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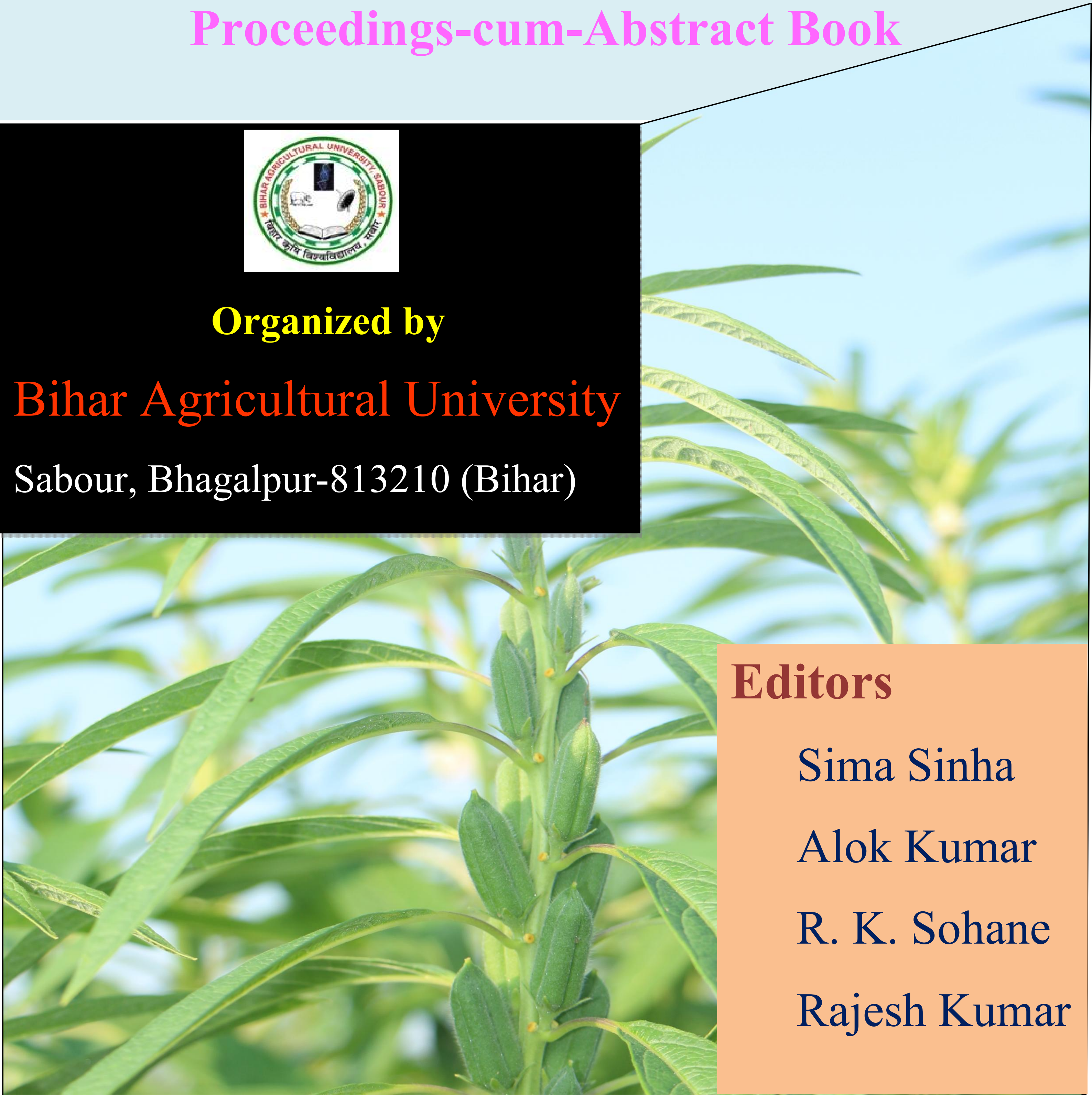
National Webinar

On

Breeding of Oilseeds: A Challenge for Self-Sufficiency

29th July 2020

Proceedings-cum-Abstract Book



Organized by

Bihar Agricultural University

Sabour, Bhagalpur-813210 (Bihar)

Editors

Sima Sinha

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Declaration

Lead Papers and Abstracts included in this book are responsible of the respective authors and not necessarily that of organizers.

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FOREWORD

Since green revolution, the production of oilseeds has witnessed very little growth as compared to exponential growth of cereal crops like paddy, wheat, maize etc. Meanwhile, with the rising income of people and population growth, the consumption of oilseeds has constantly been on the rise. Due to this, India has become the largest importer of oilseeds, a crop which India produced in surplus during the 1960s. One of the major causes for low production of oilseeds in India is low yield, which exists due to multiple factors such as non-availability of varieties having climate resilience, low oil content, lack of biotic resistance, unsuitability for mechanical harvesting and lack of post –harvest process development. Currently available varieties of oilseeds have certain shortcomings which are low oil yield, poor quality of extracted oil, shattering, synchronized maturing and so on. Thus, there is a need for genetic improvement which can involve evaluation of germplasm, selection of elite lines, pest and disease resistance, earliness and shattering resistance, quality of oil, suitability for mechanization etc.

On this context a web conference on “Breeding of Oilseeds: A challenge for self-sufficiency” was an excellent platform to exchange concepts and opinions. The web conference was attended by more than thousand participants across India and abroad. I am happy to learn that several important recommendations emerged through a critical discussion during the said web conference. I hope the Proceedings-cum-Abstract book of this web conference will be quite useful for academic and scientific communities, policymakers & other stakeholders involved in oilseed sector. I congratulate the organizers and the editorial team for their commitment and active participation which made it such a success.

(Ajoy Kumar Singh)

Technical programme of the National Webinar

On

Breeding of Oilseeds: A Challenge for Self Sufficiency

Bihar Agricultural University, Sabour, Bhagalpur (Bihar)
29th July, 2020 at 10.00-14.20

Time	Particulars
10.00-10.05	Welcome address and Opening Remarks ***Dr. Sima sinha, Organizing Secretary, BAU, Sabour, Bhagalpur,Bihar***
10.05-10.15	About the Webinar ***Dr. R. K. Sohane, Director Extension Education & Convenor, BAU, Sabour, Bhagalpur, Bihar***
10.15-10.20	Chairman's Remarks ***Dr. Ajoy Kumar Singh, Hon'ble Vice Chancellor, BAU, Sabour, Bhagalpur, Bihar***
10.20-10.50	Self-sufficiency in oilseeds: Role of seed sector and other policy interventions ***Dr D K Yadav, ADG(Seed), ICAR.***
10.50-11.20	Present status and future Potential of oilseeds in India ***Dr. A. Vishnuvardhan Reddy Director, IIOR, Hyderabad***
11.20-11.50	Breeding Oil Palm- Challenges and Oppurtunities ***Dr. RK Mathur, Director, IIOPR, Andhra Pradesh***
11.50-12.20	Sesame Breeding: Present situation and Future Projection ***Dr Tapas Das Gupta, Dean, R K Mission, Kolkata***
12.20-12.50	Pre-Breeding and Genetic enhancement in Oilseed Crops ***Dr M Sujatha, Head & Principal Scientist, IIOR, Hyderabad***
12.50-13.20	Improving Productivity of Indian Mustard: Challenges and opportunities ***Dr Naveen Singh, Principal Scientist, ICAR***
13.20-13.50	Present status and prospects of linseed in India ***Dr P K Singh, Professor, C S Azad University of Agriculture and technology, Kanpur***
13.50-14.20	The genomic advances for controlling the Sclerotinia stem rot disease in Indian mustard (*Brassica juncea*) ***Dr N C Gupta, Senior Scientist, ICAR-NIPB***
14.20	Vote of thanks

CONTENTS

ABOUT THE WEBINAR

Today, the oilseeds have become almost indispensable in our diet. It comprises of seven edible oil which are soybean, groundnut, rapeseed-mustard, sunflower, niger, sesame and safflower with two non-edible oilseeds which are castor and linseed. Moreover, oil palm, coconut, cotton seed, rice bran, tree borne oilseeds and solvent extracted oil form the secondary source. Due to the onset of green revolution, the oilseeds have been largely neglected and thus are grown in rainfed conditions and unproductive land. This has resulted in the stagnation of total production. In last fifty years, the production of oilseeds has shown very little growth, whereas the production of cereal crops such as paddy, wheat, maize etc. have risen exponentially in the same span of time. Meanwhile, with the rising income of people, the consumption of oilseeds has constantly been on the rise. Due to this, India has become the largest importer of oilseeds, a crop which was exported during the 1960s. One of the major reasons for low production is low yield, which exists because of non-availability of climate resilient variety, high oil yield, and seed for biotic and abiotic resistance, mechanization in harvesting and post-harvest process development of package of practices for different ecologies. Some of the problems with currently available varieties of oilseeds are low oil yield, poor quality of extracted oil, shattering and non-synchronized maturing and so on. Thus, there is a need for genetic improvement which can involve evaluation of germplasm, selection of elite lines, pest and disease resistance, earliness and shattering resistance, quality of oil, varieties for different climatic conditions etc. Not only this, tissue culture and molecular breeding can also provide huge possibility for further improvement in the crop variety. So, this webinar is organized for better outreach and to generate coordination among agricultural scientists to make the challenges successful in oilseeds.

LEAD PAPER

LP1. IMPROVING PRODUCTIVITY OF INDIAN MUSTARD: CHALLENGES AND OPPORTUNITIES

Naveen Singh, Rajendra Singh, Yashpal, Navinder Saini, Nanjundan J.*, Lakshman Prashad^ Gyanendra Singh, Mahesh Rao[$], S. S. Rathod[#] and M. K. Dhillon**

(Genetics Division, ICAR-Indian Agricultural Research Institute, New Delhi; [$] ICAR-National Institute for Plant Biotechnology, New Delhi; *ICAR-IARI, Regional Station, Wellington; ^ Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, New Delhi;[#]Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi; **Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi)

After cereals, oilseed crops are the second most important commodity of Indian agricultural economy. India is the third largest producer of rapeseed & mustard followed by Canada and China with a total area of 6.23 mha contributing to total production of 9.37 million tons. To meet the total edible oil requirement, India needs more than 25 million tonnes of edible oil at the current level of per capita consumption. The domestic production of edible oils is around 11million tonnes, which is only 40 per cent of the total requirement. Self-sufficiency in oilseeds was achieved through Yellow Revolution during early 1990's, but could not be sustained beyond a short period due to sharp spike in population and per capita consumption. Rapeseed-mustard group of oilseed crops are second to soybean in area and production. Due to high oil recovery and wider adaptability, it is considered as most important commodity of Indian oilseed sector. Indian mustard (*Brassica juncea;* AABB; 2n=36), commonly known as mustard, is predominant species among rapeseed-mustard group of crops in India, and accounts to more than 90% in its acreage.

Gaps in productivity

Technology Mission on Oilseeds and Palm (TMOP) started in 1985-86, has played a vital role in increasing area and production of rapeseed-mustard. Afterwards, productivity has increased significantly by continuous efforts made by different research institutions and state agricultural universities. There is a huge diversity in soil types and climatic conditions in different states of India. Keeping this fact in view, mustard growing regions of the country have been divided into five zones. It is concluded from research experiments that average yield of rapeseed-mustard can be increased significantly by adopting suitable varieties and their matching production and protection technologies. Climatic conditions and level of adoption of package and practices determines the productivity levels in different agro-climatic zones. Improved varieties of mustard are being developed and released according to soil types and climatic conditions of different zones, but optimum yield per unit area from improved varieties could not be achieved due to following reasons.

- Cultivation of old varieties despite availability of new improved varieties
- Cultivation of varieties other than notified for a particular zone or region
- Sowing of improved varieties either before or after the recommended time
- Cultivation of varieties not suitable for the cropping system or agro-ecology
- Susceptibility of the released varieties to different diseases and insects
- Challenges in management of weeds, diseases and insect-pests
- Following broadcasting method for sowing the crop
- Non-availability of improved quality seed
- Non-availability of good quantity and/or quality of irrigation water

Factors affecting productivity

Despite availability of high yielding modern day varieties with a potential yield of about 4t/ha, the average yield is hovering around 1 to 1.5t/ha since more than a decade. Production and productivity of mustard is highly variable across crop growing states of India due to variable agroclimatic conditions, cropping systems, production technologies, and biotic and abiotic stresses. Majority of mustard cultivating farmers in India are resource poor and about 24 per cent of the area under this crop don't have facilities for even a single irrigation. Abiotic stresses alone cause significant reduction in crop productivity [due to drought (17%), high temperature (40%) and salinity (50 to 90%)]. Reduced water availability and reduction in crop yields are the reported projections as a consequence of climate change. Singh and Choudhary (2003) reported up to 60% yield reduction under rainfed conditions. Drought appeared to reduce the overall mean performance of fruiting zone length, main shoot length, siliquae on main shoot, siliquae per plant, 1000 seed weight, and seed yield per plant by 28.89, 18.24, 33.17, 60.46, 19.10 and 68.76 percent, respectively(Singh et al.,2011). Chauhan et al. (2007) reported 4.3 to 60% reduction in seed yield among different genotypes under rainfed conditions in Bharatpur and Jobner regions. High temperature affects seedling survival, resulting in poor plant stand in the field, which eventually leads to decline in production and productivity of rapeseed-mustard. Prevalence of high temperature at the seedling stage also prevents the early sowing of mustard, which is a recommended practice because of many advantages it offers. Shattering of siliquae can be avoided during harvest when crop encounters high temperature, and short duration early maturing mustard is suitable for multiple cropping (Kaur et al., 2009). Higher temperatures coupled with limited water are expected to reduce crop yields, allow damaging weeds and insects to spread, and shift precipitation patterns worldwide.

Salinity is also an important abiotic stress. Nearly 6.73mha area in India is salt affected, wherein 3.77 and 2.96 mha lands are under sodic and saline soil conditions, respectively. Arid and semiarid areas in different states also have saline underground water, which are being used for irrigation purposes. Average yield in salt affected soils get reduced to 460kg/ha, thusresulting in huge economic loss.Out of total mustard growing area in the country, nearly 2 mha areas is salt affected.Frost is another abiotic stress that affects the crop every 5 to 7 years and causes huge losses (upto 100% in frost prone areas). Therefore, majority of mustard growing farmers don't want much to invest on production and protection inputs.

On the other hand, the mustard crop is attacked by many disease-causing organisms including bacteria, fungi and viruses, etc. These pathogens cause huge crop losses, and always challenged the productivity and sustainability of Indian oilseed sector. More than 22 diseases have been reported to affect rapeseed-mustard group of crops in India. However, only a few of them are considered as major diseases on the basis of economic yield loss and their distribution in different agro-ecological regions the country. The details of the major diseases and the causal organisms affecting mustard crop in India are listed below:

Economically important diseases of mustard and losses caused by them

Disease	**Pathogen**	**Extent of losses (%)**
White rust	*Albugo candida* (Lev.) Kunze	17.0-37.0
Sclerotinia Stem rot	*Sclerotinia sclerotiorum* (Lib.) DeBary	35.0
Downy mildew	*Hyaloperonosporabrassicae*	17-37
Powdery Mildew	*Erysiphecruciferarum*Opiz ex. Junell	17.0 (along with 6% reduction in oil content)
Alternaria blight	*Alternaria brassicae* (Berk.) Sacc.	10.0-70.0

Reproduced from "Manual on Management of Rapeseed-Mustard Disease", DRMR Bharatpur

Rapeseed-mustard harbors nearly 38 insect pests from field to storagein India.Among these 38 insect pests, *mustard* aphid, *Lipaphiserysimi* (Kaltenbach) and painted bug, *Bagradahilaris* (Burmeister) are the most destructive insect-pestsin major mustard growing regions of India and due to increasing global temperature theseinsect-pestsareexpected to increase their kitty inyield losses caused by these pests in the future. The damage by mustard aphid vary from 10-90% depending upon the climatic conditions, intensity of population built up and crop growth stage (Dhillon et al., 2018). In addition to the direct losses caused by this insect, it has also been reported to transmit 13 different viruses. With the development and release of mustard varieties possessing low glucosinolates (<30ppm), the losses caused by this insect are predicted to be on the higher side.

Method adopted for seeding and soil moisture conditions at the time of sowing determines the productivity of the mustard crop. Improper germination and poor seedling establishment lead to poor pant stand, thus are major impediments in realizing higher yields. Significant differences were observed among different methods adopted for seeding this crop. Broadcasting of seed in lowland and upland conditions without tillage, broadcasting of seed followed by tillage, and mechanical sowing using calibrated seed drill largely determines the per cent germination. Sowing of mustard is undertaken under pre-irrigated, conserved moisture, no moisture (rainfed), dry sowing followed by sprinkler irrigation and post rain moisture conditionsalso determines the rate of growth and plant establishment in mustard. Sowing the crop at proper moisture using seed drills has been advocated at all platforms, however, the socio-economic and agro-ecological pressures never allowed this practice to be largely accepted by the farmers especially in fragile environments.*Orabanche*, a parasitic weed, is also challenging productivity of Indian mustard. Many farmers have left cultivating mustard in heavily infested fields and opting for alternative crops.

Approaches to improve productivity

Enhancing genetic potential:

The genetic architecture of the plant imposes inherent ceiling on the genetic gains.The phenomenon yield is determined by the corollary between Harvest Index (HI) and biomass. When breeders try to improve HI beyond present level (≈0.25), there is reduction in biomass and, if biomass is improved beyond a limit the HI reduces. Therefore, to improve genetic potential beyond present level, the new plant ideotype need to be defined and created.The efforts are required to optimize these two factors to realize higher yields. This shall become possible through development of a new plant idiotype favoring higher number of siliquae per unit area. The defined ideotype may also require different plant geometry to produce more.Information from distant relatives and cultivated types shall be helpful in understanding such relationship and defining ideotype in future.

Heterosis in oilseed *Brassica* can be exploited commercially using highly efficient hybrid seed production mechanism such as cytoplasmic male sterility- fertility restoration (CMS-FR) system.In India, *Raphanussativus (ogura)* and *Moricandiaarvensis (mori)* have been widely used to develop commercial Indian mustard hybrids. If concerted efforts are made, hybrids are having potential to improve the production due to their higher yielding capacity and better tolerance to abiotic stresses. The use of distant relatives can be deployed for further improving the level of productivity through development of introgression lines, identifying yield related QTLs and introgress the in *B. juncea* background. Modern approaches like marker assisted backcross breeding shall be highly useful for such endeavors.

Yield stabilization:

Genetic potential can be achieved by cultivating notified varieties withrecommended production and plant protection technologies. Indian mustard possesses better level of tolerance against most of the abiotic stresses such as drought, heat, salinity, etc. in comparison to most othercrops cultivated in India. Indian mustard is also known to be high yielder and possess better tolerance against drought as compared to than *B. napus* and *B. rapa*,thushas enormous cultivation potential in semi-arid areas.Due to this fact, proportion of area under *B. juncea* has significantly increased, whereas the area under other species like *B. rapa*cvs. Yellow sarson, brown sarson and *B. napus*has declined. Though the level of drought tolerance is better in Indian mustard than other field crops, the crop growing environments still demand better level of tolerance. Mustard being a crop of marginal landsunder rainfed conditions, genotypes with inbuilt mechanismto tolerate scanty moisture conditions is need of the hour. We have very limited genetic variation in the cultivated germplasm which can tolerate water stress at different stages, thusresult influctuation in national production and productivity. Genotypes with high water use efficiency can be exploited for the improvement of mustard for such conditions.There have been very little efforts to understand genetic and molecular mechanisms,use of wild and related species for trait introgress, and breed genotypes possessing high water use efficiency.

Poor plant stand is another importantreason for non-realization of actual yield potential in early and timely sown crops, mainly due to high temperature at seedling stage. The late sown crop faces high temperature at reproductive stage, thus result in forced maturity and reduction in yield and oil content. Hence, genotypes having inbuilt tolerance to high temperature at seedling stage as well as terminal heat tolerance are needed. Reliable screening methodology against high temperature stress at early seedling stage is already in place (Singh et al., 2012). We have successfully developed high temperature tolerant cultivars viz., Pusa Vijay (NPJ-93), Pusa Mustard 25 (NPJ-112), Pusa Mustard 27 (EJ-17), Pusa Mustard 28 (NPJ-124), BPR-541, BPR-543, and BPR-549-9 (INGR13016)]. These genotypes mature in about 100-120 days and are highly suitable for early (September) sown conditions. Five genotypes viz. EJ-22, NPJ-113, NPJ-124, PusaBaharand 5011 (PusaAgrani x Laxmi) identified using the above-mentionedprotocol have also been characterized using various morphologically and biochemically parameters in order to establish effective heat tolerance selection criteria (Azharudheen et al., 2013). Further, the related species like *B. taurnifortii* and *B. carinata* possessing drought and heat tolerance are valuable genetic resourcesand can be used for improving the level of heat tolerance in *B. juncea*.

Screening techniques have been standardizedforsalinity tolerance at germination stage in hydroponics, pots and microplots and in target environments. The efforts to breed genotypes for salt stress conditions has resulted in release offive such varieties viz., CS-52, CS-54 (CS-614-4-1-4), CS-234-2-2, CS-56, RH-8814 (IC-401570 and BPR-540-6 (INGR13027). Fertilizers applied are not used efficiently; hence development of high fertilizer use efficient lines is highly desirable. Salinity is becoming one of the limiting factors in *Brassica* production, and genotypes tolerant to heavy metals and enhanced CO_2 utilization also need attention in the times to come.

Genetic variability in Brassicas and their related species has been studied, and also identified the sources of resistance or partial resistance against all the above-mentioned pathogens. Despite that, efforts directed toward development of resistant varieties have not been much successful. Till date, hardly any cultivar possessing resistance against major disease(s) and insect-pests has been accepted by the Indian farmers. Resistant sources and varieties succumb to regional pathotypes/races due to variable resistant or susceptible reaction; as a result the resistance in the developed variety is often challenged by farmers and scientific community. Pathogen biology and epidemiology has been well understood. However, the resistance identified using regional isolates have been poorly deployed due to limited efforts on characterization of the pathogens prevalent in India. The pathogen variability has been reported by many workers despite that host differential sets have not been developed for most of these pathogens, thus genes could not be identified and designated. Therefore, limited efforts were made to develop genomic resources enabling precise transfer of resistance in any genetic background. Furthermore, the reliability of identified molecular markers is always challenged during genotyping of populations using different isolates every time. Thus, Brassica breeders are relying mainly on selecting resistant segregants under disease epiphytotic conditions without having much knowledge about race spectrum and genes. Due to limited knowledge about the underlying genes, their precise location on chromosomes, reaction to different pathotypes/races and availability of reliable linked molecular markers, the pyramiding of genes is not possible.

Delineating pathotypes/races, on the basis of host-differentials, is pre-requisite for identification of *R*-genes and establishing gene for gene hypothesis. This shall further help in separating the effect of genes and revealing their host-stage specific differential expression. Combining race-specific and race-nonspecific genes together in one cultivar can significantly improve durability of *R*-genes deployed within *Brassica* species.In general, *B. carinata* resist white rust, alternaria leaf blight and sclerotinia stem rot diseases, tolerate drought and high temperature, and can be easily hybridized with *B juncea*. Efforts are being made to enrich the genome of *B. juncea* with *B. carinata* for productivity and adaptability traits. A good amount of genetic variability has been generated, and is being used for further improvement of *B. juncea*. In addition to this, efforts have also been made to improve *B. juncea* using *B. elongate, B. fruticulosa, B. rapa, Synapiselba, Synapsis arvensis, Eruca sativa, Erucavericaria, Deplotaxiserucoides, Camelina sativa, Raphanapussativus*, etc.Recently, genome of *Brassica juncea, B. napus, B. rapa* and *B. oleracea* has been sequenced, which can help in discovery of novel *R*-genes and enhancement our understanding about genetic relationships among different *R*-genes within and between members of *Brassica* species. Availability of DNA sequences of Brassicas and progress in functional genomics will further lead to identification of many novel genes involved in pathways of different stress tolerance mechanisms. Hybridization between divergent groups of Brassicaceae harboring numerous*R*-genes is already demonstrated in India and elsewhere, which can further complement the incorporation of identified genes/QTLs from one species to another. Once the identified genes/QTLs are tagged and mappedwith molecular markers, their pyramiding in single genetic background would be possible. This shall also open new opportunities for development of multiple disease-resistant Indian mustard genotypes.

Infrastructure development for achieving higher productivity:

Regional breeding programmes in Eastern and North-Eastern zones of India need to be strengthened. Institutional and financial support for establishing oil mills in the non-conventional area shall be helpful in increasing area under this crop. Creating irrigation facilities in areas withlimited water availability shall boost the yield levels. Sowing with seed drill following soil pulverization in rice fallow conditions of eastern India shall help in improving area and productivity under mustard cultivation. The seed hubs need to be created and strengthened in regions having low productivity.

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LP2. BREEDING OIL PALM – CHALLENGES AND OPPORTUNITIES

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Oil palm (*Elaeis guineensis* Jacq.) is a perennial crop having long breeding cycle with lot of challenges in achieving the sustainable oil palm with good yield and high quality oil palm. The African oil palm (*Elaeis guineensis Jacq.*) is the most productive and versatile oil yielding crop, almost five times more oil per hectare than any other oil yielding crops. This crop produces about 4–6 Mt ha^{-1} $year^{-1}$ of crude palm oil (CPO) as against 0.4 t ha^{-1} $year^{-1}$ of soybean oil and 0.6 t ha^{-1} $year^{-1}$ of rapeseed oil. It is the most productive oil crop in the world, with annual production of more than 65 million tons of palm oil. Indonesia and Malaysia are the two countries contribute 85% of the global palm oil supply, which accounted for 34% of world vegetable oils consumption in 2018.

Oil palm (*Elaeis guineensis* Jacq.) is a perennial, monocotyledonous, monoecious, cross-pollinating species belonging to the Arecaceae family. It grows in the wild, semiwild, and cultivated parts of the tropics of the equator, in Africa, South East Asia, and South and Central America. The center of origin and diversity seems to be in the tropical rainforests of west and central Africa where wild and semiwild palm groves are found on the coastal belt, starting with northernmost occurrences along the West African coast. Oil palm has the Latin name, *Elaeis guineensis* Jacq.; the genus name is derived from the Greek 'elaion', meaning oil, and the species name indicates its West African origin. Commercial *E. guineensis* originated in tropical Africa (Ting *et al*., 2014) and was imported into South Asia, where its industrial plantations started approximately 100 years ago. American species, *E. oleifera*, known as the American oil palm (Montoya *et al*., 2014). The centre of origin is not well defined, being broadly dispersed in C. America and the northern region of S. America. Oil palm planted with adequate rainfall, sunshine and ideal soil conditions would in return contribute to optimal growth and yield. Ecological requirements along with recommended agrochemical applications and best management system will further enhance yield. Temperate regions (generally lower than 20°C) results in slowing of flower bud differentiation, low fruit yield, and poor economy, subsequently severely affect the palm oil production. The oil palm is economically productive for more than 25-30 years, including a juvenile stage of around 3 years. Oil palm is commercially propagated through seed (hybrid seed from the cross of *Dura (D)* x *Pisifera* (*P*)). Vegetative propagation, so far, has not been standardized in oil palm. Seeds which have a dormancy or rest period for about 2 - 3 months after germination can be transported as sprouts to desired locations where the seedlings (up to 12–14 months of age) will be raised in a nursery. Based on the thickness of shell in the oil palm fruit, there are three types of palms *dura, pisifera* and *tenera.*

Oil palm breeding: perspectives and challenges

In the first half of the 20th century, breeders provided growers with selected materials derived primarily from local populations, but little progress had been achieved from those populations, which is why an offer was made to several research institutes to exchange planting materials, which led to the International Experiment. The exchange involved 4 African stations in Ivory Coast, Benin, and the two Congos, along with a station located in Malaysia. The Sabah Department of Agriculture (Malaysia) also organized some exchanges, involving materials from Cameroon and Nigeria. Numerous exchanges took place between stations in the 1970s and 80s, between Benin, Ivory Coast and Nigeria. A joint breeding programme was set up by the Unilever and Harrisons & Crosfield groups, which enabled a major exchange of materials between several countries (Cameroon, Colombia, Indonesia, Malaysia, Papua New Guinea, Thailand and the Democratic Republic of Congo)]. Since the 1990s, planting material exchanges have been more intermittent, such as between IOPRI in Indonesia, Ivory Coast and Benin in 1991. Malaysia currently has the highest collection of oil palm germplasm in the world. Snice 1973, Malaysia has collected *Elaeis guineensis* from 11 countries and *Elaeis oleifera* from seven countries. At present *Elaeis guineensis* and *Elaeis oleifera* genetic materials and other palms from Africa and Central- South America are maintained in the form of a field genebank to safeguard the long term interest of the Malaysian oil palm industry.

In India research work on oil palm improvement was initiated during 1974. The Dura population consisting of 300 palms available at Thodupuzha was the base to start the initial selection programme in which 40 superior palms were selected. Also, tenera hybrids were produced by crossing 11 such superior dura palms with *Pisifera* pollen grains imported from

Nigeria (*Pisifera* were not identified during this period). These hybrids were evaluated at the then Central Plantation Crops Research Institute (CPCRI), Research Centre at Palode during 1976 and two hybrids were selected as the promising ones with a potential of yielding 4.6 tonnes of palm oil per hectare under rainfed conditions. These hybrids were designated as Palode-I and Palode-II.

Conventional Breeding

Until the 1950s, oil palm breeding was confined to the thick-shelled *dura* variety. Efforts to improve wild genes in Africa as well as the work in Malaysia and Indonesia on the progenies of the four famous Bogor palms resulted in various breeding populations of restricted origin. Until the 1930s *dura* was cultivated on a commercial scale in Asia as well as in African countries. The superior oil content of *tenera* led to the use of T × T seed for commercial planting from the 1930s. It was later (in 1938) found that about 25% palms are sterile (*pisifera*) in the T × T population resulting in great loss to the farmers as one-quarter of the plantation was not yielding. Tenera selfing for obtaining planting material was found to yield *dura*, *tenera*, and *pisifera* in a 1:2:1 ratio because the shell character is controlled by a single gene. Beirnaert and Vanderweyan (1941) found the hybrid nature of tenera and advocated use of hybrid seed (from D × P). Consequently, in Congo (late 1940s), Sumatra (1953), and Malaysia (1956) large-scale planting of tenera was undertaken because of superior oil content. Thus the hybrid seed from selected mother palms (*dura*) and pollen parents (*pisifera*) became the commercial planting material.

The main emphasis of breeders is to evolve varieties with high fresh fruit bunches (FFB) yields and better mesocarp content, thereby increasing palm oil productivity. Reduced height increment, drought tolerance, superior oil quality, pest and disease tolerance, as well as precocity are also important considerations. The four African *E. guineensis* palms brought over by the Dutch in 1848 and planted in Buitenzorg Botanical Garden (now Bogor), Indonesia, laid the foundation for the oil palm industry in Malaysia and Indonesia. From these, the Deli *dura* palms with unique and favourable fruit qualities were developed. The Deli *dura* population is widely utilized for seed production and in genetic improvement programs in Malaysia and Indonesia. The most cultivated high-yielding oil palm variety, the thin-shelled *tenera* [oil: bunch > 20%] is produced when the thick-shelled *dura* (O/B ~ 17%) crosses with the shell-less *pisifera*. The *pisifera*, which is mostly female sterile, is used as the pollen parent. The oil palm breeding programme aims at improvement of mother palms (*Dura* improvement) and pollen parent (*Pisifera* improvement) separately and testing their combining ability in order to use the selected mother palms and *pisiferas* in hybrid seed production. The concept of a variety in true sense is not applicable to oil palm.

The Present breeding programmes have been focused around heterosis breeding (development of hybrids) and population improvement. Phenotypic mass selection combined with family selection in bi-parental crosses to the production of Dura, which in combination with Pisifera would give high yielding Tenera is being followed. The oil palm breeding programme in recent past have predominantly been directed towards high oil yield, superior oil quality, less height increment, dwarfness, and for high Bunch Index. In recent years focus on other traits like compact canopy; long stalk, big kernel *etc* have also got attention of breeders. The other important aspects in breeding are development of location specific hybrids, drought tolerance/ high water use efficiency and dry matter partitioning, early vegetative growth *etc*.

The major constraint in oil palm breeding is to achieve a selection intensity great enough to give a useful rate of immediate progress while at the same time maintaining sufficient variability for advancement in subsequent generations. The commonly used breeding methods are progeny testing, Modified reciprocal recurrent selection, Back Crossing and Bi-parental mating design. Scope of use of mutation breeding in oil palm is limited as it will require a lot of resources like land, irrigation manpower *etc*. with limited success of obtaining useful mutant in future generations.

Broadening genetic base:

Efforts are being made to broaden the narrow genetic base of oil palm through collection of elite palms from exotic plantations in India, collection from primary centres of origin, development of pre breeding populations and introgression of available exotic material to integrate in Indian population. The selected African dura of drought tolerant materials are being crossed with Indian dura used for commercial seed production. Similarly, the Nigerian tenera are being introgressed into the current tenera breeding population. Elite dura from African source are being progeny tested with Nigerian pisifera to study the performance. Similarly African pisifera and tenera are being tested with current dura materials**.**

Breeding for high Water Use Efficiency:

Oil Palm germplasm, mostly *Dura* were collected from originating countries in West Africa, where Oil Palm is growing wildly in tropical forests, by retaining all its native characteristics. The germplasm accessions collected from Cameroon, Zambia, Tanzania, and Guinea Bissau, are expected to have stress tolerance character, which is highly useful under Indian conditions to develop improved planting material to facilitate cultivation of Oil Palm in water limited and high altitude areas.

Exploitation of fertile pisifera for commercial cultivation:

Fertile pisiferas are characterized by normal fruit setting and semi fertile fruits may have varying degrees of fruit set. However pisiferas with good bunch development, and fruit set could lead to higher yield. Furthermore, the thin shelled nature of pisiferas also results in higher extraction rates (OFR), better oil bunch ratio (5-10 % more than tenera) and easier processing. There is a possibility to identify individual elite palms comprising of all desirable traits through single plant selection, which then could be mass multiplied through tissue culture techniques.

Breeding for high kernel oil:

High industrial demand for palm kernel oil, which has different fatty acid composition from mesocarp oil, coupled with its attractive higher price, that efforts are focussed on the production of oil palm hybrids with large kernel. If available variation for kernel size is large, this offers a possibility of effective selection. Though it is a low priority area in Indian context, variation for seed kernel parameters is being studied in existing dura and t x T populations.

Breeding for high bunch index and ideotype palms:

There is significant genetic variation in photosynthetic rates in modern oil palm breeding population (Smith, 1991). In our germplasm, there is sufficient variability available to exploit them to produce palms with high bunch index. To achieve high-density planting, photosynthetic rate per unit area need to be increased as shown in other crops (Rajanaidu and Zakri, 1988) and in oil palm (Corley, 1983. Corley and Donough, 1990). Work on this aspect has been initiated in oil palm about this aspect at NRCOP. According to Reddy et al, (2000), Papua New Guinea (1M-0069D×P) combination tested at NRCOP, produced maximum bunch dry weight and bunch index out of eleven hybrid combinations. Therefore breeding efforts for reduced height growth may give a solution in the long run. Alternatively, planting at a high density and replanting at an early age can be considered when we deals with varieties having vigorous height increment (Gerritsma and Wessel, 1997)

Breeding for high oil quality:

Efforts are made at PORIM to screen high yielding dura and tenera palms with high unsaturated oil with high iodine value (Rajanaidu, 1990) from Nigerian germplasm to achieve higher iodine value. Inter specific hybridization was tried between *guineensis* and *oleifera* in 1959 on latosoils of Malaysia by Hardon (1969) and he reported the advantages such as intermediate oil quality, less height increment and tendency of production of more parthenocarpic fruits. However, according to Rajanaidu et al., 1995) the oil yield of their hybrids was extremely disappointing due to the thickness of shell and thin mesocarp.

Oil palm hybrid seed production:

The commonly followed method of oil palm hybrid seed production is selection of dura mother palms on yield and other supporting parameters basis and the selection of pisifera as pollen parent is purely based on progeny testing trials where a general combiner is used in future crossing programme. In India, five oil palm seed gardens are involved in seed production. Around 30 lakh oil palm sprouts per annum is required to meet area expansion and replanting but, only 50–60% of demand met through indigenous seed production. This gap can be reduced to considerable extent by enhancing the germination percentage. Further, improved germination save resources like labour, land, water, etc. and reduces the cost of seed production drastically. Similarly, the development of micro propagation techniques in oil palm will be an added advantage for rapid multiplication.

Molecular breeding in oil palm

Finger printing in oil palm using molecular markers:

Initially several genetic diversity works were based on using RAPD, RFLP and AFLP molecular markers. However, due to certain drawbacks these markers were replaced by SSR and SNP markers. Now-a-days these markers are effectively being used in finger printing, genetic diversity of different germplasm. Some workers studied genetic relationship between elite oil palms from Nigeria and Malaysia using SSR markers.

Identification of genes in oil palm:

Okoye *et al*. (2016) studied genetic relationship between elite oil palms from Nigeria and Malaysia using SSR markers. The dura genotype has thick shell, consisted of dominant Sh allele (Sh/ Sh), and contributes 15 percentage of oil, whereas pisifera genotypes was shell less, consisted of recessive shell alleles (sh/sh), usually female sterile (Corley and Tinks, 2003), which contributes 25 percentage of oil. Babu et al (2017) identified SNP based CAPS marker for fruit form identification. The figure 1 represents the dura, pisifera, and tenera fruit form identification in oil palm using CAPS marker. Singh et al. (2014) revealed the identification of the VIRESCENS (VIR) gene, which controls fruit exocarp colour and is an indicator of ripeness. VIR is a R2R3-MYB transcription factor with homology to Lilium LhMYB12 and similarity to Arabidopsis PRODUCTION OF ANTHOCYANIN PIGMENT1 (PAP1). Ali *et al*. (2015) used 58 simple sequence repeat markers were utilized with three progeny types, namely, KA4G1, KA4G8, and KA14G8, to perform a comparative molecular mapping for association with BSR.

Molecular marker applications and marker-assisted selection in oil palm:

In addition to the use in breeding for specific traits through MAS, molecular markers are also useful for the diagnosis and characterization of diseases, determining legitimacy of genotypes/progenies, protection of intellectual property rights, etc. Oil palm in South East Asia is badly affected by basal stem rot (BSR) disease caused by Ganoderma boninense. BSR disease causes serious problems in oil palm production. Breeding for resistance is an obvious approach and a long-term solution for ganoderma disease. Ali *et al*. (2015) identified SSR markers for BSR disease. In their study, 58 SSR markers were utilized with three progeny types, namely, KA4G1, KA4G8, and KA14G8, to perform a comparative molecular mapping for association with BSR. Thonghawee *et al*. (2010) used microsatellites for parentage analysis in an oil palm breeding population. They reported that a combination of four SSR loci was sufficient to reach a nonexclusion level below 1% for the detection of planting errors. To detect pollination errors confidently, seven or eight SSR loci were necessary. Ten monomorphic SSR markers and two half sib families were used for detection of illegitimacy in oil palm as reported by Hama-Ali *et al*. (2015). Illegitimate off-spring IDs 97 and 180 were detected by three monomorphic loci, mEgCIR0425, mEgCIR3769, and mEgCIR3902, in family-1 and family-2. In addition, five loci detected one illegiti- mate off-spring, ID180. Mayes *et al*. (1996) reported DNA finger printing of 111 elite breeding palms using a comparatively limited number of highly variable RFLP probes. Using this method all but eight of the palms could be distinguished uniquely.

Future perspectives:

Conventional breeding together with molecular approaches will help in breeding programmes for improvement of oil palm. More research needs to focus on the development of trait specific molecular markers for selecting the desired oil palm genotypes. This further leads to increase in the yield in a short time and supply of desired materials to farmers.

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LP3. PRE-BREEDING AND GENETIC ENHANCEMENT IN OILSEED CROPS

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INTRODUCTION

Agriculture today is characterized by a sharp reduction in the diversity of cultivated plants. Out of an estimated total of 30,000 edible plant species, only 30 'feed the world', with the three major crops being maize (*Zea mays*), wheat (*Triticum aestivum*) and rice (*Oryza sativa*) (FAO, 1996). In the past, crop improvement has led to narrowing down of genetic base resulting in slower progress (genetic gain) in plant breeding and increased risk of genetic vulnerability. This has resulted in the accumulation of unused potential germplasm. In order to break these bottlenecks and to create superior gene pools, genetic enhancement or pre-breeding is required to enhance the value of germplasm. Reaching performance plateau may be another risk (Haussmann, 2004).

The Global Partnership Initiative for Plant Breeding Capacity Building (GIPB)/FAO and Biodiversity International use the term 'pre-breeding' to describe the various activities of plant breeding research that have to precede the stages involved in cultivar development, testing and release (Biodiversity International and GIPB/FAO, 2008). Further, the Global Crop Diversity Trust defined pre-breeding as 'the art of identifying desired traits, and incorporation of these into modern breeding materials.' Pre-breeding aims to reduce genetic uniformity in crops through the use of a wider pool of genetic material to increase yield, resistance to pests and diseases, and other quality traits. Overall, pre-breeding includes all activities directed at identification of desirable crop traits and/or genes, and their subsequent transfer into a suitable set of parents for further selection. The procedure identifies useful character(s) or genes that can be exploited in cultivar development (Ortiz, 1999). The benefits of plant breeding research and development can only be realized on a long-term basis because of the inherent nature of the crops and the eminent breeding procedures involved. Plant breeding involves two main activities, i.e., pre-breeding/ germplasm enhancement and cultivar development *per se*. The two phases, in turn, depend upon various factors, e.g., breeding goals, genetics and agronomy of the crop, breeder's long term objectives, availability of testing facilities and national cultivar registration requirements. Despite these factors, there are certain clear steps and breeding procedures followed in any conventional breeding program. These include parental choice, making crosses among chosen parents, and selection from recombined parents followed by extensive field testing of the candidate cultivars. Maintenance and multiplication and distribution of the seed are the ultimate stages of a breeding program. Systematically outlined conventional breeding procedures, timeframes and estimated breeding generations are essential to objectively consider the ultimate timescales required to release new and improved cultivars of all crops. The information may assist plant breeding students, educators, researchers, project advisors, administrators and funding agencies.

Advantages of Prebreeding

1. Broadening the genetic base and genetic variation
2. To break yield barriers
3. Development of donors for various abiotic and biotic stress resistance
4. Wild relatives are rich sources of quality traits which can be incorporated into the cultivars
5. Variability to improve other agronomic characters such as earliness, non shattering other yield contributing characters.

Activities of Pre-breeding

1. **Characterization of germplasm**

Genetic resources can be defined as all materials those are available for improvement of a cultivated plant species. According to the extended gene pool concept, genetic resources may be divided into primary gene pool, secondary gene pool, tertiary gene pool and isolated genes. The primary gene pool consists of the crop species itself and other species that can be easily crossed with it. The secondary gene pool is composed of related species that are more difficult to cross with the target crop, i.e. where crossing is less successful (low percentage of viable kernels) and where crossing progenies are partially sterile. The tertiary gene pool consists of species which can only be used by employing special techniques like embryo rescue or protoplast fusion. The fourth class of genetic resources, isolated genes, may derive from related or unrelated plant species, from animals or microorganisms. The importance of the different classes of genetic resources for crop improvement depends on the target crop species. In rape seed, on the other hand, genetic variation in the primary gene pool is small and breeders have to transfer important traits from *Brassica* species of the secondary and tertiary gene pools into the cultivated species (Hu *et al*., 2002). World-wide, 1308 gene banks are registered in the WIEWS (World Information and Early Warning System on PGR) database (http://apps3.fao.org/wiews/) and conserve a total of 6.1 million accessions, including major crops, minor or neglected crop species, as well as trees and wild plants. Of the 30 main crops, more than 3.6 million accessions are conserved *ex situ* (FAO, 1996).

2. Creation of new parent populations

The success of a crop breeding program relies on choice of the best parents possessing complementary and desired traits. Thus, breeders continuously select potential parent populations from diverse sources including land races, modern cultivars, obsolete or primitive cultivars, wild or semi-wild species. Parents with high specific or general combining abilities are selected *via* progeny testing through well-designed recombination. The progenies are evaluated to determine the genetic potential of parents for subsequent breeding and to discern the type of cultivar to be developed, *i.e*., pure line, hybrid, or open-pollinated. Progeny testing is performed in a set of target and representative environments with half-sibs, full-sibs, testcrosses or recombinant inbreds. Canola type *B. juncea* were developed which are being used as parental lines to incorporate low erucic acid and low glucosinolate in high yielding mustard varieties.

3. Introgression of new traits from other useful sources, exotic germplasm or a land race or related species

The plant breeder transfers one or more desirable traits from unrelated, exotic or semi-exotic, landrace or related germplasm into an intermediate variety with good agronomic potential but lacking a specific trait. Thus, the new variety will be developed with the introduced novel gene(s) in the existing genetic background. Often the unrelated or exotic germplasm does not have immediate usefulness and as such it has to be selected for adaptation to the target production environment. Exotic germplasm may constitute races, populations, clones, inbred lines, or other forms of genetic structure. While introgressing genes from unrelated, exotic, primitive or wild germplasm, both the desired gene(s) and a considerable amount of undesirable genetic material is introduced into the progeny that has to be removed through a series of backcrosses to the recurrent parent. The land races in soybean have given rise to three varieties *viz.,* Kalitur, JS-2, and Type 49. Majority of Indian soybean varieties have been developed using exotic parents *viz.,* Bragg, Lee, Improved Pelican, Hardee, Monetta, Shilajeet, Co 1, Gujarat Soy 1, Gujarat Soy 2, VL Soy 2, and JS 71-05 which owe their evolution to direct selection from exotic and indigenous material.

4. Creation of novel traits, for instance, through mutation breeding followed by backcrosses to good parents

Mutations lead to spontaneous changes of the genetics of individuals that are often heritable. Naturally, mutational events occur at low frequencies, i.e., 10^{-5} to 10^{-8} per locus. Induced genetic variations have been used successfully in several crops to create useful mutants. The novel mutational events can either be directly developed as essentially derived varieties or novel genes introgressed into candidate parents through a backcross program. The γ-ray-induced mutants with improved plant architecture were developed having closed capsule, determinate growth habit, resistance to *Fusarium* blight, etc. These mutants had improved oil quality with considerably higher oleic acid and low linoleic acid contents in sesame (Arslan *et al.,* 2007).

5. Creation of polyploids

Individuals with altered chromosome set (euploids) are developed by doubling the number of genome of a species or by crossing unrelated species followed by chromosome doubling of the inter-specific hybrid. Polyploids can be artificially induced by various means such as exposing plant materials to environmental shock (e.g. low or high temperature treatment, x-ray irradiation) or with chemicals (e.g. colchicine) that disrupt normal chromosome division. In groundnut development of synthetic amphidiploids (Mallikarjuna *et al.,* 2011) can facilitate better utilization of wild species in breeding programs as use of synthetic amphidiploids circumvent the crossing barriers between wild and cultivated species. Diploid *Arachis* species with A genome namely *A. duranensis, A. cardenasii, A. diogoi, A. kempff-mercadoi* and *A. stenosperma* were crossed with B genome species *A. batozocoi, A. valida Krapov, A. magna and A. ipaensis* to develop amphidiploids. Amphidiploids with resistance to foliar diseases are being used as parents to develop resistant cultivars (Kumari *et al.,* 2014).

6. Acquisition of new information on crop genetics

The breeder constantly looks for new genes from diverse sources for enhanced nutritional qualities, early maturity, high yield potential and biotic and abiotic stress tolerance. Understanding the candidate genes and the pattern of inheritance of the genes in controlling these characters is profoundly significant for effective transfer and to improve the efficiency of selection in cultivar development.

7. Plant tissue culture

Wide hybridization in crop species is restricted due to hybrid sterility due to stability barriers and chromosome pairing in hybrids which have restricted the access to genes from wild species into cultivated ones. Tissue culture techniques like ovary culture and embryo culture for embryo rescue are being used. Embryo culture was carried to rescue F_1 plants of interspecific cross between *B. juncea* and *B. tournefortii* (2n=20, DD) to incorporate biotic and abiotic stress tolerant genes to *B. juncea* (Kumar *et al.,* 2001). Protoplast fusion can overcome sexual barriers and has allowed somatic intergenomic hybrids to be created where sexual hybrids have not been reported. Many intertribal somatic hybrids have been created between wild species and cultivated *Brassica* species, with a view to incorporating useful wild genes into the cultivated species (Prakash and Bhat, 2007). In many instances, the desirable trait is expressed in the somatic hybrids. Standardized micropropagation technique for sunflower was developed to maintain wild relatives of sunflower *in vitro*, which are serving as a source of favourable traits for introgression into cultivated sunflower (Sujatha, 2006). In sesame, Dasharath *et al.* (2007) successfully developed interspecific hybrids between cultivated *S. indicum* and its wild relatives *S. radiatum* and *S. occidentale* through ovary and ovule culture. In another study, a simple and efficient protocol for production of hybrids of a cross between *Sesamum alatum* and *S. indicum* were optimized through ovule culture (Rajeswari *et al.* 2010).

Genetic enhancement for economically important traits through prebreeding in oilseed crops is presented in Table 1.

Biology and pollination behaviour in annual oilseed crops

***Brassica* spp.**

The *Brassica* species cultivated for oil purpose are *B. juncea, B. rapa, B. nigra* and *B. napus,* belonging to the family Brassicaceae. U (1935) demonstrated that *Brassica* crop species comprise three diploid species, *B. rapa* (genome AA, 2n=20), *B. nigra* (BB, 2n=16) and *B. oleracea* (CC, 2n=18), plus three amphidiploid species, *B. napus* (AACC, 2n= 38), *B. juncea* (AABB, 2n=36) and *B. carinata* (BBCC, 2n=34). The amphidiploid species originated through interspecific hybridisation between two of the three diploid species. The species are self pollinated, however insect activity leads to cross pollination to the extent of 20-30%.

Groundnut

The cultivated groundnut (*Arachis hypogea* L.) belongs to the family Fabaceae (Leguminose), and classified into two subspecies, subsp. *Fastigiata* Waldron and subsp. *hypogaea* Krap. Groundnut is an allotetraploid (2n=2x=40) with AABB genomes. Single hybridization event between the diploid progenitors followed by chromosome doubling about 3500 years ago lead to origin of cultivated groundnut in parts of South America. It is a self pollinated crop with cleistogamous flowers but natural cross pollination can occur to very small extent due to bee activities.

Soybean

Soybean (*Glycine max*) belongs to the family Fabaceae (Leguminose) with diploid chromosome number 2n=20. Soybean has been domesticated from the annual wild soybean *Glycine soja* Sieb.*et* Zucc in north China. It is a self-pollinated crop with 1-8% of natural cross pollination.

Sunflower

Sunflower (*Helianthus annuus* L.) belongs to the family Asteraceae with diploid chromosome number 2n=34. The genus *Helianthus* includes 49 species comprising of 32 perennial and 17 annual species. The species fall into three ploidy groups *viz.,* diploid, tetraploid and hexaploid. Cultivated sunflower is predominantly a cross pollinated crop. Compatibility barriers are strong between cultivated sunflower and the tetraploid species while high crossability success is reported with diploid annuals and hexaploid species. Sunflower is one of the crops which were transformed from an ornamental crop to a oilseed crop through introgressive breeding. Several economically important traits like cytoplasmic male sterility, fertility restoration, resistance genes for biotic stresses (*Spodoptera litura*, downy mildew, powdery mildew, rust, *Alternaria helianthi*), oil content and quality were derived from wild sunflowers.

Safflower

Safflower (*Carthamus tinctorius* L.) in an annual herb belonging to the family Asteraceae. Safflower was domesticated from C. *tinctorius* having diploid chromosome number 2n=24. Pollination occurs as the style and stigma protrude out of the fused anther tube. Unpollinated stigma remains receptive for several days. Outcrossing in safflower has been reported to range from 0 to as high as 59% in different genotypes through bee visits; therefore the crop is considered to be often cross pollinated crop.

Sesamum

Sesame (*Sesamum indicum* L.) in an annual herb belonging to family Pedaliaceae having diploid chromosome number 2n =26. The species was first domesticated in the Indian subcontinent. The crop is self pollinated with very low percent of cross pollination. More than 38 species have been described in this genus, which are classified into different groups on the basis of their geographic distribution, morphologic and cytogenetic information.

Constraints in Prebreeding

- Cross incompatibility
- Stability barriers and chromosome pairing in hybrids have restricted the access to genes from wild species into cultivated ones
- Linkage drag
- Hybrid inviability and sterility
- Small sample size of inter-specific hybrid population
- Lack of availability of donors for specific traits
- Exchange and accessibility of cultivated species germplasm material has become difficult due to legal restrictions like IPR

Conclusions

Pre-breeding programs can generate new base populations for breeding programs and also assist in identifying heterotic patterns for hybrid programs. The lack of pre-breeding programs is the most limiting factor for using landrace germplasms and unadapted exotic lines from collections. Certainly, pre-breeding activities will improve the knowledge about the accessions maintained in germplasm banks and will contribute to reduce the gap between available genetic resources and crop breeding programs.

Table 1. Traits improved through prebreeding in oilseed crops

Crop	Genetic resources and maintaining agency	Trait(s) introgressed or incorporated	Source	References
Brassica juncea	DRMR, Bharatpur	Low erucic acid Low glucosinolate Biotic stress tolerance Aphid resistance CMS	*B. rapa,* *B. napus* *Wild Brassica species B. elongata, B. fruticulosa, B. souliei, Diplotaxis tenuifolia, Hirschfeldia incana, Coincya monensis, Sinapis arvensis* *B. tournefortii* *Weedy Brassica*	Krik &Oram, 1981 Love *et al,* 1990 Banga *et al,* 2003 Kumar *et al*, 2001
Brassica napus	DRMR, Bharatpur	High yield, short duration	*B. rapa*	
Groundnut	ICRISAT, Hyderabad and DGR, Junagadh	Early and late leaf spot *Spodoptera* Most of the biotic stress Rosette and Nematodes rust Foliar diseases	*A. cardenasii* *A. kempf-mercadoi* *A. diogoi* *A. stenosperma* *A. hoehnei* Amphidiploids	Kumari *et al.*, 2014

Soybean	4248 with 36 wild accessions, IISR, Indore	Yield QTL Bihar hairy caterpillar Salt tolerance	*G. soja*	Concibido *et al.*, 2003 Singh *et al.*, 2007 Qi *et al.*, 2014
Sunflower	2140 with 36 wild accessions, IIOR, Hyderabad	CMS	*H. petiolaris*	
Safflower	6887 accessions, IIOR, Hyderabad	Fusarium and Alternaria wilt	*C. oxyacantha* *C. palaestinus* *C. lanatus* Exotic collections	
Sesamum	AICRP on sesame, Jabalpur	CMS	*S. malabaricum*	Bhuyan *et al.* 1997

Pre-breeding and cultivar development are interdependent activities are the controlling factors that determine the pace at which cultivars are released consistently to farmers.

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LP4. SESAME BREEDING: PRESENT SCENARIO AND FUTURE PROJECTION

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INTRODUCTION

The oil is one of the mandatory components in our diet. It comprises of seven edible oils which are soybean, groundnut, rapeseed-mustard, sunflower, niger, sesame and safflower and two non-edible oilseeds namely castor and linseed. The oilseeds have been somewhat neglected in the past fifty years due to the advent of green revolution. Thus, its cultivation has been limited to rainfed conditions and unproductive land. India has achieved major landmarks in the production of cereal crops such as paddy, wheat, maize etc. in last fifty years. On the other hand, the production of oilseeds has largely been stagnant. Meanwhile, the rising income of people has meant that the consumption of oilseeds has been on the rise constantly. These factors have combined to make India the largest importer of oilseeds, a crop which was exported during the 1960s. One of the major factors for low production is low yield, which exists due to non-availability of climate resilient variety, high oil yield, and seed for biotic and abiotic resistance, mechanization in harvesting and post-harvest process development of package of practices for different ecologies. The existing issues with the available varieties of oilseeds are low oil yield, poor quality of extracted oil, shattering, non-synchronized maturing and so on. This has created a need for genetic improvement which involves evaluation of germplasm, pest and disease resistance, earliness and shattering resistance, quality of oil, varieties for different climatic conditions etc. Tissue culture and molecular breeding are also viable avenues for crop improvement.

Sesame (*Sesamum indicum* L., 2n=2x=26), belonging to the family Pedaliaceae is commonly known as gingelly or til and tila is an important oilseed crop. This crop often referred to as "Queen of oil seed" because of its high seed oil content and excellent qualities of the seed oil and meal with presence of antioxidants like sesamol, sesamin, sesamolin and sesaminol (*Vijayarajan et al.,* 2007) is cultivated mostly in tropical and subtropical areas of Asia, Africa and South America. Sesame seed contains high oil content (46% - 50%) with (83% - 90%) polyunsaturated fatty acids (PUFA), 20% proteins lignans (sesamin and sesamolin), tocopherol, phytosterols, phytates and and various minor nutrients such as vitamins and minerals. The oil contains several fatty acids such as oleic acid (43%), linoleic acid (35%), palmitic acid (11%) and stearic acid (7%) with trace amount of linolenic acid (Kamal-Eldin *et al.* 1995, Ashri, 1998) and also has the highest antioxidant presence. Sesame seeds are not only used as in the preparation of number of food products such as tahini, halva, pinni, bakery and sweets confectionary products including bread, hamburger buns, biscuits and candy bars but also consumed as raw food. Sesame oil is considered the healthiest vegetable cooking oil which is in turn beneficial for reduction of blood cholesterol, high blood pressure and plays an important role in preventing atherosclerosis, heart diseases and cancers.

Sesame is widely cultivated over an area of more than 11.74 million ha in the world with an annual production of 6 million tonnes and yield of 512.30kg/ha (FAOSTAT, 2018. It is mainly grown in West Bengal, Rajasthan, Madhya Pradesh, and Gujarat, accounting for about 70% of sesame seeds in India and also grown in some other states like Uttar Pradesh, Orissa, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Bihar. The oilseed production in India can be overcome the shortfall by expansion of sesame.

LIMITATIONS OF SESAME CULTIVATION

There are various reasons for low productivity of sesame as sesame cultivation is mainly done as underutilized crop with poor management in marginal and sub marginal lands. Input starved conditions and seed shattering also contribute to the hindered productivity. Indeterminate growth habit asynchronous maturity, vulnerability to pests and diseases etc. makes the overall production in a stagnant situation.

STRATEGIES TO IMPROVE PRODUCTIVITY OF SESAME

- Development of high yielding variety coupled with higher oil content and improved quality especially high lignans.
- Improvement in cultivation practices that increases the harvest index and yield
- Development of varieties tolerant to diseases occurring due to Macrophomina, Phyllody etc.

- Abiotic stresses namely drought, water-stagnant condition and salinity tolerant varieties cause reduction of yield and so breeding varieties tolerant to such conditions will be helpful.
- Breeding varieties to low free fatty acid specially considering to boost up export
- Breeding for improved indeterminate growth habit and synchronous maturity. Development of non-shattering cultivars.
- Improvement in seed retention in the capsule i.e. development of closed (indehiscent) capsule cultivars for mechanized harvesting.
- Blending of varieties should be avoided to provide adequate seed cleaning of up to 99-99.5% purity is required.

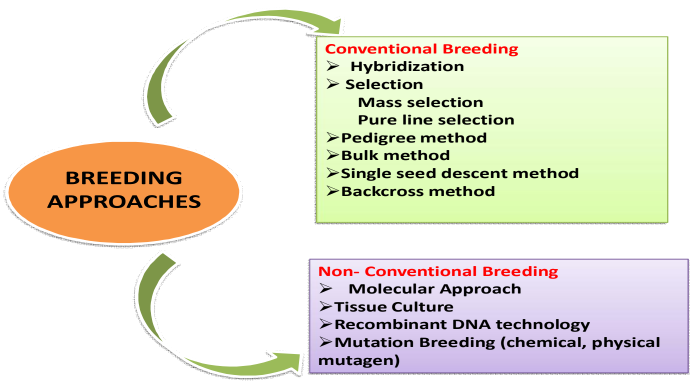
Plant Ideotype

- An ideotype plant in sesame may be identified according to the plant attributes consisting of branching style, number of capsules per leaf axil, plant height, internode length, capsule length, thickness of mesocarp, number of capsules, 1000 seed weight and maturity. (Das,2005)

Important yield traits

- Genetics of Yield Components
- Indehiscent vs dehiscent capsule
- Seed Coat Color
- Number of capsules per leaf axil
- Bi, tri or tetra-carpellate capsule
- Distance between node
- Thickness of mesocarp

BREEDING APPROACHES IN SESAME



CONVENTIONAL BREEDING

Conventional plant breeding is the natural process of selection and breeding using classical tools. Characterization and preservation of naturally existing variation in a crop is fundamental part of breeding. Before moving to hybridization, study of plant morphology is an important step in breeding which represents development of elite cultivars.

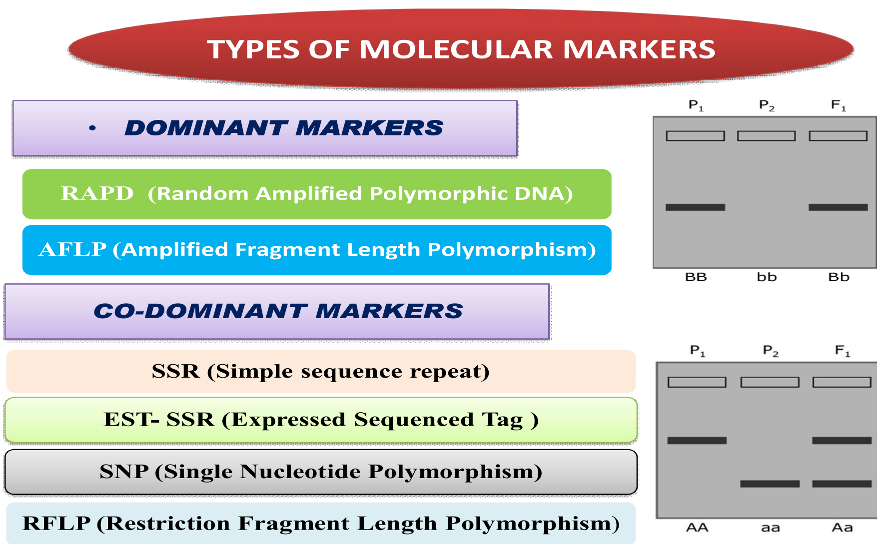
There are some limitations to conventional breeding as well. Firstly, breeding can only be done between two plants that are compatible with each other. Secondly, when plants are crossed, several unwanted traits also transferred along with the elite traits. Thirly, conventional breeding methods requires long term continuous effort that is very time consuming.

NON CONVENTIONAL BREEDING

Non-Conventional plant breeding consists of molecular approach, tissue culture, mutation for manipulating plant genome etc. This process is less time consuming compared to the counterpart. Over the past 50 years, the field of genetic engineering has grown manifold because of better research and understanding of DNA.

Molecular approach

Molecular breeding is done on the DNA level. We transfer the desirable genes in this process.



Following are the different forms of Molecular Approach:

1. Random Amplified Polymorphic DNA (RAPD)
2. Amplified Fragment Length Polymorphism (AFLP)
3. Restriction Fragment Length Polymorphism (RFLP)

4. Simple Sequence Repeats (SSR)
5. Expressed Sequenced Tag (ESTs)-SSR
6. Single Nucleotide Polymorphisms (SNP)

Advantages of molecular breeding

There are several advantages to molecular approach of breeding which are easier phenotypic evaluations of complex trait. It is easier to look for desired traits in this process which also contribute to judicious use of time. There is also reduction of cycle time and prudent use of space for germplasm selection. Less external interference and identification of homozygote and heterozygote plants are also important pros of using molecular approach.

Tissue culture

Tissue culture is the cultivation of plant cells in an artificial media which is used in micropropagation. The cell which is used for propagation is known as totipotency which can be taken from any part of plant provided it consists of a nuclei and cytoplasm. George *et al.* (1987 and 1989) reported first *In Vitro Multiplication and* regeneration *of Sesame* through Tissue Culture. Recently, In vitro shoots multiplication from nodal explants of Sesame done by Asad *et al.*(2020).

Recombinant DNA technology

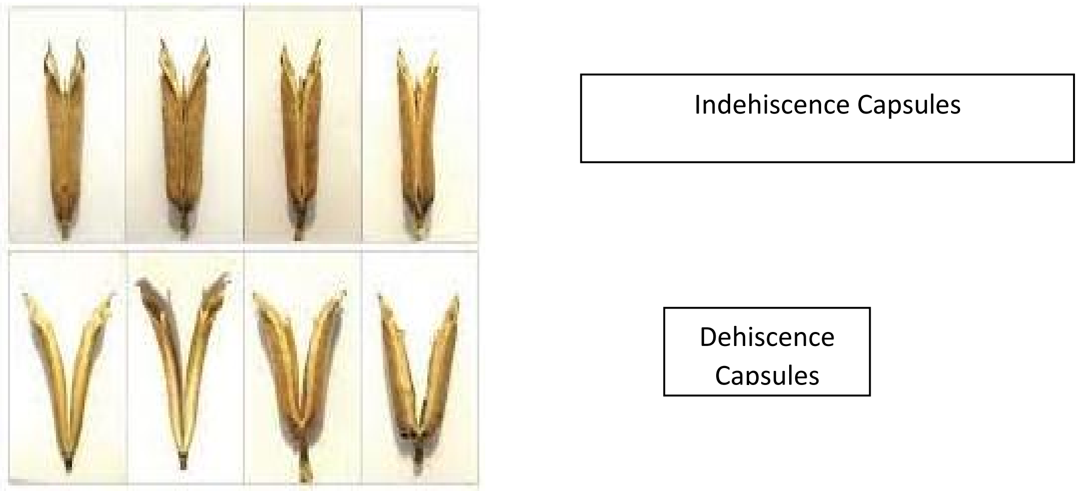
Recombinant DNA technology is the joining together of DNA molecules from two different species. The recombined DNA molecule is inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture and industry. DNA is extracted from a particular plant and is cut into suitable size for cloning, which is most often achieved by restriction enzymes. *Agrobacterium tumefaciens*-mediated genetic transformation of sesame also reported by Yadav et al. (2010).

Mutation breeding

Mutation breeding also knows as Variation breeding is the process of exposing seeds to external factors such as chemicals or radiation to generate mutants with desirable traits. It is mainly categorised into Physical Mutagens and Chemical mutagens.

Physical mutagens consist of exposing plants to radiation such as Gamma-rays and x-rays. High rates of chromosome aberrations because of radiation paved the way for Chemical mutation- as sodium azide and ethyl methane sulphonate, colchicine are also used to cause mutations. Classical breeding methods including induced mutation and screening of genotype for desirable characters became more important now (Wongyai *et al.,* (2001); *Uzun et al.,* (2003), Begum and Dasgupta (2011), Boureima *et al*., (20

DEPLOYMENT OF NEWLY DEVELOPED TOOLS IN SESAME IMPROVEMENT STRATEGY



Recently, Gar *et al*. (2020) discovered QTLs for shatter resistance capsules.

RECOMMENDATION FOR FUTURE RESEARCH IN SESAME

- Incorporation of material from diverse resources including promising exotic material and wild resources for improving specific yield components or tolerant to stresses.
- There should be long term planning that should encompass germplasm collection, crossing and selection.
- Reduction of seed shattering is an important factor that can help increase the yield.
- Breeding experience has shown that tolerance or resistance to diseases can be enhanced in breeding programmes.
- With prudent use of technology we can increase the harvest index.

Declaration

The authors declare no conflict of interest.

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LP5. OILSEEDS: A STEP TOWARDS ADEQUACY

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Introduction

Oilseed crops, grown under different agro-climatic conditions from tropical, subtropical to temperate regions are also very important for economic purposes. World population is increasing at an exponential rate therefore, demand of oilseeds is also increasing manifold. With percolation of technology, breeders are engaged in production and higher oil yield per unit area for maximum profits for the farmers. Different types of fatty acids (PUFA & MUFA) found in oilseeds crop are the major focus areas for breeders as it directly impacts the oil quality. Apart from the fatty acids, carbohydrates, vitamins & minerals are found in various oilseed crops.

Nine oil bearing annual seed crops serve as the major source of edible oil (DRMR, 2015) soybean, groundnut, rapeseed-mustard, sunflower, niger, sesame, safflower and two non-edibles, i.e., castor and linseed. The per capita consumption of oilseeds increased from 17.5 kg/year in 2015 to projected 24 kg/year in 2025 (FAO 2016). In India, edible oil consumption is growing at the rate of 6-8% annually due to the rapid economic growth and increasing consumption. This rise of oilseed consumption has been because of increase in population and per capita income.

Oilseeds helps in nutritional security and good source of fats and oil. Fat is an essential component of the diet, which provides energy and essential fatty acids (EFAs). It also meets the body's metabolic requirements and helps in the absorption of fat-soluble vitamins. Excess intake of fats, especially saturated fats, adversely affects the lipid profile and increases the risk of cardiovascular diseases. There are two types of EFAs: those derived from n-6 fatty acids (for the integrity of cell membranes), and those derived from n-3 fatty acids (essential for certain metabolic functions and protection against cardiovascular diseases). One of the important sources of fat is vegetable oil and used as raw materials for manufacturing large number of items like paints, varnishes, hydrogenated oil, soaps, perfumery, lubricants, etc. oilcake is the byproducts of oils are used as feed of cattle.

India has ~24.98 million ha of land under oilseed with production of 30.64 million tonnes and productivity of 1240 kg/ha in 2017-18. The major growing areas for soyabean are Madhya Pradesh, Rajasthan, and Maharashtra, for rapeseed mustard are Rajasthan, Haryana and MP. The major contributors for groundnut are Gujarat, Andhra Pradesh, and Tamil Nadu, for sesame West Bengal, Rajasthan and Madhya Pradesh and last but not the least for sunflower Karnataka, Andhra Pradesh and MP (Source: GOI (2013c)). Three main oilseeds of India namely, groundnut, soybean, and rapeseed-mustard which account for over 88 per cent of total oilseeds output during the 2011-12.

In 2016-17, India imported ~14 million tonnes of edible oil worth INR 73,048 crores which is approximately half of total requirement. This increase in consumption of oil is the result of increasing population and enhanced per capita consumption. With the advancement of technology in the field of plant breeding with quality improvement at its core, we can contribute to a more sustainable and increased production of oilseed crops.

Constraints and Objectives Regarding Oilseed Crop Production

There are many limitations in production of oilseeds of which irregular rainfall comes is one of the major problems in India. Due to erratic rainfall, oilseed crops face moisture stress in different developmental stages and therefore yield might be affected leading to decrease in production. There are several cultural practices through which moisture stress can be minimised e.g., proper timing and methods of sowing, weed management, plant protection, seed selection and seed rate, crop and varietal selection, crop rotation, mulching etc. The Indian farmers are facing multiple obstacles in the production of oilseeds like climatic, genetic, institutional, economic, post-harvest, marketing, and value-addition. These are the major drawbacks are-

- Oilseed crops are largely grown under rainfed condition (more than 70%) and are more prone to biotic and a-biotic stresses.

- These crops are grown with minimum inputs due to high risk and poor resource base of farmers in rainfed areas.
- High seed rate and cost of seeds
- Low productivity of oilseed crops, fragmented and under-utilized processing facilities,
- Lack of technological inputs hampered the edible oil production in the country.
- Unavailability of seeds of high yielding varieties/ Hybrid

Genetic constraints may be occurrence of diseases, reduced crop germination, non-availability of appropriate cultivars, reduced quality of soils, lack of irrigation amenities, weed infestation and occurrence of insect pests; Institutional constraints are unbalanced delivery of power/electricity, lack of understanding of superior oilseed technologies, insufficient information regarding infection and insect management, difficulty of appropriate availability of seed, poor extension services, non-availability of institutional recognition, non-availability of other inputs and reduced feature of inputs. The high shipping expenditure, insufficient storage space facilities, lack of suitable transport resources, poor highway transportation, be short of information regarding prices, market intermediaries, lack of processing services in the near by region and poor marketing organization are main constraints for farm produce to sell in the market with optimum profit.

The breeder also faces a challenge because oilseeds are a crop that is usually not planted as a main crop. Apart from this, there are some constraints of the oilseed crop which pose as a challenge to the breeders. Some of these constraints are less availability of genetic male sterile line, incompatibility, lack of availability of donors for specific traits, linkage drag, hybrid in viability and sterility, difficulty in handling of mutated lines, development of new strains of diseases and insect pest, unavailability of skilled person for hybridization etc. Following are the main objective of oilseeds improvement programme keeping in mind constraints and requirements of Indian farmers.

1. Improved yield of oil seeds
2. Quality Improvement/Nutritional enhancement in oil seed crops
3. Early maturing variety
4. Tolerance to biotic (diseases and insect pest) and Abiotic Stress (climate change, drought, flood, high or very low temperature etc.)
5. Synchronous Maturity

6. Photo insensitivity
7. Wider Adaptability
8. Dwarf stature in some cases
9. Development of GMS and CMS line for hybridization
10. Determinate growth

Different breeding methods to improve oilseed crop.

Entire Breeding methods can be classified in three different categories based on mode of pollination. These classifications are:

1. Breeding methods based on self-pollinated crops.
2. Breeding methods based on cross-pollinated crops.
3. Breeding methods based on vegetative propagated crops.

The general breeding methods are domestication, plant introduction, pure line selection, mass selection, bulk method, bedigree method, backcross method, single seed descent method, peterosis breeding, Progeny selection, synthetic breeding, composite breeding, clonal selection, mutation breeding, polyploidy breeding, distant hybridization, transgenic breeding etc. These breeding methods are generally used to improve oilseed crops.

These methods have some advantages and have some limitations. Oilseeds have their own limitations, and much research needs to be done so that the harmful substances inside the oilseeds can be reduced or removed. Erucic acid is found in mustard and rapeseed, polyphenolics are found in safflower, trypsin inhibitors and goitrogens are present in soybean. With the help of different methods of breeding, we have reduced these harmful elements in these oils to a great extent and further efforts are being made to reduce them. In fact, all these methods have given rise to many important oilseed varieties due to which the production has increased with quality but still our country is dependent on import to meet its oil needs. Increase of cultivable land for oilseeds is not possible, so we must increase production in the available land. This is possible only if design genotypes of oilseeds that perform in diverse climatic condition.

Classical breeding has a major limitation. It takes numerous years to develop a variety, which could be up to 15 years. To overcome this constraint, we can leverage the help of biotechnology. The biotechnology can work effectively in the field of intergeneric and interspecific hybridization, introgession of desirable gene, marker assisted selection etc. In fact, we can divide biotechnology into two parts in sake of convenience - tissue culture and genetic engineering.

Role of Biotechnology for oilseed improvement

We can adopt the advanced technology for fast improvement in oilseeds even in absence of significant genetic variations or incompatibility. Biotechnology is defined as the identification, isolation and manipulation followed by the introduction of desired gene(s) from one organism to another through which transgenic or genetically modified organism is developed. In 1990, genetically modified crops based on recombinant DNA technology were first introduced for industrial production. Micro propagation, soma clonal variation, anther culture, somatic hybridization and genetic engineering are used to improve the oil yield and oil quality.

In case of palm oil, micro propagation has increased the yield significantly, which is 15% higher than the conventional breeding method. Variety Pusa Jai Kishan was isolated by somaclonal variation in mustard. This isolation was done from variety Varuna of *Brassica juncea*. The seeds of this isolation were quite bold and improved in some other characters as well. Many haploids have been developed through Anther culture. There are some cybrid have been developed under somatic hybridization by using *Brassica juncea, Brassica nigra, Brassica campestris, Brassica oleracea Brassica napus* etc.

The oleic, linoleic, linolenic, palmitic, and stearic acids are five different types of fatty acids which are found in oilseeds. Because of its significance as an oilseed harvest, techniques of genetic transformation have been used broadly to develop the important character of this crop. There are several methods of gene transfer, one of them is particle bombardment method used in soybean transformation with meristems as the target tissue. With the help of strain CP4 of *Agrobacterium* sp. a line of soybean with glyphosate-tolerant was obtained through expression of the bacterial 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) enzyme. The biolistic particle delivery system and plastid genetic engineering approaches have also been useful to improve the nutritional content of soybean oil for a specific fatty acid.

Tissue culture, genetic engineering and plant breeding are applied to improve major oilseed crops like oil palm, coconut, rapeseed, mustard, sunflower, cotton seed and ground nut. There are also some minor oilseed crops which are improved through these technologies.

These minor oilseeds may be classified into two groups –First group includes annual crops like Linseed, Safflower, Niger, Tung, Chinese vegetable tallow, Poppy, Sesame, Hemp, and Maize etc. while second group contain Olive, Castor, Cacao, Mahua, oil palm and Sal etc.

Program and Policies

There have been several government initiatives focusing on improving oilseed production and attaining self-sufficiency. Government of India launched Technology Mission on Oilseeds (TMO) in May 1986 to increase oilseeds production in the country and achieve self-sufficiency in edible oils. This programme was started as yellow revolution in the oilseeds. Oil Palm Development Programme (OPDP) was launched under the "Technology Mission on Oilseeds and Pulses" in 1991-92 in the country with an aim on area expansion in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, Gujarat and Goa. An Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) was implemented during tenth five-year plan. Production of oilseeds between 1985-86 and 1993-94 were increased from 12.1 million tonnes to over 20 million tonnes and achieved an average yield increased from 644 kg/ha to 772 kg/ha during the corresponding period. Acreage of oilseeds increased from 18.9 million hectares in 1985-86 to about 26 million hectares in 1993-94. The production of oilseeds in the country remained stagnant at about 20 million tonnes during the 1990s but increased during the recent years and reached a level of about 26.5 million tonnes in 2011-12 and average productivity has been increased from 859 kg/ha to 1096 kg/ha between 2001-02 to 2011-12. Despite this increment, the productivity of oilseeds in the country remains significantly lower as compared to the world average.

Conclusion

In the last fifty years, the production of oilseeds has shown very little growth, whereas the production of cereal crops such as paddy, wheat, maize etc. have risen exponentially in the same span of time. Meanwhile, with the rising income of people, the consumption of oilseeds has constantly been on the rise. Due to this, India has become the largest importer of oilseeds, a crop which was exported during the 1960s. One of the major reasons for low production is low yield, which exists because of non-availability of climate resilient variety, high oil yield, seed for abiotic and biotic resistance, mechanization in harvesting and post-harvest process development of package of practices for different ecologies. Some of the problems with currently available varieties of oilseeds are low oil yield, poor quality of extracted oil, shattering, asynchronized maturing and so on. Thus, there is a need for genetic improvement which can involve evaluation of germplasm, selection of elite lines, pest and disease resistance, earliness and shattering resistance, quality of oil, varieties for different climatic conditions etc. Not only this, molecular breeding and tissue culture can also provide huge possibility for further improvement in the crop variety.

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ABSTRACT

Theme 1

CLIMATE RESILIENCE BREEDING FOR OILSEEDS IMPROVEMENT

T1.1 A POTENTIAL BREEDING APPROACH IN OILSEED CROPS FOR CLIMATE CHANGE MITIGATION

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ABSTRACT

Climate change in present scenario is the challenge to the mankind which has direct impact on agriculture.There are various strategies which have been developed so far to face climate change in agricultural production.One of the best strategies to serve the purpose is crop diversification for which oil seedsare a much better alternative due to their climate resilient nature. These oil seeds crops take advantage of elevatedCO_2in the environment in terms of quality as well as quantity.These crops also contribute to renewable energy production, stabilization of greenhouse gases and mitigating the risks related tovarious biotic and abiotic stresses. Climate changes restrict resource availability and alter conditions that are vital for oil seeds crop growth and yield. Hence, it is a prerequisite that there must be a phenotypic change which is ultimately is a result of genotypic change. Phenotypic plasticity is essential to predict and manage climate change impacts on current and future oil seeds production.It provides resilience under increasingly unpredictable environmental conditions. Molecular mechanisms have been identified in major oilseeds crops that rapidly sense environmentalchange and adapt to stress also helps to breed transgenic cultivar with enhanced tolerance to multiple abiotic stresses. The response to thesestresses is often accompanied by change at the transcriptome,proteome and metabolome levels.Due to the complexity of breeding for multipleabiotic stressesbecauseof large diversity;modeling can be proved to be more effective in predicting genotypic responses to abiotic stresses if allelic effects are stimulated in current and future climate change scenarios.The potential trait discovery and improve phenotypic prediction will increase when high throughput phenotyping and genome-wide association studies are integrated. Newer traits may be available in traditional land races, old cultivars, elite cultivar, breeding population, ex-situ or in-situ conserved crop wild relative or can be produced de novo using appropriate biotechnologies. Genetic manipulation of plant genome and production of genetically modified plants by means of metabolic engineering and genomics is much more efficient rather than classical plant breeding. Current research efforts to explore the possibilities to modify the genetic expression of key regulators of oil accumulation along with biochemical studies to elucidate lipid biosynthesis will establish protocols to develop transgenic oilseeds crops along much improved oil content.

Keywords: oilseeds, climate change, modeling, genetic engineering

T1.2 STRATEGIES FOR INCREASING SUSTAINABLE PRODUCTION OF OILSEEDS

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ABSTRACT

India has the fourth largest vegetable oil economy in the world after USA, China and Brazil. The country has 19% of world's area under oilseeds but accounts for only 9% world's production to meet the needs of 16% of the world population. India also enjoys a distinct position in terms of rich diversity of annual oilseed crops. The country is blessed with agro-ecological conditions favourable for growing all the nine oilseed crops apart from a wide range of other minor oilseeds and oil-bearing tree species. India is the largest producer of castor, sesame, safflower and niger and the second largest producer of groundnut and rapeseed-mustard. In India, per capita consumption of oils and fats is continuously increasing due to increase in population and improvement of standard of living. To meet the gap between demand and supply of oilseeds, the concrete strategies have to be adopted by the farmers, researchers and government. Substantial scope for harnessing the potential of oilseeds exists both in term of increase in cropped area and improved productivity. In general, there is very limited scope for expansion of area exclusively under oilseeds. However, these crops should replace the non remunerative crops like millets and minor food crops. Large potential exists to introduce oilseeds as intercrops in widely spaced crops. Newer areas and seasons for cultivation of oilseeds is the growing area to be exploited fully at Rice – Fallows crop sequence. Crop ecological zoning is the ideal strategy for efficient crop production. Availability of quality seed of improved oilseed varieties and hybrids is grossly inadequate. The average seed replacement ratio for all the annual oilseed crops put together is less than 10%. Replacement of old varieties by suitable recommended improved varieties or hybrids can increase the yield level. The potential yield can be realized only through adoption of systematic and efficient crop management practices involving soil and

moisture conservation, adoption of proper crop rotation, timely planting, adequate plant stand, balanced plant nutrition, need based plant protection, life saving irrigation and timely weed control all has great influence on productivity of oilseed crops. Location specific improved agro-production technologies should be developed for irrigated and rainfed areas. The countrywide experience through the frontline demonstrations in oilseeds clearly indicated that possibility of oilseed production by proper crop management. Different components like improved varieties (7 to 57%), use of biofertilizers (12%), mineral fertilizers (19 to 48%), need based plant protection (18 to 75%), appropriate planting time (54%), correct sowing method (30 to 35%), adequate plant stand (19 to 65%), thinning (22 to 84%), life saving irrigation (49 to 186%), timely weed control (21 to 426%) etc have profound influence to increase on the productivity in different oilseed crops. The oilseed scenario in India has undergone a dramatic change. Government policy support should create favourable conditions that could harness the best of production, processing, storage and export as that of Technology Mission of Oilseeds. The planned extension work is also necessary to disseminate the technology at farmer's level.

T1.3 EFFECT OF FUNGICIDES AND BIOCONTROL AGENTS AGAINST THE DRY ROOT ROT OF SOYBEAN UNDER FIELD CONDITIONS

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ABSTRACT

Soybean (*Glycine max* L., Merril.) is one of the most important oil seed crop known for its excellent protein (42-45%), oil (22%) and starch content (21%). The cultivation of soybean crop is Adilabad and Nizamabad districts of Northern Telangana state. So soybean seeds are known to harbor several fungi which affect their health seriously, causing germination failures and also complete death of seedlings therefore, the present field studies were undertaken to test efficacy of the bio agents and fungicides and their management of dry root rot of soybean under field conditions. Among all the eight treatments, T_5 treatment was effective control of dry root rot of soybean and minimum dry root incidence (5.4%) and maximum seed germination (80.6 %) was recorded and with seed treatment with

Pyraclostrobin + Thiophanate methyl @ 2.0 ml / kg seed as compared to control (12.6 %) and seed germination (54.8 %), whereas maximum yield (1507 kg/ha) was achieved with seed treatment with *Trichoderma asperellum* @ 10 g/kg seed as compared to control (957.6 kg/ha).

KEY WORDS: *Trichoderma asperellum,* Fungicides, Management and Soybean.

T1.4 DEVELOPMENT OF MOISTURE STRESS TOLERANT VARIETIES OF *B. juncea*

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ABSTRACT

Indian mustard germplasm stock of 443, comprising introgression lines, land races, old cultivars and advance breeding lines was used to document the variability for seed yield and its component traits under Irrigated and rainfed conditions at two locations PAU, RRS, Abohar and PAU, Ludhiana s during 2018-19 in alpha lattice design with two replications having spacing of 30x10cm. Statistical software META-Rver 6.0 (Multi Environment Trial Analysis using R) developed by CIMMYT was used for analysis of data and graphical representation of results. Statistical analysis included calculus of BLUPs, ANOVA, genetic correlations, heritability and results were presented by dendrograms and PCA biplots. BLUPs was used by fitting a mixed linear model in Imer from R-package‘‘lme4’’. To measure the response of genotypes to moisture stress, Drought Susceptibility Index and per cent seed yield reduction under rainfed conditions were used as indicators. The lines in top 10 ranks for BLUP based seed yield *viz*., PBR-378, RGN-329, RB-73, RB-50 and PBR 422 were recommended to use as parents in breeding programme for moisture stress tolerance.

Key words: *Brassica juncea*, drought susceptibility index and drought tolerance.

T1.5 PERFORMANCE OF DIFFERENT MUSTARD VARIETIES UNDER NORTHERN TELANGANA ZONE

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ABSTRACT

Oilseeds play a pivotal role in Indian economy, accounting for 5% of the gross national product and 10% of the value of agricultural products. Amongst the oilseed, rapeseed-mustard (Brassica spp.) ranks second in area next only to soybean in India as well as in the world. It is cultivated in an area of 5.74 m ha with an average production of 6.79 m t with productivity of 1.18 t ha^{-1}, while in Telangana it is grown in an area of 0.01 m ha with production of 0.02 m t and productivity of 2.00 t ha^{-1}(CMIE, 2016). In districts of northern Telangana, *viz.,* Adilabad, Jagtial, Karimnagar and Nizamabad, it is grown as *Rabi* crop. Major mustard growing states in India are Rajashan, Madhya Pradesh, Uttar Pradesh, Haryana and West Bengal. The country has been facing the problem of shortage of oils coupled with continuous increase in their prices. Improved varieties have been evolved, which can yield better than local cultivable varieties with best agronomic practices. In this connection need to identify suitable mustard varities in Northern Telangana Zone. A field experiment was conducted to find out suitable variety among 13 mustard varieties (PM 25, PM 26, PM 27,Pusa Mehak,Pusa Tarak,Pusa Jaganath,Pusa Agrani, NRCHB 101, RH 406, DRMRIJ 31, NRCDR 2, Black gold and Local variety) in terms of growth characteristics, yield attributing components and yield in randomized block design (RBD) at, Regional Agricultural Research Station (RARS), Jagtail, during *rab*i seasons of 2018-19 and 2019-20 respectively. The result of the experiment revealed that among 13 varieties PM-27 variety (1430 kg/ha) recorded significantly superior yield which is on par with NRCHB101 variety (1298 kg/ha) over other varieties.

T1.6 MOISTURE STRESS MITIGATION IN INDIAN MUSTARD THROUGH SALICYLIC ACID AND HYDROGEL UNDER RAINFED CONDITIONS OF JAMMU

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ABSTRACT

An experiment was conducted at Research farm, Main Campus, Chatha of SKUAST-Jammu during the *rabi* season of 2018-19. The experiment consisted of 9 treatments which were laid out in Randomized block design with 3 replications to study the effect of thio-urea when applied as basal dose and foliar application of salicylic acid at variable concentrations at various crop growth stages of Indian mustard either alone or in combination. The treatments consisted of Control (T1), Hydrogel @ 2.5 kg/ha (T2), Hydrogel@ 5.0 kg/ha (T3), Salicylic acid 100 ppm at flowering stage & siliqua stage (T4), Salicylic acid 200 ppm at flowering & Sliqua stage (T5), Hydrogel@ 2.5 kg/ha+ Salicylic acid 100 ppm at flowering stage & siliqua stage (T6), Hydrogel@ 2.5 kg/ha+ Salicylic acid 200 ppm at flowering stage & siliqua stage (T7), Hydrogel @ 5.0 kg/ha+ Salicylic acid 100 ppm at flowering stage & siliqua stage (T8), Hydrogel@ 5.0 kg/ha+ Salicylic acid 200 ppm at flowering stage & siliqua stage (T9). The crop was fertilized with N: P: K: S @ 80:40:15:20 kg/ha during the crop growing season. All the standard package and practices and procedures were followed during the period of experimentation.

Among the different treatments T8 (1332 kg/ha) though at par with T9 (1309.3 kg/ha), T6 (1252 kg/ha), T7 (1208 kg/ha), T4 (1198.7 kg/ha) and T5 (1195.3 kg/ha) resulted in significant increase in seed yield of Indian mustard than other treatments in comparison. However lowest yield was recorded in T1 i.e. control plots (1032 kg/ha) which was at par with application of T2 (1142 kg/ha) and T3 (11.48 kg/ha) respectively.

T1.7 CLIMATE RESILIENCE BREEDING FOR THE DEVELOPMENT OF A CLIMATE SMART OILSEED CROPS

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ABSTRACT

Next to the cereals crop, oil seed crops are the most important determinant of agricultural economy, within the segment of field crops. Oilseed crops are grown primarily

for oil, with oil content typically around 35–48%of the seed weight. With the increase of climate change, production of oilseed crops is expected to face higher growing temperatures and CO_2 levels and more variable climates, including increased water stress and salinity in some regions.Understanding plastic responsesis a crucial for predicting and managing the effects of climate change on current and future oilseed crops. The development of strategic breeding programs for climate change is essential approach for enhancing not only yield but also oil content, oil quality, and meal quality in oil seed crops.

The initial focus on breeding oilseed crop for climate change is on identifying and utilizing existing variability within the oilseed species of interest. Genetic enhancement using wild sources and mutation breeding are fruitful efforts for the development of climate smart genotypes. Prebreeding by using two basic activities like germplasm characterization and preliminary evaluation will meet the germplasm needs of oilseed crop breeders.Ideotype breeding (Designing of ideotypes i.e., ideal combination of traits in a specific genotype) can be good approach for developing climate resilient genotypes in oilseeds crops.Participatory Breeding accelerate the development of climate-resilient oilseed crop cultivars, as well as cropping systems where the crops will be produced. The resynthesis approach in oilseed crops offers considerable potential for new breeding lines with enhanced traits needed for adaptation to changing environments. The use of biotechnological approach like GM technology to access major genes from wild relatives or from completely different species offers major potential benefits to breeders. Molecular markers are being used to enhance traditional breeding and selection programs in oilseed crops. Marker-Assisted Selection (MAS) mechanism is a novel breeding method for drought and salt-tolerant Brassica oilseed crops. Integration of high-throughput phenotype and genome-wide association studies will increase trait discovery and improve phenotypic prediction.

Key Words: Plasticity, Ideotype breeding, Resynthesis, Marker-Assisted Selection

T1.8 IDENTIFICATION OF CLIMATE RESILIENT SESAME (*Sesamum indicum* L.) GENOTYPES SUITABLE FOR SOUTHERN REGION OF A. P.

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ABSTRACT

A study involving eight sesame genotypes conducted during 2018-2019 at the Regional Agricultural Research Station, Tirupathi with an objective of identifying climate resilient Sesame genotypes suitable for both Kharif and rabi seasons in southern region of Andhra Pradesh indicated the existence of differential response of genotypes for seed yield and yield components except for number of branches pert plant in both the seasons. Combined analysis also revealed that the genotypes differed significantly for all the characters except for branches per plant. The component of variation due to seasons was significant for all the characters except for days to maturity and thousand seed weight. The genotype x seasons interaction was non significant for number of branches per plant indicating the less influence of environment on the expression of the character. Among the sesame genotypes studied YLM 136 was found to be early in flowering and maturity. Plant height was more in Rabi season compared to Kharif. Similar trend was recorded for number of capsules per plant. The genotypes *viz*; YLM 136 and YLM 139 have recorded more number of capsules per plant in both the seasons. All the genotypes recorded higher mean values for Specific Chlorophyll meter readings over the check YLM 66 in both the seasons. Hundred seed weight was found higher in Rabi season compared to Kharif. Three genotypes viz., YLM 136, YLM 142 AND YLM 147 have registered higher mean values for seed weight over the seasons. Mean seed yield was found to be higher in Rabi over Kharif season. All the genotypes have recorded higher seed yield over the check YLM 66 in Kharif while YLM 136, YLM 142, YLM 146 and YLM 147 registered higher seed yield during rabi over YLM66 .Based on seed yield and yield components and two seasons YLM 136 and YLM 142 were found to be superior to the check YLM 66 for seed yield. Theses genotypes may be recommended for commercial cultivation in Southern region of Andhra Pradesh after extensive testing under on – farm testing / adaptive minikit testing.

Key words: Sesame, Multilocation trial, seed yield component

T1.9 BREEDING OILSEED CROPS FOR CLIMATE CHANGE

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ABSTRACT

Oilseed crops are the basis for biological systems that produce edible oils, contribute to renewable energy production, help stabilize greenhouse gases, and mitigate the risk of climate change; their response to climate change will be dictated by reactions to temperature, carbondioxide, solar radiation, and precipitation. Understanding the phenotypic plasticity is essential to predict and manage climate change impact on current and future oilseed crops. Breeding for phenotypic plasticity in traits other than seed or oil yield will potentially provide resilience under increasingly unpredictable environmental conditions. Crop response to abiotic stresses is often accompanied by changes at the transcriptome, proteome and metabolome levels. Due to the complexity of breeding for multiple abiotic stresses, and to the large diversity within and among taxa and species of oilseed crops, the breeding process will have to be enabled by more complex models and genetic prediction methodologies. The latter have to be supported by, and integrated with, high-throughput plant phenotyping; and provide breeders with relational databases on physiological determinants of adaptation of climate change. Modeling can be more effective in predicting genotypic responses to abiotic stresses if allelic effects are simulated in current and future climate change scenarios; and if individual or multiple phenotypic traits are assessed to guide breeding of oilseed crops, especially those with a narrow genetic base due to monophyletic origin and self pollination. Increased demand for new, diverse, and resilient germplasm in the face of climate change presents a challenge for gene banks to ensure that genetic resources are adequately conserved. Genetic manipulation of the plant genome and the production of genetically modified plants by metabolic engineering and genomics may become a more efficient route to produce oil seed crops resilient to climate change.

Key words: climate change, abiotic stress, phenotype, genotype, germplasm, genetic manipulation.

T1.10 EVALUATION OF GROUNDNUT GENOTYPES FOR DROUGHT TOLERANCE

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ABSTRACT

Groundnut (Arachis hypogaea L.) is one of the world's most important oilseed crops, both in subsistence and commercial agriculture in arid and semiarid regions of the world. Global warming, an increasing threat, is expected to increase the water scarcity in the environment, affecting plant growth and metabolism. Groundnut yield in rainfed areas has been limited by drought stress because pod yield and other growth parameters have been severely affected. Fifty genotypes of groundnut including released varieties and advanced breeding lines were used to assess the drought tolerance. These genotypes were evaluated both in managed drought stress (DS) and non stress (NS) situations during post rainy season (Jan – Apr) at Oil seeds Farm. The drought stress was imposed by withholding irrigation after 60 DAS for the drought stress trial. Observations were recorded for pod yield per plant and kernal yield per plant on randomly chosen five plants per entry per replication. The data were subjected to ANOVA and drought tolerance parameter viz., Drought Susceptibility Index (DSI) for pod yield per plant and kernal yield per plant. The results indicated that genotypes differed significantly for pod and kernal yield per plant. Among the genotypes, each three drought tolerant (ICGV 91114),K 1375 and ICGV 02125) and drought susceptible (ICGV 01279,ICGV 98170, ICGV 98175) genotypes were selected for hybridization programme to develop mapping populations.

Key words: Groundnut, Drought Susceptibility Index, Pod yield, kernal yield

T1.11 CORRELATION AND CAUSE - EFFECT OF PHYSIOLOGICAL PARAMETERS WITH SEED YIELD AMONG INDIAN MUSTARD (*Brassica juncea* L.Czern & Coss) GENOTYPES UNDER CLIMATOLOGICAL DROUGHT CONDITION

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ABSTRACT

Modern agriculture is facing multiple challenges for a substantial increase, in production to meet the needs of a escalating human population. Water dearth is a deadly consequence of both population growth and climate change and is one of the most severe factors limiting global crop productivity. With the aim of study correlation and cause effect under no irrigated and irrigated condition on some physiological traits on yield an experiment on Indian mustard (*Brassica juncea* L.Czern & Coss), was conducted in Randomized Complete Block Design accommodating 20 genotypes, from various Rapeseed & Mustard centres located across country, randomly in three replications during *Rabi* 2016-17 in Dr. Rajendra Prasad Central Agricultural University , Pusa, Samastipur , one subjected to residual moisture condition inside the Rainout shelter and another one provided with two normal irrigation. Analysis of variance revealed considerably exploitable variability for all the 15 traits. Under both conditions of phenotypic correlation revealed that grain yield per plant showed significant and positive correlation with RWC, LMSI, CC, CA, PERO, PRO, RGR, LAI, SLW, OY except ELWL. Phenotypic path coefficient under both condition revealed that all the physiological parameters showed the low direct effect except oil yield showed high direct effect on grain yield per plot. This indicated that improvement in all the physiological parameters which showed significant positive and direct effect on grain yield per plot will ultimately enhances the grain yield. The improvement in grain yield will also in turn enhance oilseed simultaneously as directly correlated.

Key words: *Brassica juncea* L., Physiological traits, Residual moisture, Root parameters, Deficit Irrigation

Theme 2

Breeding of Oilseeds for Nutritional Enhancement

T2.1 EFFECT OF STORAGE LIFE OF RICE BRAN ON THE QUALITY OF RICE BRAN OIL

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ABSTRACT

India is the world's second largest producer of rice and it is the most important cereal food crop in the country. The most important milling by-product of rice is 'rice bran' which is an excellent source of edible oil. In India, Rice Bran Oil is the most important oil among the

non-conventional oils in terms of its potential to augment the availability of oils. Full realization of its potential would help in reducing the gap between demand and supply of indigenous edible oils in the Indian market. Rice bran oil is an excellent source of oryzanol, a natural and powerful antioxidant. Besides, it meets many of the criteria that define healthy edible oil for us, covering smoking point (a high smoking point means the oil holds on to its nutritional content at higher temperatures), good monounsaturated and polyunsaturated fats (as against bad saturated fats), HDL (good) cholesterol, and so on.The typical composition of crude rice bran oil is 81.3-84.3% triglycerides, 2-3% diglycerides, 5-6% monoglycerides, 2-3% free fatty acids, 0.3% waxes, 0.8% glycolipids, 1.6% phospholipids, 4% unsaponifiables. In comparison with other vegetable oils, crude rice bran oil tends to contain higher levels of non-triglyceride components, most of which are removed during further refining processes. Its preservation for safe use is still a challenge, especially due to the poor storage facility in the rice milling industry; the quality of rice bran gets deteriorates rapidly. This study examines the deterioration level of rice bran during the storage period in average room temperature (31°C). Raw, partially parboiled and parboiled rice bran was collected right after milling. Oil is extracted by 'hexane solvent extraction' method from the 1st day of storage period for one week with the interval. Free fatty acid level, lipase activity, Iodine value and the pH value was determined from the collected rice bran oil. The preliminary result of this study showed that the deterioration level is rapidly increased during the 1 week of storage and the maximum deterioration level was found in raw rice bran. The free fatty acid (FFA) level, the degree of unsaturation and pH was respectively 17.25%, 92g Iodine/100ml oil and 3.10, whereas in parboiled rice bran it was respectively 4.23%, 101.1g Iodine/100ml oil and 6.23. Since the parboiled rice bran undergoes through a traditional stabilization method of parboiling and drying before milling, it might be a reason for the lower level of deterioration. The oil collected right after milling also showed a lower lipase activity. This study can be concluded by considering that, the less the storage time the better is the quality of the oil.

Keywords: Rice Bran, Rice bran Oil, Storage Life of Oil, Free Fatty Acid, Lipase

T2.2 GENETIC ANALYSIS OF SEED YIELD COMPONENTS IN SESAME

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ABSTRACT

Little genetic information is available for seed yield in sesame. In order to select varieties with high yield, 12 promising lines were genetically screened at Mora (Northern Cameroon) during 2011 crop season for eight characters viz… , days to 50 percentage flowering , days from flowering to capsule maturity, plant height, number of branches, number of capsules per plant, capsule length, number of seeds per capsuleand number of days to maturity. Six divergent lines were therefore crossed in all combinations using a diallel mating scheme without their reciprocals. Progenies of F1's along with their parents were evaluated during 2013 cropping season in a randomized complete block with three replicates. Preliminary analysis of variance indicated that the genotypes were significantly different for all yield Components ($p<0.05$) indicating the probability of selection. Broad – sense heritability estimates were high for all traits. Narrow sense heritability and GCA /SCA ratio indicated that both dominant and additive gene effects were Significant for these parameters with a predominance of non-additive effects.

Keywords: *Sesamum indicum L..,* yield components, diallel analysis, and Narrow sense heritability.

T2.3 SODIUM AZIDE INDUCED EARLY FLOWERING MUTATIONS IN *Brassica juncea* (L.) Czern&Coss cv. BIO-902

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ABSTRACT

Physiological similar seeds of *Brassica juncea* (L.) cv. Bio-902 were treated with different concentrations of sodium azide, ethyl methane sulphonate and gamma radiations. Mutagen doses were determined on the basis of LD_{50}. In the present study, dry and pre-soaked seeds of*Brassica juncea* cv. 'Bio- 902' were used with different doses of physical mutagen (gamma rays) and chemical mutagens Sodium azide (SA) and Ethyl methane sulphonate (EMS). Treated seeds were sown in triplicates to raise M_1 population. At maturity M_1 population was harvested and at successive Rabi season M_2 seed were sown in plant to

row pattern by which M_2 population was raised. The progenies in M_2 population were screened for early flowering mutations. Early flowering mutant was isolated from 12h water pre-soaked 6h 0.12% sodium azide treatment. Selected early flowering mutants were from M_2 population used for growing M_3 population. Isolated early flowering mutant showed 50% flowering in 35 days as compare to 48 days of control. The isolated early flowering mutant is characterised by yellow seed coat colour and comparatively high oil than control hence it can be used for further breeding programmes of mustard.

Key words: *Brassica juncea*, *Sodium azide, Mutation*

T2.4 BROWN SARSON TO GOBHI SARSON: DIVERSIFICATION OF OILSEED CULTIVATION IN JAMMU AND KASHMIR

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ABSTRACT

In the union territory of Jammu and Kashmir brown sarson is the only edible oilseed crop being cultivated during *rabi* season on account of the fact that it fits well in rice based cropping system due to its early maturity and ability to withstand the severe winters. Oilseeds are cultivated on about 55236 hectares of land area out of which 11241 ha is from Jammu region and rest is in Kashmir valley. The production and productivity of rapeseed mustard in J&K is 32.6 thousand quintals and 7 q/ha, respectively. However, there lies a huge yield gap between the productivity at national and at the UT level. The demand for oil is too high than that of production owing to which the UT is dependent on import of oil. Besides low yield potential the brown sarson is highly cross pollinating in nature, it is thus imperative that quality seed needs to be produced in isolation adopting seed villages provided with breeder seed.

To boost oilseed production, diversification from brown sarson to gobhi sarson seems to be a viable option because of the fact that the later has high seed and oil content. In this direction SKUAST-K has developed two gobhi sarson varieties which are in pipeline viz. KGS-32 and KGS-35 with yield potential of around 17 q/ha in comparison to 12q/ha in brown sarson. Availability of wider diversity in *B napus* makes it a useful candidate for canola development having low erucic acid and low glucosinulate content. The

diversification which shall lead to popularization and adoption of these varieties could result in quantity and quality wise improvement in the oilseed sector for overall socio- economic development.

T2.5 EVALUATION OF HETEROSIS FOR YIELD AND ITS CONTRIBUTING TRAITS IN INDIAN MUSTARD (*Brassica juncea* L.) UNDER TIMELY SOWN AND LATE SOWN CONDITION

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ABSTRACT

The present investigation entitled "Genetic analysis of seed yield and its contributing characters using diallel cross analysis in Indian mustard (*Brassica juncea* L. (Czern and Coss)''was conducted at Research Farm of Department of Genetics & Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar, Faizabad (U.P.) during *rabi* 2015-16. The material for present investigation comprised of 66 F'$_1$s developed by crossing 12 diverse lines *viz*., NDYR 08, NDRE-08-04, NDRE-04, Narendra Rai, DRMR1127, EC399301, PAB-09-07, MCP 807, RAURD-09-02, NPJ 121, PAB-09-05 and DRMR-IJ-11275 in half diallel fashion design. A total of 80 treatments (66 F_1's + 12 parents + 2 standard varieties Kranti and Varuna) were used for investigation for thirteen traits. In general, considerable amount of heterosis over better parent was observed for all the characters under study. Highest heterosis over better parent for days to 50% flowering was found in cross NDRE-4 x DRMR-IJ-11275 (-34.04%); in E_1; NDRE-4 x PAB-09-07 (-25.65%) in E_2; for days to maturity, highest heterosis over better parent for days to 50% flowering was observed in NDRE-4 x RAURD-09-02(-20.00) in E_1; NDRE 08-04 x NDRE-4 (-19.41) in E_2; for days to maturity, maximum heterosis over standard variety (SV1, Kranti) for days to 50% flowering was observed in NDRE-4 x RAURD-09-02(-32.60) in E_1 and NDRE 08-04 x EC-399301(-25.27) in E_2., for days to maturity, maximum

heterosis over standard variety (SV2, Varuna) for NDRE-4 x RAURD-09-02 (-19.79) in E_1 and NDRE 08-04 x NDRE-4 (-20.48) in E_2.

T2.6 DIVERSITY, NUTRIENTS AND OIL QUALITY OF TKG 306 VARIETIES OF SESAME (*Sesamum* indicum L.) AT GARIABAND DISTRICT OF CHHATTISGARH.

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ABSTRACT

Sesame is a genus of about 20 species in the flowering plant family Pedaliaceae. The plants are annual or perennial herbs with edible seeds. The best-known member of the genus is sesame, *Sesamum* indicum (syn. *Sesamum orientale*), the source of sesame seeds. Sesame is also called benne. Numerous wild relatives occur in Africa and a smaller number in India. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods. Sesamum per 100 gram 573 calories, % daily value saturated fats 76 %, Cholesterol 0%, Sodium 0%, Potassium 13% Dietary fibre 48 %. Sugar 0.3 %, Calcium 97 %, Iron 81% and magnesium 87%. In tribal belt (Bastar, Ambikapur and Gariaband) Chhattisgarh state maximum genetic diversity was observed between cluster II and III. Hence, genotypes having maximum distances should be selected from different clusters and can be utilized in future hybridization programme. TKG 306, matures in 86-90 das, 49-52%oil, white seeded 2.8 g test wt., 750-800 kg/ha seed yield, resistant to phytopthora blight, mod. Resistant to *macrophamina, cercospora* powdery mildew n alternaria leaf spot, semi appraised, 3-5 branches dark green leaf colour. This variety is best quality for seed as well as oil content. Its supplement to poor people among the requited nutrients.

Key words: Sesamum, oil seed crops, diversity.

T2.7 BREEDING LINSEED (*Linum usitatissimum* L.) FOR NUTRITIONAL ENHANCEMENT

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ABSTRACT

Linseed (*Linum usitatissimum* L.) commonly known as alsi, tisi, kshuma, lin, llion, liner, linum, line, linen, lein and lan, is a multipurpose important *Rabi* oilseed crop next to rapeseed and mustard. This crop is as old as the history of civilization. Linseed has been a rich source of two essential fatty acids, alpha-linolenic acid and linoleic acid which on metabolism lead to the synthesis of DHA (docosa hexaeenoic acid), an indispensible metabolite for the optimal development of nervous system and maturation of visual acuity (retina) in infants. Besides, linseed is the richest source of lignans (antioxidants). Its seed provides 800 times more lignans than any other plant seed (except sesame seeds which has 47 times less lignan than flax seed). Linseed is preferred not only for human use but is also an important feed supplement.

Although, its oil is the complete source of protein (all 8 essential amino acids), high level of dietary fiber, high order linolenic acid, complex carbohydrate, vitamins and minerals are also found. Linseed is basically non-edible oil and about 80 percent of its production is utilized in various industries. Its oil is used in medicine preparation for prevention and treatment of atherosclerosis, coronary heart disease and many other diseases associated with circulatory disturbances, thrombosis and also in some types of Cancer. Flaxseed is also rich in soluble and insoluble fibres and lignans, which makes it useful as a dietary supplement. Consumption of flaxseed in daily diet simplifies the risk of cardiovascular diseases such as coronary heart disease and stroke. There is also evidence that flax has anticancer effects in the breast, prostate and colon cancers. The residues remaining after the oil extraction from linseed contains about 35-40% protein and 3-4% oil, a rich source of feed to livestock like cattle. Flax is naturally high in polyunsaturated fatty acids (PUFA), more specifically in Omega-3 fatty acids; and hence flax seed as a component of poultry meal that can provide Omega-3 enriched eggsAntibiotic 'linaline' found in seeds of linseed could cure diseases in men and animals against which no known medical treatment is available. Linseed oil is rich in Omega-3 and Omega-6 fatty acids known to influence blood platelet aggregation lower the

blood cholesterol concentration and prevent coronary heart disease. The oil cake is a good feed for milch cattle and also used as organic manure to maintain the soil fertility as well as to prevent the unwanted microbes with its germicidal properties.

T2.8 HETEROSIS IN SESAME (*Sesamum indicum*)

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ABSTRACT

Oldest oil crop of India is Sesame. Being a selfand short duration crop, heterosis is not much exploited in this crop. Due to the low yield the area also is declining in the Maharashtra and being replaced by other crops but demand of sesame is increasing day by day due to its medicinal properties and high market rates. The investigation was under taken by adopting Augumented block design analysis involving two female (JLT-7 and JLT-408) and 66 diverse male parents to estimate extent of heterosis for yield and its components. The resulting 66 crosses along with their parents were evaluated at Oilseeds Research Station, Jalgaon during Kharif 2019-20 to study heterosis for yield and its components. Out of66 crosses; 11crosses exhibited standard heterosis in the range of 3.40 % to 79.06%.

The study revealed that the heterosis in seed yield was influenced by high Heterotic manifestation in number of branches per plant, number of capsule per plant, number of seed per capsule and seed weight. As regards earliness, plant height, length of capsule and oil content the extent of heterosis was moderately high. The ranking of crosses on the basis of heterosis was not similar. The cross JLT-408 x AT-324,RT-127 x JLT-408, DS-1 xJLS-120,for seed yield and higher capsule per plant, While the cross,JLT-408xJLS-907,DS-21 x JLT-408andJLS708 x JLT-408for 1000 seed weight and higher number of branches recorded desirable heterosis.These crosses may be evaluated in subsequent generation to isolate desirable segregates.

T2.9 HETEROSIS AND COMBINING ABILITY STUDIES IN INDIAN MUSTARD (*Brassica juncea* L. CZERN AND COSS)

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ABSTRACT

An experiment was carried out with a set of seven genotypes of Indian mustard viz; RAURD -1418, Varuna, JD-6, Kranti, RGN-73, PM-25 and RAURD-214 and crosses were made in 7x7 diallel crossing without reciprocals at Bihar agricultural university farm during the Rabi season (2019). F1 hybrids and the parental genotypes were grown in a Randomized Complete Block Design with three replications along with 5 checks, namely; Rajendra suflam (ZC), Kranti (NC), Varuna (NC), NRCHB-101 (ZC), CS-56 (ZC) and observations were recorded on several quantitative and qualitative characters in order to identify heterotic crosses and estimate general and specific combining ability of parent and crosses respectively. The analysis of data carried out according to Griffing (1956) Method 2 (fixed model). Out of 21 F1s, 3 hybrids *viz;* kranti x RGN-73, JD-6 x PM-25 and varuna x kranti exhibited superior cross performance for yield and its component traits showing non-additive gene action and five hybrids namely RAURD-1418 x RAURD-214 , Varuna x RAURD-214, JD-6 x RAURD-214 , RGN-73 x RAURD-214 and PM-25 x RAURD-214 were identified for earliness. Two parental genotype i.e. RAURD-214 and JD-6 were identified as general combiner for earliness because these two parents had the highest significant positive GCA effect whereas three parents i.e. Varuna, kranti and PM-25 were identified having good GCA for yield/plant. Four hybrids i.e. Varuna x kranti, JD-6 x kranti , kranti x PM-25 , varuna x RAURD -214 were identified as superior for high oil content up to 42% and showing considerably low amount of glucosinolates and erucic acid.

Key words: General combining ability, Specific combining ability, Diallel, Randomized Block design, Glucosinolates and Erucic acid

T2.10 BREEDING TOWARDS IMPROVING SEED YIELD AND OIL QUALITY IN TOBACCO

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ABSTRACT

Tobacco is a commercial crop grown in India, mainly, for its traditional uses *viz*., smoking, chewing, etc. However, it can also be exploited for the production of seed oil as tobacco plant is a prolific producer of tiny seed containing ~ 35% oil. Tobacco seed oil is rich in linoleic oil (66-76%) with 75% PUFA content. This oil is mainly used in paints, varnishes, lubricants and soap industries. The studies conducted at ICAR-CTRI, Rajahmundry indicated that tobacco oil can be used for edible purpose as its nutritional quality is comparable to sunflower and ground nut oils and is free from tobacco related harmful substances. .As a part of adrive to exploit tobacco for edible oil production at ICAR-CTRI, characterisation of a mapping population during 2017-2019, developed for seed and oil yieldwas presented here.

In general, tobacco seed is brown in colour and gives colour to the extracted seed oil. However, there are white or cream colour seed yielding genotypes in tobacco that yield clear oil with less seed per plant. In order to produce higher white seed yielding tobacco genotypes and to understand genes involved in seed and oil yield, a mapping population (Recombinant Inbred Lines-RILs) was developed from a cross between A-145, a high seed yielding (pink flower& brown seed) genotype with Jayalakshmi, a moderate seed yielding (white flower & white seed) entry. TheRILs (208), thus, developed showed variation for four plant, 14 leaf and 11 flower/fruit/testa characters. No variation was observed for plant shape, leaf type and inflorescence position relative to upper leaves. Out of 128 selected RILs studied, 118 lines with either pink or white flowers found to have brown seed and 10 with white flowers and white seed. Another set of 18 selected white seed RILs analysed for seed yield, six entries recorded higher seed yield (950-1350 kg/ha) than the parent A-145 (880 kg/ha) under the normal plant spacing adopted for leaf yield. These entries can yield oil content of 350 to 500 kg/ha. The seed yield of these entries can further be enhanced by optimising spacing and fertilisers making them to compete with regular oil seed crops. With their high seed and oil yielding potential, the selected RILs can further be evaluated and exploited for oil production making tobacco as potential oil seed crop in achieving self-sufficiency in oil production.

T2.11 HETEROSIS BREEDING OF CASTOR FOR IMPROVE OIL QUALITY

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ABSTRACT

The scientific name of castor is *Ricinus communis* family of Euphorbiaceae. Chromosome number is 2n=20. It is a perennial evergreen shrub cultivated in tropical and subtropical region. Cross pollination crop. Protogynous in nature. Mostly pollination is done by wind. India is the largest producer of castor in the world (65-70%).castor oil is an important feedstock for the chemical industry, because it is the only commercial source of ricinoleic acid, a hydroxy fatty acid which comprises about 90% of the oil. In additional to the traditional uses of ricinoleic acid, there is also a demand for vegetable oil to be used as biofuel. It is non edible oil. The presence of ricin and agglutinin is a major problem in the use of oil in nutrient application. It is also considered as an alternate source of fossil fuel. The oil has medicinal activities and also used as various applications such as coating material, print ink, and resin materials. Due to the increasing the demand in the global market there is a short supply of castor oil and this trend seems to get worst every year. Castor exists in different region and show good adaptation and high yield. Castor crop is sensitive to drought and salt stress. Heterosis breeding is used for development of hybrid cultivars of castor oil, representing an effective way to yield and its influence to get higher oil content.

Keywords: Non edible oil, cross pollination, bio fuel, ricinoleic acid, high oil content, Heterosis breeding.

T2.12 EVALUATION OF VEGETABLE SOYBEAN LINES FOR CROP DIVERSIFICATION AND NUTRITIONAL SECURITY IN THE TELANGANA STATE

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ABSTRACT

Edamame (Glycine max (L.) Merrill) also called vegetable soybean is an import vegetable and well recognized for health and nutritional benefits in the world. Soybean cultivars with large seed size and high sucrose content are desirable in the production of vegetable soybean, which is the food bean harvested at R6 stage and just before turning to yellow colour. However, the farmers in the state cultivating regular soybean for the past two decades but there is no suitable or improved vegetable soybean cultivars in the state of Telangana, India. In this study, 7 breeding lines were evaluated in replicated field trials for vegetable soybean green pod yield, 100 green seed weight, agronomic traits, cooking quality by sensory attributes and nutritional composition in Agricultural Research statation, Adilabad, Telangana state in 2018. For days to harvest at R6 stage VEG2 taken less days (62days), followed by VEG4 (63 days) and VEG7 taken 104 days to harvest at R6 stage. The trait green pod yield at harvest per plant has recorded maximum in case of genotype VEG 4 (7846 kg/ha) followed by VEG7 (7551 kg/ha). In case of 100 green seed weight, the highest mean was observed in VEG 2(75.0g) followed by VEG 4 (74.3g). The genotype VEG 4 is nutritionally equal to regular soybean and superior to other vegetables consumed in the state. Further it was well accepted as a vegetable curry by the panelists in terms of sensory attributes. Further this vegetable soybean may go as supplementary vegetable curry or food source for rural areas of Telangana for nutrition intervention programmes.

T2.13 BREEDING OF CASTOR CROP BASED ON CHEMICAL , BIOCHEMICAL AND MEDICAL PROPERTIESOF ITS OIL CONTENT

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ABSTRACT

Ricinuscommunis (Castor) is the perennial plant species under the family, Euphorbiaceae. It is the native to trophical areas of Africa and Asia .The oilobtained from castor seed is castor oil . The oil is pale yellow in color , with characteristic

odour . It is soluble in alcohol. The biochemical characteristics such as Specific gravity 0.957 , Viscosity 6.3-8.8 St , Acid value ranges between 0.4 to 4.0 . Castor oil is triglyceride , which is chemically a glycerol molecule with each three OH- group esterifies with a long chain fatty acids .The castor oil contains Ricinoleic acid(12-hydroxy,9-octadecenoic acid)- 89.5% , Linoleic acid- 4.2% , Oleic acid- 3 , Stearic acid – 1 and Palmitic acid – 1 . The other name of castor oil is "Palm of Christ / Palma Christi" , which has the ability to heal wounds and cure ailments . In India castor oil has been prized for its skin-healing , digestive-soothing , antibacterial properties commonly used in Traditional Ayurvedic medicines . It act as the powerful laxative , lubricant , moisturizer in nature . Ricin is the toxic substance present in castor oil , it become deactivates on heating .By knowning the novel characteristics of castor oil , Breeding is possible forinceasing oil content by various breeding techniques like Heterosis Breeding , Backcross Breeding , etc....

Key words: *Ricinuscommunis*, Ricinolic acid, Ricin, antibacterial property.

T2.14 COMPARISION OF CHEMICAL COMPOSITION OF SESAME SEEDS FROM OTHER OIL SEEDS FOR BREEDING PURPOSE AND ITS MEDICAL IMPORTANCE

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ABSTRACT

Sesamum indicum belongs to family Pedaliaceae . The other name of sesamum are Til , Gingelly , Tila , Ellu .The origin of sesamum is Tropical Africa . Till is grown all over the continent as drought resistant crop . Production of oil seeds plays an important role in agriculture next to food grains . Sesamum are widely cultivated in India from ancient period . It helps in maintaining the diet of human beings . Nearly oil seeds contains 20-60% of oil content . The oil contains energy , carbohydrates , fat , protein , vitamins and minerals . Out of these oil crops , Sesamum contains 50-60% of oil . Gingelly has higher fatty acids (PUFA) mainly , Oleic acid 38.84% , Linoleic acid 46.26% , Palmitic acid 8.58% , Stearic acid 5.4% and Arachidic acid 0.9% . It contains

about 5% olein and a phenol known as Sesamol , responsible for stability of oil . It has lignin derivatives such as sesamin and sesamolin . Sesame oil plays a major role in medical aspects such as used in the treatment of Hepatitis , Diabetes and Migraines . Because of its Antibacterial and Antifungal activities helps in healing of wounds . As a Antioxident , it is good for cholesterol patients . It has anti -aging properties and helps to fight stress and depression . The quantity and quality of the oil contained in the seed have been shown to depend upon ecological , genotype and physiological factors such as climate , soil type , cultivars , etc. . Sesame has a valuable seed oil appears to have numerous beneficial properties for application in food and medical industry . At present , productivity of oil seeds are very low .But the oil and protein contents are high . To overcome this self sufficiency , Breeding of oil seeds is only possible for high yield in limited area along with high protein content .

Key words : PUFA- Poly Unsaturated Fatty Acid , sesamin , sesamolin , Anti oxident – Sesame.

T2.15 EVALUATION OF SOYBEAN GENOTYPES AGAINST MAJOR INSECT PESTS

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ABSTRACT

Initially, soybean was free of pest and diseases in Northern Telangana Zone of Telangana state. However, its continuous cultivation of single variety it is susceptible to many numbers of insect pests. Therefore, there is need to identification of resistant germplasm against major insect pests of soybean. The present investigation entitled Evaluation of soybean germplasm against major insect pestswas conducted during *Kharif,* 2019 at Regional agricultural Research Station, Polasa, Jagtial, and Telangana for identifying promising entries for resistance against major insect pests viz., stem fly and defoliators of soybean. A total of 23 soybean genotypes were screened under field conditions and lowest per cent plant damage by stem fly was lowest recorded in Basar (5.00) and MACS -1188

(6.66) genotypes. Regarding stem tunneling by stem fly, zero stem tunnelling was recorded in JS 20-34 and MACS-1188 and it was high in susceptible check JS-335 (59.37). Defoliation by defoliators viz., semi looper, *Spodoptera exigua* and*Spodoptera litura*was also recorded in different genotypes and lowest defoliation was observed in MACS- 1188 (3.88) followed by JS 20-29 (14.89) compare to susceptible check JS-335 (43.66).

Key words: Screening, Stem fly, Defoliators, soybean, Management, Maize

T2.16 STABILITY ANALYSIS FOR SEED YIELD AND ITS ATTRIBUTING TRAITS IN MUSTARD (*Brassica juncea* L.)

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ABSTRACT

Mustard is one of the most important oil seed crops of the country as well for Jharkhand and it occupies considerably large acreage among the *Brassica* group of oil seed crops. The oil present in the embryo represent about 38-45% of the seed dry weight. Use of diverse cultivars with high yielding ability, high oil content and early maturity would enable farmers to achieve higher production and consequently change the edible-oilseed scenario of the state. The objective of this study was to select suitable genotypes of mustard, which widely adapted to the climatic conditions of sub zone V of Jharkhand. Sixteen genotypes of mustard were evaluated for the stability of yield and yield components by growing them in three consecutive *Rabi* seasons during 2017-18 to 2019-20 at Zonal Research Station, Chianki (*Birsa Agricultural University*), Chanki, Palamau. The significant differences among the genotypes and the environments suggested that the presence of wide variability among genotypes and environment. The genotype and Environment interaction plays significant role in varietal selection. The G x E interaction was significant for five characters *viz*; plant height, number of primary branches per plant, siliqua per plant, seeds per siliqua and seed yield. Based on the stability parameters *i.e bi* unity, $S^2di= 0$ and high mean, the genotypes

TM-179, RL-1359 and Pusa Bold were found to be stable for seed yield. The crosses TM-179 and BAUM-08-14 were also stable for 1000 seed weight, number of primary branches per plant and 50% flowering. These genotypes are found suitable for Palamau region, could be utilized as variety or for developing high yielding stable mustard genotypes.

***Key word*: - *Brassica juncea*, environment, G x E interaction, stability, yield.**

T2.17 DELINEATING MULTIVARIATE DIVERGENCE, HERITABILITY, TRAIT ASSOCIATION AND IDENTIFICATION OF SUPERIOR OMEGA-3-FATTY ACID SPECIFIC GENOTYPES IN LINSEED (*Linum usitatissimum* L.)

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ABSTRACT

Present investigation was undertaken to evaluate 50 linseed genotypes for three consecutive years for seed yield, oil content and agro-morphological traits using multivariate approach. Higher range, large value of Shannon-weaver diversity index for both traits and genotypes and large differences in mean values for most of the characters showed that a wide and significant variation existed among the genotypes and traits. Pooled analysis of variance revealed highly significant differences ($p<0.001$) among the genotypes for all the characters studied. The phenotypic coefficient of variation (PCV) was slightly higher than genotypic coefficient of variation (GCV) signifying little influence of environment on the expression of all the traits studied. High PCV and GCV were recorded for seed yield per plant, number of primary branches per plant, number of bolls per plant, days to 50% flower and plant height indicating variation and scope of improvement through phenotypic selection. High heritability coupled with high genetic advance for all the traits revealed that they are predominantly governed by additive gene action and phenotypic selection will be effective. Cluster analysis for yield and agro-morphological traits using unweighted pair group method of arithmetic averages (UPGMA) grouped the genotypes into nine clusters with varied

number. Clustering of linseed genotypes from different geographical locations or source/origin into same cluster has confirmed that they are genetically related, and possibly from the same progenitor, but could have been separated by geographical or ecological barrier. The principal component analysis (PCA) revealed that most of the variation (76.41%) was accounted by first four PCA and indicated role of traits that contributed significantly towards a wide variation among the genotypes. Average diversity indices of 1.755337 and 3.895 for genotypes and traits respectively, further validated that the genotypes were more diverse among themselves and for all the traits studied. The positive associations of seed yield per plant with plant height, number of bolls per plant and number of primary branches per plant; primary branches per plant with number of bolls per plant and number of seeds per boll and oil content with seed yield per plant and number of bolls per plant; implies that improving one or more component traits could result in genetic enhancement of seed yield and oil content in linseed. The significant negative association of seed yield per plant and oil content with days to flowering and days to maturity has great advantages in breeding short duration linseed cultivars for hot and water stress climatic conditions of semi-arid regions. Trait specific genotypes namely, Shival, Sharda, IC54970, Mukta, IC56363, T-397, IC53281 and RLC-92 were identified for the development of short duration and dwarf cultivars with more number of primary branches, number of bolls, seeds per boll, seed yield, oil content and omega-3-fatty acid through intercrossing or selection in further generations.

Key words: Multivariate approach, phenotypic diversity, Shannon-weaver diversity index, association analysis, cluster analysis, principal component, linseed, omega-3-fatty acid, UPGMA, heritability, genetic advance, PCV, GCV

T2.18 DECIPHERING GENOTYPE × ENVIRONMENT INTERACTIONS BY AMMI METHOD FOR YIELD AND COMPONENT TRAITS IN LINSEED (*Linum usitatissimum* L.)

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ABSTRACT

In the present study, additive main effects and multiplicative interactions (AMMI) biplot analyses were used to identify stable genotypes for number of bolls per plant, seeds per boll, seed yield per plant and oil content to dissect GEI in linseed (*Linum usitatissimum* L.). Trials were conducted in randomized complete block design (RCBD) with two replications over three consecutive years, 2016-17, 2017-18 and 2018-19. ANOVA analysis revealed genotype and G×E interaction effects contributed significant sum of square for number of bolls per plant (96.50% and 0.30%); seeds per boll (74.01% and 4.24%); seed yield per plant (94.06% and 1.57%) and oil content (92.06% mainly genotype effect). The dissection of GE interaction for all the traits was mostly explained by the first and second principal component axis (IPCA1 and IPCA2). Results of genotypes stability in AMMI1 and AMMI2 biplot analyses were showed differential response with some exceptions that indicates the different sets of genes and effect of environment on the cumulative expression of traits under study. The AMMI2 biplot graphs showed similar environmental response for number of bolls per plant, seeds per boll, seed yield per plant and oil content as in case of AMMI1 analysis. The SSI statistic fully corresponds with the results of the AMMI1 biplot models for all the traits of top ranked genotypes across the environments. The linseed genotypes identified for yield and stability could be advocated for varietal recommendation and further use in hybridization program in semi-arid conditions.

Key words: AMMI biplot analysis, G x E interaction, IPCA1, IPCA2, linseed, oil content

T2.19 A REVIEW ON FUNCTIONALITY OF PROTEIN PRODUCTS OF OILSEED

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ABSTRACT

The nutritive value and functional properties can be improved by incorporation of either oilseed proteins or modified or processed oilseed proteins. The nutritional value and functional properties of the oilseed depends on its processing. The processing methods like Physico-chemical and thermal treatments affect nutritional values and functional properties. The solubility, foaming capacity & stability, viscosity, gelation, emulsion capacity & stability and water and oil retention are functional properties that are responsible for change in protein behaviour during processing and storage. The desired properties can be obtained by modification in chemical and enzymatic treatment.

In this research, data from different oilseeds and different defatting & extraction processes have been collected and arranged according to the protein contents. The properties due to hydration mechanisms, properties related to protein structure and properties related to protein surface have been considered for formulation of proteinic food products from oilseeds.

T2.20 GENETIC DIVERSITY STUDIES IN GERMPLASM OF NIGER [(*Guizotia abyssinica* (L.f.) Cass.]

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ABSTRACT

Niger genotypes (Forty) were evaluated at ZARS, Igatpuri during *Kharif*, 2019 for ten yield and yield contributing characters to study the genetic diversity existing among them

by using Mahalanobis D^2 statistic with the objectives to estimate identify suitable parents for future hybridization programme on the basis of inter cluster D^2 values and cluster means.

Analysis of variance indicate that the mean sum of square due to genotypes were highly significant for all the characters except days to 50% flowering. The forty genotypes are grouped into nine clusters. Cluster I had maximum eighteen genotypes followed by cluster II eight genotypes. The cluster V, VI, VII, VIII, IX were solitary since they had only one genotype, whereas cluster III had six genotypes and cluster IV had three genotypes. The inter cluster distance D ranged from 7.48 to 16.50. The range of intra cluster distance was observed from 0.00 to 8.06. Among all intra cluster values cluster III (D^2=8.06) had highest value which was followed by cluster IV (D^2=7.26), cluster II (D^2=6.88) and cluster I (D^2=6.12) . The cluster mean for seed yield per plant is varied from 6.30 g (cluster VIII) to 23.20 g (cluster IV). The cluster mean observed for days to 50 % flowering was varied from 94 (cluster VII) to106 (cluster VIII and IX). The cluster mean for days to maturity was varied from 129 (cluster VII) to 145.50 (cluster IX). Cluster mean for plant height was varied from 95.70 cm (cluster VII) to 133.40 cm (cluster IX). The cluster mean for number of branches per plant was varied from 6.0 (cluster VI) to 11.70 (cluster IX). The cluster mean for the diameter of capitulum ranged from 6.0 mm to 19.45 mm (cluster IV). The cluster mean for the number of capitulum per plant ranged from 46.60 (cluster VI) to 90.60 (cluster IX). The cluster mean for number of seeds per capitulum was varied from 16.50 (cluster VIII) to 51.33 (cluster IV). In case of test weight, it was minimum 2.93 g in cluster VIII and maximum 4.18 g in cluster IV. While, in case of oil content cluster mean varied from 32.57 per cent (cluster IV) to 39.20 per cent (cluster VIII). The present study revealed that plant height was (28.59 per cent) contributed more to genetic diversity followed by oil content (21.18 per cent), seed yield per plant (17.95 per cent).

Keywords:-Cluster, Cluster mean, Genetic diversity, Niger.

T2.21 EVALUATION OF RELATIONSHIP BETWEEN HETEROSIS AND GENETIC DIVERSITY FOR QUANTITATIVE AND QUALITATIVE TRAITS IN SESAME (*Sesamum indicum* L.)

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The experiment was conducted at Dr.P.D.K.V., Akola in RBD with three replications including 45 F1 crosses long with the parents of sesame (*Sesamum indicum* L.) where assessed for rank correlation to generate the information on relationship between heterosis and genetic divergence for quantity and quality traits in sesame. The correlation between heterosis and genetic divergence was found significant for number of seed per capsule and seed yield per plant whereas rank correlation between useful heterosis and genetic divergence was found significant for seed yield per plant, days to 50% flowering and plant height. The characters showing significant relationship among heterosis, useful heterosis and genetic divergence, preference should be given to those genotypes which perform better for the characters viz. days to 50% flowering, plant height, number of seeds per capsule and seed yield per plant. The present study reported the importance of NIC-12607, SP-1162-B, TKG-21, Shekhar, Swetha Til, Hima, JCSC-8, SI-7-2, RT-46 as one of the parent and AKT-64, JLT-7 and Phule Til-1 as another parent for getting high heterotic cross in F1 generation .

Theme 3

Advance Genetic Tools for Enhancing Breeding Efficiency

T3.1 **UTILIZING LOCAL GROUNDNUT GERMPLASM FOR DISEASE RESISTANCE USING MOLECULAR BREEDING APPROACHES**

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ABSTRACT

Rust (caused by *Pucciniaarachidis*) and late leaf spot (LLS) (caused by *Cercosporidiumpersonatum*) are two major foliar fungal diseases of groundnut and can cause upto 50%–70% yield loss. Groundnut oil comprises about 80 % unsaturated fatty acids (UFA) and 20%saturated fatty acid. Current workwas focused on getting improved lined of groundnut having foliar disease resistance and high fatty acid content using molecular breeding approaches. Total 155 local groundnut germplasms, collected from Shivpuri, Dhar, Jhabua and Badwani area of Madhya Pradesh were grown during Rabi 2020 at RVSKVV research farm at normal field conditions. Observations on Days to 50% flowering, Days to maturity, Total fresh weight (gm), Total dry weight (gm), Total number of pods /plant, 100 Kernal weight (gm), Pod yield/per plant, Sound Mature Kernel %, Shelling % and Harvest index were taken for morphological yield attributing traits characterization.Morphological traits were observed for standard error (S.E.), critical difference (CD) and coefficient of variation (CV) using OP Stat software. The coefficient of correlation among all morphological traits at maturity was calculated using SPSS ver.19 software. The similarity matrices was used to construct a dendrogram for all the genotypes using NTSYS-pc based on UPGMA.Early leaf spot disease scoring was done at 35 and 45 days after sowing and late leaf spot scoring was done at 75 and 85 days after sowing on 1 to 9 scale. Allele specific molecular markers were used for molecular characterization of these germplasms and disease resistant and high yielding germplasms were selected. These germplasms could be used for groundnut varietal improvements.

T3.2 SESAME: NEW PLANT BREEDING APPROACHES FOR CROP IMPROVEMENT

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ABSTRACT

Sesame (*Sesamum indicum* L.) is a high value and important oilseed crop in India and have good dietary value, health benefits and industrial applications. Sesame oil maintains a balanced fatty acid composition with more or less equal and higher percentages of unsaturated fatty acids. In spite of its several merits, it is behind in genetic improvement as compared to other commercial oilseed crops. Narrow genetic base, less attention to genetic improvement and cultivation in marginal lands with poor crop management practices are the major constraints for increased yield potential. Yield loss in sesame due to capsule shattering and the crop is sensitive to a wide array of biotic and abiotic stresses. Sesame yields are highly variable depending upon the growing environment, cultural practices, and cultivar use. Several opportunities now exist for sesame improvement as a result of recent developments plant breeding techniques. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi, maintains over 6000 accessions of sesame, including the world sesame collection. Wide diversity is available in the existing germplasm for various morphological and yield-related traits and by utilizing this genetic diversity; it should be possible to improve the productivity of existing sesame cultivars. Innovative pre-breeding and breeding approaches such as identification of candidate genes/quantitative trait loci (QTL) form wild or land races by using genomics tool, gene specific molecular marker and introgression this gene with monitoring in succeeding breeding cycles using molecular markers, introgression of candidate gene by genetic transformation like trasgenesis and cisgenesis approaches can pave the way for genetic improvement in sesame. In addition, mutagenesis, somaclonal variation, interspecific hybridization and somatic hybridization can be used to restructure the plant's ideotype.

Key Words: Sesame; Breeding constraints; Sesame collection; Breeding strategies; Genetic improvement

T3.3 ADVANCES IN SESAME

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ABSTRACT

Sesame is a high value and important oilseed crop owing to its dietary uses, health benefits and industrial applications. Sesame oil maintains a balanced fatty acid composition with more or less equal and higher percentage of unsaturated fatty acids. In spite of its several merits, it is behind in genetic improvement as compared to other commercial oil seed crops.Narrow genetic base, less attention to genetic improvement and cultivation in marginal lands with poor management practices are the major constraints for increased yield potential. Sesame has ample scope to breed cultivars with greater yield, as the gap between the potential and realized yields in this crop is enormous.Capsule shattering leads to heavy loss of seed yield and the crop is sensitive to a wide array of biotic and abiotic stresses.Innovative breeding approaches such as mutagenesis, somaclonal variation, interspecific hybridisation, somatic hybridisation and genetic transformation can be used to restructure the plant's ideotype. In addition, identification of candidate genes/quantitative trait loci (QTL) and their monitoring in succeeding breeding cycles using molecular markers can pave the way for genetic improvement in sesame.In this pursuit, the author present a detailed outline of the importance of sesame as a potential oilseed crop, it's biosystematics, floral biology, genomics, breeding goals, present status of breeding strategies and attention to prospects for sustainable production and productivity in future.

T3.4 NEXT-GENERATION PLANT BREEDING IN THE OMICS ERA: CURRENT STATUS AND FUTURE PROSPECTIVE.

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ABSTRACT

Genetic and genomic resources are imperative for the improvement of any crop species. Recent abrupt changes to climate requires efficient exploitation of crop genetic

resources aiming at the beneficial allele-hunting process to rectify the genetic erosion, loss of diversity and hidden hunger, with back drop of declining and deteriorating resources and without adversely affecting the environment. Conventional breeding is still dependent to a considerable extent on subjective evaluation and empirical selection of natural and induced genetic variations. On the other hand, with the advent of next generation sequencing (NGS) technologies, identification of candidate genes/ alleles/ QTLs regulating the key agronomic as well as nutritional traits is possible at a pace and precision not contemplated before and eventually for marker-assisted genetic enhancement which in turn would facilitate the development of breeding lines to accelerate crop breeding improvements for achieving food security and nutrition. This review attempted to discern the latest NGS-based Phenotyping technologies and their role to unlocking the genetic potential of crops; then, we discuss the paradigm shift that is underway in plant breeding.

Keywords: next-generation sequencing, omics, genome selection and genome editing.

T3.5 MAJOR CONSTRAINS OF SOYBEAN OIL CONSUMPTION AND BASIC PRINCIPLES OF RESOLUTION.

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ABSTRACT

Soybeans are a globally consumed crop and best source of oil and protein content. Consumption rate of soya oil are increasing, during 2015 consumption rate was nearly 4.5 million metric tons however in 2019 it increased to nearly 6 million metric tons. Other than oil and protein soybean are richest source of Ca, isoflavones, vitamin C, B1 and B9. Presence of some major problems like deficiency of sulfur-containing essential amino acids, digestive flatulence, beany flavor, oxidative instability, presence of anti-nutritional properties like lipoxygenase, lectins, urease and trypsin inhibitor with soybeans leads to unfit use as human diet. On the other hand, soybean oil is composed of five fatty acids: palmitic acid, stearic acid, oleic acid, linoleic acid, and linolenic acid. The percentage of these five fatty acids in

soybean oil are 10%, 4%, 18%, 55%, and 13%, respectively. This fatty acid content in soya oil leads to low oxidative stability that restrict the uses of soybean oil as meal. In addition, Soybean breeders have achieved considerable advancement in the overall yield of soybean along with more protein and oil content, now must be focused on quality improvement. Quality improvement of oil include improving the ω-3 fatty acid level, low linolenic acid oil, high oleic acid oil, raised stearic acid combined with high oleic acid, production of novel fatty acids and improved tocopherol content and composition. Several molecular and breeding techniques are being used to achieve quality parameter of soya oil include conventional breeding, metabolic engineering, genomics and proteomics, marker-assisted selection, transgenesis (genetic engineering) and automatic mutagenesis (TILLING, Targeting Local Lesions in Genomes). Plant breeders have developed several soybean varieties having desirable character but recent need is to develop soybean variety with improved oil quality.

Keywords: Isoflavones, Digestive flatulence, Conventional breeding and Mutagenesis.

T3.6 RECENT ADVANCES IN ENHANCEMENT OF OIL CONTENT IN SOYBEAN

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ABSTRACT

Oilseed crops contain plant oils which are valuable agricultural commodity. The major oilseed crop was soybean, which is also known as a dual crop comes under the family Papilionoideae, where there are two popular types used world wide.They are:(1) Black seeded soybean (contains protein content of 40-42% and oil content of 18-22%) which has been highly used in North India for consumption purpose . (2) Yellow seeded soybean(contains oil content of 40-42% and protein content of 18-22%).Hence, due to these reasons, soybean has been widely used for oil extraction purpose. Majority of oilseed meal consist of protein and high contents of essential amino acid which are beneficial to human health and well being. The fat yields of oilseed crops are generally high, varied from crop to crop; high polyunsaturated fatty acids contents also prevent against coronary heart

disease.The manipulation of seed oil composition to deliver enhanced fatty acid compositions, which are appropriate for feed or fuel, has always been a main objective of metabolic engineers. Genetic engineering approaches have presented major break through in elevating oil content in oilseed crops such as soybean additionally, current research efforts to explore possibilities to modify the genetic expression of key regulators of oil accumulation along with biochemical studies to elucidate lipid biosynthesis will establish protocols to develop transgenic oilseed crops along much improved oil content. In this review, we describe current distinct genetic engineering approaches investigated by researchers for ameliorating oil content and its nutritional quality and discuss challenges for engineering oil content to yield oil at much higher rate in oilseed crops.

Key words: oil content, fatty acid, genetic engineering.

T3.7 DIVERSITY ANALYSIS OF *Brassica juncea* MUTANTS USING MORPHOLOGICAL AND MOLECULAR MARKERS

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ABSTRACT

Mutation breeding helps to strengthen the germplasm which could be exploited for crop improvement. Mutations for various morphological characters yield and including yield attributes were isolated from parent variety Bio902 using γ-irradiation and Ethyl Methane Sulphonate (EMS). Their morphological and molecular diversity analyses were performed. Morphological diversity was assessed using PCA analysis and result revealed six principal components and altogether explained 74.34% of total accumulated variability was applied since the analysis without rotation of axes failed to load all the variables. The UPGMA based cluster analysis showed formation of 8 clusters of the stable mutant lines. For molecular marker study, 20 SSR primers were used out of which eight primers showed polymorphism. The percent polymorphism varied from 66.67 to 100% with an average of 77%. Polymorphism Information Content (PIC) values ranged from 0.08 to 0.48 with an average of

0.34 per primer combination. Distance-based cluster analysis was performed and dendrogram showed the presence of three major clades. First clade consists of Bio902 along with five mutant derived from γ-irradiation. Findings of this study shall be useful for DNA fingerprinting of mutant lines which could be utilised in breeding programme.

T3.8 GENETICALLY ENGINEERED TECHNOLOGY TO PRODUCE GM MUSTARD HYBRIDS

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ABSTRACT

Brassicas, using traditional breeding methods, are hard to hybridize. The hybrids suffer from low vigour, which makes them impractical for commercial cultivation. In the offspring of crosses of genetically distinct parents, vigor can be greatly enhanced to outperform the parental lines. In plant breeding, this phenomenon called 'hybrid vigour' has been a great boon. Canola and mustard studies contributed to the discovery of a few sterile male lines and incomplete female restorer lines, rendering the natural system commercially unviable. To imitate the natural phenomenon of hybrid vigour, separate male sterile (MS) and fertility restorer (RF) lines established through GE are used. Barnase/barstar gene system, in which herbicide resistance is associated with male sterility, so that the herbicide can destroy the male fertile lines, leaving the seed producing male sterile plants unharmed. The MS line crosses with the RF line to ensure the development of fully fertile hybrids that are used in agricultural production. Barnase, a *Bacillus amyloliquefaciens* ribonuclease (enzyme), prevents the formation of pollen and results in male sterility in transgenic plants.The bar gene from *Streptomyces hygroscopicus* encodes the phosphinothricin acetyltransferase enzyme, which restores male fertility in the transgenic lines. By spraying a herbicide, a phsphonithricin resistance-coding (pat) gene is used to suppress undesirable segregates. An

engineered male sterility has not been used except for barnase-barstar system but this is likely to be more important in future hybrid-breeding programmes.

Theme 4

Seed System and IPR

T4.1 INTELLECTUAL PROPERTY RIGHTS IN MODERN SCIENCE

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ABSTRACT

The rights given to persons over the creations of their minds or intellect which usually give the creator an exclusive right over the use of his/her creation for a certain period of time are known as Intellectual property rights. Examples of intellectual properties include inventions, publications, videotapes, music, computer software and plant varieties. Intellectual property rights (IPRs) play a key role in every sector and have become the basis for crucial investment decisions. IPRs are exclusive rights and therefore there is always a challenge to strike a balance between the interests of innovators and the interests of the society at large. For plant breeder's rights, patents, and trademarks national governments are responsible and the protection is valid only in countries in which they are issued while trade secrets and copyright are not country specific.

Plant breeder's rights and patents are the most relevant forms of Intellectual property protection in modern science especially in case of plant breeding. The rights which are used to protect new varieties of crops by giving exclusive commercial rights for about 20 -25 years to market a new variety or its reproductive material are known as Plant breeder's rights. The variety must be novel, distinct, uniform, and stable. With few exceptions, this protection prevents anyone from growing or selling the variety without the owner's permission. Patents are the most powerful in the Intellectual property system and considered to be the most critical form of protection for modern science. Patents are generally granted about 20 years on temporary basis and also are country specific.

Most scientists argue that the stronger intellectual property system is one of the cornerstones of modern science. In contrast, other scientists argue that intellectual property rights are constraints on development of economic growth.

Keywords: IPRs, Plant breeder's rights, Modern science, Patents, Novel, Uniform.

T4.2 ENCOURAGEMENT OF FARMER SOCIETIES ON SESAME SEED PRODUCTION TO ATTAIN SELF SUFFICIENCY OF OIL SEEDS AND OIL IN TELANGANA

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ABSTRACT

Sesame (*Sesamum indicum*L.) is one of the world's oldest oilseed crop In India, sesame is being grown over an area of 16.67 lakh hectares with production of 6.57 lakh tonnes and productivity of 405 kg/ha (Food and Agriculture Organization, 2016). In Telangana, it is grown over an area of 0.2 lakh hectares with an annual production of 0.09 lakh tonnes and productivity of 453 kg/ha (Directorate of Economics and Statistics, Government of Telangana, 2016).There is a great scope to increase area (introducing to non traditional areas like rice/turmeric/cotton fallows) and productivity by growing in turmeric fallows. In Telangana sesame area is increasing in cotton, redgram and turmeric fallows. Most of the farmers growing local varieties and old varieties. Due to non availability of good quality and improved varieties of sesame seeds to the farmers. However, with the help of research and intervention of Scientists, department of agriculture the yield of the crop has increased significantly and farmers have started cultivating new varieties with improved management practices in some areas.

AICRP on sesame, RARS, Polasa, Jagtial conducting training programmes to Agriculture extention officers under NMOOP, tribal farmers under TSP and training to progressive farmers on sesame seed production and management practices, storage and packing. In Northern Telangana zone, farmers of Adilabad and Jagtial district farmers inspired to take up seed production and selling the sesame seed to other farmers and they are getting more income from seed production compared to selling to the local market. We are encouraging and providing training to the farmer societies, so that they are producing good quality seed and selling to other farmers through societies. So, that we can reduce the seed shortage of sesame seed in the future, if all the farmers of different villages practice seed production with improved varieties with less cost.

If governament encourage these societies and provide the cold storage facilities, oil extraction units on subsidy basis to the societies in the future, we may self sufficient in oilseeds and oil in Telangana. Then we can supply good quality of sesame seed and oil to the people. So, reduce the import of oil from foreign countries we can save economy of India.

T4.3 PERFORMANCE OF NEW CULTURES FOR SEED YIELD AND OIL IN SESAME (*Sesamum indicum* L.)

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ABSTRACT

Sesame (*Sesamum indicum* L.) popularly known as simsim, til, gingelly. Sesame occupies utmost importance in our daily life. Sesame seed oil is one of the important edible oil. Sesame oil is used in industries, cosmetics, medicines & pharmaceuticals. Sesame is highly remunerative crop for the farmers. The average productivity of sesame in India is 413 kg/ha, while the world is 512 kg/ha (FAO STAT 2020). There is a need to increase the productivity in sesame. Demand for edible oil is also increasing with increasing population. There is a need to develop high yielding varieties in sesame to counter the demand for the edible oils. In the present investigation, seven newly developed sesame brown seed cultures were were tested against the check YLM-66 during three seasons, Kharif 2017, Kharif 2018 &Kharif 2019 for eight characters *ie*., days to 50 % flowering, plant height (cm), number of branches per plant, number of capsules per plant, 1000 seed weight (g), days to maturity, seed yield (kg/ha), oil percentage. Pooled analysis was carried out for all the eight parameters over three seasons at Agricultural Research Station, Yellamanchili, Visakhapatnam Dt. Andhra Pradesh. All the test cultures are developed at Agricultural Research Station, Yellamanchili through pedigree method. The cultures are tested in Randomized Block Design, with three replications, plot size of 3 X 4.5 m, spacing of 30 X 10 cm, in all the three seasons. All the essential agronomic and plant protection practices are adopted as per the requirement. The observations recorded for the eight parameters are subjected to pooled analysis. The results revealed that the culture YLM-146 recorded highest significant seed yield per plant (g) of 734 kg/ha followed by YLM-142 with 696.97 kg/ha, when compared with the check YLM-66 with 564.50 kg/ha (Table 1). There are no significant differences observed for the remaining parameters compared with the check. Though non-significant, the culture YLM-146 recorded highest oil percentage of 48.57%. In the present study YLM-146 & YLM-142 recorded highest seed yield and found prominent. These new cultures may be further tested and adopted for commercial cultivation.

Keywords: Sesame, brown seed, seed yield, oil

Table 1: Mean values of the characters over three seasons in Sesame (*Sesamumindicum* L.)

	Plant height (cm)	Days to 50 % flowering	Number of capsules per plant	Number of brancehes per plant	1000 seed weight	Seed yield kg/ha	Days to maturity	Oil Percentage
1 YLM 136	131.3111	37	110	6	**3.32**	487.8	89	45.74
2 YLM 139	131.6444	37	110	6	2.91	569.6	88	46.28
3 YLM-141	126.6667	37	107	6	2.77	580.9	90	44.64
4 YLM-142	128.8222	36	108	5	3.16	**696.97****	88	45.96
5 YLM-143	129.6222	**35**	96	6	3.22	570.7	89	47.86
6 YLM-146	130.2333	38	**111**	6	2.91	**734.14****	89	48.57
7 YLM-147	128.3111	37	107	6	2.92	600.6	89	47.94
8 YLM-66©	**133.9556**	37	109	6	3.08	564.5	89	47.78
Mean	**130.0708**	**37**	**107**	**6**	**3.04**	**600.6**	**89**	**46.85**
C.V.	6.10	3.85	10.19	13.06	9.71	13.1	1.36	2.91
S.E.	2.647	0.47	3.63	0.25	0.098	26.26	0.40	0.45
C.D. 5%	NS	1.3408	NS	NS	0.278	74.41	NS	1.29
C.D. 1%	NS	1.7847	NS	NS	0.370	99.05	NS	1.72
Range Lowest	**126.67**	**35**	**96**	**5**	**2.77**	**487.75**	**88**	**44.64**
Range	**133.96**	**38**	**111**	**6**	**3.32**	**734.15**	**90**	**48.57**

Highest

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ncy”

Theme 5

Dissemination of Technology

T5.1 WAYS AND MEANS FOR TECHNOLOGY DISSEMINATION IN OILSEEDS FOR INCREASING PRODUCTION AT FARMERS LEVEL

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ABSTRACT

Oilseed crops are the second most important determinant of agricultural economy, next only to cereals within the segment of field crops. The self-sufficiency in oilseeds attained through "Yellow Revolution" during early 1990's, could not be sustained beyond a short period. Despite being the fourth largest oilseed crop producing country in the world, India is also one of the largest importers of vegetable oils today. There is a spurt in the vegetable oil consumption in recent years in respect of both edible as well as industrial usages. The demand-supply gap in the edible oils has necessitated huge imports accounting for 60 per cent of the country's requirement (2016-17: import 14.01 million tonnes; cost Rs. 73,048 crore). Despite commendable performance of domestic oilseeds production of the nine annual crops (Compound Annual Growth Rate of 3.89%), it could not match with the galloping rate of per capita demand (~6%) due to enhanced per capita consumption (18 kg oil per annum) driven by increase in population and enhanced per capita income. In India, about14 million people are involved in the production of oilseeds and another one million in their processing. Even though there was many improved high yielding varieties / hybrids and efficient production technologies developed through researchers, the yield gap is not minimized. The major hurdle is the dissemination of technology up to the end users (farmers/ stakeholders). Efforts has been made by adopting efficient extension activities with use of information technology to educate the farmers to overcome the shortcomings faced in adoption. Exploitation yield reservoir for oilseed in India is one of the mean. The results obtained from FLDs have conclusively proved the beneficial impact of the production technology over the farmer's practices. The impact of improved technologies in yield increase was positive and the realizable yield gap was 40% between the mean yield with improved technology (IT) and the national average yield. According to this, the large scale location specific result and method demonstrations on famer's field should be conducted for increasing the confidence among the farmers. Productivity enhancement from various technological interventions will be great help to increase the production. In this context, popularization of newly developed varieties and good agricultural production technologies be disseminate by organizing various extension activities *viz*., farmers rally, farmers training programmes, field days, farmers – scientist forum, group discussion, radio and TV programmes during the crop season, preparation and distribution of video films of production technology among the extension personnel and farmers, use of press media like new paper, folder, bulletins in local language, competition, evaluation and felicitation of the farmers, etc. The time has come for the use of information technology of stakeholders with less dependence on the human resources for the extension work. Use of various apps, software tools for fertigation manager, pest and disease management systems, krishi salla through mobile will help and guide the farmers. This may prove to be a better extension strategy to disseminate the technology for improving the production and productivity at farmer's level.

T5.2 A NOTE ON HONEYBEES AND PRODUCTIVITY OF OIL-SEED CROPS

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ABSTRACT

During late 1970s, India achieved amazing results in increasing the crop productivity of cereals, like Wheat, Paddy etc. India not only became self-reliant in cereals but started exporting Wheat and Rice. However, a similar breakthrough was not achieved in Oil-seeds. The Government of India therefore launched "Oil-seed Technology Mission" in 1986 to boost up oil-seed production. It is now more than 30 years that this Mission was started but the productivity of oil-seed crops per hectare is stagnant. In 1994, we imported edible oil equal to 10 % of the home production. In 2004 we imported edible oil equal to home production. During the last decade, we are importing edible oil 170 % to 200 % of home production, worth about Rs. 70,000 crore every year.

We are importing Sunflower oil and Soybean oil from Ukraine, Brazil and Argentina. Oil seed productivity per hectare in these countries is two times more than the productivity per hectare in India. Soybean is self-pollinated crop, not dependant on insects for pollination. But the flowers remain open and receptive for the bees to transfer pollen during day time. If this cross-pollination is not accomplished during day time, plants self-pollinate. Thus, if honey bee colonies are made available during the flowering of Soybean, there is an increase in yield up to 40 to 60 % over the control plots without honey bees (Research Paper by Agricultural Scientists from Brazil).

Interestingly, in the Beekeeping Industry (Number of Honeybee colonies), Ukraine ranks number one in Europe and 5th in the world. After the USA, Australia, and New Zealand, Brazil and Argentina are Rankers, maintaining about a million honey bee colonies.

All the countries maintaining large number of colonies are self-sufficient and exporters of edible oil, pulses etc.

According to the ICAR report, India needs minimum 70 lakh honey bee colonies just to pollinate 12 major crops of India that are insect dependent for pollination. As against this minimum need we have just 15 to 20 lakh honey bee colonies? Inadequate population of insect pollinators- honey bees and therefore deficit pollination is one of the main reasons for low productivity of these crops in India.

After hybrid seed, proper doses of fertilizers, irrigation and other cultural practices, "HONEY BEES FOR POLLINATION" is the most important and indispensable Input for cross-fertile crops. Besides producing lakhs of tons of honey, honey bees, through cross-pollination, improve the yields of many crops, including oil-seeds crps, both qualitatively and quantitatively.

T5.3 STATUS AND WAY FORWARD FOR ACHIEVING SELF SUFFICIENCY IN OILSEED PRODUCTION IN INDIA.

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ABSTRACT

Oilseed crops are the second most important crops play an important role for determination of agricultural economy, next only to cereals. The self-sufficiency in oilseeds attained through “Yellow Revolution” during early 1990’s, could not be sustained beyond a short period. As far Status is concerned, India is the 4th largest oil seed producing country in the world after USA, China and Brazil, which contributes about 10% of the world oilseeds production, 6-7% of the global production of vegetable oil, and nearly 7% of protein meal. Area under crop during 2016-17 was about more than 26.67 million hectares producing 30.06 million tonnes annually. Despite being the fifth largest oilseed crop producing country in the world, India is also one of the largest importers of vegetable oils today. The area under oilseeds has experienced a deceleration in general, and this is due to their relative lower profitability against competing crops like maize, and chickpea etc. under the prevailing crop growing and marketing situations. The growth rates of all annual oilseed crops during past

decade (2001-02 to 2011-12) is poor (negative for area and production) especially for sunflower, safflower, linseed, niger; and negative for area of groundnut. Soybean and castor crops have registered positive and high growth rates and rapeseed-mustard registered higher rate of production. The demand-supply gap in the edible oils has necessitated huge imports accounting for 60 per cent of the country's requirement (2016-17: import 14.01 million tonnes; cost Rs. 73,048 crore). The import of edible oils during 2015-16 reveals that, sum a total of 15.88 million tonnes of oilseed and vegetable oil products valued Rs. 69331.96 crore were imported by India. Therefore, strategies for enhancing the productivity (and profitability) of oilseed should be oilseed based production system need to be prepared for enhancing livelihood security of the people in the country. It is also need to be time tested with scale neutrality that can be grounded for enhancing the productivity of the oilseed based production system. The productivity may be increased by increasing the production of location specific variety of seed and their proper distribution along with use of low cost technology for high impact on productivity which leads to high return on investment with special emphasis on eco-friendliness, high input use efficiency, quality improvement and value addition with a bearing on the employment through entrepreneurship development. Local seed companies may also be promoted to reduce the dependence on multinational seed companies .Generation of appropriate agricultural technology and its dissemination to the farmers are becoming more and more challenging in the context of the climate change. Both the numbers and the quality of the technically qualified person in agriculture are inadequate. There is a need to step up investment in agricultural research, education, extension to reach among unreached section of society. It may be concluded that Crop and varietal diversification may be introduced. Quality of production and value addition need to be emphasized. The outreach of most modern crop production technology may be facilitated up to the last farmers.

T5.4 STUDY ON EFFECT OF SEED PRIMING WITH ANTIOXIDANTS ON LOW VIGOUR SEED LOT OF SESAME (*Sesamum indicum*) VAR. TMV-7

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ABSTRACT

Sesame (*Sesamumindicum*) is a well-known oilseed crop which belongs to Pedaliaceae family. The varied biological happenings taking place in the seed during storage are seed deterioration that leads to reduction in vigour and viability of seeds due to complex changes taking place in cellular constituents. Studies were carried out to find the effect of seed priming with antioxidants at different soaking durations in low vigour sesame (TMV-7) seed lot. Seed priming with the aqueous solution of antioxidants consisted of the following steps: 1) Dissolving the antioxidant substances in distilled water, 2) Priming the seeds for several hours with the obtained aqueous solution and 3) Taking the seeds out of the solution, wash it with distilled water followed by shade drying and bring back to original moisture. Antioxidant is any substance that delays, prevents or removes oxidative damage to a target molecule. The treatment includes control (T_0), glutathione @ 0.05% (T_1), glutathione @ 0.1% (T_2), alpha tocopherol @ 1% (T_3), ascorbic acid @ 0.5% (T_4) and soaking durations 4 hours (H_1), 5 hours (H_2). Among the treatments glutathione @ 0.05% (T_1) with soaking duration 5 hours (H_2) have recorded higher germination (82%), shoot length (4.3 cm), root length(14.6 cm), vigour index (1550) compared to control having germination (64%).

Keywords: Sesame, Low vigour lot, Soaking duration, Priming, Antioxidants.

T5.5 MANAGEMENT OF *Alternaria sesami*, AMAJOR SEED BORNE FUNGUS IN SESAME, THROUGH SEED TREATMENT WITH FUNGICIDES, BIO-CONTROL AGENTS AND BOTANICAL EXTRACTS

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ABSTRACT

A total of six seed treatments, comprising two each of fungicides (hexaconazole@ 0.2% and combination product of carbendazim 12% + mancozeb 63% @ 0.2%), bio-control agents (*Trichodermaviride*and *Pseudomonas fluorescens* @ 10 g kg^{-1} seed)and botanicals (garlicclove extract 10% andneemleaf extract 10%), which were identified as the best effective treatments under *in vitro* conditions, were imposed for the management of *Alternaria* blight caused by *Alternariasesami*, amajor seed borne fungus in sesame.The treated seed of sesame variety, YLM-17,along with control (without seed treatment) was sown in pots. The experiment was laid out in Completely Randomized Design (CRD) with three replications in the laboratory of Plant Pathology, Regional Agricultural Research Station (RARS), Lam and the Department of Seed Science and Technology, Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh during 2017-2018.Spraying with combination product of carbendazim 12% + mancozeb 63% @ 0.2%wasdone soon after the appearance of *Alternaria*leaf spot at 15 days interval for 2 times.

Sesame seed treated with combination product of carbendazim 12% + mancozeb 63% @ 0.2% recorded significantly higher seed germination (98.75%), seedling length (16.80 cm), seedling vigour index-I (1659) and seedling vigour index-II (2.94) when compared to control (untreated seeds) (90.00%, 10.41 cm, 938, 2.21, respectively). Lowest seed germination (95.00%), seedling length (12.52 cm), seedling vigour index-I (1191) and seedling vigour index-II (2.42) was recorded in seed treatment with neem leaf extract 10% among the seed treatments.Data on per cent disease index before spray, after first spray (30 DAS) and second spray (45 DAS) revealed that the seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% was significantly superior to other treatments with lower per cent disease index (4.1, 10.8 and 12.4, respectively), while the control exhibited highest per cent disease index (15.2, 28.5 and 33.7, respectively). Seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% was effective in reducing the disease intensity (63.20%) of *Alternaria* leaf spot and increasing plant height (44.11 cm), number of capsules per plant (12.53), seed yield per plant (2.23 g) and harvest index (14.17) when compared to control (without seed treatment)(27.73 cm, 5.77, 0.84 g and 7.36, respectively). Among the seed treatments, neemleaf extract 10% showed lower plant height (36.17 cm), number of capsules per plant (9.27), seed yield per plant (1.79 g) and

harvest index (12.35).Seed treatment with combination product of carbendazim 12% + mancozeb 63% @ 0.2% reduces the seed borne infections besides improving yield and seed quality parameters in sesame.

T5.6 OIL PALM: ORNAMENTAL TO MULTIFARIOUS UTILITY

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ABSTRACT

Oil palm (*Elaeis guineensis*) is an attractive evergreen, single-stemmed palm tree belongs to family *Palmaceae* that can grow up to a height of 20-30 meters. The erect, cylindrical, unbranched stem can be 22 - 75cm in diameter; it is topped by a crown of about 40 - 60 live dark green leaves. The tree is also planted in the garden for ornamental purpose. It is the highest oil yielding plant among the perennial oil yielding crops, mainly cultivated in humid tropical climate with temperature range 29-33 °C (maximum) and 22-24 °C (minimum) with rainfall 2,500-4,000 mm and relative humidity more than 80% along with not less than 5 hrs sunshine/day. It can be grown up to 900 m above MSL. It is the crop that has a greater advantage in the productivity per hectare that is much higher than that of any oil crop, therefore reducing the land cost, infrastructure, maintenance and harvesting. It is a crop of the future and resource of health and nutrition, value addition, waste utilization, eco-friendly, diversification, import substitution plus sustainability. It needs less than half the land required by other crops (such as sunflower, soybean or rapeseed) to produce the same amount of oil that makes palm oil the least expensive vegetable oil in the world. India is the major user of palm oil products, capturing over 20 percent of global supply. Palm oil is balanced oil with respect to saturated and unsaturated fatty acid contents and help increasing good cholesterol and lowering bad cholesterol. This oil trims down tendency for blood to clot and behaves as a powerful antioxidant. Palm oil is generally used for home cooking, in restaurants, in snack foods, instant noodles manufacture. It is also used in production of margarine, bakery and frying shortenings confectionery fats, ice creams and as a replacement for butter fat in some dairy products. This oil is too suitable for deep frying because it is relatively stable at high temperature compared with the more unsaturated oils. About 10% of

palm oil is utilized for non food products like oleochemicals, biodiesel *etc*. The oleochemicals can be used for the manufacture of candles, cosmetic products, soaps, pharmaceuticals, textile and rubber processing. The waste derived from palm oil industry (Empty Fruit Bunches, Palm oil Mill Effluent) as well as plantations (fronds) can be converted into high quality organic fertilizer. EFB, palm fronds and palm trunks can be used for the manufacture of medium density fibre (MDF) boards, different types of papers and paper boards. Fibre derived from the EFB is suitable for the production of mattress, car seats, insulation, composite panels, thermal insulating materials, packaging materials, rubberized mattresses, coir geo-textiles *etc*. The oil palm is an emerging oilseed crop which can raise the economic status of small scale farmers having small land holding and has potential for doubling farmer's income in developing countries like India.

Keywords: Oil palm, Palm oil, EFB, *Elaeis guineensis*

T5.7 INFLUENCE OF TERMINAL NIPPING AND GROWTH REGULATORS ON PRODUCTIVITY AND PROFITABILITY OF SESAME (*Sesamum indicum* L.)

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ABSTRACT

A field experiment was conducted at farm of Agricultural Research Station, Mandor (Jodhpur) during the *kharif*, 2016, 2017 & 2018 under rainfed conditions to study the effect of terminal nipping and growth regulators on productivity and profitability of sesame crop. Seven treatment combinations viz. control, terminal nipping at 30 DAS, salicylic acid spray 100 ppm at 30 DAS, DAP spray 2% at 30 DAS, terminal nipping at 30 DAS + salicylic acid spray 100 ppm at 30 DAS, terminal nipping at 30 DAS + DAP spray 2% at 30 DAS, terminal nipping at 30 DAS + salicylic acid spray 100 ppm at 30 DAS + DAP spray 2% at 30 DAS were evaluated. The field experiments were laid out in a randomized block design (RBD). Seed yield of 462 kg/ha recorded with salicylic acid spray 100 ppm at 30 DAS was significantly higher than terminal nipping at 30 DAS (371 kg/ha), terminal nipping at 30 DAS + DAP spray 2% at 30 DAS (400 kg/ha) and terminal nipping at 30 DAS + salicylic acid spray 100 ppm at 30 DAS (408 kg/ha). The maximum seed yield noted with salicylic

acid spray 100 ppm at 30 DAS was statistically at par with DAP spray 2% at 30 DAS, terminal nipping at 30 DAS + salicylic acid spray 100 ppm at 30 DAS + DAP spray 2% at 30 DAS and control. The highest net return (Rs 10432/ha) and BCR (1.58) were found with salicylic acid spray 100 ppm at 30 DAS followed by DAP spray 2% at 30 DAS and the lowest net return (Rs. 4583/ha) and BCR (1.25) were found with terminal nipping at 30 DAS.

Key words: salicylic acid, terminal nipping, sesame, productivity and profitability.

T5.8 EFFECT OF ZINC AND IRON ENRICHMENT THROUGH FERTI-FORTIFICATION ON PRODUCTIVITY AND PROFITABILITY OF SESAME (*Sesamum indicum* L.)

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ABSTRACT

A field experiment was conducted at farm of Agricultural Research Station, Mandor (Jodhpur) during the *kharif*, 2016, 2017 & 2018 under rainfed conditions to study the effect of zinc and iron enrichment through ferti-fortification on productivity and profitability of sesame crop. The experiment was conducted on zinc and iron enrichment through ferti-fortification in sesame in rainfed condition. The pooled data of three years of seed yield was significantly increased by 37.63 % in soil application of $ZnSO_4$ @ 12.5 kg ha^{-1} + soil application of $FeSO_4$ @ 12.5 kg ha^{-1} and foliar application of foliar application of ZnSo4 @ 0.5% at 30 & 45 DAS over control and followed by soil application of ZnSO4 @ 12.5 kg ha^{-1} + soil application of $FeSO_4$ @ 12.5 kg ha^{-1} and foliar application of FeSO4 @ 0.5% at 30 & 45 DAS and soil application of ZnSO4 @ 12.5 kg ha^{-1} + soil application of FeSO4 @ 12.5 kg ha^{-1} but statistically these were at par. Numerically the maximum net monetary returns Rs. 11045/ha was recorded in T_{10} followed by Rs. 11032 recorded in T_9 and Rs. 11004/ha in T_8 and minimum NMR recorded in control. The highest B:C ration (1.58) was recorded in T_8 followed by 1.56 in T_{10} and 1.55 in T_9 and being minimum 1.27 in control.

Key words: Zinc and iron, ferti-fortification, sesame, productivity and profitability.

T5.9 INDUCTION OF PAL ACTIVITY BY NON-CONVENTIONAL CHEMICALS AGAINST CHARCOAL ROT OF SESAME

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ABSTRACT

Sesame (*Sesamum indicum*) is an important oilseed crop of India and abroad. It suffers with both biotic and abiotic stresses. Among biotic stresses, charcoal rot of sesame (*Sesamum indicum*) caused by *Macrophomina phaseolina* is an important disease in sesame growing areas. *M. phaseolina* is non-specific, wide host range, seed and soil borne in nature, very difficult to manage with fungicides and non availability of resistant varieties which impelled to biochemical defence analysis with non-conventional chemical to combat against the pathogen. Hence, the present study was carried out to know the impact of non-conventional chemicals on the activity of phenylalanine ammonia lyase (PAL) a biochemical defence parameter of the plant. Treatment with non-conventional chemicals *viz*., salicylic acid, acetyl salicylic acid, indole acetic acid, indole butyric acid, thiamine and riboflavin which induces defence against pathogen. As the concentration of different non-conventional chemicals increased from 50, 100 and 200 ppm there was reduction in the incidence of charcoal rot disease. The maximum induction of resistance in the plant was recorded by the treatment of salicylic acid at 200 ppm concentration after challenge inoculation with *M. phaseolina* followed by indole acetic acid, indole butyric acid, acetyl salicylic acid, riboflavin and thiamine. The activity of PAL was increased slowly after inoculation day of the pathogen which reached at peak after six days of challenge inoculation and subsequently PAL activity slightly declined after six days of inoculation with all tested non-conventional chemicals. Salicylic acid showed maximum induction of PAL activity followed by indole acetic acid, indole butyric acid, acetyl salicylic acid, thiamine and riboflavin in each concentration in both HT 1 and HT 2 varieties. Sesame variety HT 2 showed higher induction of PAL activity with lower disease incidence of charcoal rot as compared to HT 1. It showed that variety HT 2 had higher resistance against charcoal rot disease due to more induction of PAL activity.

Key words: Sesame, charcoal rot, *Macrophomina phaseolina*, phenylalanine ammonia lyase

T5.10 EVALUATION OF INDIAN MUSTARD GENOTYPES IN NON TRADITIONAL AREA OF VIDARBHA REGION OF MAHARASHTRA FOR SEED YIELD AND IT'S CONTRIBUTING TRAITS.

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ABSTRACT

Multi location varietal trial on Indian mustard was conducted on 7 locations of Vidarbha region of Maharashtra for evaluating seed yield and its contributing traits of 11 genotypes along with 4 checks namely TAM 108-1, Shatabdi, Bio-902 and Kranti. The seed yield differences among 11 genotypes and four checks were significant at all locations. At Nagpur, four genotypes were significantly superior over all checks in which genotype ACN-184 recorded highest seed yield of 2001 Kg/ha followed by ACN-141 recorded 1981 Kg/ha. Similarly, at Akola, the genotype ACN-184 (993 Kg/ha) ranked first for seed yield where as, ACN-141 (986 Kg/ha) ranked second for seed yield which were significantly superior over best check TAM 108-1.

ACN-141 showed highest seed yield of 1202 Kg/ha followed by ACN-201 showed 1190 Kg/ha which were only genotype significantly superior over all checks at Amravati. At Ekarjuna, the genotype ACN-184 recorded highest seed yield 1303 kg/ha which was significantly superior over all the four checks followed by ACN-141 (1259 kg/ha) and ACNMM-14 (1224 Kg/ha) which were significantly superior over TAM 108-1, Shatabdi, Bio- 902 & Kranti. The genotype ACN-184 recorded highest seed yield of 1425 Kg/ha followed by ACN-141 recorded 1372 Kg/ha which were significantly superior over all the checks along with ACNMM-23, ACNMM-15 & ACN -214 at Sindewahi. In Washim, the genotype ACN-141 recorded highest seed yield of 1784 Kg/ha followed by ACN-184 recorded 1766 Kg/ha which were significantly superior over best check TAM 108-1. Similarly in Achalpur, the genotype ACN-141 showed highest seed yield of 1321 Kg/ha which were only genotype significantly superior over best check Shatabdi.

On an average over seven locations, ACN-141 (1415 kg/ha) ranked first followed by ACN- 184 (1389 Kg/ha). These genotypes may be either used for development of varieties after two to three years multi location testing or used in crossing programme for isolating desirable segregants.

Key word: Indian mustard, Multi location testing, non traditional area, Genotypes and Seed yield

T5.11 ASSESSMENT OF VARIABILITY IN FATTY ACID COMPOSITION OF THREE DIVERGENT OILSEED CROPS

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ABSTRACT

Oilseeds are a major source of edible oils. They are rich in essential fatty acids which is required in our daily diet for proper growth and development. Fatty acids are the building block of most lipids. In the present study variability in the fatty acid composition *i.e.*, Oleic Acid, linoleic and linolenic acid with reference to the three important oilseed crops *viz.*, linseed, sesame and soyabean was studied, for which the seeds of potentially superior genotypes of the three selected oilseed crops were evaluated by standard procedures. Significant statistical differences were observed in the different genotypes. In the three oilseed group UFA content was found to be more than twice the SFA content. Soybean was found to be the richest source of essential ω-6 linoleic acid (51.87%) and linseed of ω-3 linolenic acid (53.57%). Sesame had a good amount of linoleic acid (44.41%). The amount of oleic acid in linseed genotypes varied from 20.21 to 27.59 per cent, 4.91 to 5.79 per cent in sesame genotypes and in soybean 24.93 to 28.48 per cent. The amount of linoleic acid in linseed genotypes varied from 11.18 to 12.46 per cent whereas 41.65 to 45.88 per cent in

sesame and about 50.01 to 52.84 per cent in soybean genotypes. The amount of linolenic acid in linseed varied from 49.79 to 58.39 per cent, while in sesame varieties 0.19 to 0.43 per cent and 6.09 to 7.75 per cent in soybean genotypes. The potentially superior genotypes identified can be used for further research by the plant breeders to develop a variety with high nutrional parameters.

Keywords: Oleic Acid, Linoleic Acid, Linolenic Acid, oilseeds, nutrition

T5.12 FRONTLINE DEMONSTRATIONS ON WHOLE PACKAGE IN MUSTARD CROP: IMPACT IN ENHANCING CULTIVATION AREA IN NORTHERN TELANGANA ZONE

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ABSTRACT

In Telangana, mustard is being cultivated in 7000 acres particularly in Northern Telangana Zone during rabi season (Department of Agriculture, Governament of Telangana, 2019) under Rice-Mustard, Maize-Mustard, Mungbean-Mustard (mention crop sequences) cropping systems. The farmers of this region are also actively involved in mustard hybrid seed production for private seed companies. However the farmers are realizing poor yields and low oil content due to lack of improved varieties or hybrids developed for this region, package of practices, INM, IPM practices and lack of efforts to complete the value chain. In order to improve the area, production and productivity of mustard in Telangana we are conducted 15 Front Line Demonstrations (FLD's) in Jagtial district during rabi 2019-20 by using recently released (from ICAR-DRMR) variety NRCHB 101. The results showed 28.04 per cent increase in yield with Improved practice (IP) (1142.66 kg/ha) as compared to farmers practice (766.26 kg/ha).The additional net returns accrued with IP was Rs. 28,063/ha. FLDs proved a positive impact on adoption of improved technology in mustard cultivation in Northern Telangana Zone. Mustard area, production and productivity can be increased by bringing more area in rice fallows with zero tillage practice and also through intercropping/mix cropping (with Bengal gram, maize) in Telangana state particularly in Northern Telangana Zone, which is a non traditional mustard area.

T5.13 MANAGEMENT OF MUSTARD APHID, *Lipaphis erysimi* (KALT.) (*Homoptera: Aphididae*) IN BIHAR

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ABSTRACT

Mustard aphid, *Lipaphis erysimi* (Kalt.), is the most serious insect-pest of rapeseed-mustard and responsible for causing the yield losses ranging from 35.4 to 96 per cent depending upon weather condition in Bihar. Among the various causes of low yield of mustard crops, damage caused by the mustard aphid is the most serious. To overcome the ill effects of synthetic chemical pesticides, utilisation of bio-agents in management of the pest population is emphasised. As the cold and cloudy weather favours the pest multiplication, sowing the crop earlier than the normal sowing time escape the pest attack. It's a serious pest and both nymph and adult suck the sap of the tender leaves, twigs, stem inflorescence and pods by means of piercing and sucking type of mouth parts. The affected leaves usually curl and in case of severe infestation the plant wilt and dry. When attack on inflorescence, the pod formation is adversely affected. The aphids also secrete *'honey dew'* on which black mould develops. Black moulds adversely affect the normal physiological activities of the plants. The aphids appeared in the third week of December, increased in January/ February and reached peak numbers in mid February. The temperature of the environment was important in aphid multiplication. Frequent rain kept the population density low. As the cold and cloudy weather favours the pest multiplication, sowing the crop earlier than the normal sowing time escape the pest attack. Spraying of crop with 0.07% Endosulphan 35 EC or 0.05% Malathion 50 EC. Thus, entomopathogenic fungi like *V. lecanii* or NSKE along with release of

C. septempunctata can be used as alternative measure to manage mustard aphid instead of solely relying on insecticides.

Key words: Mustard aphid, Incidence, Management

T5.14 ENCOURAGEMENT OF FARMER TO CULTIVATION OF MUSTARD CROP IN NORTHERN TELANGANA ZONE DURING RABI SEASON

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ABSTRACT

India is the third largest rapeseed-mustard producer in the world after China and Canada with 12 per cent of world's total production. Rapeseed-mustard group of crops is the major oilseed crop of India. Among the seven annual edible oilseeds cultivated in India, rapeseed-mustard contributed 28.6 percent in the total production of oilseeds. India holds a premier position in rapeseed-mustard economy of the world with 2nd and 3rd rank in area and production, respectively. This group of oilseed crops is gaining wide acceptance among the farmers because of adaptability for both irrigated as well as rainfed areas and suitability for sole as well as mixed cropping. Besides, it offers higher return with low cost of production and low water requirement. Being a major Rabi (winter season) oilseed crop and having an advantage of soil moisture conserved during monsoon; it has greater potential to increase the availability of edible oil from the domestic production.

Due to its low water requirement (80-240 mm), rapeseed-mustard crops fit well in the rainfed cropping system. Cultivated in 26 states in the northern and eastern plains of the country, about 6.8 mha is occupied under these crops (2006- 07). Nearly 30.7% area under rapeseed mustard is under rainfed farming.

Indian mustard is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat which contribute > 80 % area and production, out of which more than 47.0% contributed by Rajasthan state alone. The crop takes 135-150 days to mature, while early varieties maturing in 110 days are suitable to extend cultivation in non-traditional/non Conventional areas like Telangana state. It grows well under low temperature

and average (day and night) temperature of 25 ^{0}C is required at the time of sowing for optimum germination and such situation exists in Northern Telangana Zone of Telangana state. Being a major Rabi (winter season) oilseed crop and having an advantage of soil moisture conserved during monsoon; it has greater potential to increase the availability of edible oil from the domestic production. So, enhance the mustard cultivation in Northern Telangana State is needful, so Regional Agricultural Research Station, Polasa, Jagtial conducting training programme on awareness of mustard cultivation in Northern Telangana Zone to agricultural extension officers (AEO's) and farmers and also conduct field days, FLD's, farmer-scientist interaction meeting in ground level to increase mustard cultivation.

T5.15 EFFECT OF INTEGRATED CROP MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF LINSEED IN VIDARBHA REGION OF MAHARASHTRA

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ABSTRACT

The impact of integrated crop management through frontline demonstrations in adoption of production technologyand economics of Linseed was studied in five districts of Vidarbha under irrigated, rainfed and utera condition during *Rabi* season 2019-20 with an objective to demonstrate the integrated crop management technologies on real farm situation verses farmers practice to have an incremental change in net returns. The prevailing farmers practice was treated as control for comparison with demonstrated technology with variety PKV NL-260. The average yield of linseed in Akola, Buldhana, Nagpur, Chandrapur and Gadchiroli districts was 967, 668 and 690 kg ha^{-1} in improved technology of irrigated, rainfed and utera condition and in farmer practice plots 809, 528, and 583 kg ha^{-1} respectively. The impact of integrated crop management practices increases the seed yield of linseed by 19.53, 26.51 and 18.35% more in the farmers practices. The integrated crop management practice also resulted in an incremental change in net returns of Rs. 4412, 5537 and 4030 ha^{-1}

respectively in irrigated, rainfed and utera system. The higher B: C ratio was recorded with integrated crop technology than farmers practice. Integrated crop management technologies with variety PKV NL-260 proved more remunerative and economically feasible to the Linseed growers than their conventional methods.

T5.16 IMPACT OF FRONTLINE DEMONSTRATION ON MUSTARD IN EASTERN VIDARBHA REGION OF MAHARASHTRA

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ABSTRACT

The study was conducted on impact of frontline demonstrations in adoption of improved production technologies and economics of Mustard variety TAM 108-1 in Gondia and Nagpur districts of Eastern Vidarbha on whole package during *Rabi* season 2019-20 with an objective to demonstrate the variety for production potential and profitability with improved technologies on real farm situation. The existing farmers practice with local variety was treated as control for comparison with demonstrated technology with variety TAM 108-1. The average yield of mustard in both districts was 826 and 681 kg ha^{-1} in improved technology and farmer practice plots respectively. The maximum and minimum yield obtained with improved practice was 1125 and 500 kg ha^{-1} respectively. The yield advantage was 21.27 % more in adopting improved package of practices than the farmers practices, providing substantial additional net returns of Rs. 4209 per ha. The higher B:C ratio (2.52) was recorded with improved technology than farmers practice (2.45). The results clearly showed the positive impact of front line demonstrations over farmers practice towards increasing the productivity upto 21.27 % in TAM 108-1 than local variety.

T5.17 GROUNDNUT AN EMERGING CROP FOR KONKAN REGION OF MAHARASHTRA STATE

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ABSTRACT

Maharashtra is one of the leading oilseeds growing state having 2.80lakh hectare area, 3.57 lakh tones production and1275 kg/ha productivity as compared Konkan region has0.88lakh hectare area, 1.29 lakh tones production and 1477 kg/ha productivity. Groundnut (*Arachis hypogea* L.) is a self-pollinated annual crop, widely grown for its highquality edible oil and food use in the tropical and warm temperate regions of the world. Climate change is the present challenge to mankind, which has direct effect on agriculture, there are various strategies developed to face climate change in agriculture. Crop diversification is one among the best strategies, in which oilseeds fits very well since they are climate resilient crops by their true nature. Oilseed crop groundnut take the advantage of fixing nitrogen, so it is successfully cultivated in Konkan region is due to release of groundnut varieties Konkan Gaurav, Trombay Konkan Groundnut Bold (TKG Bold) also known as Konkan Taporaby the local people due to the bold size of seed and Konkan Bhuratna.

<table>
<tr><th></th><th>Konkan Gaurav</th><th>TKG Bold</th><th>Konkan Bhuratna</th></tr>
<tr><td>Year</td><td>1990</td><td>1993</td><td>2018</td></tr>
<tr><td>Duration (days)</td><td></td><td rowspan="3">120</td><td rowspan="3">115-120</td></tr>
<tr><td>Kharif</td><td>105</td></tr>
<tr><td>Rabi</td><td>125</td></tr>
<tr><td>Yield (q/ha)</td><td>18-20</td><td>20-22</td><td>25-30</td></tr>
<tr><td>Features</td><td>Semi spreading, alternateflowering, Dark green obovate leaf shape, medium size oblong pods with medium size oval</td><td>Spanish bunch type, dwarf plant (70-80 cm) obovate dark, greenleaves with large oblong kernel, bold nut with large</td><td>26 days seed dormancy, resistant to early and late leaf spot, rust, PBND and alterneria leaf blight diseases, Resistant to</td></tr>
</table>

	whitish red kernel, suitable for Kharif and Rabi Season	dormancy	trips, jassids, leaf miner and defoliator insect and pests, suitable for both Rabi and Kharif Season.

Packages of practices recommended by DBSKKV, Dapoli showed positive effect on groundnut yield,though it is an emerging crop for Konkan region ascompared to rest of Maharashtra, it is fetching popularity nowadays and rice – groundnut is one of the profitable cropping systems in Konkan region with higher economic returns moreover groundnut crop in Konkan have the highest groundnut productivity (1800 kg ha-1) over national productivity during rabi season, so by encouraging rice-groundnut cropping pattern of oilseed groundnut will be fulfil the increasing demand of oil import up to some extent.

T5.18 EVOLUTION OF FUNGICIDES AND BIO-CONTROL AGENTS AGAINST THE FOLIAR DISEASES OF SESAME

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ABSTRACT

Foliar diseases such as *Alternaria*, *Cercospora* leaf spot and powdery mildew are major constraint causing the substantial yield and trade losses under favorable weather conditions in NT zone. If infection occurs at early stage of crop growth, the yield losses will be more severe. Of the foliar diseases, severe incidence of powdery mildew occurs during summer season, whereas the *Alternaria*, *Cercospora* leaf spot occurs in *kharif*, late *kharif* and summer sown crop in Northern Telangana zone. The pathogens infect all parts of sesame (foliar infection occurs on leaves, stem and seed capsule). The foliar diseases can be best managed by timely application of fungicides. All the foliar diseases are weather dependent and rapidly flare up under favourable weather conditions. The foliar diseases of sesame, the incidence of powdery mildew, *Alternaria* and *Cercospora* were observed in the experiment.

Among the eight treatments tested, the minimum powdery mildew incidence was recorded with treatment T1 (Myclobutanil @ 1 g per liter of water) over the untreated check, whereas maximum yield was recorded and followed by treatment T_5 (Spray of Hexaconazole 5% + Captan 70%@ 2 g/l)

KEY WORDS: Fungicides, Bio-control agents, *Alternaria*, *Cercospora,* powdery mildew and sesame

T5.19 SCREENING OF NIGER (GUIZOTIA ABBYSSINICA (L.F.) GERMPLASM AGAINST ALTERNARIA LEAF SPOT

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ABSTRACT

Niger (*Guizotia abbyssinica* (L.f.) Cass) is a minor oilseed crop in India, cultivated on a sub-marginal lands, hilly areas, and sloppy areas and around forest lands which are dry land. It has tolerance to insect pests, diseases and attack of wild animals. In order to evaluate Niger germplasm for Alternaria leaf spot disease, 48 lines were collected from local area of Nasik, Ahemadnager district and were screened for disease resistance during kharif 2018-19 at Zonal Agriculture Research Station Igatpuri. Each germplasm line was sown in a single line. The same were evaluated for seed yield and other ancillary characteristics viz., days to 50% flowering, days to maturity, plant height, number of primary branches, number of capitula and seed yield. Among 48 lines sown, all lines were germinated and evaluated for disease incidence during flowering time. The 0-5 scale was used to score the disease. 32 lines were found to be immune as these didn't showed any infection (i.e. 0% infection). The Six (6) lines were scored 1 by showing 1-10% disease incidence and are found to be resistant and 14 lines were scored 2 by showing 11-25% disease incidence and are moderately resistant. The remaining germplasm (28) lines were scored 4-5 by showing 40-50% of the genotypes were found to be susceptible. For confirmation, the disease scoring is in progress under epiphytotic condition. The genotypes with high yielding and less/no disease incidence were also identified. These collected Niger germplasm GP-19-46, GP-19-26, GP-19-01, GP-19-47, GP-19-32 and GP-19-35 showed resistant to the Alternaria leaf spot.

Keywords: Niger, screening, resistant, susceptible, Alternaria leaf spot

T5.20 EVALUATION OF THE PERFORMANCE OF WATER ABSORBING GRANULES ON WATER PRODUCTIVITY AND SOIL PHYSICO-CHEMICAL IN MUSTARD (*Brassica juncea* L.) UNDER LIMITED IRRIGATION

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2018-19 and 2019-20 at Research farm of Bihar Agricultural College, Sabour with the objective to find out the effect of different super absorbent polymers and irrigation levels on water productivity and soil physico-chemical properties in mustard. Three irrigation levels (control, one irrigation and two irrigations) were placed in main plot while nine levels of super absorbent polymers (P_1- Magic hydrogel @ 5.0 kg/acre, P_2- Alsta hydrogel @ 6.0 kg/acre, P_3- Vedic hydrogel @ 3.0 kg/acre, P_4- Eco sarovar hydrogel @ 3.0 kg/acre, P_5- Stockosorb 660 hydrogel @ 8.0 kg/acre, P_6- Vaaridhar G1 hydrogel @ 1.0 kg/acre, P_7- Nano hydrogel @ 8.0 kg/acre, P_8- Solid rain hydrogel @ 6.0 kg/acre and P_9- Zeba hydrogel @ 5.0 kg/acre) were put in sub plots laid out in split plot design replicated thrice. Control (no irrigation) registered maximum water productivity which was found significantly superior over rest of irrigation levels. Application of solid rain hydrogel @ 6.0 kg/acre registered highest water productivity which was at par with P_7 and P_5. Soil physical properties *viz.*, bulk density, porosity, mean weight diameter and water holding capacity were not significantly influenced by irrigation levels. Difference in bulk density and porosity of soil was found non significant. However, application of super absorbent polymers exhibited slight improvement in water holding capacity and mean weight diameter of soil under P_7, P_5, P_2, P_1 and P_8. Soil fertility properties like organic carbon, available P_2O_5 and K_2O were not significantly affected by irrigation treatments. Control (no irrigation) exhibited highest available N in soil which was found at par with one irrigation and was significantly superior over two irrigations. There was significant improvement in available N in soil owing to nano hydrogel @ 8.0 kg/acre. Available P_2O_5 in soil was not significantly influenced by different hydrogels. There was significant improvement in available K_2O in soil owing to magic hydrogel @ 5.0 kg/acre which was at par with rest of hydrogels except P_3, P_4 and P_9.

Key words: Irrigation, Mustard, Soil Properties, Super absorbent polymer, Water Productivity

T5.21 DISSEMINATION OF TECHNOLOGY IN AGRICULTURAL OILSEEDS IN INDIA.

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ABSTRACT

In spite of successful research on new agricultural practices concerning crop cultivation, majority of the farmers are not getting under –bound yield due to several reasons. It is true that India possesses valuable agricultural knowledge and expertise. However, a wide information gap exists between research and practice. Indian farmers need timely expert advice to make them more productive and competitive. We have made effort to bridge the information gap by exploring advances in innovation technology. We propose the framework for a cost-effective agricultural information dissemination system (Agr IDS), to disseminate expect agricultural knowledge to the farming community in order to improve crop productivity. Agr IDS is a scalable system which can be incrementally developed and extended to cover all the farmers (crop) of India in a cost-effective manner.The ICT in agriculture is increasingly important. E-agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication process.

Although the agriculture sector in India is currently passing through a difficult phase. India moving towards an agricultural emergency due to lack of attention, insufficient land reforms, defective land management, on-providing of fair prices to farmers for their crops, inadequate investment is irrigational and agricultural infrastructure in India.

New approaches towards the dissemination of agricultural technology such as Agriculture Technology Management Agency (ATMA) model have contributed to diversification of Agricultural production in Assam and Utter Pradesh. This extension apporoach in now being scaled-up across India.

Dissemination technology amongst small-scale farmers is associated with the "Diffusion of Innovation" model used by the extension services. Social system adopts it. Thus, the strategy is said to maximize the extension worker's output and his/her direct and indirect input (Monu 1982).

India was importing one billion dollars of cooking oils each year, when large portions of Indian land are well suited to growing oil crops. Farmers did not grow these crops because they found other crops were more profitable. This was causing India costly economic situation.

Their goal was to make farmers see the benefits of planting oilseeds. We move into where there is gross exploitation and try to restructure the marketing system so that the small producer the intervention on oil was complete India was exporting oil cakes at the rate of 600 million per year.

National Mission on Oilseeds and Palm Oil (NMOOP) envisages increase in production of vegetable oil sourced from oilseeds, oil palm and tree borne oilseeds. The mission is implemented through three Mini Mission (Oilseeds, Oil Palm and TBOs) with specific targets.

TMOP mission was launched 1986 to increase the production of oilseeds to reduce import and achieve self-sufficiency in edible oils.

India occupied a prominent place in globe oilseeds scenario with 12-15 percent of area, 6-7 percent of vegetable oil production and 9-10 percent of the total edible oil consumption and 13.6 percent of vegetable oil imports. Nine annual oilseeds, which include seven edible oilseeds viz., Repeseed-mustard (Brassica Spp.), Soybean (Glycine max), Groundnut (Arachishypogaea), Sunflower (Helianthus annuus), Sesame (Sesamumindicum), Safflower (Carthamustinctoris) and Niger (Guizotiaabyssinica) and two non-edible crops viz., Castor (Ricinuscommunis) Linseed (Linumusitatissimum) are grown in the country.

Among the various pollinating agents, honey bees play a very important role in pollination oilseeds crops. The honey bee pollination not only results in higher yields, it also gives a better quality of produce and the efficient pollination of flowers also serves to protect the crops against pets.

In sunflower, bee keeping found effective in increasing higher number of seeds per head, percent seed setting, seed test weight and germination of seeds. Bee pollination in sesame improved seed generation and vigour of seeds.

Estimate of augmented crop yields due to pollination by honey bees have made in different parts of the world and the increase in yields due to bee pollination in oilseeds crops are presented in Figure-1.

Sl. No.	Crop	% Yield increase due to bee pollination

1.	Rapeseed	12.8 to a39.3
2.	Mustard	128.1 to 159.8
3.	Sunflower	48.2 to 155.0
4.	Niger	38.5 to 260.7
5.	Safflower	4.2 to 114.3
6.	Sesame	22.0 to 33.0
7.	Soybean	18.1
8.	Castor	30.6
9.	Linseed	1.7 to 40.0

Figure: - 1

Thus qualitative and quantitative parameters of oilseeds crops significantly increased with honey bee pollination. Integration of beekeeping as part of Best Management Production (BMP) should be adopted to enhance productivity in oilseed crops.

Keywords: Dissemination of Technology, agricultural oilseeds, production of oilseeds.

T5.22 EFFECT OF INTEGRATED CROP MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF LINSEED IN VIDARBHA REGION OF MAHARASHTRA

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ABSTRACT

The impact of integrated crop management through frontline demonstrations in adoption of production technology and economics of Linseed was studied in five districts of Vidarbha under irrigated, rainfed and utera condition during Rabi season 2019-20 with an objective to demonstrate the integrated crop management technologies on real farm situation verses farmers practice to have an incremental change in net returns. The prevailing farmers practice was treated as control for comparison with demonstrated technology with variety PKV NL-260. The average yield of linseed in Akola, Buldhana, Nagpur, Chandrapur and Gadchiroli districts was 967, 668 and 690 kg ha^{-1} in improves technology of irrigated, rainfed

and utera condition and in farmer practice plots 809, 528, and 583 kg ha^{-1} respectively. The impact of integrated crop management practices increases the seed yield of linseed by 19.53, 26.51 and 18.35% more in the farmers practices. The integrated crop management practice also resulted in an incremental change in net returns of Rs. 4412, 5537 and 4030 ha^{-1} respectively in irrigated, rainfed and utera system. The higher B:C ratio was recorded with integrated crop technology than farmers practice. Integrated crop management technologies with variety PKV NL-260 proved more remunerative and economically feasible to the Linseed growers than their conventional methods.

T5.23 IMPACT OF FRONTLINE DEMONSTRATION ON MUSTARD IN EASTERN VIDARBHA REGION OF MAHARASHTRA

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ABSTRACT

The study was conducted on impact of frontline demonstrations in adoption of improved production technologies and economics of Mustard variety TAM 108-1 in Gondia and Nagpur districts of Eastern Vidarbha on whole package during Rabi season 2019-20 with an objective to demonstrate the variety for production potential and profitability with improved technologies on real farm situation. The existing farmers practice with local variety was treated as control for comparison with demonstrated technology with variety TAM 108-1. The average yield of mustard in both districts was 826 and 681 kg ha^{-1} in improves technology and farmer practice plots respectively. The maximum and minimum yield obtained with improve practice was 1125 and 500 kg ha^{-1} respectively. The yield advantage was 21.27 % more in adopting improve package of practices than the farmers practices, providing substantial additional net returns of Rs. 4209 per ha. The higher B:C ratio (2.52) was recorded with improved technology than farmers practice (2.45). The results clearly showed the positive impact of front line demonstrations over farmers practice towards increasing the productivity upto 21.27 % in TAM 108-1 than local variety.

T5.24 EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON GROWTH AND YIELD OF NIGER (*Guizotia abyssinica L.*Cass).

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ABSTRACT

A field experiment was conducted to study the effect of different levels of nitrogen and phosphorus on growth and yield of Niger during *Kharif* season, 2002-2004 at Zonal Agricultural Research Station, Western Ghat Zone, Igatpuri Dist-Nasik (M.S.). Niger variety IGP-76 was sown in *kharif* season in randomized block design with twelve treatment and three replications. The plant spacing was 30x10 cm with plot size 3.60 x 2.40 m^2. The soil of the experiment field was shallow laterite. The result revealed that the treatment T_{12} (N @ 40 kg/ha + P @ 40 kg/ha (20kg/ha through SSP +20 kg/ha through RPen) + PSB) produced significantly higher seed yield of Niger (508 kg/ha), gross monetary returns (Rs.9295/ha) and net return (Rs.4626/ha) than rest of the treatments. However, application of N@40 kg/ha + P@20 kg/ha through SSP+PSB is followed to treatment T_{12} with seed yield of 502 kg/ha, gross monetary returns of Rs.8827/ha, Net return Rs.4519/ha and highest B:C ratio of 1:2.02. In spite of such significance the productivity of this crop is very low which may be enhanced by adequate and integrated management of nutrient supply especially phosphorus, because being oilseed crops niger responds well to phosphorus. It was concluded that the seed yield and ancillary characters were significantly influenced due to different levels and sources of phosphorus. It significantly produce higher seed yield than the control and rest of the treatment combinations, during both three years as well as in pooled analysis.

Keywords: Niger, nitrogen, phosphorus.

T5.25 PERFORMANCE OF FRONT LINE DEMONSTRATION ON NIGER [*GUIZOTIA ABYSSINICA* (L.F.) CASS] IN WESTERN GHAT ZONE OF MAHARASHTRA

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ABSTRACT

Niger is an edible oilseed crop of tribal farmers of Western Ghat zone of Maharashtra. It supplements to the socio-economic condition and fulfils the requirement of cooking oil of the Indian tribal community. The production and productivity of Niger crop continues to be quite low due to socio-economic and agro-ecological situations, low levels of management in crop production, cultivation in poor marginal lands and repeated use of local cultivars and predominantly under marginal conditions of small-holder agriculture. Drought, broadcast sowing, improper plant population, low input management, cuscuta, lodging due to high wind and rain are the causes of low productivity. The yield of Niger can be increased by demonstrating the improved agronomic package of practices *viz.* timely sowing of the crop, proper nutrient management, weed management and need based plant protection measures at the farmer's field under the keen supervision of concern scientists working in the operational area. Keeping in view, the front line demonstration was conducted on Phule Karala, Phule Vaitrana and Phule Sahyadri variety of Niger crop, under All India Coordinated Research Project on Niger operating at Zonal Agricultural Research Station (ZARS), Igatpuri Dist. Nashik in farmer's field for a consecutive year from 2012–13 to 2016–17. The increase in seed yield of 73.40%, 41.37% and 27.54% with cost benefit ratio of 1.75, 1.95 and 1.88 was obtained from front line demonstration on whole package, fertilizer application and line sowing over farmer's practices respectively. It can be concluded that FLD programme on niger effectively increase the production and productivity in the specific region of Maharashtra.

Key words: - Niger, front line demonstration, yield, B: C ratio

T5.26 MANAGEMENT OF MUSTARD APHID, *LIPAPHIS ERYSIMI* (KALT.) (*Homoptera*: Aphididae) IN BIHAR

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ABSTRACT

Mustard aphid, *Lipaphis erysimi* (Kalt.), is the most serious insect-pest of rapeseed- mustard and responsible for causing the yield losses ranging from 35.4 to 96 per cent depending upon weather condition in Bihar. Among the various causes of low yield of mustard crops, damage caused by the mustard aphid is the most serious. To overcome the ill effects of synthetic chemical pesticides, utilisation of bio-agents in management of the pest population is emphasised. As the cold and cloudy weather favours the pest multiplication, sowing the crop earlier than the normal sowing time escape the pest attack. It's a serious pest and both nymph and adult suck the sap of the tender leaves, twigs, stem inflorescence and pods by means of piercing and sucking type of mouth parts. The affected leaves usually curl and in case of severe infestation the plant wilt and dry. When attack on inflorescence, the pod formation is adversely affected. The aphids also secrete *'honey dew'* on which black mould develops. Black moulds adversely affect the normal physiological activities of the plants. The aphids appeared in the third week of December, increased in January/ February and reached peak numbers in mid February. The temperature of the environment was important in aphid multiplication. Frequent rain kept the population density low. As the cold and cloudy weather favours the pest multiplication, sowing the crop earlier than the normal sowing time escape the pest attack. Spraying of crop with 0.07% Endosulphan 35 EC or 0.05% Malathion 50 EC. Thus, entomopathogenic fungi like *V. lecanii* or NSKE along with release of *C. septempunctata* can be used as alternative measure to manage mustard aphid instead of solely relying on insecticides.

Key words: Mustard aphid, Incidence, Management

KEY RECOMMENDATIONS

In oilseeds, India is dependent on import to fulfil the demand of country which results in outflow of foreign capital. In terms of monetary value, it is next only to petroleum. Thus, there is an immediate need to reduce the import of oilseeds and oil. Certain actions are needed to reduce the dependency of oilseed on foreign countries to meet local demands. One of the major initiatives is increasing oilseed production through incorporation of high yielding varieties.The varieties should be zone wise so that they are suitable for local climatic condition. There is a need to encourage farmers to cultivate oilseeds, which would increase the area of cultivation. Emphasis on oilseed crops, following proper package of practices, providing sufficient nutrition and irrigation and correcting deficiencies are some of the other factors which could increase productivity and quality of oilseeds.

Certain strategies are advised to be followed to achieve self-sufficiency in oilseed. These are:

- To increase Seed Replacement Rate (SRR) with new variety
- Increasing seed production & distribution of newly released variety
- Promotion of new variety through minikits/Front Line Demonstration (FLD)
- Area expansion under protected irrigation
- Area expansion through rice fallow and intercropping
- Low cost technologies with high impact on productivity resulting in higher income
- Improve oil processing facility
- Technologies with high impact that involve reasonable investment with high return on investment (ROI)with emphasis on eco friendliness, high input use efficiency
- Quality improvement and value addition leveraging technologies with a bearing on the employment through skill development
- Association of ICAR-KVKs/SAUs in technology transfer
- Increase Minimum Support Price (MSP) for promotion of grower and reduction of price risk

For further advancement in oilseeds breeders, biotechnologists, physiologists and other departments need to work hand in hand.

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