Member for ACTA Scientific Agriculture, Hyderabad, Telangana.

Others

- Dr. H.P. Meena co-chaired the technical session on "Sustainable Technology for Crop Improvement" and conducted the proceedings in the 4th International Conference on "Global Approaches in Natural Resource Management for Climate Smart Agriculture (GNRSA-2020) during Pandemic Era of COVID-19" during February 26-28, 2021.
- Dr. S.N. Sudhakara Babu delivered a key note speech at International Webinar, ICAR-IIFSR, Modipuram held between September 29 and October 01, 2021.
- Dr. S.N. Sudhakara Babu acted as an invitee for an interaction meeting with member expert, Working Group on Biofuels, Ministry of Petroleum & Natural Gas along with a couple of young successful entrepreneurs on October 4, 2021.
- Dr. H.P. Meena received appreciation certificate for his contribution as Organizing Coordinator for smooth functioning of the 3rd International Conference on "Global Initiative in Agricultural, Forestry and Applied Sciences for Food Security, Environmental Safety and Sustainable Development" during October 17-18, 2021.
- Dr. K. Sakthivel delivered a lead paper on, "Diversity of *Ralstonia solanacearum* and its Integrated Management Options in India" in the International Virtual Conference on Recent Advances in Crop Disease Management, organized by Annamalai University, Tamil Nadu on October 19, 2021.
- Dr. K. Sakthivel delivered a guest lecture on "Plant Disesases and Integrated Management in Oilseed Crops" to the trainees of Post Graduate Diploma in Plant Health Management Programme (PGDPHM), NIPHM, Hyderabad on December 06, 2021.
- Dr. K. Sakthivel delivered a lecture on "IDM on Oilseed crops" to the trainees of NIPHM, Hyderabad on December 18, 2021.
- Dr. G.D. Satish Kumar acted as an honorary advisor for the National Conference (online) on "Transformation of Agricultural Extension-Strategies for Effective Reformation" during December 22-23, 2021.
- Dr. H.P. Meena received the "Certificate of Excellence in Reviewing" from the Asian Journal of Agricultural and Horticultural Research.
- Dr. H.H. Kumaraswamy was one of the science mentors in a national level program, "Vidhyarthi Vigyan Manthan (VVM)", initiated by the Vigyan Bharati in collaboration with Vigyan Prasar.

Radio/TV talks

- Dr. M. Sujatha, Dr. G.D. Satish Kumar and Dr. J. Jawahar Lal delivered a radio talk on "Overall oilseeds scenario and AICRP activities" to All India Radio, which was broadcasted on September 05, 2021 at 07:15 to 08:00 p.m.

Human Resource Development

Annual Training Plan Implementation

Category-wise Training Attended

S.No.	Category	Total no. of employees	No. of employees attended
1	Scientific	39	7
2	Technical	26	5
3	Administrative & Finance	20	3
4	SSS	77	0
	Total	162	15

a) Scientific Staff

Name	Designation	Name of the training programme	Organizer/Venue	Date
Dr. H.P. Meena	Scientist (SS)	Enhancement of research skills, and refinement of technology by a scientist (online)	ICAR-IIHR, Bengaluru	January 18-20, 2021
Dr. A.L. Rathnakumar	Principal Scientist	MDP on "Management and Leadership Development" (online)	IRMA, Anand	October 21-22, 2021
Dr. A.L. Rathnakumar	Principal Scientist	MDP on PME (online)	ICAR-NAARM, Hyderabad	October 25-30, 2021
Dr. Ch. Sarada	Principal Scientist	Analysis of Multi-Location Experiments (online)	ICAR-NAARM, Hyderabad	October 28-30, 2021
Dr. H.D. Pushpa	Scientist (SS)			
Dr. P. Padmavathi	Principal Scientist	Integrated Nutrient Management and Nutrient Budgeting through Advanced Models to Improve Crop Productivity (online)	IISWC, RS, Ooty	November 29-December 3, 2021
Dr. P. Kadirvel	Principal Scientist	SNP Mining, GWAS and Genomic Selection (online)	ICAR-IASRI, New Delhi	December 16-21, 2021
Dr. C. Lavanya	Principal Scientist	Science, Technology and Emerging Trends in Governance (online)	IIPA, New Delhi	December 20-24, 2021

b) Technical Staff

Name	Designation	Name of the training programme	Organizer/Venue	Date
Shri P. Demudu Naidu	Technical Assistant (T-3)	Skill Developments in Maintaining Soil Health, Plant Health for Better Crop Ecosystems (online)	ICAR-IIHR, Bengaluru	January 21-23, 2021
Shri S. Venu Smt. G. Sailaja Shri J. Ashok	Technical Assistant (T-1)			
Shri V. Sambasiva Rao	ACTO	Repair and Maintenance of Office, Residential Building Including Guesthouses (online)	ICAR-CIAE, Bhopal	August 10-12, 2021

c) Administration

Name	Designation	Name of the training programme	Organizer/Venue	Date
Shri K. Srinivasa Rao	FAO	Accrual Accounting (online)	ICAR-NRRI, Cuttack	January 19-21, 2021
Smt. Swaroopa Rani	Assistant	Accrual Accounting (online)	ICAR-NRRI, Cuttack	September 20-24, 2021
Shri G. Rakesh	Assistant	Asset management (online)	ICAR-IARI, New Delhi	October 06-08, 2021

Participation in Conferences/Seminars/Symposia/Webinars/Meetings/ Workshops/Trainings

Scientific Staff

Name	Name of the programme	Organizer/Venue	Date
Dr. K. Alivelu	Science and Technology for Rural Societies for Women Scientists and Technologists (online)	IIPA, New Delhi	January 04-08, 2021
Dr. S. Senthilvel	Generic Online Training Course in Cyber Security	Ministry of Electronics and Information Technology (MeitY), Government of India	January 05, 2021
Dr. J. Jawahar Lal	Maintenance Breeding in Field Crops	ICAR-IISS, Mau in collaboration with ICAR-IARI, Karnal	January 09, 2021
Dr. P. S. Srinivas	Discussion Meeting on Challenges in the Management of Phytoplasma Diseases	Institute of Wood Science and Technology, ICFRE, Bengaluru	February 05, 2021
Dr. J. Jawahar Lal	International Webinar on Capacity Building on OECD Seed Certification under Indo-German Cooperation Seed Sector Development	DAC in collaboration with ICAR-IARI, New Delhi and ICAR-IIMR, Hyderabad	February 08-12, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. P. S. Srinivas	Emotional Intelligence at Workplace for Scientists/Technologists (online)	DST and COD, Hyderabad	February 15-19, 2021
Dr. V. Dinesh Kumar Dr. S. Senthilvel Dr. Ch. Sarada	Global Castor Conference-2021	Solvent Extractors' Association of India, Mumbai	February 19, 2021
Dr. V. Dinesh Kumar Dr. S. Senthilvel Dr. Ch. Sarada	Industry-Academia Interface to Formulate a Roadmap to Increase Domestic Production of Castor Oil Derivatives	ICAR-IIOR, Hyderabad	February 23, 2021
Dr. C. Manimurugan	Workshop on Seed Fumigation and Preservation	Gubba Y4, Yellampet, Medchal, Telangana	February 25, 2021
Dr. K.T. Ramya	Constraint Analysis and Strategies for Improving Productivity of Major Crops Grown in NC Zone (online)	RARS, Anakapalle, ANGRAU, Guntur	February 25-26, 2021
Dr. T. Boopathi	International Conference of Agricultural Librarians & Users Community	UAS, Bengaluru	February 25 - 26, 2021
Dr. P.S. Srinivas	National Webinar on Plant Health Management:Impacts of Climate Change and Invasive Alien Species on Agriculture	ANGRAU, Tirupati	February 26, 2021
Dr. S.V. Ramana Rao	State Level Technical Committee (SLTC) - Fixation of Scales of Finance for the Year 2021-22	Telangana State Co-operative Apex Bank Ltd. Hyderabad	March 06, 2021
Dr. K.T. Ramya Dr. A.L. Rathnakumar Dr. P. Ratna Kumar	International Symposium on Physiological Interventions for Climate Smart Agriculture (online)	ICAR-SBI, Coimbatore and Indian Society of Plant Physiology, New Delhi	March 11-12, 2021
Smt. K.S.V.P. Chandrika	Bioprospecting of Natural Resources for the Production of Biopesticides	ICAR-IARI, New Delhi	March 15-19, 2021
Smt. P. Madhuri	Online Training on Applications of Artificial Intelligence and Cloud Computing in Agriculture	ICAR-NAARM, Hyderabad	March 15-20, 2021
Dr. Mangesh Y. Dudhe	Generic Online Training on Cyber Security for Central Government Ministers/ Departments	Ministry of Electronics and Information Technology, Govt. of India	March 17, 2021
Dr. K. Sakthivel	National e-Conference on Plant Health and Food Security: Challenges and Opportunities	Indian Phytopathological Society, ICAR-IARI, New Delhi	March 25-27, 2021
Dr. N. Mukta Dr. H.P. Meena	International Webinar on Exchange on PVP Post Control Measures (online)	PPV & FRA, New Delhi and Federal Ministry of Food & Agriculture (BMEL), Germany	April 8, 2021
Dr. H.P. Meena	National Webinar on Plant Genetic Resources in India, Management and Utilization (online)	ATPBR, Maharashtra	April 09, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. Mangesh Y. Dudhe	7th Plant Genomics and Gene Editing Congress and 2nd Microbiome for Agriculture Congress:Asia	Global Engage	April 20-21, 2021
Dr. H.P. Meena	International Webinar on Food Security Through Innovative Postharvest Technologies in Horticulture (online)	College of Agriculture, Lalsot, Rajasthan	May 04, 2021
Dr. Praduman Yadav	Food Security through Innovative Postharvest Technologies in Horticulture (online)	College of Agriculture, Lalsot	May 04, 2021
Dr. S.V. Ramana Rao	Orientation Training for ICAR related CBBOs under the CSS-Formation and Promotion of 10000 FPOs (online)	NCDC, New Delhi	June 10, 2021
Dr. S.V. Ramana Rao	Price Policy for Rabi Crops 2021-22 Season (online)	CACP, New Delhi	June 14, 2021
Dr. Mangesh Y. Dudhe Dr. H.P. Meena	International Webinar on Sunflower Genetic Resources for Breeding: Germplasm Evaluation and Conservation (online)	International Sunflower Association, France	June 15, 2021
Dr. H.P. Meena	International Webinar on Genetics and Plant Breeding (online)	International Sunflower Association, France	June 16, 2021
Dr. H.P. Meena	International Workshop on Scientific Writing (online)	ICAR-NDRI, Karnal	June 23-24, 2021
Dr. J. Jawahar Lal Dr. C. Manimurugan Smt. K.S.V.P. Chandrika	International Webinar cum Workshop on Seed Quality Enhancement (online)	Seed Centre, TNAU, Coimbatore and ICAR-ICAR-IIMR, Hyderabad	June 23-25, 2021
Dr. P. Duraimurugan Dr. T. Boopathi	National Webinar on Microbial Biopesticides: Next Generation Preparedness (online)	DBT and Assam Agricultural University	July 02, 2021
Dr. T. Boopathi	International Webinar on Desert Locust *Schistocerca gregaria* (Forskål)-International Scenario and a Potential Threat to India	NIPHM, Hyderabad.	July 02, 2021
Dr. S. Senthilvel Dr. Praduman Yadav Dr. M. Santhalakshmi Prasad	Meet on Value Addition in Linseed (online)	ICAR-IIOR, Hyderabad	July 06, 2021
Smt. B. Usha Kiran	International Web Conference on Innovative and Current Advances in Agriculture & Allied Sciences (online)	Society for Scientific Development in Agriculture & Technology (SSDAT), Meerut, India	July 19-21, 2021
Dr. P.S. Srinivas	First Biannual Subcommittee Meeting of National Network of Plant Health Experts	NIPHM, Hyderabad	July 22, 2021
Dr. A.L. Rathnakumar Dr. P. Duraimurugan Dr. Praduman Yadav	Interface Meet on Export Quality Sesame Seeds	ICAR-IIOR, Hyderabad and IOPEPC, Mumbai	July 27, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. G.D. Satish Kumar	Annual Group Meeting on Rapeseed-Mustard (online)	ICAR-DRMR, Bharatpur	August 06-07, 2021
Dr. S.V. Ramana Rao	Ideation Workshop on Rurban Mission 2.0 (online)	NIRD & PR, Hyderabad	August 11, 2021
Dr. G. Suresh	National Webinar on Food and Nutritional Security: Challenges and Opportunities in Rainfed Areas	Indian Society of Dryland Agriculture and ICAR-CRIDA, Hyderabad	August 16, 2021
Dr. S.V. Ramana Rao	Discussion meeting on Sustainable Rurban Mission Ideation Proposal on Value Chains in Oilseeds (online)	NIRD & PR, Hyderabad	August 19, 2021
Dr. M. Sujatha	Workshop on Climate Change-Sunflower Resistance to Drought (online)	International Sunflower Association	August 19-20, 2021
Dr. P. Duraimurugan	Training on Scientific Cultivation of Castor in Haryana (online)	CCS Haryana Agricultural University, Hisar and ICAR-IIOR, Hyderabad	August 25, 2021
Dr. G.D. Satish Kumar	XXVIth Meeting of ICAR Regional Committee No. VII Comprising the States of Maharashtra, Madhya Pradesh, Chhattisgarh and Goa (online)	ICAR-IASRI, New Delhi	August 25, 2021
Dr. K. Ramesh	Rice-Fallow Management in Eastern India (online)	ICAR Research Complex for Eastern Region, Patna, Bihar	August 26, 2021
Dr. K. Ramesh	Advances in Sustainable Management of Natural Resources for Food and Nutritional Security (online)	NAU, Navsari	August 26-27, 2021
Dr. M. Sujatha Dr. S. Senthilvel Dr. Mangesh Y. Dudhe Dr. H.H. Kumaraswamy	National Conference on Oil palm – A Right Choice Towards Self-Sufficiency in Edible Oil Production	ICAR-IIOPR, Pedavegi	September 06, 2021
Dr. K. Ramesh	Panel Discussion on Organic Farming in Maharashtra-Challenges and Opportunities	ICAR-NRC for Grapes, Pune	September 08, 2021
Dr. Ch. Sarada	Building Sustainable FPOs-Millet Farming to Business	ICAR-IIMR, Hyderabad	September 13, 2021
Dr. G.D. Satish Kumar	XXVIIth Meeting of ICAR Regional Committee No. VIII Comprising the States of Karnataka, Kerala, Tamil Nadu and UTs of Puducherry and Lakshadweep (online)	ICAR-IASRI, New Delhi	September 14, 2021
Dr. K. Alivelu	Birth Centenary Symposium on Contributions of Prof. C.R. Rao in Statistics	ICAR-IASRI, New Delhi	September 19, 2021
Dr. J. Jawahar Lal	International Conference on Reorienting Agronomic Research & Education to Combat Current and Future Challenges in Agriculture	Dr. Rajendra Prasad Agricultural University, Pusa, Samastipur	September 20-22, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. R.D. Prasad Dr. K. Ramesh	Strategies for Climate Risk Management and Resilient Farming	ICAR-CRIDA, Hyderabad	September 20-24, 2021
Dr. J. Jawahar Lal	International Webinar-cum-Workshop on Capacity Building on Seed Quality Enhancement under Indo-German Bilateral Cooperation on Seed Sector Development	ICAR-IARI, New Delhi	September 22-24, 2021
Dr. T. Boopathi	International Webinar on Bio Control - A Global Sustainable Approach for Eco-Friendly Agriculture	NIPHM, Hyderabad	September 24, 2021
Dr. J. Jawahar Lal Smt. B. Usha Kiran	International Webinar on Plant Developmental Plasticity: A Molecular Perspective (online)	Acharya Nagarjuna University and IISER, Andhra Pradesh	September 27-29, 2021
Dr. S.N. Sudhakara Babu Dr. G. Suresh Dr. K. Ramesh	International Webinar on Alternate Cropping Systems for Climate Change and Resource Conservation (online)	ICAR-IIFSR, Modipuram, Uttar Pradesh	September 29 - October 01, 2021
Dr. H.P. Meena	International Web Conference on Novel Breeding Approaches for Food Security Under Changing Climatic Conditions (online)	UAS, Dharwad	October 04, 2021
Dr. T. Boopathi	Workshop on Annual Review Meeting on National Agricultural Innovation Fund (NAIF) Scheme of ABI/ZTMC/ITMU of Crop Science Division	IP & TM Unit, ICAR, New Delhi	October 05-11, 2021
Dr. R. D. Prasad Dr. P. Duraimurugan	National Meeting on Biopesticides-Registration and Quality assurance: Issues and Way Forward (online)	ICAR-NBAIR, Bengaluru	October 06, 2021
Dr. M. Sujatha	Web Conference on Sunflower-Pollinator Interactions	International Sunflower Association	October 06-07, 2021
Dr. A.L Rathnakumar Dr. K.T. Ramya Dr. H.P. Meena	International Conference on Future Challenges and Prospects in Plant Breeding	TNAU, Coimbatore and Indian Society of Plant Breeders	October 06-07, 2021
Dr. Ch. Sarada	Agricultural Census	ICAR-IASRI, New Delhi	October 07, 2021
Dr. P.S. Srinivas	Implementation and Use of Agricultural Research Management System (ARMS)	ICAR-IASRI, New Delhi	October 11, 2021
Dr. M. Santha Lakshmi Prasad	Indian Phytopathological Society (IPS) Platinum Jubilee Lecture Series (Online)	Indian Phytopathological Society (IPS) , IARI, New Delhi	October 13, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. P. Duraimurugan Dr. T. Boopathi	3rd International Conference on Global Initiative in Agricultural, Forestry and Applied Sciences for Food Security, Environmental Safety and Sustainable Development (GIAFAS-2021) (online)	Shri Guru Ram Rai University, Dehradun, Uttarakhand, India	October 17-18, 2021
Dr. S. Senthilvel	International Webinar on Enabling Food and Nutrition Security in Drylands	ICRISAT, Patancheru	October 19, 2021
Dr. P.S. Srinivas	Implementation and Use of Agricultural Research Management System (ARMS)	ICAR-IASRI, New Delhi	October 20, 2021
Dr. M. Sujatha	Global Conference (online)	IOPEPC, Mumbai	October 21, 2021
Dr. M. Santha Lakshmi Prasad	International Webinar on Biotic Stress Management in Rapeseed-Mustard	ICAR-DRMR, Bharatpur	October 21, 2021
Dr. K. Alivelu Dr. S. Senthilvel Dr. P. Ratna Kumar Dr. K.T. Ramya	Analysis of Multi-Location Experiments (online)	ICAR-NAARM, Hyderabad	October 28-30, 2021
Dr. M.A. Aziz Qureshi	Online Seminar on Quality Improvement and Proficiency Testing of Soil Laboratories in India	ICAR-IISS, Bhopal, Madhya Pradesh	October 31, 2021
Dr. K. Ramesh	Mechanized Weed Management in Different Field Crops	ICAR-DWR, Jabalpur	November 01-03, 2021
Dr. M. Sujatha Dr. A.L. Rathnakumar Dr. K. Ramesh	Meeting of Stakeholders to Discuss the Draft Project Proposal on Profiling of Indian Sesame Varieties for their Quality Attributes, Promotion of BMPs for higher productivity, Mapping of Major Growing Regions for Pesticide Residues and Organic Cultivation	ICAR-IIOR, Hyderabad and IOPEPC, Mumbai	November, 02, 2021
Dr. S.V. Ramana Rao	Brainstorming Session on Agri-startups in India: Opportunities, Challenges, and Way Forward	NAAS, New Delhi	November 11, 2021
Dr. Ch. Sarada	Strengthening Capacities for Nutrition-Sensitive Agriculture and Food Systems-Integration of Nutrition into the trainings by Agricultural EAS Providers in India	MANAGE, Hyderabad	November 15-17, 2021
Dr. H.P. Meena	2nd International Agrobiodiversity Congress on Agrobiodiversity for Food System Transformation (online)	ISPGR, New Delhi	November 15-18, 2021
Dr. J. Jawahar Lal	Meeting on Enhancing the Role of Cooperatives in Seed Sector	DAC	November 23, 2021
Dr. P. Padmavathi Dr. P. Ratna Kumar Dr. G.D. Satish Kumar	5th International Agronomy Congress on Agri Innovations to Combat Food and Nutritional Challenges	PJTSAU, Hyderabad	November 23-27, 2021

Name	Name of the programme	Organizer/Venue	Date
Dr. P. Duraimurugan	Orientation Workshop on NAARM's DRIVE Dashboard and National S&T Survey 2020-21 (online)	ICAR-NAARM, Hyderabad	November 29, 2021
Dr. K. Ramesh	Management of Water Surplus-Deficit Dichotomy in North Eastern Agriculture to enhance the Productivity	NIRDPR, Guwahati	November 30, 2021
Dr. H.H. Kumaraswamy	International Conference on Integrated Agriculture, Natural Farming, Biodiversity Conservation and Rural Bio-Entrepreneurship under Changing Climate Scenario	NAAS Regional Chapter NER, Barapani and International Union of Organic Agriculture, at College of Agriculture, Kyrdemkulai, Meghalaya	December 7-9, 2021
Dr. Lakshmi Prayaga Dr. P. Ratna Kumar	National Conference of Plant Physiology-2021 on Frontiers of Plant Physiology for Climate Smart Agriculture	ICAR-NIASM Baramati	December 09-11, 2021
Dr. N. Mukta	Webinar on Plant Variety Protection Intricacies and Impact on Trait Development (online)	ICAR-IISR, Indore	December 10, 2021
Dr. K. Ramesh Dr. G.D. Satish Kumar	Management Development Program (Pre-RMP)	ICAR-NAARM, Hyderabad	December 13-24, 2021
Dr. C. Manimurugan	International Conference on Vegetable Research and Innovations for Nutrition, Entrepreneurship and Environment (online)	ICAR-IIVR, Varanasi	December 14-16, 2021
Dr. N. Mukta Dr. S. Senthilvel Dr. H.P. Meena	International Webinar on Exchange on Biochemical and Molecular Techniques (BMT) Guidelines and Implementation of BMT in DUS (online)	PPV & FRA, New Delhi and Federal Ministry of Food, Agriculture and Consumer Protection (BMEL), Germany	December 16-17, 2021
Dr. T. Manjunatha	11th Online Training Programme on Science, Technology and Emerging Trends in Governance for Scientists and Technologists	IIPA and DST, New Delhi	December 20-24, 2021
Dr. V. Dinesh Kumar	National Workshop on Self-sufficiency in Oilseeds	Govt. of Gujarat, Gandhinagar	December 22, 2021
Dr. N. Mukta	XXXXVIth Meeting of Plant Germplasm Registration committee (online)	ICAR-NBPGR, New Delhi	December 24, 2021

Technical Staff

Name	Designation	Name of the programme	Organizer/Venue	Date
Smt. J. Gnana Prasuna	Technical Assistant (T-3)	Statistical Techniques for Data Analysis in Agriculture (online)	ICAR-IASRI, New Delhi	October 4-13, 2021

Publications

Research Papers

Anita, M., Diksha, P., Ramesh, K. and Gouda, B. 2021. Nutrient uptake, post-harvest soil nutrient status and economic returns from sunflower (*Helianthus annuus* L.) hybrids under different tillage and nutrient levels on lowland rice fallow environments of Odisha. Journal of Oilseeds Research, 38(1): 110-114. http://krishi.icar.gov.in/jspui/handle/123456789/68608.

Anita, M., Gouda, B. and Ramesh, K. 2021. Productivity and profitability of summer sunflower (*Helianthus annuus* L.) with integrated nutrient management. Journal of Oilseeds Research, 38(1): 106-109. http://krishi.icar.gov.in/jspui/handle/123456789/68607.

Chandrika, K.S.V.P., Dinabandhu Patra, Praduman Yadav, Aziz Qureshi, M.A.A. and Balaji Gopalan. 2021. Metal citrate nanoparticles: a robust water-soluble plant micronutrient source. RSC Advances, 11(33): 20370-20379. http://krishi.icar.gov.in/jspui/handle/123456789/68604.

Chary, R.G., Gopinath, K.A., Ratnakumar, P., Bhaskar, S., Singh, V.K., Deepika, S., Kumari, K.V., Sridhar, K.B., Narsimlu, B., Kumar, B.R. and Rasul, A. 2021. Management of major abiotic stresses in field crops. Indian Journal of Agronomy, 66 (5th IAC Special Issue) (2): S258-S278w. http://krishi.icar.gov.in/jspui/handle/123456789/68596.

Dudhe, M.Y., Meena, H.P., Sujatha, M., Sakhre, S.B., Ghodke, M.K., Misal, A.M, Neelima, S., Kulkarni, V.V., Praduman Yadav, Ranganatha, A.R.G. and Reddy, A.V.V. 2021. Genetic analysis in sunflower germplasm across the four states falling under the semi-arid environments of India. Electronic Journal of Plant Breeding, 12(4): 1075-1084. http://krishi.icar.gov.in/jspui/handle/123456789/69928.

Jegadeeswaran, M., Kadirvel, P., Srinivas, P.S., Senthilvel, S., Selvaraj, V.M., Mobeen, S., Reddy, Y.R., Kiran, B.U. and Mukta, N. 2021. Genetic mapping reveals a major QTL associated with tolerance to the aphid, *Uroleucon compositae* (Theobald) in safflower (*Carthamus tinctorius*). Plant Breeding, 140(2): 320-330. http://krishi.icar.gov.in/jspui/handle/123456789/68846.

Kadirvel, P., Anil Kumar, Ch., Geethanjali, S., Basavaraj, P.S., Rushwanth Reddy, Y., Dinesh Rahul, V. and Senthilvel, S. 2021. Current scenario of marker-assisted selection in breeding of minor oilseed crops of India. Journal of Oilseeds Research, 38(4): 303-319. http://krishi.icar.gov.in/jspui/handle/123456789/73634

Krishna Teja, I., Ramana Rao, S.V., Bhavani Devi, I., Prasad, S.V., Ravindra Reddy, B. and Praveen Kumar, P. 2021. Growth performance of groundnut in Ananthapuramu district of Andhra Pradesh – a temporal analysis. Asian Journal of Agricultural Extension, Economics & Sociology, 39(7): 81-87. http://krishi.icar.gov.in/jspui/handle/123456789/69842.

Krishna Teja, I., Ramana Rao, S.V., Bhavani Devi, I., Prasad, S.V., Ravindra Reddy, B. and Praveen Kumar,P. 2021. Spatio-temporal performance of major edible oilseeds in Andhra Pradesh. Journal of Oilseeds Research, 38(2): 199-206. http://krishi.icar.gov.in/jspui/handle/123456789/697845.

Lakshmamma, P., Lakshmi Prayaga., Alivelu, K. and Reddy, A.V.V. 2021. Drought tolerant and physiologically efficient genetic resources for rainfed castor. Journal of Oilseeds Research, 38(2): 187-194. http://krishi.icar.gov.in/jspui/handle/123456789/68838.

Lakshman, S.S., Meena, H.P., Chakrabarty, N.R. and Ghodke, M.K. 2021. Study of gene action and combining ability for seed yield and yield attributing traits in sunflower (*Helianthus annuus* L.). Journal of Oilseeds Research, 38(2): 145-151. http://krishi.icar.gov.in/jspui/handle/123456789/69929.

Manivannan, N., Chandirakala, R., Manonmani, S., Viswanathan, P.L., Ganesamurthy, K., Dudhe, M.Y., Sujatha, M., Reddy, A.V.V., Sasikala, R., Rajendran, L., Selvakumar, T. and Suganthy, A. 2021. Sunflower COH 3: A high yielding and high oil content sunflower hybrid for Tamil Nadu. Electronic Journal of Plant Breeding, 12(2): 525-528. http://krishi.icar.gov.in/jspui/handle/123456789/70411.

Mohanty, S.K., Jagadev, P.N. and Lavanya, C. 2021. Combining ability studies for seed yield and its component traits in castor (*Ricinus communis* L.). The Pharma Innovation Journal, 10(8): 1489-1495. http://krishi.icar.gov.in/jspui/handle/123456789/69098.

Navya, M., Duraimurugan, P. and Bhowmick, A.K. 2021. Effect of insecticides and fungicides on growth and sporulation of *Metarhizium rileyi* (Farlow) Samson. The Pharma Innovation Journal, 10(7): 1444-1447. http://krishi.icar.gov.in/jspui/handle/123456789/69851.

Navya, M., Duraimurugan, P. and Bhowmick, A.K. 2021. Effect of spinetoram 11.7 SC and some newer chemicals against *Spodoptera litura* (F.) on soybean. Biological Forum, 13(2): 720-724. http://krishi.icar.gov.in/jspui/handle/123456789/69850.

Pandey, B.B., Ratnakumar, P., Usha Kiran, B., Dudhe, M.Y., Lakshmi, G.S., Ramesh, K. and Guhey, A. 2021. Identifying traits associated with terminal drought tolerance in sesame (*Sesamum indicum* L.) genotypes. Frontiers in Plant Science, 12: 739896. http://krishi.icar.gov.in/jspui/handle/123456789/68599.

Payal, P. and Dinesh Kumar, V. 2021. Attack the enemy silently in its own den: SIGS-Spray-induced gene silencing, a novel approach to contain pathogens. Journal of Oilseeds Research, 38(1): 19-24. http://krishi.icar.gov.in/jspui/handle/123456789/69676.

Radhamani, J., Pushpa, H.D., Shriram Gomshe, S., Choudhary, S.B., Vinay Kumar, Rajani Bisen and Sujatha, M. 2021. Early maturing niger germplasm accessions. Indian Journal of Plant Genetic Resources, 34(3): 495-498. http://krishi.icar.gov.in/jspui/handle/123456789/73567

Ramanjaneyulu, A.V., Indudhar Reddy, K., Nagesh Kumar, M.V., Madhavi, A., Venkata Ramana, M., Srinivas, A. and Suresh, G. 2021. Agro-economic feasibility and indices of castor + groundnut intercropping system under irrigated conditions during rabi season in Telangana. International Journal of Bio-resource and Stress Management, 12(2): 74-81. https://doi.org/10.23910/1.2021.2154a. http://krishi.icar.gov.in/jspui/handle/123456789/68837.

Ramanjaneyulu, A.V., Nagesh Kumar, M.V., Madhavi, A., Neelima, T.L. and Suresh, G. 2021. Quantifying the effects of phosphate solubilising fungi and phosphorus chemical fertilizer on phosphorous economy and productivity of rainfed castor on alfisols. International Journal of Economic Plants, 8(2): 66-72. http://krishi.icar.gov.in/jspui/handle/123456789/68836.

Ramanjaneyulu, A.V., Neelima, T.L., Venkata Ramana, M., Nagesh Kumar, M.V., Suresh, G., Madhavi, A., Srinivas, A. and Vishnuvardhan Reddy, D. 2021. Selective mechanization improves productivity, energy indices and profitability of rainfed castor (*Ricinus communis*) in India. Indian Journal of Agronomy, 66(2): 223-228. http://krishi.icar.gov.in/jspui/handle/123456789/68834.

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Souvenir Article

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On-going Research Projects

A. Institute Supported Projects

S. No.	Project No.	Project title	Investigators	Start date	End date (proposed)
1	101-6	Identification, characterization, evaluation and multiplication of the trait specific germplasm and pre-bred lines for the development of superior populations in sunflower	**Mangesh Y. Dudhe** H.P. Meena M. Sujatha K. Sakthivel P.S. Srinivas	2021	2024
2	101-7	Diversification of parental base for development of superior hybrids in sunflower (*Helianthus annuus* L.)	**H.P. Meena** M. Sujatha Mangesh Y. Dudhe K. Sakthivel P.S. Srinivas Lakshmi Prayaga P. Ratna Kumar Praduman Yadav K. Ramesh	2021	2026
3	102-9	Development of genetic and genomic resources and identification of genes/markers for agronomic traits in safflower	**B. Usha Kiran** V. Dinesh Kumar	2015	2021
4	102-10	Diversification of safflower germplasm through exploitation of wild species	**N. Mukta** H.P. Meena Praduman Yadav R.D. Prasad P.S. Srinivas	2020	2025
5	102-11	Improvement of safflower for high oil, biotic and abiotic stress resistance coupled with high seed yield through recombination and heterosis breeding	**H.D. Pushpa** Praduman Yadav R.D. Prasad P.S. Srinivas B. Usha Kiran P. Ratna Kumar	2020	2025
6	103-14	Development of genomic resources and tools for applications in castor breeding	**S. Senthilvel** R.D. Prasad M. Santha Lakshmi Prasad	2017	2022

S. No.	Project No.	Project title	Investigators	Start date	End date (proposed)
7	103-15	Optimization of regeneration and transformation protocols to realize grey mold resistant transgenic castor (*Ricinus communis* L.)	**V. Dinesh Kumar** M. Sujatha B. Usha Kiran H.H. Kumaraswamy R.D. Prasad Rohini Sreevathsa, (NRCPB, ICAR-IARI, New Delhi)	2017	2022
8	103-16	Exploitation of plant genetic resources for identification of trait specific accessions with resistance/ tolerance to biotic/abiotic stresses in castor	**J. Jawahar Lal** T. Manjunatha Praduman Yadav P. Lakshmamma K. Sankari Meena	2020	2025
9	103-17	Designing new plant types in castor suitable for mechanical harvesting	**C. Lavanya** P. Lakshmamma G. Suresh T. Manjunatha	2021	2026
10	103-18	Development of diverse parents and early to medium maturing castor hybrids with high oil yield, resistance to major pests, diseases and drought	**T. Manjunatha** C. Lavanya S. Senthilvel P. Lakshmamma	2021	2026
11	103-19	Breeding for resistance to gray mold and capsule borer in castor	**S. Senthilvel** R.D. Prasad P. Duraimurugan	2021	2026
12	104-12	Agronomic interventions for increasing productivity and resource use efficiency (nutrient and moisture) of emerging cropping systems involving oilseeds	**S.N. Sudhakara Babu** Md. A. Aziz Qureshi K. Alivelu	2015	2022
13	104-16	Developing best management practices for organic soybean-sesame cropping system	**K. Ramesh** Md. A.Aziz Qureshi P. Duraimurugan Praduman Yadav T. Boopathi (since June 2021) K. Sankari Meena (since June 2021) C. Manimurugan (since June 2021)	2018	2023
14	104-17	Fabrication of Fe and Zn nanosystems as efficient nutrient sources	**K.S.V.P. Chandrika** Md. A. Aziz Qureshi Praduman Yadav Balaji Gopalan (BITS, Hyderabad) Anupama Singh (ICAR-IARI, New Delhi)	2018	2022

S. No.	Project No.	Project title	Investigators	Start date	End date (proposed)
15	104-18	Agronomic interventions for enhancing resource use efficiency in castor based cropping systems	**G. Suresh** Md. A. Aziz Qureshi	2018	2023
16	104-19	Developing best management practices for sesame under rice-sesame cropping system	**K. Ramesh** Md. A. Aziz Qureshi Praduman Yadav Harisudan (Agronomy), TNAU, Vriddhachalam K.V. Ramanamurty (Agronomy), ANGRAU, Ragolu B.S. Dhir (Agrl. Entomology), OUAT, Mahisapet Mangal Tuti (Agronomy), ICAR-IIRR	2019	2022
17	104-22	Approaches to improve nutrient use efficiency in oilseed crops	**Md. A. Aziz Qureshi** K. Ramesh P. Ratna Kumar	2021	2024
18	104-23	Lignin extraction from agricultural waste and its applications in agriculture and industry	**K.S.V.P. Chandrika** C. Manimurugan K. Ramesh	2021	2025
19	105-14	Screening and identification of dependable sources of resistance to insect pests of castor & deciphering the associated mechanisms	**P. Duraimurugan** J. Jawahar Lal	2017	2022
20	105-15	Screening and identification of dependable/durable sources of resistance to biotic stresses of sesame and deciphering the associated mechanisms	**K. Sakthivel** M. Santha Lakshmi Prasad P. Duraimurugan H. H. Kumaraswamy K.T. Ramya	2017	2022
21	105-17	Screening and identification of durable sources of resistance to castor diseases and race identification of wilt pathogen	**M. Santha Lakshmi Prasad** T. Manjunatha	2020	2024
22	105-18	Identification of sources of resistance to leaf webber/capsule borer and leafhopper and understanding the mechanisms of resistance in sesame	**T. Boopathi** K. Sakthivel	2020	2024
23	105-19	Exploitation of chitinolytic bacteria and development of effective formulation against major insect pests, diseases and plant parasitic nematodes of oilseed crops	**K. Sankari Meena** R.D. Prasad P. Duraimurugan K.S.V.P. Chandrika	2021	2025

S. No.	Project No.	Project title	Investigators	Start date	End date (proposed)
24	106-3	Development of high throughput protocol to detect adulteration in oils and formulation of oil blends for enhanced nutritional quality and stability	**Praduman Yadav** K.S.V.P. Chandrika K. Alivelu	2021	2025
25	107-18	Impact assessment of hybrids/ varieties of IIOR mandated crops in varied agro ecological regions of India	**S.V. Ramana Rao** Ch. Sarada Dr. K.P. Thakar, SDAU, Sardarkrushinagar)	2018	2022
26	107-20	Development of ICT tools for technology dissemination in oilseed crops	**P. Madhuri** C. Lavanya N. Mukta H.P. Meena K.T. Ramya H.D. Pushpa J.Jawahar Lal S.V. Ramana Rao G.D. Satish Kumar	2020	2025
27	107-22	A cross platform application for Identification and advisory for managing diseases and insects in oilseed crops through Image Analysis and Artificial Intelligence	**Ch. Sarada** R.D. Prasad M. Santha Lakshmi Prasad K. Sakthivel P.S. Srinivas P. Duraimurugan T. Boopathi S.V. Ramana Rao G.D. Sathish Kumar G. Rekha , KLEF, Hyderabad	2021	2023
28	107-23	Analysis of yield gaps and developing suitable extension strategies for reducing yield gaps in oilseeds	**G.D. Sathish Kumar** K. Alivelu	2021	2025
29	108-2	Exploitation of inter and intra specific genetic resources for development of elite breeding lines in sesame	**K.T. Ramya** J. Jawahar Lal A.L. Rathnakumar P. Ratna Kumar K. Sakthivel	2017	2022
30	108-3	Development of genetic and genomic resources and identification of gene/ marker for different agronomic traits in sesame	**H.H. Kumaraswamy** M. Santha Lakshmi Prasad P. Duraimurugan P. Ratna Kumar	2017	2022
31	109-1	Exploitation of plant genetic resources for development of improved breeding populations in niger (*Guizotia abyssinica* Cass.)	**H.D. Pushpa** M. Sujatha	2017	2022

S. No.	Project No.	Project title	Investigators	Start date	End date (proposed)
32	110-1	Development of seed production and seed quality maintenance technologies for oilseed crops	**C. Manimurugan** S.N. Sudhakara Babu M.Y. Dudhe J. Jawahar Lal H.D. Pushpa T. Boopathi	2020	2025
33	111-1	Exploitation of linseed genetic resources for development of elite breeding lines with high seed yield, oil and quality	**A.L. Rathnakumar** Mrs. B. Usha Kiran Praduman Yadav T. Boopathi Md. A. Aziz Qureshi	2020	2025

B. Externally Funded Projects

Sl. No.	Title	Investigators	Year of start	Year of completion	Sponsoring organization	Budget (Rs. In Lakh)
1	Mass production of *Bacillus thuringiensis* (Bt) and *Beauveria bassiana*, formulation as oil based suspension concentrates singly and in combination and field evaluation	**P. Duraimurugan** K.S.V.P. Chandrika	2017	2022	ICAR Network-AMAAS	8.15
2	A novel biopolymer based multilayer seed coating with Trichoderma and other microbial inputs and their tracking on applied surfaces in oilseed crops for integrated disease and nutrient management	**R.D. Prasad** K.S.V.P. Chandrika V. Dinesh Kumar K. Sakthivel K. Sankari Meena K. Ramesh Md. A. Aziz Qureshi	2021	2026	ICAR Network-AMAAS	-
3	Frontline demonstrations (FLDs) on oilseeds and other extension activities	**G.D. Satish Kumar** J. Jawahar Lal K. Ramesh R.D. Prasad G. Suresh P.S. Srinivas P. Duraimurugan	2021	2022	NFSM-Oilseeds under DAC & FW, Govt. of India	257.00
4	Seed production in agricultural crops	**J. Jawahar Lal** C. Manimurugan T. Manjunatha H.P. Meena H.D. Pushpa	2021	2022	DAC & FW, Govt. of India	-
5	Central Sector Scheme for Protection of Plant Varieties and Farmers Rights Authority (ANNUAL)	**N. Mukta** C. Lavanya Mangesh Y. Dudhe	2008-09	Continous	PPV & FRA, Govt. of India	10.25

Sl. No.	Title	Investigators	Year of start	Year of completion	Sponsoring organization	Budget (Rs. In Lakh)
6	Development of distinctiveness, uniformity and stability (DUS) testing guidelines for niger [*Guizotia abyssinica* (L.f.) Cass.]	**N. Mukta** H.P. Meena	2020	2023	PPV & FRA, Govt. of India	9.00
7	Delineating the effector biology of phytoplasma affecting selected crop taxa in India with special emphasis on sesame (*Sesamum indicum* L.)	**V. Dinesh Kumar** Suman Lakhanpaul, Department of Botany, Delhi University	2019	2022	NASF, ICAR	55.28
8	Exploitation of genetic and genomic resources for improvement of niger (*Guizotia abyssinica* L.F. Cass) through breeding and biotechnological tools	**M. Sujatha** H.D. Pushpa Praduman Yadav	2020	2024	DBT, Govt. of India	298.57
9	Exploiting genetic diversity for improvement of safflower through genomics-assisted discovery of QTLs/genes associated with agronomic traits	**P. Kadirvel** N. Mukta R.D. Prasad P.S. Srinivas PradumanYadav Lakshmi Prayaga P. Ratna Kumar P. Padmavathi Md. A. Aziz Qureshi Ch. Sarada	2020	2025	DBT, Govt. of India	608.40
10	Formation and development of farmer producer organizations (FPOs)	**G.D. Satish Kumar** R.D. Prasad G. Suresh Md. A. Aziz Qureshi S.V. Ramana Rao P. Padmavathi Ch. Sarada T. Manjunatha	2021	2026	National Cooperative Development Council (NCDC)	50.00
11	Competitive oilseeds production technologies for improving profitability and socio-economic conditions of small holders in rainfed oilseeds production system of Telangana	**S.V. Ramana Rao** P. Lakshmamma P. Padmavathi G.D. Satish Kumar K. Alivelu Md. A. Aziz Qureshi P. Duraimurugan Ramya K.T. T. Manjunatha P. Madhuri S.T. Viroji Rao Gnan Prakash Sarat Chandra Venkata Ramana G. Vidyasagar Reddy	2017	Continuing	KVK Scheme Extension Division, ICAR	27.50

Infrastructure Development

Library and Documentation

The Library and Documentation Unit continued to collect, store, organize and disseminate information on all aspects of crop, improvement crop production, crop protection and utilization of oilseed crops. An amount of Rs. 10.4 lakhs was spent during the period under report to acquire 9 books and for subscription to 52 Indian periodicals and 6 foreign periodicals, 2 database *viz.*, Indian patent and IndiastatAgri. A total of 32 books and 48 publications were received gratis besides newsletter and annual reports from different organizations. New records of books were added to the computerized library catalogue database. The KOHA Integrated Library Management Software is in operation at ICAR-IIOR. A total of 301 articles have been delivered to indenters through e-mails. Literature search was carried out in the mandate crops using in-house database, CROP CD, AGRIS on CD and AGRICOLA.

Civil works

The following maintenance/repair and minor works were carried out during 2021.

S.No.	Name of the work	Amount (Rs.)
1	Repairs in old tissue culture for making as visitors room	4,94,564
2	Repair of main drain channel from C-4 to F-4 and G-3 plots at ICAR-IIOR	8,23,200
3	Repairs and maintenance of canteen, kitchen, toilets of VIP suits and ground floor common toilet in ICAR-IIOR hostel	9,32,004
4	Shed for oil extraction unit	4,57,961

The following works were carried out during the year 2021 with CPWD.

S.No.	Name of the work	Amount (Rs.)
1	Seed processing laboratory at Rajendranagar	99,17,700
2	Construction of seed processing cum storage unit at Narkhoda research farm of ICAR-IIOR, Hyderabad	44,55,000

Inauguration of the Seed Processing-cum-Storage Unit: The Seed Processing-cum-Storage Unit under Seed Hub Project sponsored by DAC & FW at Narkhoda farm was inaugurated on October 27, 2021.

Hindi Activities

राजभाषा कार्यशालाओं का आयोजन

राजभाषा विभाग, गृह मंत्रालय द्वारा जारी वार्षिक कार्यक्रम के अनुसार हिन्दी का कार्यसाधक ज्ञान प्राप्त सभी कर्मचारियों के लिए वर्ष की प्रत्येक तिमाही में कार्यशाला का आयोजन करना अनिवार्य है। इस संदर्भ में मार्च माह में हिन्दी आलेखन टिप्पण विषय पर एक कार्यशाला का आयोजन किया गया जिसमें अतिथि व्याख्याता श्री. नवीन नैथानी, प्राध्यापक, हिन्दी शिक्षण योजना, हैदराबाद थे। जून माह में हिन्दी की व्याकरण संबंधी समस्याएँ एवं समाधान विषय पर कार्यशाला का आजोजन किया गया जिसमें अतिथि व्याख्याता श्री. अंबादास, सेवानिवृत्त प्राध्यापक, हिन्दी शिक्षण योजना, हैदराबाद थे। वर्ष की तीसरी तिमाही में हिन्दी दिवस के अवसर 14 सितंबर को कंप्यूटर में यूनिकोड पर कार्य विषय पर कार्यशाला का आयोजन किया गया जिसमें अतिथि व्याख्याता श्री. कमालुद्दीन, सर्वकार्यभारी अधिकारी, हिन्दी शिक्षण योजना, विशाखापट्टनम थे। वर्ष की अंतिम तिमाही की कार्यशाला अहिन्दी भाषियों को हिन्दी में आने वाली कठिनाईयों पर आयोजित की गई जिसमें श्री. अंबादास, सेवानिवृत्त प्राध्यापक, हिन्दी शिक्षण योजना, हैदराबाद थे। कोविड-19 के कारण उत्पन्न परिस्थितियों के मद्देनजर उपरोक्त सभी कार्यशालओं का आयोजन ऑनलाइन किया गया।

हिन्दी पखवाडा समारोह

14 सितंबर, 1949 को भारतीय संविधान में हिन्दी को राजभाषा का दर्जा दिया है। अतः इस दिन को हिन्दी दिवस के रुप में मनाया जाता है। इस संदर्भ में संस्थान में 14-27 सितंबर, 2021 तक हिन्दी पखवाड़े का आयोजन किया गया ।

हिन्दी पखवाड़े की शुरुआत हिन्दी दिवस के शुभ अवसर पर 14 सितंबर, 2021 को अपराह्न 2.00 बजे एक ऑनलाइन कार्यशाला के आयोजन से किया गया जिसमें श्री. कमालुद्दीन, सर्वकार्यभारी अधिकारी, हिन्दी शिक्षण योजना, विशाखापट्टनम **कार्यालयीन शब्दावली** विषय पर कक्षा चलाई गई।

कोविड-19 के कारण उत्पन्न परिस्थितियों के मद्देनजर इससे संबंधित मानदंडों का उचित अनुपालन करते हुए, प्रतियोगिताओं का आयोजन किया गया। इस पखवाडे का समापन समारोह भी ऑनलाइन ही आयोजित किया गया।

Promotions/Transfers/Superannuations

Promotions

Name	Position/Grade	Effective date
Shri T. Bichanna, UDC	Assistant	Febraury 12, 2021
Shri A. Srinivasa Raju, Technical Assistant	Senior Technical Assistant	2016
Shri N. Vasant, Technical Assistant	Senior Technical Assistant	2016
Shri K. Srinivas, Technical Assistant	Senior Technical Assistant	2016
Shri M. Indrasena Reddy, Technical Assistant	Senior Technical Assistant	2018
Shri Y.V. Rao, Technical Assistant	Senior Technical Assistant	2018
Shri G. Ramulu, Technical Assistant	Senior Technical Assistant	2018
Shri A. Srinivasa Raju, Senior Technical Assistant	Technical Officer	January 2021
Shri N. Vasant, Senior Technical Assistant	Technical Officer	January 2021
Shri. V.Y Swamy, Senior Technical Assistant	Technical Officer	January 2021
Shri K. Srinivas, Senior Technical Assistant	Technical Officer	September 2021
Shri P. Srinivasa Rao, Personal Assistant	Private Secretary	June 24, 2021
Shri. P. Srinivas, Skilled Support Staff	LDC	July 19, 2021
Shri J. Narasimha, Skilled Support Staff	Technician (T-1)	July 19, 2021
Smt. S. Swarupa Rani, Assistant	Asstt. Admn. Officer	August 16, 2021
Shri A. Prem Kumar, Junior Accounts Officer	III MACP	May 30, 2021
Shri G.B.N Prasad, Assistant	III MCAP	October 3, 2021
Shri G.P Saradhi, Senior Technical Assistant	Technical Officer	2016
Shri G. Ramulu, Senior Technical Assistant	Technical Officer	2016
Shri. Y.V. Rao, Senior Technical Assistant	Technical Officer	2016
TSCL (67) Rajendranagar and Narkhoda Research Farm	Skilled Support Staff	September 01, 2021

Transfer/Joining

Name	Post	From	To	Date
Shri K. Srinivasa Rao	Finance Accounts Officer	ICAR-IIOR	ICAR-IIRR, Hyderabad	October 14, 2021
Shri A. Prem Kumar	Junior Accounts Officer	ICAR-IIOR	AFO, ATARI, Hyderabad	November 10, 2021
Smt. J. Gnana Prasuna	Technical Assistant	ICAR- CICR, Coimbatore	ICAR-IIOR, Hyderabad	July 01, 2021
Dr. Divya Ambati	Scientist (Plant Breeding)	ICAR-IARI, Indore	ICAR-IIOR, Hyderabad	October 12, 2021
Shri Vinod Kumar Sahoo	Senior Finance & Accounts Officer	ICAR-IIMR, Hyderabad	ICAR-IIOR, Hyderabad	October 14, 2021

Retirements

Name	Post	Date
Shri P. Srinivasa Rao	Assistant Chief Technical Officer	March 31, 2021
Smt. G. Bharatamma	Skilled Support Staff	March 31, 2021
Smt. G. Chennamma	Skilled Support Staff	March 31, 2021
Shri G. Mallesh	Skilled Support Staff	March 31, 2021
Shri G. Balakishan	Chief Technical Officer	June 30, 2021

Demise

Smt. K. Narasamma, Skilled Support Staff expired on February 05, 2021.

Personnel

Dr. M. Sujatha	Director (A)

Director's Cell

Smt. C. Lalitha	Private Secretary
Sri. P. Srinivasa Rao	Private Secretary

Crop Improvement

Name	Position	Discipline
Dr. V. Dinesh Kumar	Principal Scientist & Head	Biotechnology
Dr. N. Mukta	Principal Scientist	Economic Botany
Dr. A.L. Rathnakumar	Principal Scientist	Plant Breeding
Dr. C. Lavanya	Principal Scientist	Plant Breeding
Dr. Senthilvel Senapathy	Principal Scientist	Plant Breeding
Dr. Kadirvel Palchamy	Principal Scientist	Genetics
Dr. Mangesh Y. Dudhe	Senior Scientist	Plant Breeding
Dr. T. Manjunatha	Senior Scientist	Plant Breeding
Dr. J. Jawahar Lal	Senior Scientist	Plant Breeding
Dr. H.P. Meena	Senior Scientist	Plant Breeding
Smt. B. Usha Kiran	Scientist	Biotechnology
Dr. H.H. Kumaraswamy	Scientist	Biotechnology
Dr. K.T. Ramya	Senior Scientist	Genetics & Plant Breeding
Dr. Divya Ambati	Scientist	Plant Breeding
Dr. C. Manimurugan	Scientist	Seed Science & Technology
Dr. H.D. Pushpa	Scientist	Genetics & Plant Breeding
Shri P. Gopinadhen	Technical Officer (F/F) (T-5)	-
Shri G. Srinivasa Rao	Technical Officer (F/F) (T-5)	-
Smt. P. Mary	Senior Technician (T-2)	-
Shri J. Narasimha	Senior Technician (T-2)	-
Shri Narasimha	Technician (T-1)	-
Smt G. Sailaja	Technician (T-1)	-

Crop Production

Name	Position	Discipline
Dr. S.N. Sudhakara Babu	Principal Scientist & Head	Agronomy
Dr. G. Suresh	Principal Scientist	Agronomy
Dr. P. Padmavathi	Principal Scientist	Agronomy
Dr. P. Lakshmamma	Principal Scientist	Plant Physiology
Dr. Lakshmi Prayaga	Principal Scientist	Plant Physiology
Dr. Md. A. Aziz Qureshi	Principal Scientist	Soil Science
Dr. K. Ramesh	Principal Scientist	Agronomy
Dr. Ratna Kumar Pasala	Principal Scientist	Plant Physiology
Dr. Praduman Yadav	Senior Scientist	Biochemistry
Smt. K.S.V.P. Chandrika	Scientist	Agricultural Chemicals
Smt. Ch.V. Haripriya	Chief Technical Officer (F/F)	-
Shri S. Narsimha	Technical Officer (T-5)	-

Crop Protection

Name	Position	Discipline
Dr. R.D. Prasad	Principal Scientist & Head	Plant Pathology
Dr. M. Santha Lakshmi Prasad	Principal Scientist	Plant Pathology
Dr. P. Satya Srinivas	Principal Scientist	Agricultural Entomology
Dr. P. Duraimurugan	Principal Scientist	Agricultural Entomology
Dr. T. Boopathi	Senior Scientist	Agricultural Entomology
Dr. K. Sakthivel	Scientist	Plant Pathology
Dr. K. Sankari Meena	Scientist	Nematology
Shri Ch. Anjaiah	Senior Technician (F/F) (T-2)	-
Shri S. Saida Reddy	Technical Assistant (F/F) (T-3)	-

Social Sciences

Name	Position	Discipline
Dr. S.V. Ramana Rao	Principal Scientist & Head	Agricultural Economics
Dr. Ch. 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 (SS)	Computer Applications

Support Services

Technical Information Cell

Name	Position
Dr. T. Boopathi	Officer i/C
Smt. J. Gnana Prasuna	Senior Technical Assistant (T-4)

Library & Documentation

Name	Position
Shri G. Raghunath	Assistant Chief Technical Officer
Shri V. Sambasiva Rao	Assistant Chief Technical Officer

Farm Section

Name	Position
Shri M. Bhaskar Reddy	Chief Technical Officer (F/F T-9)
Shri C. Prabhudas	DMO (LDC)
Shri A. Srinivasa Raju	Technical Officer (A/c Mechanic) (T5)
Shri N. Vasanth	Technical Officer (Workshop) (T5)
Shri K. Srinivas	Technical Officer (Workshop) (T5)
Shri M. Indrasena Reddy	Senior Technical Assistant (Tractor Driver) (T4)
Shri Y. Venkateshwar Rao	Technical Officer (Tractor Driver) (T5)
Shri Demudu Naidu Panchada	Technical Assistant (T-3)
Shri J. Ashok	Technician (T-1)
Shri S. Venu	Technician (T-1)

Seed Section

Name	Position
Dr. J. Jawahar Lal (Plant Breeding)	Senior Scientist
Shri T. Veeraiah	Senior Technical Assistant (F/F) (T4)

Administration

Name	Position
Shri Shitanshu Kumar	Senior Administrative Officer
Shri Pradeep Singh	Assistant Director (OL)
Smt. R.A. Nalini	Assistant Administrative Officer
Shri G. Srinivas Yadav	Personal Assistant

Name	Position
Shri P.R. Varaprasada Rao	Assistant
Shri E.V.R.K. Nagendra Prasad	Assistant
Shri T. Bichanna	Assistant
Smt. P. Gyaneshwari	UDC
Shri B. Giri	UDC
Smt. P. Swapna	LDC
Shri P. Srinivas	LDC

Stores

Name	Position
Shri Rakesh Geeda	Assistant Administrative Officer
Shri G.B. Nagendra Prasad	Assistant
Smt G. Maheshwari	LDC

Audit & Accounts

Name	Position
Shri Vinod Kumar Sahoo	Senior Finance & Accounts Officer
Smt. S. Swarupa Rani	Assistant Administrative Officer
Shri G. Raghava Kiran Kumar	Stenographer

Drivers

Name	Position
Shri G. Ramulu	Technical Officer, Driver, T-5
Shri G. Pardhasaradhi	Technical Officer, Driver, T-5
Shri E. Ravi Kumar	Senior Technical Assistant, Driver, T-4

Skilled Supporting Staff

Name	Position
Shri M. Venkatesh	Skilled Supporting Staff
Shri A. Rambabu	Skilled Supporting Staff
Shri M. Ramulu	Skilled Supporting Staff
Smt. B. Kistamma	Skilled Supporting Staff
Shri K. Sanjeeva	Skilled Supporting Staff
Shri B. Vishnu	Skilled Supporting Staff
Shri B. Gnaneshwar	Skilled Supporting Staff
Smt. K. Kalavathi	Skilled Supporting Staff

Name	Position
Smt. A. Lalitha	Skilled Supporting Staff
Smt. K. Suseela	Skilled Supporting Staff
Shri N. Buchaiah	Skilled Supporting Staff
Shri R. Venkatesh	Skilled Supporting Staff
Shri M. Krishna	Skilled Supporting Staff
Smt. K. Krishnaveni	Skilled Supporting Staff
Smt. G. Pentamma	Skilled Supporting Staff
Smt. C. Chandrakala	Skilled Supporting Staff
Shri R. Ramulu	Skilled Supporting Staff
Smt. Ch. Satyamma	Skilled Supporting Staff
Smt. E. Sujatha	Skilled Supporting Staff
Smt. G. Sobha Rani	Skilled Supporting Staff
Smt. G. Anasuya	Skilled Supporting Staff
Shri B. Anjaiah	Skilled Supporting Staff
Shri P. Narasimha	Skilled Supporting Staff
Shri B. Ramesh	Skilled Supporting Staff
Smt. K. Bhagyamma	Skilled Supporting Staff
Shri D. Mallesh	Skilled Supporting Staff
Shri B. Sankaraiah	Skilled Supporting Staff
Shri N. Mallesh	Skilled Supporting Staff
Shri K. Yadagiri	Skilled Supporting Staff
Smt. S. Padmamma	Skilled Supporting Staff
Smt. N. Ratnamma	Skilled Supporting Staff
Smt. P. Venkatamma	Skilled Supporting Staff
Smt. P. Balamani	Skilled Supporting Staff
Smt. Y. Shanthamma	Skilled Supporting Staff
Shri N. Ramulu	Skilled Supporting Staff
Smt. N. Venkatamma	Skilled Supporting Staff
Smt. B. Lakshmamma	Skilled Supporting Staff
Smt. M. Venkatamma	Skilled Supporting Staff
Smt. Y. Lakshmi	Skilled Supporting Staff
Smt. B. Kamalamma	Skilled Supporting Staff
Smt. P. Satyamma	Skilled Supporting Staff
Smt. B. Suvarna	Skilled Supporting Staff
Smt. Y. Balamani	Skilled Supporting Staff

Name	Position
Smt. P. Santhamma	Skilled Supporting Staff
Smt. K. Balamani	Skilled Supporting Staff
Smt. B. Andallu	Skilled Supporting Staff
Shri. M. Narasimha	Skilled Supporting Staff
Shri M. Jangaiah	Skilled Supporting Staff
Shri M. Kistaiah	Skilled Supporting Staff
Shri. M. Gopal	Skilled Supporting Staff
Smt. K. Bhagyamma	Skilled Supporting Staff
Smt. P. Yellamma	Skilled Supporting Staff
Smt. P. Lakshmi	Skilled Supporting Staff
Smt. P. Bharathamma	Skilled Supporting Staff
Smt. T. Jangamma	Skilled Supporting Staff
Smt. P. Suseela	Skilled Supporting Staff
Smt. P. Amrutha	Skilled Supporting Staff
Smt. M. Sukkamma	Skilled Supporting Staff
Smt. M. Lakshmi	Skilled Supporting Staff
Smt. Y. Yadamma	Skilled Supporting Staff
Shri B. Venkataswamy	Skilled Supporting Staff
Shri C. Kumar	Skilled Supporting Staff
Shri P. Siddeshwar	Skilled Supporting Staff
Shri P. Nagesh	Skilled Supporting Staff
Shri G. Mallesh	Skilled Supporting Staff
Shri G. Mallesh	Skilled Supporting Staff
Shri M. Venkatesh	Skilled Supporting Staff
Smt. C. Bhagya	Skilled Supporting Staff
Smt. P. Karunamma	Skilled Supporting Staff
Smt. E. Parvathamma	Skilled Supporting Staff
Shri S. Venkatesh	Skilled Supporting Staff
Shri M. Komaraiah	Skilled Supporting Staff
Smt. D. Balamani	Skilled Supporting Staff
Shri. A. Aagulu	Skilled Supporting Staff
Smt. R. Kalyani	Skilled Supporting Staff
Smt. E. Devamma	Skilled Supporting Staff
Smt. K. Kistamma	Skilled Supporting Staff

Press Coverage

10 మన తెలంగాణ | www.manatelangana.news

కుసుమ పంటల సాగుపై రైతులకు శిక్షణ

నూనెగింజల సాగుతో లాభాలు

-కలెక్టర్ పాముబు బసు

మరియపూర్‌లో కుసుమ పరిశీలిస్తున్న కలెక్టర్ పాముబు బసు

Long lasting Inverter Battery

సమస్త తెలంగాణ

ON HD

కుసుమ సాగుపై భరోసా

केंद्रीय वैज्ञानिकों ने किया 'करडई' फसलों का निरीक्षण

» किसानों का किया मार्गदर्शन

संवाददाता। यवतमाल

हैदराबाद स्थित भारतीय तेलबिया संशोधन केंद्र के वरिष्ठ वैज्ञानिक डा.जवाहर लाल व डा.सतीश राव ने वरोरा उपविभाग के जरीत व चिमूर तहसील के करडई फसल का निरीक्षण किया। हाल ही में वरोरा तहसील के मेसा-वाघोली स्थित किसान पवन चारतिले व वडगांव के किसान माणिक भोयर के खेत में पेट कैकर केसीय वैज्ञानिकों ने किसानों को करडई फसल को लेकर तकनीकी मार्गदर्शन कर आवश्यक सुझाव दिए। विभागीय कृषि सहसंचालक नागपुर रवींद्र भोसले व जिला अधीक्षक कृषि अधिकारी डा.उदय पाटील के मार्गदर्शन में चंद्रपुर जिले में पहली बार करडई फसल की बुआई की गई है। रबी सत्र में चना, गेहू इन फसलों का उत्पादन खर्च दिनों-दिन बढ़ रहा है।

लोकमत

करडई पिकाची केंद्रीय शास्त्रज्ञांकडून पाहणी

लोकमत न्यूज नेटवर्क

वरोरा : हैदराबाद येथील भारतीय तेल बिया संशोधन केंद्रामधील वरिष्ठ शास्त्रज्ञ डॉक्टर जवाहरलाल व डॉ. सतीश राव यांनी वरोरा उपविभागातील वरोरा व चिमूर तालुक्यातील करडई पीक प्रात्यक्षिकाची पाहणी केली व तांत्रिक मार्गदर्शन केले.

करडई पिकाची पाहणी करताना केंद्रीय शास्त्रज्ञ.

रावेझी कृषी सहसंचालक रवींद्र भोसले, जिल्हा अधीक्षक कृषी अधिकारी डॉ. उदय पाटील यांच्या मार्गदर्शनात चंद्रपूर जिल्ह्यात प्रथमच करडई पिकाची लागवड करण्यात आली. रब्बी हंगामात हरभरा गहू या पिकावरील उत्पादन खर्च दिवसेंदिवस वाढत आहे. तेलवर्गीय पिकाची वाढती मागणी लक्षात घेता व आपल्या परिसरात नवीन पीक लागवडीस प्रोत्साहन देण्यासाठी करडई पीक प्रात्यक्षिक वर भर देण्यात आला. फारच कमी उत्पादन खर्च असलेले कमी पाण्यात उत्पादन देणारे काटेरी गुणधर्मामुळे जंगली जनावरांपासून धोका नसलेले आरोग्यास उपयुक्त व गुणकारी बाजार भावसुद्धा योग्य असलेले पीक करडईची वर्धा तालुक्यात ५० एकर लागवड करण्यात आली.

पिकाबाबत तांत्रिक मार्गदर्शन व पाहणी करण्याकरिता केंद्रीय शास्त्रज्ञांनी वरोरा तालुक्यातील मेसा, वाघोली येथील शेतकरी पवन भारतीय, वडगाव येथील शेतकरी माणिक भोयर यांच्या शेताला भेट देऊन शेतकऱ्यांशी चर्चा करून येणाऱ्या अडचणी व उपाय सुचविले. त्यानंतर चिमूर तालुक्यातील मालेवाडा येथील तालुका बीज गुणन केंद्र व पांढरवनी येथील शेतकरी वाघमारे यांच्या शेतातील करले पिकाची पाहणी केली. याप्रसंगी वरोरा तालुका कृषी अधिकारी व्ही.आर. प्रकाश, कृषी अधिकारी गोंधळी, मंडल कृषी अधिकारी विजय काळे उपस्थित होते.

విత్తనోత్పత్తి సాంకేతికతపై రైతులకు శిక్షణ

తానూరు, న్యూస్‌టుడే: భారతీయ నూనెగింజల పరిశోధన సంస్థ ఆధ్వర్యంలో మండలంలోని బామ్నితండాలో కుసుమ పంట కోత అనంతరం విత్తనోత్పత్తిలో సాంకేతికతపై రైతులకు బుధవారం శిక్షణనిచ్చారు. కుసుమ పంట విత్తనోత్పత్తిలో మెళకువలు, మార్కెటింగ్ పద్ధతులపై నూనెగింజల పరిశోధన సంస్థ శాస్త్రవేత్తలు సుధాకర్‌బాబు, సురేష్, జవహర్ అవగాహన కల్పించారు. అనంతరం వారికి బ్యాటరీ పిచికారీ పంపు డబ్బాలను పంపిణీ చేశారు. కార్యక్రమంలో సర్పంచి

బామ్నితండాలో కుసుమ పంటను పరిశీలిస్తున్న వ్యవసాయ శాస్త్రవేత్తలు, రైతులు

4 సమయజ్యోతి

బుధవారం, 24 మార్చి 2021

నూనెగింజల సాగుపై రైతులకు అవగాహన