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100 GLORIOUS YEARS OF COTTON RESEARCH AND WAY FORWARD

National Symposium
on

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October 18 - 19, 2022

BOOK OF ABSTRACTS

Editors

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TAMIL NADU AGRICULTURAL UNIVERSITY

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FOREWORD

Globally more than 250 million people receive income from cotton production. India is the second largest cotton producer in the world. Cotton contributes roughly 50 per cent of all textiles. Textiles account for 24 per cent of industrial production and 25 per cent of industrial employment. India's Bt cotton production area was 123 lakh ha (95%) out of 129.57 lakh ha during the year of 2021 and 371 lakh bales of seed cotton were obtained from the total cultivated area. Tamil Nadu grows cotton on 1.38 lakh hectares with an average annual production of 2.69 lakh bales of lint.

In commemoration of the golden jubilee year of Tamil Nadu Agricultural University and the centenary year of Department of Cotton, TNAU the National symposium on "100 glorious years of cotton research and way forward" (Hybrid mode) is jointly organized by Department of Cotton, CPBG and Indian Society of Plant Breeders during 18th-19th October 2022 at TNAU, Coimbatore. The symposium focuses on four thematic areas such as cotton crop improvement and Biotechnology, crop production and mechanization, crop protection and policy issues.

I hope this symposium will serve as an occasion to propose and integrate ideas and stimulate young minds. I, appreciate the participants who have delivered their research paper in the symposium. I am sure that, book of abstracts would be useful to all the scientists and research scholars for their future research work. I congratulate the organizers for their effort in organizing the symposium.

13/10/2022

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Date: 13.10.2022

PREFACE

Cotton, the "King of Fibers," continues to be an important crop in our country. Cotton is one among the main earner of foreign exchange for the country, and right now, about 20% of all export money comes from textiles. It is cultivated in about 312 lakh hectares across the world and in around 126.14 lakh hectares in the country and is the largest producer of cotton in the world. India accounts for around 37.5% of the global cotton area and contributes 26% (*i.e* 6.20 Million MT) of global cotton production (23.92 Million MT). Nowadays, cotton production is declining owing to several reasons of which penetration of technical knowhow is of prime importance. Many advanced technologies have been developed, which when implemented at right time during crop cultivation could augment the area of cotton *vis-a-vis* its productivity. Besides, continuous generation of technologies to sustain and bolster the productivity of cotton is of paramount importance. In this regards, untiring research undertaken at the Department of Cotton has resulted in generation of many varieties, technologies which benefitted the farmers. The Department of Cotton has attained a remarkable mile stone of reaching its centenary year. To recognize and commemorate the contributions made by the Department, a compendium of "100 Glorious Years of Cotton Research and Way forward" has been brought out by the scientist of the Department.

This book would be a useful resource material for cotton researchers. It has general information about cotton farming, breeding techniques, management and protection technologies and the transfer of technology. I want to thank the authors for their hard work in putting together all the information available and presenting it in a clear way. I am confident that this book of abstracts will be useful to cotton research community.

R. Ravikesavan 13/X/22

Lead and Oral Papers

Fibre quality improvement in India - Breeders' perspective

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Cotton is the most important commercial crop of India cultivated mainly for its textile fibre till date due to its inherent eco-friendly and comfort characteristics. Qualitative transformation has taken place in cotton production in India since Independence mainly from coarse non-spinnable cotton to medium, long, extra long and superfine cotton. Currently, the long and extra long staple cotton production is more than 75% of total cotton production, which was only 17 % before establishment of AICRP on Cotton in the country. This is mainly due to the concerted efforts of cotton breeders who developed high yielding long and extra long staple cotton varieties and hybrids suitable to different agro ecosystem of the country.

What the mills look for in cottons is staple length, micronaire and strength, the primary characteristics on which yarn quality depends. With the establishment of AICRP on Cotton during the year 1967, more emphasis was given to the improvement of yield as well as quality in cotton, which led to the quantum increase in the production of long and extra long staple cotton in India. A brief account of some of the important milestones in fibre quality improvement in cotton is given below.

1967: All India Coordinated Cotton Improvement Project was established with head quarter at Coimbatore and all the research centers of cotton in different State Agricultural University were brought under one project.

1970: First commercial cotton hybrid of the world (Hybrid 4) was released from Surat by the noted breeder Dr. C. T. Patel.

1972: First commercial interspecific cotton hybrid of the world (Varalaxmi) was released from Dharwad by the noted breeder Dr. Katarki

1976: Infrastructure of cotton research got strengthened with the establishment of Central Institute for Cotton Research at Nagpur.

1982: Regional station of Central Institute for Cotton Research was established at Sirsa to strengthen the research efforts in North Zone.

1999: Technology Mission on Cotton was launched.

2002: Transgenic Bt Cotton was approved for commercial cultivation in India.

2005: First transgenic extra-long staple interspecific Bt cotton hybrid (MRC 6918) of M/s. Mahyco was approved for commercial cultivation in India.

2006: Transgenic extra-long staple interspecific Bt cotton hybrid (RCHB 708) of M/s. Rasi Seeds was approved for commercial cultivation in India.

Currently, several conventional extra-long staple *G. hirsutum* and *G. barbadense* varieties as well as hybrids (both intra hirsutum and inter-specific hybrids) having more than 32.5 mm of 2.5% span length, which were released under AICRP on Cotton, are under cultivation in India.

The major problem with regard to long and extra long staple cotton varieties and hybrids in India is that these varieties are cultivated in varied agro-climatic conditions including rainfed situations, which lead to the variation in fibre quality attributes. Indian cottons in the staple group 31- 36 mm have been found to have lower micronaire value not exceeding 3.5 units in majority of the cases as compared to an average value of 4.0 in imported cotton. The lower micronaire value has been found to be not due to intrinsic finer nature of the cotton but has more to do with immaturity arising from lack of adequate cell wall development. The tenacity values in Indian cottons in this category have been noted to be on the lower side by about 4 – 10 g/tex.

From the above discussion, it is clear that the ELS cotton should be cultivated in ideal agro climatic condition to achieve the maximum lint yield as well as the uniform and better fibre quality. Some of the potential areas for augmenting ELS cotton in India may be Salem, Dharmapuri, Coimbatore and Erode districts in Tamil Nadu; Mysore, Chamrajnagar, Chickmagalur, Shimoga, Dharwad, Davangare, , Belgaum, Hasan, Tumkur, Bijapur and Gulbarga districts in Karnataka; Khandwa in Madhya Pradesh; and Anand and Talod in Gujarat.

Ever since three Bt cotton hybrids have been approved for commercial cultivation in India during 2002, there was a sharp increase in area under cultivation of such hybrids. Several ELS Bt cotton hybrids have been released by private sector and can contribute towards increased ELS production with required thrust for cultivation of ELS cotton through Best

Management Practices, besides matching marketing facility and assured buy back in case of contract farming.

Since cotton is processed into yarn in groups of fibres rather than as individual fibres, properties such as length variability, short fibre content, fineness, maturity and bundle strength among others influence the yarn quality and strength and resulting in textile products.

Improvements in fibre quality have long been a primary objective of cotton breeders. One major obstacle for early breeders was the lack of reliable methods to measure fibre characteristics. Those methods have become available with the advent of HVI in late 1960s and AFIS in 1980s. During the last two decades, cotton breeders have used HVI (High Volume Instrument) as their primary and often sole source for fibre quality evaluation and using the HVI data for making plant selections, especially in India. However, earlier research recognized the need for additional information about AFIS properties and the potential role of AFIS in breeding programmes. The intent of the AFIS design was not to correlate other fibre measurements with AFIS. It was designed to provide unique fibre data. Fibre data generated by Advanced Fibre Information System technology is also now available to plant breeders, and provides additional information on length characteristics and fibre maturity. Variation in fibre lengths and therefore shape of the distribution curves vary across cultivars with more uniform length and distribution desirable to reduce wastage in spinning and to produce better yarn.

The quantity of short fibres in a cotton sample is an important cotton quality parameter. Short cotton fibres have detrimental impacts on yarn production performance and yarn quality. There are different parameters for characterizing the amount of short fibres in a cotton sample. The most widely used parameter is short fibre content (SFC). It is a general practice in the textile industry to remove short immature fibres in the combing process to improve the fibre length distribution and tenacity.

The AFIS instrument individualizes and presents individual fibres to electro-optical sensors in order to measure fibre maturity, which is otherwise difficult in conventional method, and requires only very little quantity of lint for testing. Further, AFIS method of maturity measurements shows good correlations with the reference method.

Cotton fibre maturity, degree of secondary cell wall thickening relative to the perimeter, is one of the most important fibre quality and processing

parameters of cotton. Immature fibres result in low dye uptake, increased fibre breakage, fabric defects, and waste.

Future thrusts:

- Basic and applied aspects of research on cotton fibre quality improvement suiting to modern textile industry needs keeping in backdrop the necessity of sustained production of appropriate staple requirements.
- Development of *G. barbadense* cultivars which are better than Suvin in terms of seed cotton yield, ginning outturn and micronaire through both conventional and biotechnological approaches to cater to the needs of increasing demand of Indian textile industries.
- Identification of superior parental combinations in case of interspecific hybrids which can result in increased seed cotton yield, lesser susceptibility to sucking pests and have lesser mote contents.
- Improving the fibre length and strength of *G. hirsutum* cultivars as well as intra-hirsutum hybrids matching the fibre qualities available in the foreign market.

Current status of transgenic cotton

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Cotton is the most important fiber crop in India cultivated more than 12.0 mha by 4.0 million small and marginal farmers. Over two decades, transgenic cotton has been influencing global cotton production systems. Currently, farmers are cultivating more than 190mha of GM crops globally. Soybean (50%), maize (30%) cotton (13%) and canola (5%) (ISAAA, 2020). However, among the transgenic crops, Bt cotton has gained enormous popularity and acceptability in developing countries especially like India (11.6 mha), Pakistan (2.8 mha), Mayanmar (0.3 mha), Sudan (0.2mha), Mexoco (0.2 mha) and Eswatini (<0.1 mha) (ISAAA 2018). Bt cotton efficiently controlled American bollworm and further reduced the pesticide usage by 50% and enhanced the productivity from 300kg lint/ha to 550kg lint/ha in India. A number of traits for biotic and abiotic stresses are being tested among them insect resistance and herbicide tolerance traits alone or stacked are commercially successful in cotton. Herbicide tolerant cotton has been developed to survive six different herbicides namely, glyphosate, glufosinate, dicamba, 2, 4-D, isoxaflutole and bromoxynil (but not in use). For control of cotton bollworms mainly different version of *Bt*-toxins are used such as, *cry1Ac, cry1Ab, cry1C, cry1F, cry2Ab, cry2Ae* and *vip3a*. Initially, *Bt*-cotton was commercialized with a single gene *cry1Ac*. The second-generation biotech cotton contained *cry1Ac+cry2Ab*; *cry1Ac+cry1F*; *cry1Ab+cry2Ae*; *cry1+cry2+vip3A* and *Bt+HT* (*epsps*). Bt-cotton and HT cotton are grown in Argentina, Australia, Brazil, Colombia, Mexico, Paraguay, South Africa and USA, whereas developing countries such as India, Burkina Faso, China, Pakistan, Myanmar and Sudan approved only *Bt*-cotton and have not approved HT cotton for commercial cultivation (Balasubramani *et al*. 2021).There are five Bt transgenic cotton events carrying *Cry1Ac* individually or pyramided with *Cry2Ab* or fused with *Cry1Ab* and released for commercial cultivation in India. In 2017, GEAC authorized ICAR to evaluate and approve new cotton hybrids / variety developed through the approved five events (Mon531, Mon15985, Event-1, GFM event and MLS-9124). Presently, a number of Bt hybrids and Bt varieties have been approved after evaluation through ICAR-AICRP on cotton in different cotton growing states/zone.

Unfortunately, *Helicoverpa zea* (in the USA) and the pink bollworm *Pectinophora gossypiella* (in India) have developed resistance to *cry1Ac and cry2Ab* toxins in *Bt*-cotton. The key reason for the outbreak of pink bollworm resistance in India was due to poor or no refuge planting along with Bt-cotton in India (Mohan, 2020). Further, pink bollworm is generally considered as monophagous insect with high affinity towards cotton flowers and bolls. However, till now, no Bt or any other traits are available to manage Pink bollworm except management practices. The best approach to confer resistance against pink bollworm is the genetic engineering for the production of Bt toxin (Tabashnik and Carriere 2019). In case of Bt cotton, glyphosate resistance was recorded in 13 weed species each in USA and Australia and 8 each in Argentina and Brazil. Research reports show that adoption of Bt-cotton resulted in an initial decrease of insecticide usage followed by an increase in many countries. Insecticide usage has been increasing constantly over the past 10 years in India, Pakistan, China, Brazil and USA for the control of thrips, whiteflies, mealybugs, boll weevils and pink bollworms. Enhanced use of herbicides to control resistant weeds in USA and Brazil is an emerging concern.Drought tolerance governing genes mainly involved in cellular level tolerance such as *Arabidopsis* Vacuolar Sodium / Proton Antiporter Gene (AtNHX1), *Arabidopsis* vacuolar H+-pyrophosphatase gene (AVP1), *A. thaliana* Enhanced Drought Tolerance1 / Homeodomain Glabrous11 (AtEDT1/HDG11) and *Syntrichia caninervis* Aldehyde dehydrogenase 21 (ScALDH21) have been successfully validated in *Gossypium hirsutum* at green house as well as field conditions (Yu *et al.* 2016; Yang *et al.* 2016). Similarly, *Thellungiella halophila* H + -PPase (TsVP1), Osmotin gene and NAC transcription factor (SNAC1) genes have been successfully deployed and validated for drought tolerance in cotton under greenhouse conditions (Liu *et al.* 2014)

Cotton fibre yield and quality has been improved (10-35%) by over expression of sucrose synthase *GhsusA1* gene from superior quality germplasm line (Jiang *et al*. 2012) and PHYB gene (Rao *et al*. 2011). Significant improvement in fiber strength and micronaire in all transgenic lines having higher expression of the expansin gene was reported due to the action of *CpEXPA3* an expansin gene from *Calotropis procera* in cotton (Bajwa *et al.,* 2013). A number of actin-binding proteins viz., *GhADF1* (Wang *et al.* 2009), *WLIM1a* (Han *et al.* 2013) which participates in the regulation of actin

cytoskeleton dynamics and are reported to be associated with regulation of fibre quality traits in cotton. Over-expression of *WLIM1a*, a LIM domain protein of elongation and secondary wall synthesis stages, improved fiber strength and fineness traits through modulation of actin cytoskeleton dynamics and transcription factor for lignin biosynthesis (Han *et al.* 2013).

Gao *et al.* (2017) obtained transgenic cotton plants containing CRISPR/Cas9 induced gene editing mutations in the GhCLA1 gene. The mutation efficiency was reported as 80.6% of the transgenic lines containing mutation in the GhCLA1 target site resulting in an intense albino phenotype due to interference with chloroplast biogenesis. Ramadan *et al.* (2021) optimized pooled sgRNA to knockout multiple gene by CRISPR/Cas9 system. Wang *et al.* (2022) targeted single adenine base editing in cotton such as A-to-G substitution generated a single amino acid change in the phosphatidyl ethanolamine-binding protein (GhPEBP), leading to a compact plant architecture, an ideotype for mechanized harvesting.

In cotton, gossypol is a toxic terpenoid present in seed glands, which makes cotton seed unfit as food for human consumption or as feed for nonruminants. With advent of RNAi (RNA interface) technology, Sunilkumar *et al.* (2006) silenced the gene delta-cadinene synthase, which affecting the levels of gossypol. Globulin seed specific promoter was used to silence the delta-cadinene synthase gene selectively in the seeds by 97% without precursor for gossypol biosynthesis and related terpenoids in rest of the plants, since they play major role on defense against insect pests. This transgenic event TAM66274 was approved in USA for commercial cultivation in 2018 (Rathore *et al.* 2020).GM technologies so far have assisted growers in managing bollworms and weeds. Target insects and weeds have been developing resistance thereby necessitating the need for new genes or new technologies.With new options of gene editing technologies such as CRISPR/Cas or RNA interference (RNAi) on the anvil, there is new hope that there could be newer technologies with better selectivity, with positive impacts on yields, promise in combating weeds, insect pests, diseases, drought and with least negative impacts on biosafety and biodiversity.

Organic cotton breeding in India – way forward

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Organic cotton production in India is on the increasing trend in 2021-22 the organic cotton production was 47 lakh bales from the area of 22 lakh ha. earning the credit of India producing 56% of total global organic cotton production. Organic cotton is grown in the lands that are converted to organic growing condition without application of synthetic fertilizers, chemical pesticides and maintained for low input cropping. The scope for increasing the organic cotton growing area and linking the organic seed cotton to the trade and export is promising. Organic seed cotton yarn fabric and garment are now being certified with appropriate organic certification regulations of NPOP, NOP, GOTS; OCS and ISO IWA-32-2019.

This year, Just now in September 2022 for the first time in India, two organic cotton bred varieties, one in Desi cotton (*G.arboreum*) and the other in Upland cotton (*G.hirsutum*), developed by Switzerland – India collaboration have been released following the Participatory Plant Breeding (PPB). These two varieties possess ideotype and traits suitable for low input, wide adaptation and repeatable performances for regenerative organic agriculture and tested for GX EX management and GX EX society interactions.

Another important vital activity to be initiated in India is organic seed production for the organic seed cotton assuring quality and non GMO nature following double certification for organic seed and non GMO nature. Simultaneously training the farmer producers and the farmers involvement will help to promote and sustain the organic cotton production system and in the adoption of internal control and external certification for the organic quality assurance. Stepped up activities are desirable to organic cotton breeding to develop suitable organic varieties for different agroclimatic zones.

APEDA has accredited 32 Certification Bodies (CB) in India. The ISCOP (Indian Society for Certification of Organic Products) established in Coimbatore in 2002-02 is one such CB involved in organic certification and in organizing ICS (Internal Control System) for organic cotton production. The ICS is a self organized and self monitored system of producer farmers that guard organic integrity. The ISCOP has now enrolled 138 ICS distributed over 8 states in India.

Research innovations and farmers initiatives for sustainable cotton production in bangladesh

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Bangladesh is the 2nd largest cotton importer and 4th consumer in the world (USDA, 2022). Textile sector of the country is the biggest industrial sector comprising 510 yarn and 1011 fabric and finishing mills, that contribute 13% of GDP, 86% of export earnings and provide more than 5 million employments, of them 80% are women (BTMA, 2022). The current investment in the primary textile sector is more than $ 6.00 billion. The demand for cotton fiber in Bangladesh is increasing day by day and 8.5 million bales (480 ponds/bale) of cotton fiber was imported by expending $3.0 billion in the year 2021 (Mirdha, 2021).

Cotton have been cultivating in this region from times immemorial and the tribals of Chittagong Hill Tracts are growing *Gossypium arboreum* (Deshi cotton/Comilla cotton) under Jhum cultivation practices. *Gossypium hirsutum*, the new world cotton was introduced in the country after the liberation from Pakistan, when local textile industries were facing serious crisis on lack of cotton fiber. The Cotton Development Board was established in 1972 to boost up cotton production in Bangladesh and cotton cultivation was started as experimental basis with the introduction of Deltapine-16, a cotton variety imported from United States of America (USA) in 1974-75 cropping season and commercial cultivation was started in 1976-77 in the farmer's field. Another cotton namely Phuti karpas (*Gossypium arboreum* var. neglecta) was grown around south of Dhaka, along the bank of the Meghna river. This cotton fiber was used to produce Muslin, a finest fabric famous during Mughal Era. *Bombax ceiba* (silk cotton), locally known as Shimul tula, a plant has also been grown from times immemorial all over the country. This short fiber cotton is used for making pillow, quilts, toys etc. and roots of Shimul tree is widely used for medicinal purpose in the rural areas.

Research Innovations

Initially, Cotton research in Bangladesh was done by the scientist of Cotton Research Division of Bangladesh Agricultural Research Institute till 1991. Cotton Development Board started cotton research from 1991 under Breeding, Agronomy, Soil Science, Pathology and Entomology discipline in 5 research center and 3 sub-center located different places in the country. Also cotton

research in Bangladesh was included in NARS (National Agricultural Research System) system in 2012. The main focus of cotton research in the country includes development of hybrid and short duration high yielding cotton varieties with desirable fiber characteristics, generation of agronomic management technologies to increase productivity, improving soil fertility by integrated management of organic and inorganic fertilizers, identification of bio-pesticides in controlling cotton insect pest and disease management. Besides, research on stress management has been prioritized to expand cotton cultivation in the hill, char, saline, drought and agroforestry areas combining the traditional knowledge and skill of farmers with biotechnology tools. The key achievements of cotton research in Bangladesh are- release of 22 open pollinated and one hybrid cotton variety, 28 technologies of agronomic management including intercropping, cropping pattern, weeding, high density planting etc., 12 technologies of soil management and 11 technologies of insect-pest and disease management. Cotton Development Board and JK Agri-genetics of India signed MTA for introduction of Bt cotton in Bangladesh and also another MTA is under process with the Rallis India Ltd. to conduct biotechnological research, especially transgenic cotton. Cotton Development Board initiated mutual understanding with national universities, research organization and international institutions i.e. Nazilli Cotton Research Institute, Turkey and Cotton Research Institute, Egypt on research collaboration.

Farmers Initiatives

In Bangladesh cotton are facing high competition with a huge number of high value crops i.e. vegetables, flowers, fruits, spices, oil seeds, pulses with 195 cropping intensity. Most of the high and medium high land areas are practicing 3 crops cropping pattern and dominated with rice-based cropping pattern, about 73% cultivated lands are occupied by rice crop. Due to long duration cotton can't fit to the existing cropping pattern, so that most of the farmers are allocated marginal lands to grow cotton, where other crops are not profitable to the farmers. Farmers in the intensive cultivation areas are practicing intercropping cotton with red amaranthus, danta, radish, jute leaf, coriander leaf, summer onion, cauliflower etc. to get extra benefit for sustainable production. Also, cotton seed are relayed in the field of arum, chilli, turmeric and pineapple during their maturity. In the orchard areas farmers are growing cotton during first 2-3 years in the newly established mango, lichi, guava, banana, papaya and orchards of other wooden plants. Also, farmers innovation in other production and management practices in cotton cultivation have been found on weed management, planting practices

and seed bed preparation, nutrient management and insect-pest management. All the initiatives are introduced by the farmers for the sustainability of cotton production in Bangladesh.

Conclusion

Cotton research in Bangladesh need more emphasize on development of sustainable technologies suitable for the hill, char land, drought, saline and agroforestry areas with biotechnological tools and techniques. National and international linkages should get more priorities for the collaboration of cotton research specially biotech research. Also mainstreaming farmers indigenous technologies and knowledges in sustainable cotton production in Bangladesh.

Status and strategies for cotton production in Tamil Nadu

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Introduction

Tamil Nadu occupied a prominent place in the history of cotton in India. The country's revolution with regard to cotton began at Coimbatore of Tamil Nadu which is popularly called as the Manchester of south Indian cotton industry. The State accounts for 19% of the Nation's Textile output with a robust network of all the sub-sectors of the Textile industry. State Textile industry is the largest economic activity after Agriculture. Tamil Nadu is the leading state in the country in Textile sector and having major stakeholders with 46% of spinning capacity, 60% of yarn export, 20% of power loom capacity, 12% of handloom capacity, 70% of cotton fabric knitting capacity, direct employment to around 31 lakh people, more than Rs. 50,000 crore exports and 1/3 of textile business in the country.

Status of Cotton farming

The cotton cultivation data reported in current science in 1930 revealed that erstwhile Madurai District was having 6.0 lakh hectare. The statistics of 1964-65 reported that 3.8 lakh ha area was occupied by cotton with production of 3.6 lakh bales with productivity of 171 kg/ha. The recent statistics in 2021-22 reported that cotton is cultivated in 1.3 lakh ha with production of 6.0 lakh bales with productivity of 797 kg/ha. The area of cotton is continuously reduced from last ninety years . The introduction of Bt technology resulted in an increasing the acreage of cotton in all states. The cotton cultivable area increased respectively 30, 50 and 60 per cent at national level, Gujarat and Maharashtra. However, the similar increasing trend was not observed in Tamil Nadu.

Cotton is the ruling commercial crop in rainfed ecology, but under irrigated system cotton is one among the many crops for adoption. Moreover, cotton is labor intensive crop. Cotton is the crop whose cultivation has not been mechanized to the extent of other crops like wheat, maize, sunflower, including rice. The tropical climate of Tamil Nadu suits for cultivation of many field and horticultural crops and crop diversification index is high in Tamil Nadu. The vigorous irrigation development, labour intensive nature of cotton cultivation, higher wages and adoption of competitive crops led

to reduction of cotton area in Tamil Nadu.

The land suitability for cotton growing in Tamil Nadu has been surveyed by the National Bureau of Soil Survey (NBSS) and Land Use Planning (LUP). In total 8.7 lakh hectares are found to be highly suitable for cotton. Apart from this another 25 lakh hectares which are moderately suitable for cotton cultivation with moderate limitations of soil texture, gravelliness, depth, calcareousness and fertility can also be considered for cotton cultivation with proper management

In order to meet out the demand of the spinning mills of the State with regard to supply of cotton the expansion of cotton area and increasing the productivity is warranted.

Expansion of Area

At present about 50,000 ha of cotton is being cultivated in delta districts in rice fallows with the existing filter points and tube wells but potential is in many lakh hectares. By utilizing the tube wells and filter points and by supply of oil engines to the cotton growers, additional area could be brought out under cotton. In addition to that short duration arboreum cultivation may be explored under rainfed condition by using summer rainfall in command areas. In areas where cotton is not grown traditionally, it has been proposed to educate the farmer and train them to cultivate cotton in the districts of Thiruvannamalai, Vellore, Kancheepuram, Cuddalore, Karur, Ramanathapuram, Sivagangai and Theni. The practice of cultivating cotton a mixed crop/ intercrop in groundnut, banana and vegetable under irrigated condition should be explored. At present, 45 % of cotton is cultivated under irrigated condition. In order to bring more area under irrigated condition, the adoption of the sprinkler/drip irrigation systems will be popularized in cotton growing areas.

Technological options to enhance production and profitablity

Since cotton is a crop of relatively longer duration, its slow initial growth offers a vast scope for cultivation of suitable vegetable intercrops. The significantly highest gross return (Rs1, 50,278/ha), net return (Rs 99,232/ha), per day profitability (Rs 662/day) and seed cotton equivalent yield (7.31 t/ha) had been arrived with multi-tier system consisting of cotton with radish, cluster bean and beet root. Multi-tier intercropping system produced statistically as much as equal seed cotton yield (2.55 t/ha). Many cotton producing countries like Brazil, China, Australia, Spain, Uzbekistan, Argentina and Greece had tested, proved and adopted High Density Planting System (HDPS) of cotton as tool to achieve higher productivity. High Density Planting System has been suggested as an alternative strategy

instead of conventional one to increase yield (30-40 %). HDPS could be promoted 60 % of rainfed area of Tamil Nadu.

Drip irrigation resulted in 40-50% water saving 25% fertilizer saving plus 34% enhanced yield than normal planting. The technology on polythene mulching in cotton proved that the technology can control the evaporation loss, 40% water saving as compared to conventional irrigation and up to 85 % water saving when combined with drip irrigation. The technology could be promoted to irrigated cotton production system. Poly mulch with drip fertigation registered 78 q/ha at ICAR-CICR.

The demand for the textile products made out of ELS cotton (32 mm and above) is growing exponentially. The western zone and North western zone of Tamil Nadu has sizeable areas suitable of ELS cotton. The demonstration of ICAR-CICR technologies under NAIP project made great success in increasing the ELS cotton area from 6 acres to 352 acres in the project villages. A success story was recorded by harvesting of 40.9 q/ha of yield by adopting ICAR-CICR technologies in ELS cotton under rainfed condition

Cotton may not be a preferred crop under labour scarce situation. Cotton is the crop, of whose, cultivation has not been mechanized to the extent of other crops like wheat, maize, sunflower and rice. Picking cost share 30-40 % of cost of cultivation; which erodes the profitability of cotton farming. Therefore, mechanical cotton pickers are the only solution to overcome the problems

Contract Farming is the most convenient and safer option, which comes to the rescue of small and marginal farmers in terms of guaranteed income and low capital investment. Total cost of cultivation was higher in case of non-contract farming when compared to contract farming by a difference of Rs.2000/- which was due to higher labour use in the former case. B:C ratio over total cost and cost of production per quintal was remunerative under contract farming compared to non-contract farming in cotton.

Adoption of drip fertigation in cotton is need of hour to improve productivity of cotton

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Cotton crop is cultivated mostly as rainfed and under traditional method of Irrigation i.e. flood irrigation and fertilizers are used. Drip irrigation technology has proved its merits in increase in yield, improve in quality, saving of water, fertilizers, labour, power and time. It has introduced in our country since three decades. Adoption of drip irrigation and fertilizers applied through drip irrigation i.e. fertigation resulted yield increase significantly in Cotton crop. and also observed additional benefits of saving water, fertilizers, power, labour n time. Maharashtra is on the top in adoption of drip irrigation. 5.82 Lakh ha area is under drip in Cotton crop n.farmers are harvesting yields 40 - 50 Quintals/ ha. Mohansingh Rajput from Jalgaon district harvested raw - Seed Cotton yield 40.75 Qnt / ha under Jain irrigation drip fertigation against National productivity 13.94 Qnt / ha and earned net returns Rs 130,300. Drip fertigation explored more genetic potential of variety used and also improved water and fertilizers use efficiency 80 – 90 % against 30 – 35 % in conventional cultivation.

Hence, Adoption of Drip fertigation in Cotton is need of hour to improve productivity of Cotton.

Whitefly outbreaks in north cotton growing zone of India and its impact

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Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) has been reported as a serious pest on a number of cultivated crops in tropical and subtropical areas including Africa, Asia, Central and South America, Australia. It is a polyphagous pest and feeds on about 900 plant species and transmits many viral diseases in plants, observed on manycrops namely green gram, black gram, pigeon pea, cluster bean, cucurbits, okra, brinjal, chili, weeds, *etc.* and many of them acted as a off season source of survival also .The adults and nymphs suck cell sap resulting in leaf yellowing, leaf wilting, leaf drop and overall decline in growth of the plant. They also excrete sugary liquid called 'honeydew' on which sooty mould grows which interfere the photosynthesis and ultimately growth of plant. Whitefly was first reported as a serious pest of tobacco in Greece 125 years ago (1889). The first whitefly specimen was discovered in 1897 in USA on sweet potato crop. Thereafter, whitefly occurrence was first recorded on cotton at Pusa, Bihar (India) during 1905 and assumed the status of a serious pest of cotton in Punjab in the 1930s, initial outbreak experienced during 1930 to 1943. The pest emerged as a threat to cotton in India only after 1984 with the introduction of synthetic pyrethroids to control cotton bollworms. Subsequent, outbreaks of this pest were noticed in different cotton growing states in India *viz*., Andhra Pradesh (1984-87), Tamil Nadu, Maharashtra and Karnataka (1985-87), Gujarat (1986-87) and Punjab (1996). A severe outbreak of whitefly was experienced during 2015 in the entire North zone on cotton in India followed by current season (2022) again witnessed a severe epidemic of whitefly incidence.

Based on the weekly data recorded from experimental area of ICAR-Central Institute for Cotton Research under unprotected conditions, during 2015 outbreak, population of whitefly adluts/ 3leaves ranged from 0.30 to 57.74 and 0.23 to 55.58 per three leaves in RCH 650 BG-II and HS 6 (Non-Bt) genotypes where as during 2022 cotton season whitefly adult population/3 leaves ranged

between 6.50 to 74.10 and 11.10 to 84.00 in cultivar RCH 650 BG-II and HS 6, respectively. Similarly, the seasonal mean for whitefly was also higher during 2022 season *i.e.,* 33.50 and 38.53 adults per three leaves compared to 2015 season *i.e,* 20.93 and 20.32 adults per three leaves. During 2015 the incidence of whitefly was noticed during 31st SMW whereas its advancement was recorded during 2022 cotton season *i.e.,* 28th SMW. Long persisting incidence of whitefly, especially remained above ETL (Economic Threshold level) consistently for more number of Standard Meteorological Weeks (>10SMW) during 2022. Advanced, prolonged duration of incidence and intensity was noticed during 2022.

Similarly weekly data were also recorded from farmer's field locations regularly to assess the ground situations. The whitefly populations were above economic thresholds in almost all the location surveyed in Punjab, Haryana and Rajasthan. During the year 2022 maximum number of locations *i.e.,* 585 out of 1317 locations (44.42%) crossed ETL. This year (2022) incidence in north zone was higher compared to past few years mainly because of several factors which are responsible for outbreak of whitefly including late sowing due to wide sowing window, use of susceptible, hairy or undescriptive genotypes, availability of alternative potential host (summer moong), high nitrogenous fertilizers, inadequate phosphorus and potassium in the soil, improper spray application methods, hormoligosis (sub lethal doses of insecticide) and favorable weather. Between two outbreak experienced during the 21st century in North zone *i.e.,* 2015 and 2022, current season 2022 was more severe suppressing the crop growth due to advanced invasion forcing farmers to abandoned their fields, ultimately these fields acted as a reservoir of whitefly for the adjoining and late sown crop.

Whiteflies have a significant impact on agricultural crops. Many crop losses estimation studies in crop others than cotton are available. During the cotton season 2015-16, an outbreak of whitefly incidence was recorded during August in the cotton growing areas of Haryana, Punjab and Rajasthan leading to a heavy loss in crop. The cotton productivity in Punjab fell substantially from five year (2010-14) average of 573 kg lint/ha to only 197 kg lint/ha in 2015. The Government of Punjab promptly moved in by providing partial monetary compensation of INR 20,000 per ha to cotton farmers and a proportionately worked out amount to farm laborers. This relief to cotton growers and pickers worked was INR 7360 million (equivalent to about 105 million US dollars). Though exact crop losses due to whitefly during 2022 are yet to be assessed but the intensity of the damage was comparatively severe.

Current scenario and future scope of biopesticides in Indian cotton farming

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Worldwide, cotton (*Gossypium spp*.) known as "White Gold" is one of the important cash crops of the world and plays a noteworthy role in agriculture and industries. It provides more than 65% of raw materials for the textile industry, food, feed, cottonseed oil, and protein and plays an important role in the agricultural and industrial economy. India produced around 61.57 lakh metric tons of cotton during 2021-2022 and is the highest cotton producer in the world followed by China, USA and Brazil. Insects, mites, pathogens, weeds, nematodes, rodents and birds constitute the pest complex of cotton. Insect pests and diseases are a major threat to cotton production and productivity. The cotton plant is the host of 1326 species of insects; however, most insects are formal visitors and are not observed to feed on cotton tissues. In India too, there are over 166 insects recorded as pests on cotton crops and a few of them like bollworms, sucking pests and mealybugs are economically important. From immemorial time, agriculture has been fronting damage happenings to abundant insect pests, and diseases which results in an essential reduction in crop yield. The cotton insect pest scenario has also shown a continuous change during the past sixty years. The climatic change scenario has played a significant role in altering the cotton pest problems. Several minor and infrequent insect pests and diseases are emerging and posing threat to cotton production and productivity. Within all countries of the world, chemical pesticides are expansively and indiscriminately used. The injurious ecological consequences of synthetic chemicals have forced for exploration of some unusual approaches. Consequently, there is an amplified societal burden to substitute chemical pesticides progressively with biopesticides which are harmless to humans and non-target organisms. Biocontrol is a constitutive component of IPM that provides a sound ecological foundation for sustainable cotton production. Ultimately, the adoption of IPM has substantially enhanced pest management and, in some cases, reduced pesticide use, consequently reducing the rise in demand for synthetic chemical pesticides.

Biopesticides in comparison with conventional synthetic chemical pesticides are less toxic, effective in smaller quantities, quick biodegradable, target-specific, and decompose faster, resulting in lower exposure maintaining ecological balance, etc. This leads to the increased development of compounds based on the recreation of naturally occurring toxins of biological derivation having numerous biological actions. A recent review of above 215 research publications on the biocontrol of cotton pests in the world indicates that 55% of biocontrol work is focused on antagonistic and 45% on entomopathogens. Only 1-3% of research reached from laboratory to polyhouse/field. To date, in India, 123 insecticides, and 13 fungicide formulations including 20 biopesticide products of 7 biopesticides are registered for cotton pest management. Biopesticide research on the subcontinent is at a relatively early stage, but evolving rapidly, and focusing on indigenous entomopathogens. ICAR-CICR is doing cutting-edge research on the evaluation and development of biopesticides for the management of cotton insect pests. The recent innovations of ICAR-CICR include antagonistic, endophytes, entomopathogens, PGPRs, etc. Among several studies, rhizospheric bacteria *Pseudomonas fluorescens,* rhizospheric fungi *Trichoderma asperellum* endophytic fungi *Nigrospora sphaerica*, were evaluated against bacterial blight, Alternaria blight, grey mildew, rust *Corynespora cassiicola,* and *Fusarium solani, Macrophomina phaseolina* and found effective against single or multiple pathogens. The application of *Bacillus tequeilencis* + *Bacillus aryabhattai*as was found effective against *Alternaria* leaf blight, bacterial leaf blight and grey mildew under field conditions. The formulations of entomopathogenic fungi *Beauveria bassiana, Verticillium lecanii* and *Metarhizium anisopliae* were found effective against mealybug, *Paracoccus marginatus*. Similarly, among 373 EPFs, foliar application of *Cordyceps javanica* –0102; *Beauveria bassiana* 4511, and *Metarhizium anisopliae* -1299, (singly or in IPM module) showed promising results in terms of whitefly nymphal mortality at multilocation field trials and their compatibility with chemical/botanical insecticides. Additionally, entomopathogenic nematodes were evaluated and found effective against coleopteran pests. Studies on seed biofilm of potential native K solubilizing microorganisms showed better K availability (µg/ml) and enhanced yield in cotton compared to uninoculated control at different intervals. Mobile volatile compounds from rhizobacterial strains *Bacillus cereus, Bacillus aryabhattai* and *Bacillus tequilensis* were evaluated and found effective in inhibiting the mycelial growth of *Macrophomina phaseolina*. Intensive research is ongoing to find out

promising microbial/botanicals including volatile compounds (plants and microbes) for the development of broad-spectrum formulations for insect pest, disease management, and plant growth enhancement.

Currently, the biopesticides market has a small share (5–6%) compared to the global crop protection market, ($3-$4 billion) against the demand of 17% CAGR. Over the next five years, this will continue due to its diversity. This puts the crop protection segment on a trajectory to enter the mainstream, presenting opportunities for investment and collaboration as these products compete with synthetic pesticides. Moreover, the market growth of biopesticides in India suffers from slow adoption, limited resources for large-scale production, quality issues, spurious products, and other challenges associated with regulation and commercialization. Despite onerous regulation, quality-control issues and limited large-scale production facilities, investment in domestic fermentation technologies, improved delivery systems, and promotion of biological control through private and public initiatives will increase the share of biopesticides in the country. Presently improvements in microbial research, products, and grower awareness of the benefits that biocontrol offers need to be boosted. The development of advanced, cost-effective quality biopesticides as an alternative to conventional chemical insecticides could overcome many of the obstacles that biocontrol is now facing. It is believed that in near future the use of microbial biopesticides will increase in agriculture and it will face even stiffer competition from new pesticide chemistries and transgenic plants. Thus, there is a need for intensive research in the search for broad-spectrum biopesticides, the development of cost-effective, and broad-spectrum microbial products suitable for IPM, and increasing grower awareness of the benefits that biocontrol offers. Further, it is required to develop biopesticides as an alternative to conventional chemical insecticides which could overcome many of the obstacles that microbial control is now facing.

Insect pest management in cotton: Contemporary issues and priorities

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The pest management in cotton crop is being challenged by new threats in recent times *viz*, development of resistance to Bt cotton by the pink bollworm (PBW); emergence of sucking pests as one of the key limiting factors in cotton cultivation and incipient menace from new pests and invasive insects. Of the biotic stresses in cotton, insect pests cause by far, the highest economic losses. Of the 1326 species of insects found on cotton, the sucking pests and the bollworm complex were designated as the key pests of cotton. Since the introduction of Bt cotton during 2002 in India, the threat from bollworms lingered at insignificant levels for almost 15 years. India, being the largest grower of Bt cotton hybrids expressing Cry1Ac and Cry2Ab toxins, harnessed the benefits of bollworm suppression, insecticide usage reduction against bollworms and yield advantage. However the PBW re-emerged as a threat to cotton cultivation in India as the pest developed resistance to Bt cotton . The evolution of resistance and pest adaptation to Bt crops containing Cry1Ac and Cry2Ab has been observed in all the cotton growing zones of the country. The development of resistance is due to multiple factors such as absence of refuge or supply of fraudulent refuge, mono cropping, cultivation of long duration hybrids, extended cropping season (Naik *et al*, 2020).

To circumvent the PBW menace several approaches are being undertaken at national level. Since the reappearance of PBW in Bt cotton, the ICAR- CICR is closely monitoring the pest status in all the major cotton growing states. Under the network project on Insecticide Resistance Management (IRM): Dissemination of Pink bollworm management strategies sponsored by the National Food Security Mission: Commercial Crops, a total of 2520 pheromone traps are installed in 105 identified villages across 21 cotton growing districts of the North, Central and South zones. Weekly trap catches and corresponding field damages by PBW are being recorded by the trained personnel since 2018 at all the locations. Based on the observations, pest forewarning and suitable control measures are disseminated through various channels like mass media and direct voice/text messages to cotton growers across the zones. A total of 1050 farmers were also adopted in the identified villages and critical inputs like insecticides, botanicals

and biocontrol agents are supplied at free of cost for the timely management of PBW. By this effective monitoring of PBW using pheromone traps and timely intervention through integrated pest management approaches, a reduction of 39.3% in volume of pesticide usage was noticed among the adopted farmers. Periodical field demonstrations, kisan melas and campaigns are being conducted to popularise the importance of pest monitoring and timely management of PBW in cotton across the country (Rameash, 2021).

Cotton jassid, *Amrasca devastans* and whitefly, *Bemisia tabaci* have become a serious threat to cotton in recent years. Jassid occurs in all the three cotton growing zones of India and whitefly infest cotton especially in the in northern parts of India. The problem assumes a serious dimension in relation to the Cotton Leaf Curl Virus (CLCuV) being transmitted by the whitefly. Resistance in the leafhopper and whitefly were quantified more recently against the commonly used insecticides. Resistance ratio to imidacloprid was high, up to 2,089-fold, in leafhopper populations from Jalna, in Maharashtra, and 7,264-fold with leafhopper populations in the Haveri district of Karnataka. The highest resistance ratio to thiamethoxam was 6,554-fold in the populations of leafhoppers from the Indore district of Madhya Pradesh and 13,945-fold in the populations of leafhopper from the Haveri district of Karnataka. Broadly, leafhopper populations in Central and South India were resistant to neonicotinoids, imidacloprid, and thiamethoxam as compared with that in the populations from North India (Kranthi *et al,* 2019). Insecticide resistance to selected organophosphates, pyrethroids, and neonicotinoids in seven Indian field populations of *B. tabaci* genetic groups Asia-I, Asia-II-1, and Asia-II-7 was reported (Naveen *et al*. 2017). The variability of the LC_{50} values was 7 times for imidacloprid and thiamethoxam, 5 times for monocrotophos, and 3 times for cypermethrin among the Asia-I, whereas they were 7 times for cypermethrin, 6 times for deltamethrin, and 5 times for imidacloprid within the Asia-II-1 populations. Window-Based IRM Strategies were developed by the ICAR-CICR to tackle the sucking pests, where in emphasis was given on the conservation of natural enemies, through intelligent selection and use of insecticides on the basis of economic threshold levels instead of calendar-based sprayings. Exploitation of host plant resistance in the first 60 days, thereby avoiding use of broad-spectrum organophosphates against sucking pests and withdrawal of pyrethroids against bollworms, was an important feature in this program. The choice of insecticides was based on their ecotoxicological profiles, ensuring minimal disruption of the cotton ecosystem (Kranthi *et al*, 2002)

Apart from the established key pests, an array of new pests and invasive insects pose significant threat to the cotton cultivation. Invasive mealybugs (*Phenococcus solenopsis*); new pests viz., mirid bug, *Creontiades biserratense*; flowerbud maggot, *Dasineura gossypii*; tea mosquito bug, *Helopeltis theivora* etc are creating potential yield loss in cotton. The fall armyworm, *Spodoptera frugiperda* was reported to occur on cotton crop at Ahmednagar district in Maharashtra during 2019 (Udikeri, 2021). The fall armyworm has been reported as an economic pest of cotton in several cotton growing regions of USA and during 1996 local outbreaks of the pest was observed in the southern Alabama and Georgia on both conventional and transgenic cotton plants expressing Cry1Ac delta-endotoxin (Smith, 1997). The single Bt trait was less effective in killing neonates of FAW whereas 100% mortality was caused by Bollgard II (Armstrong *et al*., 2011). Constant vigil on the pest migration, area wide monitoring and investigations on the adoptability of FAW to cotton in India are essential to contain the invasive pest.

Cotton extension approaches and their impact on Indian cotton production

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Cotton is the crop which influenced civilizations, kingdoms and societies. Since ancient times, cotton has been cultivated in India and many archaeological evidences support the information. Production of cotton in India was 3.04 million bales during 1950-51 and 37.1 million bales in 2020-21. It is an undeniable fact that together with technological advancements, the extension approaches adopted in yester years like "Grow More Cotton" to present day "Technology Mission on Cotton" had impacted the production of cotton in India. To document the various extension attempts and their impact on Indian cotton production, an analysis was done using the available secondary data. Results revealed that during pre-independence period, significant extension initiatives were executed to grow American cotton in India. After independence, the approaches like "Cotton Extension Scheme" and "Grow More Cotton" campaigns resulted the significant increase in cotton area and production. In the same period, the "Package Programme" ensured 5.5 m bales by the end of 1968-69 and the institutional arrangements during 1969-1990 increased the production around 8.4 million bales. The "Technology Mission on Cotton" implemented during 1999 to 2017 increased the area as 11.86 m ha and production to 33.34 m bales. The first line extension programs of Indian Council of Agricultural Research also influenced the production of Indian cotton. Front Line Demonstrations in cotton has proved that through proper technology adoption, an increase of 18-46% in seed cotton yield could be achieved. Metaanalysis of studies on impact of Farmers Field Schools on cotton revealed that there was significant change in the knowledge and adoption of pest management behavior of cotton growers.The cotton advisory services that are tailor made for cotton through web and mobile and other digital tools have been contributing to the prosperity of the crop.An ante assessment of using smart technologies like usage of Internet of Things (IoT), drones, sensors, robotics, data analytics, artificial intelligence enabled

cotton farming and virtual reality training tool to increase the quantity and quality while minimizing the human labours has also been attempted using the available secondary data and the results revealed that smart technology transfer practices have the acceptance among cotton growers with a hope that these technologies have the potential to bring out desirable changes in cultivation behaviour and production augmentation.

OP 01

Interspecific hybridization to broaden the genetic base in cotton through embryo rescue

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The embryo rescue technique plays an important role in modern plant breeding. It has been widely used for producing interspecific and intergeneric hybrids for transfer of desirable gene from wild species into cultivated species, as well as progenies of incompatible crosses which lead to embryo abortion. Interspecific hybrids have been obtained from diploid cultivated (*Gossypium arboreum*, *G. herbaceum*) and wild species (*G. anomalum, G.stocksii*) of cotton. The early abortion of young embryo was prevented by repeated application of growth regulators (GA3 and NAA) followed by culturing immature hybrid embryos about 15 days after pollination. Best growth and development of callus were obtained on modified MS media containing Indole acetic acid, Kinetin, Activated charcoal and Adenine Sulphate. It was also reviewed that the growth of mature embryo in liquid medium was better than solid medium. Age and the genotype of the plant also responsible for development of hybrid embryo.

OP 02

Evaluation of newly developed inter-specific cotton hybrids (*G. hirsutum* x *G. barbadense*) for yield, yield contributing characters and fibre quality character under irrigated condition

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An experiment for evaluation of 27 inter-specific cotton hybrids (*G. hirsutum* x *G. barbadense*) along with two checks for yield, yield contributing characters and fibre quality characters was taken at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri under irrigated conditions during 2021-22. The experiment was laid out in randomized block design with three replications. Two rows of 7.2 m length of each genotype with a spacing of 120 cm x 90 cm were sown. Results were statistically significant for seed cotton yield and ranged from 608 kg/ha to 1604 kg/ha. Out of 27 hybrids, two hybrids *viz.* RHB-2024 (1604 kg/ha) and RHB-2011 (1388 kg/ha) recorded significantly superior seed cotton yield over the best check Phule Mahi (1307 kg/ha). Ginning outturn ranged from 28.15 to 40.00 percent, the highest ginning percentage was recorded by the genotype RHB-2021 (40.00 %) followed by RHB-2011 (37.39%), RHB-2019 (36.16%) and RHB-1512(34.69%). The UHML ranged from 28.4 mm to 34.7, the highest UHML was shown by check Bahubali(34.7mm). The micronaire value ranged from 3.1 to 4.5 ug /inch, the highest micronair value was shown by RHB-2008. For earliness, three genotypes *viz.* RHB-2013, RHB-2005 and RHB-2010 showed earliness in fifty percent flowering and fifty percent bursting. In conclusion, it was clearly visible that among the genotypes studied, the RHB-2024 performed well for yield and yield contributing characters.

OP 03

Invivo haploid induction in *Gossypium barbadense* L. through semigamy

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Semigamy or hemigamy is an incomplete fusion of male and female gametes during fertilization in which sperm nucleus enters into the egg cell but they do not fuse with its nucleus, preserving its viability like the egg cell nucleus and dividing, later on both independently. It has been reported in plant species viz., Coix *aquatic*, *Zephyranthes spp*., *Rudbeckia spp*., *Cooperia pedunculata*, *Theobroma cacao* including *Gossypium barbadense*. In semigamy, once the male nucleus enters into the egg cell, eventually it is sequestered, and becomes ruminant part of the embryo tissue. However, in *G. barbadense*, male nucleus is not sequestered and it contributes to the embryo development as like genetically inherited by independently present in the embryo. Hence, maternal and paternal nuclei proceed to divide independently resulting in combination of progenies arise such as normal tetraploid, diploids, haploids and chimeric embryos. Embryo sectors, which has different ploidy in chimeric forms arise either as diploid or haploid. These semigamitic lines would be of great help in producing haploid plants that leads to production of homozygous lines. Semigamy is an unique system that promotes induction of haploids *invivo*, in conversely *invitro* haploid induction is a complex one and needs efficient tissue culture protocol in orthodox crop like cotton. Once the haploid produced is doubled, it results in plants with doubled chromosomes as that of their normal plants and would be completely homozygous. Genetic inheritance studies revealed that an incomplete dominant gene (Se) governs the trait semigamy. Transfer of semigamy (Se) gene to other non semigamtic lines will be a viable option to harness the haploid induction which would pave the cotton improvement especially to fix the heterosis in inbred lines.

OP 04

Genetic characterization of *desi* cotton (*Gossypium arboreum* L.) germplasm for surgical/medical cotton properties

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Desi cotton(*Gossypium arboreum* L.) varieties are highly suitable for surgical cotton purpose because of its short staple, coarse fibre nature and better fluid absorption capacity. The demand for surgical or absorbent cotton is growing at the rate of 10 percent per annum across the world and about 3to 3.5 million bales would be required to fulfill both the domestic demand and export market within next five years. Therefore, identification of promising *arboreum* genotypes suitable for surgical industry is very much essential. Hence, the present research work was carried out with the objective of evaluating *G. arboreum* germplasm for fibre quality traits associated with medical cotton applications. A total of 150 *G. arboreum* germplasm along with five check varieties were raised in the experimental farm of Department of Cotton, TNAU, Coimbatore during *kharif* 2019 using augmented block design. All the accessions were primarily evaluated for two important fibre quality traits namely 2.5% span length and micronaire which are known to be associated with the characteristics of surgical cotton and the data obtained was used to constitute a trait based referencese to f155 *desi* cotton accessions. Screening of accessions for 2.5% span length identified 15accessions in Class I (20mm and below), out of which RG 876 had minimum value of 17.2. Based on micronaire trait, 67 accessions with the class mean of 6.6 were identified in Class V. It was found that RG385 had the minimum value of 6.0, whereas RG876 recorded the maximum value of 8.3. Further, ten accessions superior for micronaire (≥7.0) were tested for surgical properties such as absorbency, sinking time and water holding capacity. Overall results suggested that three genotypes namely Phule Dhanwantri, CNA1039 and FDX231 had excellent surgical properties and were superior for yield as well as these genotypes can be used as promising donor lines for the development of *desi* cotton varieties suitable for medical textile industries.

OP 05

Molecular and cytological studies for Jassid resistance in upland cotton (*Gossypium hirsutum* L.)

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Cotton is the world's top natural fiber crop and an essential crop for bioenergy generation. It belongs to Malvaceae family and genus *Gossypium*, which has about 50 species, including 45 diploids (2n = 26) and 5 allotetraploids (2n = 52). *G. hirsutum* L., *G. arboreum* L., *G. herbaceum* L., and *G. barbadense* L. are the four cotton species cultivated in India. Among four cultivated species, *G. hirsutum* L. occupies the majority of the cultivated areas in India. The *G. hirsutum* L. cultivars *viz.,* MCU 5, CO 14, CO 17, TCH 1828, KC 2, KC 3, GISV 323 and GTHV 15-34 were utilized in this study. Cotton breeding program uses molecular markers to increase the effectiveness of resistant trait introgression into a favourable genetic background. The present aim of the study is to identify the polymorphism present in *G. hirsutum* L. cultivated species for trichome hairiness. The trichome hairiness confers resistance against Jassids (*Amrascabiguttula*). Marker JESPR 154 amplified at 154 bp in the parents KC 3, GISV 323, GTHV 15-34 and RHC 1409. Cytological studies also confirms the presence of hairiness (KC 3, GISV 323, GTHV 15-34 and RHC 1409) and hair-lessness (MCU 5, CO14, CO 17, TCH 1828 and KC 2) traits among the parents. Hence these studies helps in identifying and screening the jassid resistant cultivars in cotton.

OP 06

Identification of stable boll weight linked markers in upland cotton (*Gossypium hirsutum* L.)

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Boll weight is a crucial factor in cotton breeding that affects lint yield, and it was never easy to simultaneously enhance yield and fibre quality attributes. Boll weight contributes 10% to lint yield and also a key trait for the evaluation of quality of cotton. Recent advances in molecular markers have led to promising approaches for precise identification of quantitative trait loci (QTLs) for boll weight in upland cotton (G. hirsutum). Through extensive literature collection, boll weight specific QTLs were identified and the SSR markers linked to the QTLs with phenotypic variance of above 10% were filtered and used in our study. As a result, 14 such markers were discovered which covered three linkage groups (1, 15, and 26). These markers were screened for parental polymorphism in ten parents (seven parents with high boll weight and three parents with low boll weight). Segregation of the identified SSRs in this study on the investigated genotypes ensured that these markers can be employed in molecular breeding for cotton boll weight improvement. It has also been found that SSRs such as NAU2820 and JESPR234 were shown to be linked not only with boll weight but also with other yield contributing and fibre quality traits. This study therefore discovered that SSRs that can be used to enhance cotton yield and fibre quality attributes at the same time.

OP 07

Yugank Bt –A new, early maturing Bt cotton variety for rainfed agro-ecologies of Central India

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Cotton (*Gossypium* spp.) is an important commercial crop grown for its fibre, feed, oil and fuel wood. India contributes highest to world's cotton and production, but the productivity is very low in India compared to the major cotton growing countries of the world. Development of early maturing Bt varieties amenable to high density planting system (HDPS) is an advocated approach for increasing the cotton yields in India. In this endeavor, a medium staple Bt cotton variety, Yugank Bt (CICR-H Bt Cotton 60) tolerant to jassids (major sucking pest on cotton), early in maturity (140-150 days), suitable for high density planting system (HDPS) and mechanized harvesting of cotton was developed from ICAR-CICR, Nagpur. This variety was identified by Central Varietal Identification Committee based on its exceptional performance in ICAR-AICRP on Cotton Trials for 3 consecutive years (2019-20 to 2021-22). It yielded an average of 12.65 quintals per hectare of seed cotton across 18 locations over 3 years. The variety recorded a potential yield of 22.1 quintal per hectare at Surat during 2020-21 under closer spacing. It had a yield superiority of 17.43% over non-Bt zonal check, 34.06% over Bt zonal check and 36.39% over non-Bt local check. Average boll weight of this entry is 3.4 grams. This medium staple Bt cotton genotype has a mean fibre length of 24.8 mm and mean fibre strength of 25.7 g/tex across locations and years. The potential fibre length of the variety is 25.8 mm at Nagpur and Surat during 2021-22 and potential fibre strength is 28.5 g/tex at Akola during 2020-21.This variety has superior ginning out turn (GOT) of 38.1% with the potential of 43.9% recorded at Nagpur during 2019-20. This variety is compact in plant architecture with an average of <1 monopodia for plant with average of 73.43 bolls for metre square indicating its amenability to HDPS. It also combines good tolerance to pest and diseases. With early maturity, Yugank Bt can help Indian cotton farmers to escape from damage of pink bollworm, terminal drought stress and also provide an opportunity for taking up second crop. This new Bt cotton variety tolerant to sucking pests, compact in plant architecture and early in maturity with higher GOT and yield superiority can contribute to increasing the productivity in rainfed conditions of Central zone of India.

OP 08

Humic acid complexed of macronutrients and its interaction with micronutrients in rainfed cotton

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Complex fertilizers were developed to enhance nutrient use efficiency (NUE) and balanced nutrition in crop plants. Similarly, humic acid was shown to bind with nutrients and also act as a soil pH buffer. However, coating of humic acid with complex fertilizer grades and its role in enhancing the NUE in cotton in the presence of micronutrients has not been studied so far. Therefore, a field experiment was conducted with humic acid coating (Torrent) complex grade and micronutrient (Copper, Manganese and Iron) with addition or omission on Bt-cotton hybrid during 2019-20 with 2 replications in factorial randomized block design under rainfed condition. The fertilizer inputs were sponsored by Smartchem Technologies Pvt Ltd, Pune. With torrent, the addition of all micronutrients (Cu, Mn, Fe) had improved the seed cotton yield (SCY) by 1.75 % more than the omission of all micronutrients. However, without torrent, the addition of all micronutrients had higher SCY (+11.35%) than the omission of all micronutrients. However, the torrent coating had a negative effect on the SCY by 9.60%. The interactions between the torrent and micronutrient addition / omission was found to be significant ($P<0.05$) on SCY. Mn and Cu omission had a positive effect on the SCY by 8.5 and 15.2% through addition of all micronutrients and the omission of all micronutrients respectively. Similarly, the treatments with Mn omission (3.8, 10.9%), Fe omission (4, 11.1%), Fe and Cu omission (3.7, 10.8%) had an equivalent yield. The experimental results indicated small gain in SCY through the treatment was 30 kg ha^{-1}, though there was an increase in leaf micronutrient concentrations of Cu and Mn. Conversely, its effect on Fe uptake was negative. Further, cotton growth and fiber quality parameters were not significantly affected. Overall, it was concluded that the chelation property of humic acid complexation enhances the nutrient availability as well as cotton productivity at rainfed areas.

OP 09

Performance of cotton variety NDLH-2051-1 (*Gossypium hirsutum*) under different nitrogen levels and plant densities in rainfed vertisols of scarce rainfall zone of Andhra Pradesh

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The cotton variety NDLH-2051-1 was evaluated under rainfed condition at Regional Agricultural Research Station, Nandyal (Andhra Pradesh), India during *kharif,* 2020-21 in vertisols. The study included two plant geometries *viz*; S_1- 90 cm × 60 cm (18518 plants ha^{-1}), S_2- 60 cm × 30 cm (55,555 plants ha^{-1}) as main treatments and three nitrogen levels *viz*: N_1- 75 % RDN, N_2-100 % RDN, N_3-125 % RDN as sub treatments, two varieties *viz*: NDLH-2051-1, Srirama in split plot design with three replications.

Higher number of sympodia (11.8), no of bolls per square meter (32) and boll weight (4.1 g) and seed cotton yield (1345 kg/ha) was recorded with 90x60 cm than 60 x 30 cm. Among the nitrogen levels, higher yield parameters like number of sympodia (10.8), no of bolls per square meter (32) and boll weight (3.7) and seed cotton yield(1297 kg/ha) was recorded with 125% RDN and was on par with 100 % RDN (1230 kg/ha), where as lowest yield parameters and yield (1072) was recorded with 75 % RDN. Highest yield parameters like number of sympodia (10.5), no.of bolls per square meter (33) boll weight (3.7) and seed cotton yield was highest with NDLH-2051-1 (1326 kg ha^{-1}) than srirama (1173 kg ha^{-1}).

OP 10

Growth, yield and economics of cotton as influenced by weed management practices under rainfed conditions

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The field experiments were conducted at All India Coordinated Research Project on Cotton, Chamarajanagar, during *Kharif* season of 2017 and 2018 to identify suitable weed management practice in medium black cotton soil of Southern Dry Zone of Karnataka. The experiment was laid out in randomized block design consisting of ten treatments and replicated thrice. The pooled data indicated that the growth, yield and economics of cotton differed significantly between the treatments. Among different weed management practices (T_{10}) weed free check recorded significantly lower weed dry matter (104 kg/ha), higher weed control efficiency (88.71 %) and maximum seed cotton yield (1841 kg/ha), followed by (T_7) plastic mulching with weed dry matter of (113 kg/ha), weed control efficiency (86.74 %) and seed cotton yield (1832 kg/ha). However, these two treatments are found to be on par with each other. The next best treatment was (T_6) pre emergence application of Pendimethalin @ 1.0 kg a.i/ha followed by tank mixture (Quizalofopethyl 50 g a.i/ha+ Pyrithiobac Sodium @ 62.5g a.i/ha) at 2-4 weed leaf stage + one hoeing with a weed dry matter of (144 kg/ha), weed control efficiency (82.96%) and seed cotton yield (1716 kg/ha). The higher weed dry matter and lower seed cotton yield was noticed in weedy check (875 kg/ha and 620 kg/ha, respectively). Similar trend was observed with respect to gross returns and net returns. The higher gross returns was observed in (T_{10}) weed free check (Rs. 105202/ha), followed by (T_8) plastic mulching (Rs.104657/ha), While maximum net returns was obtained in (T_{10}) weed free check (Rs. 59075/ha), followed by (T_6) pre emergence application of Pendimethalin @ 1.0 kg a.i/ha followed by tank mixture (Quizalofopethyl 50 g a.i/ha+ Pyrithiobac Sodium @ 62.5g a.i/ha) (Rs.57393/ha).

OP 11

Technology capsule for complete mechanization in cotton

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Field experiment was conducted at Cotton Research Station, Veppanthattai farm during August 2021- January 2022. The soil of the experiential field was black cotton soil (Peelamedu series/ vertisols with typic chromosterts). The rainfall received during the study period was 793 mm in 44 rainy days. Seven treatment combinations (T1 to T7) are tested in randomized block design and replicated thrice under rainfed conditions. Cotton variety CO17 under technology capsule treatment T7 recorded 44 per cent more yield than growing CO17 in conventional way in rainfed (T2). Significantly higher and comparable seed cotton yield was recorded with T1, T7 and T6. (T1-Bt hybrid +120 x 60 cm + 120: 60: 60 NPK Kg/ha + HW @20 and 45 DAS; T7-CO 17 + 100 x 10 cm + 50: 25: 50 NPK Kg/ha + PE *fb* MW @ 25 and 45 DAS + GR - MC 100 ppm @ Square formation and boll development stage + Defoliant Spray –Sodium Chlorate 0.9%; T6- CO 17 + 100 x 10 cm + 50: 25: 50 NPK Kg/ha + PE *fb* MW @ 25 and 45 DAS + GR - MC 100 ppm @ Square formation and boll development stage) Cost of cultivation and gross income was higher with T1 and was followed by T7. Net income and B:C ratio was higher with T7 and was followed by T1 in case of net income and T6 in case of B:C ratio. Also T7 was highly suitable for complete mechanization in cotton. To conclude, HDPS based technology capsule (CO 17 + 100 x 10 cm + 50: 25: 50 NPK Kg/ha + PE *fb* MW @ 25 and 45 DAS + GR - MC 100 ppm @ Square formation and boll development stage + Defoliant Spray –Sodium Chlorate 0.9%) may be recommended for enhanced productivity and profitability and for suiting complete mechanization in cotton farming under rainfed conditions.

OP 12

Impact of intercropping systems on productivity, nutrient uptake and water use efficiency of irrigated Bt cotton

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Field experiments were conducted at Cotton Research Station, (TNAU), Srivilliputtur, Tamil Nadu under winter irrigated season of 2020-21 and 2021-22 (September to February) to identify suitable inter cropping system for *Bt* cotton with higher productivity and nutrient uptake. The experiments were carried out in a randomized block design with three replications. The treatments consisted of control (T_1 - Sole cotton), two rows of intercrop of small onion with cotton (T_2), two rows of cluster bean with cotton (T_3), two rows of coriander with cotton (T_4), one row onion + one row cluster bean with cotton (T_5), one row cluster bean + one row coriander with cotton (T_6), one row coriander + one row onion with cotton (T_7), one row each onion + cluster bean + coriander with cotton (T_8), normal planting of cotton + 2 rows black gram (T_9), normal planting of cotton + 2 rows green gram (T_{10}). The results revealed that the total nutrient uptake of all the intercropping systems were significantly higher than sole Bt cotton indicating complimentary effect. Among the intercropping systems, higher nutrient uptake was observed with Bt cotton intercropped with three crops (onion, cluster bean, and coriander) followed by that of two rows of cluster bean. The seed cotton equivalent yield was highest with intercropping of one row each of onion and cluster bean with cotton (3749 and 3015 kg / ha) followed by two rows of cluster bean (3697 kg / ha and 2905 kg / ha).The water use efficiency and labour use efficiency were also higher with one row each of onion and cluster bean intercropped with cotton followed by intercropping of two rows of cluster bean with cotton. The study inferred that intercropping of cluster bean and onion were found suitable for higher yield and nutrient uptake with efficient use of water and labour.

OP 13

Effect of bio stimulant on growth and yield of cotton

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Cotton (*Gossypium hirsutum L.*), a natural fibre plant, is a prominent cash crop that is grown commercially for agricultural and industrial purposes in more than 80 countries around the world with a major contribution from India (6,205,000 metric tons), followed by China, USA, Brazil, and Pakistan. Bio-stimulants are plant extracts that encompasses a variety of bioactive compounds which enable to enhance the several physiological processes thus encourage optimum growth and yield of crop.Bio stimulants are used in cotton (*Gossypium hirsutum* L.) to balance vegetative and reproductive growth as well as to increase cotton seed yield and fiber quality. Therefore, in order to study the effect of bio stimulant on growth and development of bt cotton hybrids/varieties. Field experiment was conducted during 2022 under irrigated condition. The experiment design was Factorial Random Block Design (FRBD) with three replication. Two cultivars *viz*., TCHT175380 (Bt)& Co 17 (non bt)and biostimulants [B1.Bio stimulant@4mg/litre at 30 , 45 and 60 DAS (20 mg+5 litres of water +0.5 ml of DMSO) B2. Bio stimulant@ 4mg/litre at 45, 60 & 75 DAS (20 mg+5 litres of water +0.5 ml of DMSO) 3. DMSO@100 µL/litrespray at 30, 45, 60 & 75 DAS (0.5 ml of DMSO+ 5 litre of water) B4.Control (water spray- 30, 45, 60 & 75 DAS)] were included in this study. The results show that, plant height(86.83 cm), Sympodia (17.33No.) , Boll wt (4.15 g), No of bolls (53.70 no.), seed cotton yield (1942 kg/ha) and has significance over non Bt variety.Among the Bio stimulants treatment, Bio stimulant@ 4mg/litre at 45, 60 & 75 DAS has recorded maximum net return (68856) and B:C ratio (1.99). We conclude that Bt hybrid performed well than Non Bt variety and spraying of Bio stimulant@ 4mg/litre at 45, 60 & 75 DAS provided higher economic returns.

OP 14

Studying the physiological potential of zero monopodial compact cotton TCH 1819 culture to increase the boll retention

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Cotton is the most important global cash crop and controls economy of many nations. Global sustainability of cotton yield is the major challenge for meeting impending threats under climate change and abiotic stresses. India is experiencing water scarcity since last many years. Selection of cotton cultivars which survive and give better yields in normal and water stress conditions have greater scope in India and the world over at large because of shortage of irrigation water resources. With this background, present field experiment was taken up to study the growth, physiology, and yield traits of TCH 1819 culture by different chemical treatments and by giving drought stress. Observations on the leaf parenchymal cells distinguished the source sink relationship of the culture. By characterizing the physiological potential through manipulation by growth retardant (Mepiquat chloride (0.015%)), increased yield by 30% was realized. Drought stress affected the metabolites compounds by upregulating 25 metabolites in the culture and thrived under squaring stage stress. Drought stress reduced the yield by 37% in TCH 1819 at flowering stage. Results suggest that water stress during flowering stage is sensitive toTCH 1819.It can be concluded from the study that the traits identified are the potential indicators for drought tolerance in breeding programme before releasing a variety.

OP 15

Evaluation of IPDM capsule against key insect pests of cotton in traditional growing areas of Perambalur district in Tamil Nadu

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Cotton originated in both India and Peru. India's cotton crop in the 1960s covered 5.89 million hectares of land and yielded 3.1 million bales. Over the course of the day, cotton was planted on a total of 133.41 million hectares across 11 major cotton-growing states by an estimated 6 million farmers (CICR Annual Report 2020). There are approximately 326 different insect species that feed on cotton. The sucking pests (jassids and whiteflies) and the bollworm complex are responsible for the most economic damage. Because of its destruction, lint often contains a lot of trash, which drives down the price of Indian cotton on international markets. To overcome this problem, this paper focuses on the effects of the IPDM capsule rather than on farmers' methods. The experiment was set up at Cotton Research Station, Veppantattai, Perambalur, during 2020-22. Based on research conducted on cotton's sucking pests and bollworms, the IPDM capsule consists of treating the seeds with Imidacloprid 600 FS (10 g/1 kg) and Bacillus subtilis (10 g/1 kg), setting up yellow sticky traps (40 per hectare) at 20 DAS and pheromone traps (12 per hectare) at 40 DAS, and drenching with Profenophos 50% EC (5 ml/lit.) at 25 DAS for stem weevil management directed towards the collar region of the stem. Nimbecidine 0.03% EC @ 2.5 lit./ha follwoed by Flonicamid 50% WG 150g/ha was prayed at 30 DAS and 45 DAS for sucking pests managment. Chlorpyriphos 20% EC 2 lit./ha and Trifloxystrobin + Tebuconazole @ 0.6 g/lit. was sprayed for bollworms and Alternaria Leaf Blight at 55 and 65 DAS. *Trichogramma chilonis* / *T. bactrae* @ 1.5 lakh/ ha field release at weekly intervals of 45 DAS @ 3 times. The above IPDM practices registered a minimum

population (in numbers/3 leaves) of aphids (4.22 nos.), thrips (2.86 nos.), leafhoppers (2.46 nos.), whitefly (1.86 nos) and mealy bugs (5.26%), mirid bug (8.62%) and pink boll worm (6.40%) when compared with the farmer's practice (Fipronil 5% SC@ 2000ml/ha on 25 DAS + Imidacloprid 30.5 SC@ 75g/ha on 40 DAS + Thiamethoxam 25 % WG @ 100g/ha on 55 DAS and Profenophos 50% EC 2 lit./ha on 75 DAS) which registered the maximum population of 8.60, 4.52, 3.82 & 2.68 numbers of aphids, respectively and 9.86, 15.42 & 10.62 per cent damage of mealy bug, mirid bug and pink boll worm incidence. Untreated plots had a significantly higher population of sucking pests (> 5 per 3 leaves), with 16.52% mealy bug, 20.86% mirid bug, and 18.62% pink boll worm damage. Regarding yield data revealed that the highest kapas of 2282 kg/ha was recorded in IPDM imposed plots with the BCR of 1:1.86 followed by farmers practice 2098 kg/ha of kapas with BCR of 1:1.58, whereas control plots recorded 1680 kg/ha of kapas with the BCR of 1:1.24.

OP 16

Seasonal incidence of insect pests of cotton in Cuddalore district of Tamil Nadu

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Cotton is commonly known as the 'White gold' of India. It is one of the important commercial fiber crops of farmers' community and significantly contributes to the national economy. It provides the raw material to allied sectors like ginning, fabric production, textile processing, garment manufacturing and their marketing *etc*. The insect pest constitute one of the major limiting factors.Heavy damage is caused by insect pests and it has been estimated that about 20-25% of yield losses. A study on the seasonal incidence of cotton is essential as it provides information on the status of various insect pests and also helps in identifying the vulnerable stage of the crop. This information helps in developing an efficient management model for the insect pests attacking the crop at various growth stages. The field experiment was laid out with an area of twenty cents with plot sizes of 5x4 m^2 and sowing was taken up with the CO-17 variety during November 2020 to study the seasonal incidence of major pests at the Regional Research Station, Vridhachalam, Cuddalore District, Tamil Nadu. The occurrence of insect pests of cotton and their natural enemies was recorded at weekly intervals from twenty randomly selected plants which were grown under unprotected conditions. The seasonal incidence studies indicated that insect species *viz*., Leafhopper, *Amrasca biguttula biguttula* Ishida, Whitefly, *Bemisia tabaci* (Gennadius), Thrips, *Thrips tabaci* Lindeman, Ash weevil, *Myllocerus* sp., Leaf roller, *Sylepta derogata* (Fabricius), American bollworm, *Helicoverpa armigera* (Hubner), Cotton Stem Weevil, *Pempherulus affinis* (Faust), Pink Boll Worm, *Pectinophora gossypiella* (Saunders), Red Cotton Bug, *Dysdercus cingulatus* (Fabricius) were observed. The incidence of sucking pests *viz*., leafhopper, whitefly and thrips population were observed all throughout the vegetative stage and flowering stage. Leafhopper population is

observed more when compared to the other sucking pests' population. Ash weevil population was noticed throughout the cropping stage. There is no incidence of cotton stem weevil and pink bollworm was observed. Red cotton bug population was observed during square formation stage and maturation stage. However, Natural enemies population *viz*., Spiders and Coccinellids were observed throughout the season. Correlation studies revealed that the leafhopper population correlated positively and significantly with sunlight hours, whereas the whitefly and thrips populations correlated negatively and significantly with maximum temperature. . However, Spiders and Coccinellids had a positive significant correlation with maximum temperature. But, rainfall and rainy days had a negative and significant correlation to them. Spiders and Coccinellids had a positive and significant correlation to sunshine hours.

OP 17

Bio-efficacy of ginger-garlic-green chilli extract for the management of Jassids (*Amrasca devastans*) in organic cotton

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Organic cotton refers to cultivationof cotton without use of any synthetic fertilizers and pesticides. The demand for organic cotton is higher in baby and band-aid cloth manufacturing industries. Cotton jassid (*Amrasca devastans*) is an important sucking pest causes yield reduction up to 35 per cent (Atwal, 1996). Though it is an early phase pest, however, its occurrence has been observed all through the crop season serving as one of the limiting factors in economic productivity of the crop. Hence, a study on the effect of ginger-garlic-green chilli extract against jassids in organic cotton was conducted in Tamil Nadu Agricultural University, Coimbatore during 2018-2020. Only organic manures were applied throughout the cropping period. Cow urine-based ginger, garlic and green chilli extracts were prepared and applied twice when the jassid population exceeds ETL. Pre and post treatment jassids counts were taken by following standard procedure. The per cent reduction over control was calculated and efficacy of the ginger-garlic- green chilli extract was worked out.

In first spray, the jassid population in the pre-treatment count ranged from 6.21 to 6.78 nos. /3 leaves. Whereas, in post treatment count the jassid population was less (3.08 nos./3 leaves) in 5% each of ginger, garlic and green chilli extract sprayed plots which was on par with NSKE 5% applied treatment followed by garlic extract 5% applied plot with the jassid count of 3.84 nos. / 3 leaves. The percent reduction over control was more (53.85) in ginger-garlic-green chilli each 5% applied treatment followed by NSKE 5% applied treatment (50.74).

In second spray, the jassid population in the pre-treatment count was less when compared to the first spray count and the numbers ranged from 3.08 to 7.26 nos. / 3 leaves. Whereas, in post treatment count the jassid population was also less (1.73 nos. /3 leaves) in 5% each of ginger, garlic and green chilli extract sprayed plots which was on par with NSKE 5% applied treatment followed by garlic extract @ 5% applied plot with the jassid count of 1.71 nos. / 3 leaves. The percent reduction over control was more (58.89) in ginger-garlic-green chilli each 5% applied treatment followed by NSKE 5% applied treatment (51.33).

The ginger, garlic, and green chilli extract (5%) application produced the highest cotton kapas yield (2446 kg/ha), followed by the NSKE 5% application (2329 kg/ha). The untreated check only got 962 kg of cotton per hectare. The application of NSKE 5% had the greatest BCR (2.12), followed by the application of garlic extract (2.01). (1.74).

According to the study, foliar application of a cow urine-based ginger, garlic, and green chilli extract (5%) was successful in controlling cotton jassids in an organic environment, and it may be the best alternative to NSKE.

OP 18

Evaluation of integrated pest management packages against sucking pests under high density planting system in cotton

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Cotton is grown as a staple cash crop in India and being attacked by an array of insect pests from sowing to harvest, which results in severe yield loss. The concept of high density planting systems in cotton has succeeded in the farmer's dwelling to increase the productivity per unit area. Under high density planting systems, insect pests are considered an important biotic stress, particularly sucking pest complex. Field experiments were conducted at Cotton Research Station, Veppanthattai, Tamil Nadu during *Rabi* season 2019-20 in high density cotton planting system (60 x 15cm). The treatments were structured with four different IPM package in different plots with the variety TVH 002. The sucking pest *viz*., leafhoppers, thrips, whitefly, aphids and natural enemies were recorded along with yield parameters. Among different treatments, leafhopper mean population was low in the T_2 treatment [Seed treatment with *Beaveria bassisana* @ 10 g/kg of seed + soil application of neem cake @ 250 kg/ha + yellow sticky trap @ 40 nos./acre + release of green lacewing @ 1 lakh eggs/ha at 30 DAS + need based spray of Dinotefuran 20 % SG@ 150 g/ha or Flonicamid 50% WG @ 150 g/ha or azadirachtin 10000ppm @ 1 lit./ha] after the first spray compared to other treatments. The per cent reduction over T_4 (control plot without any IPM module) was 65.14 per cent. After first spraying, the lowest thrips population was recorded in T_2 (2.38 nos./ 3 leaves) followed by T_1 module (2.97 nos./ 3 leaves). Control plot had maximum thrips population (7.11 nos./3 leaves). The aphid population was also reduced in T_2 module, with a reduction of 66.39 per cent. Whitefly population was low in T_2 plots (1.63nos./3 leaves) with 63.37 per cent reduction. Yellow sticky traps kept in T_2 treatment plots recorded the maximum population during October second fortnight with 17.4 no./ trap and afterwards it showed in declining trend. The population of predatory coccinellid was high in control plots (0.56/plant) followed by T_2 IPM module (0.40/plant). The overall mean data of different sucking insects revealed that T_2 IPM package had lowest population of sucking pests. The coccinellid population was more in the untreated control plots but there was no significant difference among IPM plots. The maximum yield was recorded in T_2IPM imposed plots with 19.46 q/ha.

OP 19

Assessment of mirid bugs damage in cotton ecosystem of Tamil Nadu

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India's Bt cotton production area was 123 (95%) out of 129.57 lakh ha during the year of 2021 and 371 lakh bales of seed cotton were obtained from the total cultivated area. India depends heavily on cotton exports, but the country consistently suffers yield losses due to insect pests. Mirid bugs, a type of insect pest, are becoming a problem because they are immune to the Bt toxin. The potential damage caused by the mirid bug in Tamil Nadu was evaluated by conducting roving surveys at square and boll formation stages in the state's major cotton-growing districts (Coimbatore, Erode, Salem, Attur, Perambalur, and Kallakurichi) in three chosen fields for each district. In each field on 20 randomly chosen plants @ 5 randomly selected squares per plant mired damage was assessedAs mired adults and nymphs damage squares and bolls by sap sucking. Mirids eat squares' ovules, pollen sacs, and peduncles. Feeding on a flower bud causes yellow fluid to ooze from the buds and stain the bracts and bud tip. Mirid damage the developing anthers also. Deformed bolls due to infertilization of some ovules in an ovary led to malformed boll development, is called "parrot beaking." Damaged ovules and anthers/pollen sacs turn in to brown colour. In the case of Infestation on tender bolls, black patches develop on their rinds. Also noted were square and boll shedding. When assessing the damage, aforementioned factors were taken into account. The number of squares and bolls displaying symptoms of parrot beak were used to arrive the damage percentage. According to the survey results, all the districts surveyed viz., Coimbatore (26.35%), Erode (24.98%), Salem (28.42%), Attur (18.42%), Perambalur (28.60%), and Kallakurichi (30.2%) were affected.

OP 20

Influence of weather factors on seasonal incidence of whitefly complex on cotton in Tamil Nadu

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Cotton is one of the world's largest and most important cash crops. Insect-pest damage is one of the most significant causes of low productivity. The current research was undertaken to determine the correlation between whitefly population dynamics and weather factors from January to August 2021 at two seasons (winter and summer), respectively. The main objectives of the studies are to observe the whitefly population dynamics and correlate them with various weather factors. The results showed that the peak population of whiteflies was recorded in the 9th SMW with a population of 9.80 nos./3 leaves in January 2021 and the 31st SMW of August 2021 (8.93 nos./3leaves). According to simple correlation analyses, the whitefly population was positively correlated with minimum temperature, maximum temperature, and minimum relative humidity in 2021 and negatively correlated with rainfall. Information on population dynamics in relation to current meteorological parameters is required for the development of a weather-based pest forecasting system. Predicting the peak period of pest activity can help us develop effective management strategies that will lead to an increase in productivity.

OP 21

Potential survival of life stages of cotton stem weevils under different stacking condition

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Cotton *(Gossypium hirsutum)* is one of the most economically important agricultural crops and yields the most valuable product fibre for the textile industry. The potential survival of mean life stages viz., larval, pupal and adult was studied under different stacking conditions. Treatments are cotton stalks heaped (T1), Sprinkling of water once in every 5 days (T2), Sun drying of cotton stalks (T3) and Cotton stalks in submerged condition (T4). The treatment of sun drying of cotton stalks (T3) recorded mean minimum survival of larval, pupal and adult at 10, 20, 30 and 40 Days after stacking (DAS) was 37.62%, 28.43%, 26.92% and 19.97% respectively, whereas mean maximum survival of 73.07, 65.70, 58.38% and 49.22% was obtained with sprinkling of water once in every 5 days (T2) at 10, 20, 30 and 40 DAS respectively. The results indicated that, when compared to the other treatments, sun-dreying cotton stalks expressed the best results.

OP 22

Sudden wilt - An emerging stress in cotton crop in Punjab

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Cotton is the world's leading fiber crop, popularly known as the "White Gold," and is an important *Kharif* crop of the South-western Region of Punjab. The production and productivity of cotton crop is influenced by the biotic and abiotic factors, arises due to the sudden changes in weather conditions, have now becomes an emerging researchable issue in cotton belt in Punjab. In the South-Western region of Punjab, the incidence of Para wilt is very common and considered a significant reason forthe lowering of cotton yield. Additionally, a new form of wilt or senescence popularly known as the "Sudden wilt" or "Sudden senescence" has been widely noticed in Fazilka and Bathinda districtsin the last few years. The Sudden wilt was widely noticed during 2018-19 in Fazilka district, when its adverse effects were observed during the full bloom of flowering and boll for mation period of cotton. The problem of sudden senescence of the cotton crop or wilt disease-like symptoms usually appearsafter100-120 days old crop during the month of August-September. When weather is hot and humid and night temperature are comparatively low. If this condition persisted for a long time and further followed by rain and temperature fluctuations, sudden senescence of the cotton crop or sudden wilt like symptoms starts to appear in the field. The problem of sudden wilt is generally noticed in the high yielding *Bt* cotton hybrids raised in field where the cotton crop was cultivated for a long-time. Therefore, the field trials were conducted at PAU's Regional Research Station, Bathinda, to manage the sudden wilt in the *Bt* Cotton hybrid, *viz.* RCH 773 BG II using novel micro and nano-formulations. The surface soil samples of the studied fields were also collected and analyzed for basic soil properties. The pH of the experimental soils ranged from 8.03 to 8.15, EC from 0.028 to 0.035 dS m^{-1}, soil organic carbon from 0.200 to 0.268%, available nitrogen from 87.8 to 102.4 kg ha^{-1}, available phosphorous from 2.18 to 7.32 kg ha^{-1}, and available potassium 120 to 268 kg ha^{-1}.

Among the 12 treatments studied, Nano selenium@10 ppm has shown encouraging results in managing the Sudden wilt in cotton compared to the other treatments. More than 90 per cent of the Sudden wilt affected plants were recovered after 4-5 sprays (starting after 60 days after sowing) of Nano selenium@10 ppm.

OP 23

Detection of cotton leaf curl virus strains and associated DNA satellites in the cotton belt of Punjab

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Cotton leaf curl disease (CLCuD) is considered as a major threat to the cotton (*Gossypium hirsutum*) production in Punjab. It is caused by monopartite begomoviruses which are frequently associated with ssDNA satellites molecules, collectively called as cotton leaf curl associated begomoviruses (CABs). Survey was conducted in the different cotton growing districts of the South Western Punjab including Bathinda, Faridkot, Muktsar and Fazilka. In the present study, four CLCuD-begomoviruses and its satellites were characterized though rolling circle amplification (RCA) followed by PCR with universal primers pairs corresponding to coat protein (CP) gene. Pairwise sequence analysis revealed that CLCuD-begomovirus isolates from Bathinda (MW836809 and MW921474) and Abohar (MW921475) are the member of CLCuMuV-Rajasthan strain and Mansa isolate was found closely related to *Cotton leaf curl Multan virus* (CLCuMuV) species. All the betasatellite isolates characterized (MW855104, MW855105, MW855106 and MW855107) in this study were found closely related to a single species of *Cotton leaf curl Multan betasatellite* (CLCuMB). Two types of alphasatellites *i.e. Cotton leaf curl Multan alphasatellite* (CLCuMA) (MW921476) and *Gossypium darwani* symptomless alphasatellite (GDrSLA) (MW921477) were found to be associated with CLCuD in Bakainwala and Muktsar region, respectively. The betasattelites isolates from Ludhiana, Bakainwala and Faridkot showed the presence of major recombination event *via* RDP4 software.

OP 24

Management of soil-borne diseases (root rot and wilt) and disorders (parawilt) in cotton through antibiotics and ACC-deaminase producing fluorescent Pseudomonad strains

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Cotton (*Gossypium* sp.) the "White Gold" is an important cash crop of India which plays a vital role in the Indian economy. Various biotic (root rot and wilt diseases) and abiotic stresses (parawilt/drought) are the major constrains in cotton production. Microbe based biological control offer an alternative for the chemical control leading to management of both biotic and abiotic stress in ecologically sustainable manner.Plant-growth-promoting rhizobacteria (PGPR) particularly fluorescent Pseudomonads colonize the rhizosphere of many plant species and confer beneficial effects, such as increased plant growth and reduced susceptibility to diseases caused by various pathogens . The main objectives of the present study were (1) screening and characterization of the different fluorescent Pseudomonad isolates against the growth of root rot (*Rhizoctonia solani*) and wilt (*Fusarium oxysporum* f. sp. *vasinfectum*) pathogens *in vitro* and (2) testing the efficacy of talc-based formulation of the most effective fluorescent pseudomonad isolates individually and in combination against root rot, fungal wilt and para wilt and growth promotion and seed cotton yield. Thirty fluorescent pseudomonad isolates were isolated from rhizosphere soils of cotton collected from different locations of Tamil Nadu. Among the isolates screened, the isolate APKP4 and VPNP5 were significantly superior in inhibiting the mycelial growth of wilt and root rotpathogens followed by KYIP5 and SVLP1 and these isolates also showed the higher growth promoting activity in cotton seedlings and growth hormones like IAA and ACC deaminase. In the field experiments, the results revealed that the plots treated with the mixture of APKP4+VPNP5+KYIP5 recorded only 1.42,0.45 and 0.45% and 1.27, 0.00 and 0.00% incidence of root rot,fungal wilt and para wilt in the first and second season, respectively. The same treatment also recorded significantly higher seed germination (98.80 and 97.62%), plant height (127.2 and 130.2cm), no. of bolls/plant (53.93 and 57.93) and seed cotton yield (24.87 and 25.16 q/ha) in the first and second season, respectively than other treatments.

OP 25

Evaluation of the susceptible/resistant *Gossypium barbadense* lines to *Tobacco streak virus*(TSV) and thrips under natural conditions

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Necrosis disease caused by *Tobacco streak virus* (TSV) is the most devastating one. *Tobacco streak virus* (TSV) is the type species of the genus Ilarvirus, of the family Bromoviridae that includes viruses having tripartite quasiisometric particles of size 27 to 35 nm. TSV has wide host range, infecting more than 200 plant species belongs to 30 dicotyledonous and monocotyledonous plant families. TSV occurrence was reported from over 26 countries world wide.The symptoms developed due to TSV infection in cotton plant resembled almost similar to physiological or nutritional disorders and herbicide phytotoxicity which is very difficult to distinguish. The distribution of TSV in the germplasm of ELS cotton *Gossypium barbadense* for the period of two years 2017 to 2019 in Coimbatore revealed the per cent disease incidence varies from 5.81% (DB 3, DB 25) to 26.60 % (ICB 71). The most economical and convenient way to manage TSV is to grow resistant varieties. Screening of germplasm to explore resistant source is a basic step towards the solution of this hazardous virus problem. The same can be utilized in the breeding programme for evolving TSV tolerant/resistance varieties of cotton. Susceptible lines (94), Resistant lines (14) of *G.barbadense* were sown with control Suvin with augmented design. One row each of Bhendi (Hybrid Co4), Blackgram (Co6) and Chilli (Variety Bullet) were sown. Parameters like mean per cent TSV disease incidence and mean thrips population were observed. Biometric parameters like Plant height, No. of monopodial branches, No. of sympodial branches, No. of bolls/plant and Boll weight were observed both in the susceptible and resistant lines. The symptom expression in *G. barbadense* was very distinct with dark purple necrotic spots and drying of squares. The disease incidence ranges from in susceptible lines: 11.5 to 27.5 %. The disease incidence ranges from in resistant lines: 3.2 to 10.0%. The mean thrips population ranges from 1.3 to 11.3 in both susceptible and resistant lines. Correlation derived was significant with negatively correlated: -

0.07. There is no any significant difference in the biometric parameters like Plant height, No. of monopodial branches, No. of sympodial branches and Boll weight in both susceptible and resistant lines. Wherein the parameter No. of bolls/plant was found to be more in resistant lines when compared to the susceptible lines. This is due to drying of squares observed in susceptible lines which reduced the no. of bolls in the plants alternatively resulted in reduced yield.

OP 26

Bio prospecting of *Streptomyces* sp for combating bacterial blight of cotton

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Cotton is an important cash crop grown in India which plays a vital role in Indian economy. Cotton is vulnerable to many diseases. Among these, bacterial blight caused by *Xanthomonas citri* pv. *malvacearum* was the major limiting factor which reduced the crop yield up to 50 per cent. Studies were carried out at Department of Plant Pathology, TNAU, Coimbatore to identify the most effective *Streptomyces* sp. against bacterial blight of cotton. A total of 45 actinobacterial isolates were collected from cotton rhizosphere and screened for their *in vitro* antagonism against bacterial blight of cotton. Out of these, six isolates showed more than 18 mm inhibition zone against the pathogen were selected for further studies. Morphological, biochemical characterization was done. Molecular characterization was performed using specific primer with the amplicon size of 620bp. Sequencing of the effective six isolates followed by BLAST analysis confirmed all the isolates as *Streptomyces* and the accession number were obtained. The growth promotion activity of six effective *Streptomyces* isolates were tested by roll towel method in cotton and the results revealed that all the isolates were competent in promoting root length and shoot length of cotton plants. All the six isolates were tested positive for siderophore, cellulase, protease and amylase. Based on the *in vitro* inhibition of *X. citri* pv. *malvacearum* and growth promotion the best isolate *S. rochei* CS29 was selected and formulated as liquid formulation. The formulation was evaluated for its efficacy against bacterial blight of cotton under glass house condition. The results revealed that the seed treatment with *S. rochei* CS29 @10 ml/kg of seed + foliar spray @ 10ml/l of water recorded the lowest bacterial blight incidence of 18.0 PDI as against 49.0 PDI in control. This accounted for the disease reduction of 63.2 per cent. The growth promoting actinobacteria *viz.*, *S. rochei* CS29 can be effectively exploited for the ecofriendly sustainable management of bacterial blight in cotton.

OP 27

Factorial analysis of the constraints faced in the cotton production in cotton belt of Punjab

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Cotton remained as the most important cash crop in Punjab. Highly sensitive cotton crop is prone to abrupt biotic and abiotic factors over the period of time in the cotton belt of Punjab. Cotton leaf curl virus disease outbreaks were reported in 1993 and 1996. During 2009 and 2012, this problem was found very severe in Ferozepur, Muktsar, Faridkot, Abohar and Fazilka districts of Punjab. In 2015, the whitefly epidemics occurred in Punjab. During 2022, Pink boll worm attacked quite at initial stages along with the whitefly infestation that lead to sooty mould and cotton leaf curl virus disease incidence up to 100 per cent in most of the fields. The dry weather prevailed during the sowing period of cotton in *Kharif* 2022 caused poor germination, mortality of the seedlings, scorching of the leaves ultimately resulting in stunted growth and stressed flowering and droppings in the cotton crop.

Monitoring and regular surveillance of the cotton crop during the last 3 years (2020 to 2022) in cotton belt of Punjab highlighted some important undisclosed issues that caused adverse impact on production and productivity of cotton in Punjab. During *Kharif* 2022, the study reported 92.09 percent area were with non recommended *Bt* cotton hybrids while 7.91 percent under un-recommended *Bt* cotton hybrids compared to 100 percent recommended *Bt* hybrids during previous years. Procurement of non-recommended 4G/5G *Bt* cotton seeds from unauthorized source in Gujarat was the main reason. In addition to this, 66 per cent farmers are using higher seed rate of *Bt* cotton hybrids during 2021, while 95 per cent in 2022 which proved uneconomical. None of the farmers soaked seed before sowing which is pre-requisite for good germination and plant stand. The cotton crop remained under fed over the years. Study revealed that in *Kharif* 2022, 40 per cent farmers applied Nitrogen, 55 percent Phosphorus and 40 per cent Potash as per the recommended dosages while rest are using lower rate of these fertilizers, respectively. Further, none of the farmers applied the recommended dose of Zinc sulphate while 83.75 percent used Potassium nitrate and 96.25 per cent applied Magnesium sulphate below recommendation to cotton crop. This reduction is maximum compared to previous years.

In case of pesticides use, farmers are found to be more dependent on Pesticides dealers compared to the Agricultural scientists. Thus giving more application of tank mixed insecticides or readymade mixtures of insecticides as compared to previous years. The number of neglected cotton fields are found to be maximum in kharif 2022 as compared to the previous years and interest of the farmers towards cotton cultivation is declining. Number of pesticide sprays are also found to be increased progressively. The *Kharif* 2022 crop have faced maximum number of biotic and abiotic stresses that may lead to the reduction in cotton yield not only in Punjab but in the adjoining states. Though the average price of cotton has increased from Rs.5175 per quintal in 2019 to Rs.7417 per quintal in 2021, the overall returns from cotton has decreased Rs.50197 to Rs.38123 per acre during this period.

Theme Area 1

Crop Improvement and Biotechnology

PP 01

Genetic variability studies in F_4 segregating population of naturally brown coloured upland cotton (*Gossypium hirsutum* L.)

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Cotton, the king of fibres, is the most fundamental raw material for textile industries worldwide. The cotton fibre with accumulated pigments in lumen is called naturally coloured cotton. The naturally coloured cotton eliminates the process of dyeing in fabrics. Despite the economic and ecological benefits, commercial cultivation of naturally coloured cotton is very limited by the farmers because of few drawbacks. The most important among them is the low quality fibres. The fibre colour is negatively correlated with fibre yield and quality. The development of fibre colour in cotton is genetically controlled. The brown colour reported to have dominant heredity. The inheritance study of fibre colour will enable us to determine the gene action involved in lint colour which could be utilized in developing coloured varieties by crossing white linted with colour linted lines. In order to improve the quality of the colour cotton, direct and reciprocal hybridization was made between colour cotton genotype Parbani American with ELS white cotton variety MCU 5 at Department of Cotton, Coimbatore. The F_4 families of two cross combinations *viz.,* Parbani American x MCU 5 and its reciprocal cross were selected based on lint colour and fibre length (UHML) of more than 27 mm and were sown during Winter 2021 for the selection of desirable segregants with colour and superior fibre quality traits. Harvesting was done based on color intensity and fibre quality analysis was done in coloured progenies. The study's main goals were to assess the genetic variability, as well as heritability in the broad sense and genetic advance in coloured lint progenies. Such knowledge may be used to formulate an effective selection strategy for the synthesis and development of novel colour cotton genotypes with better fibre quality attributes and a wide genetic base. The qualitative traits *viz.,* upper half mean length, fibre strength and micronaire values were observed to have moderate PCV and GCV, high heritability and high GAM for the cross MCU 5 x Parbani American but its reciprocal cross showed low PCV and GCV, high heritability and moderate GAM for UHML. Micronaire value was noted to have

high PCV, high GCV, high heritability and GAM for the cross Parbani American x MCU 5. High PCV and GCV indicated the presence of significant variability for these traits. Selection pressure can be applied on such traits to isolate promising genotypes. High heritability coupled with high genetic advance as per cent of mean indicates that heritability is most likely due to additive gene effects and selection for the traits is effective in the cross MCU 5 x Parbani American. Both the F_4 populations exhibited highly significant differences for all the three fibre quality traits. Almost all the traits were highly heritable having prominent broad sense heritability with moderate to high genetic advance which can be utilized for improvement in future breeding programs.

PP 02

Selection parameters for the improvement of for seed cotton yield and fibre properties in upland cotton

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An experiment was carried out at Cotton Research Station, Srivilliputtur, Tamil Nadu Agricultural University during winter 2018 with twenty F_1 hybrids developed in a Line x Tester fashion and twelve parents to estimate gene action, combining ability and standard heterosis for sixteen traits in *hirsutum* cotton. All the traits studied exhibited greater SCA variance than GCA suggesting that these traits are controlled by dominant gene action. Among the parents used, the line TSH 330 was identified as good general combiner for most of the fibre traits and tester RAH 1017 as good combiner for seed cotton yield along with other testers Suraj, SVPR 5, TSH 0499 for most of fibre properties. The hybrid TSH 330 x RAH 1017 was the best hybrid for seed cotton yield and TSH 330 x GISV 310 hybrid for fibre properties like upper mean half length, bundle strength and fibre fineness and these would be well suited for exploiting heterosis breeding. The cross combinations TSH 330 x RCH 1217 for upper half mean length and fibre fineness and TSH 330 x GISV 310 for fibre fineness and fibre elongation percentage could be further forwarded. The hybrid TSH 330 x SVPR 5 is also recommended for recombination breeding for exploitation of the traits like bundle strength and fibre fineness. Hybrid KC 3 x CPD 1601 was the best hybrid combination and could be suggested for recombination breeding for earliness followed by TSH 330 x Suraj for boll weight, KC 3 x RCH 1217 for seed index, TSH 330 x TSH 0499 for uniformity index as they expresssed non-significant *sca* effects for hybrid and significant *gca* effects for respective parents.

PP 03

Correlation and path analysis for seed cotton and yield component traits in cotton (*Gossypium hirsutum* L.)

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In cotton, thirteen genotypes were studied to assess the association between seed cotton yield and yield contributing traits. The correlation co-efficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be imposed for genetic improvement in yield. In correlation study, among the yield contributing traits, plant height possessed highly significant positive correlation with seed cotton yield followed by number of sympodial braches per plant, number of bolls per plant and boll weight. Regarding inter correlation of the yield components, boll weight recorded highly significant positive correlation with plant height and number of sympodial branches per plant. Number of sympodial branches recorded highly significant positive correlation with plant height.The path analysis study indicated that plant height showed the highest positive direct effect on yield followed by number of sympodial branches per plant and number of bolls per plant. While selecting the genotypes for breeding programme for crop improvement in cotton, the traits namely plant height, number of sympodial branches per plant, number of bolls per plant and boll weight should be given importance.

PP 04

Correlation and path analysis in cotton (*Gossypium hirsutum* L.)

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Seed cotton yield is a dependent character which is of economic value. Correlation and path coefficient analysis have been worked out for 16 characters *viz.,* days to first flowering,days to 50 % flowering, plant height, number of monopodia/plant, number of sympodia/plant, number of bolls/plant, boll weight, seed index, lint index, ginning percentage, upper half mean length, bundle strength, fibre fineness, uniformity index, fibre elongation percentage and seed cotton yield (kg/ha)with a set of 32 genotypes of upland cotton during winter 2018 at Cotton Research Station, Srivilliputtur, Tamil Nadu Agricultural University, India.The correlation study revealed that seed cotton yield was found to be positively and significantly correlated with traits *viz.* number of monopodia/plant, boll weight, upper half mean length and bundle strength. Further partitioning of correlation coefficients into direct and indirect effects revealed that days to 50 per cent flowering, plant height, bolls/ plant, seed index, lint index and bundle strength showed direct positive effects on seed cotton yield. Hence selection for these traits would be quite effective to improve the seed cotton yield.

PP 05

Assessment of upland cotton cultures for yield potential under rainfed condition

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Seven advanced cotton cultures along with six checks namely SVPR6, CO14, KC3, RCH659NBt, BGDS1063 and MCU5 were evaluated to assess its yield potential at Regional Research Station, Aruppukottai under rainfed situation during Rabi 2021-22. Experimental materials were raised in three replications in a randomized block design (RBD) with each culture in six rows of 6.3m length and with a spacing of 100cm between rows and 45cm between plants. Recommended agronomic practices and need based plant protection measures were followed to obtain good crop stand. Among the cultures evaluated, the culture TSH387 registered significant seed yield (1622 kg/ha) than the check variety RCH659NBt (1534 kg/ha) followed by the cultureTCH1999 (1605kg/ha). Highest bolls/plant was recorded by the entry TSH387 (56.1) and boll weight was registered by the check RCH659NBt (5.3g).

PP 06

Investigating the genetics of Lintless-Fuzzless genotypes of upland cotton (*Gossypium hirsutum*.L)

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Cotton often known as white gold is the most widely used seed fibre in the world and is as ancient as human civilization. There has been no decline in the importance of cotton over years and prevails as a crop of choice. Still it is recognized as the King of fibres and holds an important position in the textile industry by supplying the prime raw material for the industry. Cotton fibres arouse from single-celled seed trichomes derived from the outer epidermis of the ovule. Cotton fibres can be classified as lint which is ginned off and as linter (fuzz) which remains on the seed after ginning. Differences in these fibres arise due to their temporal difference in fibre initiation after anthesis. Lint fibres are very long, fine, spinnable and fabricated to high-quality textiles whereas linter is very thin, short cylindrical fibres attached to the seed coat. The proportion of fuzz to lint fibre per seed also determines the value of a cultivar on a commercial scale. Thus, it becomes imperative to understand the genetics of lint and fuzz development and to design high-yielding linted-fuzzless varieties which would reduce both ginning time and energy. Hybridization between high yielding cultivars with fuzzless mutants provides an opportunity to develop combinations like fuzzless – linted, fuzzy-lintless, fuzzy-linted and fuzzless-lintless types which would enhance the understanding of the inheritance of fuzz and lint. Delineating gene action for fuzzlessness (with or without lint) will help to choose a breeding strategy to incorporate this trait. Moreover, cottonseed, which is a byproduct, is generally considered as an important source of healthy vegetable oil. The fuzzless cottonseed is reported to be a more potential oil donor compared to fuzzy genotypes. Thus, generation of a high-yielding linted-fuzzless type and a lintless fuzzless type would serve the needs of fibre and oil industries respectively in the near future.

PP 07

Jassid screening in F_2 population of upland cotton

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An inheritance study was conducted for under studying jassid resistance in eight F_2 crosses. Inheritance pattern of genes responsible for resistance to jassids in cotton could be identified by genetic analysis. The F_2 population showed segregation for resistance and susceptibility based on the injury level. Individual plants were grouped based on the grading scale from 1 to 4 for cotton leafhopper infestation. Segregating populations are used to decipher the genetics of traits. In all the crosses, the probability values (p) in chi square tests were more than 0.05. This indicated that all the crosses fit either 13:3 or 15:1 expected ratio at a significance level of α=0.05. The crosses *viz.,* MCU5 x KC 3, CO 14 x KC 3, CO 14 x KC 2 and CO 14 x RHC 1409 were fitting satisfactorily into the segregation ratio 15:1 (15 susceptible and to 1 resistant type plant). From this ratio, it is evident that when either gene is dominant, it hides the effects of the other gene which was also mentioned that duplicate dominant epistasis. For the remaining crosses namely TCH1828 x KC2, TCH 1828 x GTHV 15-34, CO 14 x GISV 323 and CO 17 x KC 3, they fit in 13:3 segregation ratio (13 susceptible to 3 resistant type of plants). This gene action is referred as inhibitory gene action. The calculated Chi-square value was less than the table chi-square value at level of significance (0.05) with degree of freedom (1) indicating non-significant results in all the crosses.

PP 08

Variability, heritability and genetic advance in upland cotton (*Gossypium hirsutum* L.)

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Cotton is an important fibre crop of global importance which is grown in around 32–36 million-hectares area of tropical and northernmost agricultural latitudes in over 80 countries of the world to fulfill the current global needs of humanity for the natural fiber. The significant fluctuations in world cotton production, consumption and decreased yields require world cotton science to pursue new research directions and develop innovations to substantially increase and stabilize cotton production worldwide. Innovations on increasing yield with the improvements of fiber quality without affecting the maturity and other key agronomic traits are the key challenges faced by the cotton research community. Keeping this in view, fourteen entries of upland cotton (*Gossypium hirsutum* L.) were evaluated in Randomized Block Design with three replications for seed cotton yield and its attributing traits at Regional Agricultural Research Station, ANGRAU, Lam, Guntur, Andhra Pradesh during 2021-22. Biometrical observations were recorded on plant height (cm), number of monopodia, number of sympodia, number of bolls per plant, boll weight (g), seed index (g), ginning out turn per cent, seed cotton yiled (kg/ha) and lint yield (kg/ha). The analysis of variance study indicated the presence of significant difference among all the traits in *Gossypium hirsutum* accessions. Phenotypic co-efficient of variation values were higher than genotypic co efficient of variation. The highest phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) as well as high heritability coupled with high genetic advance were recorded for seed index, lint yield, plant height and number of bolls/plant. The combinations of high heritability with high genetic advance will provide a clear base on the reliability of these particular characters in selection of variable entries. Based on *per se* performance, the entries L2240, L2234, L2236, L2238 and L2237 were identified as potential entries for seed cotton yield (kg/ha) with high ginning out turn per cent, number of bolls per plant and boll weight (g). Hence, these entries may be utilized for crossing programme to improve a particular character in crop improvement.

PP 09

Variability and heritability studies in F_2 population of upland cotton (*Gossypium hirsutum* L.)

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Cotton is an important fibre crop grown in India. It is often cross-pollinated crop in which large amount of variation is observed for many important traits.The variances in segregating population is assessed through phenotypic and genotypic variances. The variance in segregating population of four crosses *viz.,* CO 17 x KC 2, TVH 002 x KC 3, TVH 002 x RAHC 1039 and TCH 1894 x NDLH 32 was evaluated using phenotypic and genotypic variances for all the traits, the environmental variance was lower than the phenotypic and genotypic variance. Higher PCV and GCV were observed for number of monopodia per plant and boll weight in all the crosses. Low PCV and GCV were observed for ginning outturn, upper half mean length, uniformity ratio, days to first flowering and elongation percentage in all the four crosses. Moderate PCV and GCV were recorded for seed index in all the crosses.Single plant yield showed high PCV and GCV in the crosses CO 17 x KC 2 and TCH 1894 x NDLH 32. Plant height had additive gene action in all the crosses. The internode length and number of bolls per plant had additive gene action in the cross CO 17 x KC 2. Number of sympodia per plant had a high environmental influence in CO 17 x KC 2 and TVH 002 x RAHC 1039 crosses. Boll weight had shown additive gene action in all the four crosses. Single plant yield was highly influenced by environment in all the crosses but was selectable in the crosses *viz.*, CO 17 x KC 2 and TCH 1894 x NDLH 32.

PP 10

Analysis of genetic variability and genetic diversity in *Gossypium arboreum* germplasm

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A total of 150 indigenous *arboreum* cotton germplasm lines with five check varieties were used in the present study to assess the genetic variability and diversity for yield and fibre quality traits at Department of Cotton, Centre for Plant Breeding and Genetics, Tamil Nadu Agriculture University, Coimbatore during *kharif* 2019. Genetic variability studies indicated high PCV and GCV for the traits plant height, number of monopodia, single plant yield and lint index. High heritability coupled with high genetic advance was observed for plant height, number of nodes, number of bolls, number of monopodia, boll weight, single plant yield, lint index and 2.5% span length suggesting the prevalence of additive gene action in inheritance of these traits. Correlation studies revealed that single plant yield had highly significant positive correlation with number of bolls, number of monopodia, boll weight, seed index, ginning outturn and elongation percentage. PCA analysis of 17 quantitative traits showed that first five principal components exhibited more than 1.0 eigen value and contributed about 71.53 % to total variability. It was found that most of the important yield attributing traits was captured by PC1 and PC3, while important fibre quality traits were captured in PC2. Hierarchical clustering analysis resulted in formation of five major clusters among which cluster IV had the largest number of 81 genotypes, followed by cluster I, cluster III and cluster V. The information obtained from this study will be useful in *desi* cotton breeding program to enhance fibre quality and yield.

PP 11

Inheritance studies in upland cotton (*Gossypium hirsutum* L.) for leafhopper resistance

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One of the most significant cash crops in India is cotton which is regularly infested by more number of sucking pests. These sucking pests decreases the yield by 28%. For the control of insect pests, farmers rely on chemical insecticides. Cotton was sprayed with 54% of the pesticides in India. Health risk along with insect resistance, resurgence of secondary pests, environmental pollution and the eradication of natural enemies are the consequences of the widespread use of chemical insecticides. In order to control insect pests, alternative methods of insect control should be used. Host-plant resistance is one of the most significant, affordable and environmentally friendly methods of pest management. Varieties against sucking pests has been reported by earlier workers.The inheritance study was conducted for Jassid screening in four F_2crosses.The F_2 population exhibited segregation for resistance and susceptibility based on injury grade. Individual plants were classified according to a scoring system of 1 to 4 for cotton jassid infestation. The probability values (p) in chi square tests were greater than 0.05 in all crosses. At a significant level of =0.05, all the crosses fit in either the 13:3 or 15:1 ratio. It was found that the crosses MCU5 x KC 3, MCU5 x NDLH 1755 was fitting satisfactorily into the segregation ratio 13:3(13 susceptible and to 3 resistant plants). The crosses CO 14 x NDLH 1938 and CO 17 x NDLH 1755 were fitting satisfactorily into the segregation ratio 15:1 (15susceptible and to 1 resistant plant). Only genetic study might reveal the inheritance pattern of genes responsible for resistance.

PP 12

Development of high polymorphic SSR markers for Jassid resistance screening in upland cotton (*Gossypium hirsutum* L.)

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A key component of pest control is the creation of pest-resistant cultivars. Host-plant resistance, refers to the resistance mechanism connected to morphological or structural plant traits that impede normal insect feeding or oviposition or increase the insect death. To keep the sucking pest below the economic threshold level, farmers must rely on insecticides. Alternative cotton types that produce high seed cotton with less sucking insect infestation are desperately needed to help farmers. Apart from morphological screening, genotypic screening for jassids paves way for reliable results for generation of resistant cultivars. Two of the cotton cultivars were subjected to on level investigation to ascertain their resistance level to Jassids. Thirty six primers were utilized for the genotypic studies for Jassid resistance in cotton. CO 14 and NDLH 1938 were used for the study. NDLH 1938 showed amplification for JESPR 154, SSR primer at 150 bp confirming the presence of hairiness trait. The same parents were confirmed cytologically for trichome length and density. Cytological studies also confirmed that NDLH 1938 parent confers resistance to Jassid with high trichome density compared with CO 14 parent.

PP 13

Genetic studies on yield, fibre quality and other related traits in the interracial and inter specific derivatives of cotton (*Gossypium* spp.)

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An investigation was taken up towards the identification of potential parents and superior cross combinations having superior yield and fibre quality attributes in cotton. Twelve cotton derivatives of wild and racial cotton were crossed in all possible combinations excluding reciprocals. Sixty six F_1 hybrids and F_2 families thus generated were evaluated along with their parents. Eleven characters *viz*., days to first flowering, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield per plant, ginning outturn, 2.5 per cent span length, uniformity ratio, fibre fineness, bundle strength and elongation per cent were considered for the study. The *gca* variance was observed to be greater in magnitude than *sca* variance for all the traits indicating the preponderance of additive gene action. Amon the parents studied, *palmeri* der. 2 and *palmeri* der. 3 were good general combiners for yield and yield components, number of sympodia per plant, number of bolls per plant, boll weight, seed cotton yield as revealed from F_1 and F_2 generations. The parent *thurberi* der. 2 is good for quality characters like bundle strength and elongation per cent. The *sca* effects revealed that cross combination PD 2×PD 3 for six characters, TD 2×AD 1 for five characters and the hybrid PD 1×PD 2 for five characters and PD 2×AD 3 for fibre quality characters could be exploited for improving these particular traits. Crosses which recorded high *per se* performance also registered high *sca* effects in general. The study also indicated that crossing of good general combiners does not necessarily result in best combinations, nor low × low cross always resulted in poor combination. On the basis of *per se* performance, *sca* effects and heterosis and inbreeding depression, the crosses namely PD 2 × PD 3, PD 3 × TD 2 and RD 2 × RD 3 could be acclaimed as the best crosses for most of the traits and could be used for further exploitation.

PP 14

Development of eco-friendly colour cotton varieties with high yield and fibre quality through induced mutagenesis

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The interest on evolution of ecofriendly colour cotton is attracting the textile sector in the recent years and the available colour cotton varieties are poor in yield and fibre quality. The environmental pollution will be very much reduced if dyeing and bleaching process are circumvented by use of naturally colour linted cottons. An attempt was made to induce genetic variability for fibre length, strength and yield in colour cotton varieties with retention of colour. Four brown linted lines (Lousiana brown, Nankeen brown, Russian brown and *Hirsutum* Tashkent) and two white linted promising varieties (MCU 5 and MCU 12) were included in this study. Parental seeds and the F_1's synthesized using these parents were exposed to irradiation at 200, 250 and 300 Gy. A total of 129 gamma treated (200, 250 and 300 Gy) selfed plants from M_1 generation of colour cotton varieties *viz.*, Nankeen Brown and Lousiana Brown and 249 treated (200, 250 and 300 Gy) single plants of F_1M_1 generation from the crosses Lousiana Brown x MCU 5, Lousiana Brown x MCU 12, Nankeen Brown x MCU 5, Nankeen Brown x MCU 12, Russian Brown x MCU 12 and *Hirsutum* Tashkent x MCU 12 were raised as M_2 and F_2M_2. The parents were also raised along with the treatments for effective comparison. Results of the present study indicated that irradiation increased the variability in M_2 / F_2M_2. The average yield per plant (g) ranged between 70.6 (Lousiana Brown, 200 Gy) to 275.0 (Lousiana Brown, 250 Gy) in M_2 and the highest single plant yield (246.0 g) was noticed in Nankeen Brown x MCU 5 (200 Gy) among the F_2M_2. The germination reduced with increase in dose in F_1 and F_1M_1. Among the mutants, monostem and big boll mutants were identified. The variation in lint colour was noticed in M_2 / F_2M_2 generation from light brown to dark brown. While considering the fibre properties, the span length (mm) ranged between 18.3 (Nankeen Brown, 200 Gy) to 29.1 (Nankeen Brown, 250 Gy) in M_2 and18.2 (Russian Brown x MCU 12, 200 Gy) to 30.7 (Lousiana Brown x MCU 5, 250 Gy) in F_2M_2 and bundle strength (g / tex) from 12.7 (Nankeen Brown, 200 Gy) to 20.1 (Lousiana Brown, 200 Gy) in M_2 and 13.2 (Lousiana Brown x MCU 5, 200 Gy) to 21.4 (Lousiana Brown x MCU 5, 250 Gy) in F_2M_2. Single plants with brown lint colour, better fibre and high yielding were selected for further studies.

PP 15

Yield stability evaluation of promising cotton genotypes (*Gossypium hirsutum* L.) by GGE biplot analysis

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Seed cotton yield is a complex polygenic trait subject to changing environmental conditions. Cotton genotypes perform differently in different areas especially in highly variable environmental conditions. These conditions reduce their yield stability. Further, it complicates selection procedures for important traits under different environments. It also leads to unpredictable outcome during genotypes evaluation for yield and related traits at multi-locations over the years due to G × E interaction. It is very important to find superior stable genotypes and their adaptation in diverse agro climatic conditions. Hence, yield stability appraisal is a good selection parameter that classifies the genotypes as narrow base or wider adaptability. This study was planned to evaluate suitability and yield stability of twenty five newly developed cotton advanced lines along with two checks *viz.*, CO 14 and MCU 13 and the crop was raised during 2019-2021. Yield data were analyzed using the GGE biplot method. According to the results of combined analysis of variance, genotype × environment interaction was highly significant, where G and GEI captured 60.3% of total variability. The first two principal components (PC1 and PC2) explained 68% of the total GGE variation with PC1 and PC2 explaining 60.3 and 23.7 respectively. Among three environment (seasons), each of the season comes under three separate mega environment. The first mega environment contains E2 with TCH 1999 (1691 kg/ha) as a winner genotype. The second and third mega environment contains E3 and E1 with TCH 2000(1992 kg/ha) and TCH 2010(1888 kg/ha) as winner genotypes respectively. Mean performance and stability of genotypes indicated that genotypes TCH 2001 (1711 kg/ha), TCH 2004 (1742 kg/ha) and TCH 2008 (1743 kg/ha) were highly stable with high seed cotton yield.

PP 16

Studies on genetic variability, correlation and path analysis in interspecific cotton hybrids (*Gossypium hirsutum* L. × *Gossypium barbadense* L.)

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Genetic variability, Correlation and path coefficients analysis were estimated using fifteen biometrical traits in twenty four interspecific cotton (*Gossypium hirsutum* X L. *Gossypium barbadense* L.) hybrids. The experimental study was conducted at Department of Cotton, Centre of Plant Breeding and Genetics (CPBG), Tamil Nadu Agricultural University, Coimbatore during *Summer*, 2020-2021. High PCV and GCV were noticed for number of monopodia per plant, number of sympodia per plant and ginning outturn. High heritability coupled with high genetic advance was obtained for majority of the traits except seed index, upper half mean length, uniformity ratio, bundle strength and elongation percentage which indicated the role of additive gene action. The genotypic correlation studies for fifteen biometrical traits revealed that seed cotton yield per plant confirmed significant positive association with plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, uniformity ratio, bundle strength and fibre fineness. Path analysis showed that number of bolls per plant, bundle strength and fibre fineness had very high positive direct effects. Number of bolls per plant, bundle strength and fibre fineness have to be considered for effective selection of the population to enhance the seed cotton yield per plant.

PP 17

Correlation analysis in the segregating population of upland cotton (*Gossypium hirsutum* L.)

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Cotton is grown worldwide for its fiber, cottonseed oil and meal for animal feed. It is grown under diverse agro-climatic conditions around the world. Cotton plays an eminent role in Indian economy in terms of creating direct and indirect employment opportunities in the agricultural and industrial sectors. A study was taken up using four F_2 segregating populations *viz.*, CO 17 x KC 2, TVH 002 x KC 3, TVH 002 x RAHC 1039 and TCH 1894 x NDLH 32 for performing correlation analysis between various quantitative traits. The mutual relationship among yield and fibre quality characters was measured through correlation coefficient which enables selection on positively correlated component characters that aid in genetic improvement. The quantitative traits recorded included days to first flowering, plant height, internode length, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, single plant yield, ginning outturn, seed index, lint index, upper half mean length, uniformity ratio, bundle strength, elongation percentage and fiber fineness. The crosses *viz.*, TVH 002 x KC 3 and TCH 1894 x NDLH 32 had a positive and significant correlation for number of sympodia per plant and seed index with single plant yield. The cross TVH 002 x RAHC 1039 had a significant negative correlation between uniformity ratio and single plant yield. In all the four crosses *viz.*, CO 17 x KC 2, TVH 002 x KC 3, TVH 002 x RAHC 1039 and TCH 1894 x NDLH 32, quantitative traits *viz.*, plant height, internode length, number of bolls per plant, boll weight and lint index had significant correlation with single plant yield. Hence selection of these traits will be beneficial to improve the yield.

PP 18

Generation mean analysis for fibre quality traits in cotton

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The choice of breeding strategy for obtaining desirable genetic improvement in any crop is determined by the nature and magnitude of gene action. In order to obtain genetic advancement for polygenic traits such as fiber qualities in cotton, it is necessary and important to have a thorough knowledge and understanding of gene interactions. This study was carried out to understand the genetic architecture of fibre quality traits in cotton. Fifty crosses were made by crossing 15 genotypes in a line × tester fashion (*Gossypium hirsutum* × *Gossypium barbadense*) and their parents were evaluated along with standard check hybrid TCHB 213 for ginning percentage, lint index, seed index, 2.5 per cent span length, fibre fineness, bundle strength, uniformity ratio, and elongation percentage. A six-parameter model of generation mean and variance analyses have done to estimate the epistatic effects in four different crosses; SVPR 4 x SUVIN, GJHV 97/6/2 × TNB 26, SVPR 3 × SUVIN and KC 2 × TNB 26.

The analysis of variance revealed a significant difference between the parents and crosses, and the combining ability analysis revealed a very significant difference for line x tester interaction. The proportionate contribution of hybrids and lines to total variance was greater for all the quality traits taken for this study, whereas testers contributed less to total variance. All the quality characters showed dominant gene action, supporting the use of heterosis breeding to maximize dominance gene action. Overall, the lines TCH 1710, SVPR 4, GJHV 97/6/2, SVPR 3 and the testers TNB 26 and SUVIN were the best parents for producing

hybrids with better fiber quality traits. Among the crosses studied, SVPR 4 × SUVIN and SVPR 4 × TNB 26 showed a considerable amount of *per se* performance, *sca* effects, and standard heterosis for fibre quality traits along with selected yield parameters. Hence, those two hybrid crosses can be further studied and evaluated for future hybrid breeding program in cotton. Additionally, the hybrids of the following crosses, MCU 7 x PSH, MCU 5 x PSH, MCU 5 x TNB 1, SVPR 3 x TNB 26, SVPR 4 x TNB 26, SVPR 2 x SUVIN, MCU 5 x TNB 10 and TCH 1608 x TNB 10 had non-significant *sca* effects while their parents had shown significant *gca* effects. These hybrids could be used for recombination breeding to find better segregants with ideal fiber quality traits in later generations.

PP 19

Genetic variability, heritability, correlation and path analysis for yield and fibre quality traits in upland cotton (*Gossypium hirsutum* L.)

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The success of crop improvement programmes depends on variability and heritability of desirable traits. The present experiment was carried out at research farm of Cotton Research Station, Srivilliputtur, to determine genetic variability, heritability and genetic advance estimates in upland cotton (*G. hirsutum* L). The analysis of variance involving a set of sixty four improved *hirsutum* genotypes received from various research institutes under AICRP on Cotton for fourteen characters *viz.,* Days to 50 % flowering, plant height, monopodia / plant, sympodia / plant, bolls / plant, boll weight, seed index, lint index, ginning percentage, upper half mean length, bundle strength, fibre fineness, lint yield and seed cotton yield (kg/ha) revealed highly significant mean sum of squares for all the characters indicating greater variability among the genotypes. Variability studies indicated the presence of high estimates of phenotypic coefficient and genotypic coefficients of variation for monopodia / plant, bolls / plant, seed cotton yield and lint yield whereas moderate PCV and GCV were observed for plant height and fibre fineness. Plant height, monopodia / plant, bolls / plant, seed cotton yield, fibre fineness, lint yield showed high heritability coupled with high genetic advance as per cent of mean indicating the preponderance of additive gene action in inheritance of these traits. Hence selection is effective for the inheritance of these traits. Correlation study revealed that lint yield, plant height, sympodia / plant, days to 50% flowering, upper half mean length and days to flowering had a significant positive association with seed cotton yield. Path analysis revealed that lint yield and seed index has maximum positive direct effect on seed cotton yield followed by plant height and bolls / plant.

PP 20

Identification of drought tolerant entries based on stress tolerant indices and physiological traits in RIL population of cotton (*Gossypium hirsutum*)

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The present investigation was taken up in a recombinant inbred population of cotton at advanced stage (F_{10}) derived from the cross MCU 5 x TCH 1218 in order to identify drought tolerant lines based on stress tolerant indices and physiological traits. To achieve these objectives, 220 recombinant inbred lines, parents and check KC3 were evaluated across two locations *viz.,* Coimbatore and Aruppukottai in a randomized block design with two replications during Kharif 2018-19 and stress tolerant indices were estimated from single plant yield under both locations while physiological traits were recorded at rainfed condition alone.

Based on different multivariant analyses, 18 RILs *viz.,* RIL 16, 20, 60, 71, 73, 74, 116, 131, 134, 137, 139, 143, 146, 147, 148, 149, 164 and 168 were identified as best performers under rainfed condition which also exhibited lowest mean rank for physiological and yield traits. Among these entries, RIL 74 and RIL 73 had low percentage of injury and high relative water content respectively. Association analysis revealed that tolerance index, yield reduction ratio, stress tolerance index and stress susceptibility index were significant and positively correlated among themselves. Negative correlation was noticed between yield under stress (YS) and tolerance index (TOL), yield reduction ratio (Yr) and stress susceptibility index (SSI).

PP 21

The importance and future perspectives of natrally coloured cotton (*Gossypium sp.*): an overview

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Cotton is one of the important fibre crops worldwide due to its strength of the fiber, softness and its contribution towards world annual fibre demand of 35%. Hence it is considered as "white gold". India is one of the top 10 cotton-producing countries. Cotton belongs to the family Malvaceae and the genus *Gossypium* is comprised of 45 diploid species (2n = 26) and five tetraploid species (2n = 52). In general, there are two types of fiber: fuzz and lint. The fuzz fibre is highly intact with the seed with a fibre length of 5 mm, whereas the lint fibre is highly spinnable with a fibre length around 3 cm. Nowadays, the usage and production of white cotton is more due to its fibre strength and quality, but it undergoes the process of dyeing, which affects the environment as well as produces skin allergies in humans. The alternate eco-friendly approach of naturally coloured cotton eliminates the process of dyeing, and thus it is highly environmentally safe without any allergies in humans. In India, 40 coloured genotypes belonging to the upland cotton (*G. hirsutum*) are available in the shades of brown and green, and they are preserved in the national gene bank of cotton at the Central Institute for Cotton Research. There are some drawbacks to naturally coloured cotton that they are short and weak with non-availability of desired wide colours. Studies have already been conducted to improve its quality and colour through a genetically modified approach in countries like Australia, China, *etc*. The future perspectives in the area of naturally coloured cotton are i. Improving fibre quality and maturity ii. Developing the plants with different shades of colour with uniformity iii. Creating a desirable plant with a high-yielding, early-maturing habit iv. Create male sterility lines in coloured upland cotton.

PP 22

DUS guidelines based morphological characterization among cotton genotypes

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Cotton is one of the important and economically significant crops of India and Tamil Nadu. Protection of Plant Varieties and Farmers Right Act (PPVFRA (2001)) envisages characterizing newly developed varieties based on which enables protection of new varieties and registration of varieties for any specific novel traits. Advanced cotton cultures suitable for growing under rainfed conditions developed at Cotton Research Station (TNAU), Veppanthattai was characterized based on DUS. A set of twelve genotypes consisting of six advanced cotton cultures and six varieties which are in cultivation in the state of Tamil Nadu were taken for the present investigation. DUS guidelines were followed in laying out and conduction of the trial and during observation of various characters. Among the genotypes studied, cotton variety CO 15 exhibited colouration in anther filament which was found to be unique for the variety. In addition to anther filament colouration, stigma exertion, boll glanding, pollen colour and leaf colour were found to be the most variable / distinguishing characters among the set of genotypes studied.The present study proved the utility of these subset of characters in classification of genotypes based on phenotypic traits and also identified distinct characters for the test genotypes.

PP 23

Study of Pollen fertility variation in the F_1 hybrids and parents in cotton

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Wide hybridization has been used as a gene mining tool for infusing the various precious genes available in wild background to the cultivated one. But, often the fertility level of the progenies in the F_1 pose a hurdle on the way of developing the further generation of prebreeding material. Again the fertility levels also get affected by other external factors like the ploidy of the parents, and climatic factors. But the F_1 plants tend to flower almost all the season with varying numbers of flowers on them. In order to study the prospectively better season for undertaking further attempts for developing F_2, and backcrossing, the pollen fertility of the parent and the F_1 hybrid was assessed in three different seasons during the year 2021-22. The results have depicted that the fertility levels were comparatively higher in F_1 hybrids in the early monsoon and late winter season. Among the F_1 hybrids, CO 14 *x G. armourianum* has shown highest fertility level followed by CO 17 x *G. armourianum*. Wild species have shown varied fertility level which was comparatively good in late winter flowering.

PP 24

Character association of seed cotton yield with its attributing traits in *Gossypium hirsutum* L.

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Cotton is one of the very important commercial fibre crops of India that exhibits distinct association. An experiment was conducted during *Kharif* 2021-22 using nine varieties along with two checks in RBD design to know the association between seed cotton yield and its attributing traits. Data on biometrical observations like days to 50 per cent flowering, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), seed index (g), lint index (g), Ginning out turn (%), lint yield (kg/ha) and seed cotton yield (kg/ha) were collected and analysed for character association of seed cotton yield with its contributing traits. Seed cotton yield exhibited significant genotypic positive association with number of sympodia per plant (r=0.806**), number of bolls per plant (r = 0.900**), boll weight (r = 0.738**), ginning out turn per cent (r = 0.699**) and lint yield (r = 0.992**) while non-significant negative association was noticed with days to 50% flowering (-0.048**), number of monopodia (-0.405**). Hence, more emphasis could be given on number of sympodia per plant, number of bolls per plant, high boll weight, number of bolls per plant and ginning out turn in the development of high yielding genotypes in cotton and direct selection pressure can be implied on these traits.

PP 25

Studies on heterosis for seed cotton yield and its contributing traits in cotton (*Gossypium barbadense* L.)

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Cotton is one of the most important commercial crop which is accessible to the development of varieties and highly suitable for the commercial exploitation of heterosis. Heterosis is the increased vigour of the hybrids (F_1) over the average of the parents or over the better parent. The chief objective of any hybridization programme is to congregate the desirable genes present in two or more parents into a single genetic background which would result in novel variability. These developed hybrids are utilised directly or indirectly in the crop improvement programmes. Considering all these in view, the present study was undertaken to estimate the extent of heterosis for seed cotton yield and its contributing traits in *Gossypiumbarbadense*L. through diallel mating design. Totally fifteen hybrids were synthesised by using six different *Gossypiumbarbadense* genotypes and F_1s were evaluated along with corresponding parents and varietal check of Suvin check to identify the best hybrids. Among the hybrids evaluated, the maximum percent (184.34) of heterosis for seed cotton yield was observed in the hybrid TCB 47 × CCB 6 followed by TCB 47 × CCB 5 (145.60 percent) and CCB 5 × CCB 6 (106.48 percent). All these three hybrids showed significant heterosis for important traits *viz*., sympodia, bolls/plant, boll weight, lint index, seed index and ginning outturn. Four hybrids *viz*., TCB 45 × CCB 7, TCB 45 × CCB 5, TCB 45 × CCB 2 and TCB 47 × CCB 2 exhibited significant positive heterosis over mid parent, better parent and standard check for seed cotton yield/plant. Hence, all these identified hybrids may be utilized for commercial exploitation after testing their adaptability and stability to different environments.

PP 26

Leveraging molecular breeding tools in genetic improvement of surgical properties and yield in *G. arboreum*, an untapped natural fiber

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There is an enormous increase in demand for absorbent cotton. Considering the economic change caused by health crisis and with the development of medical facilities and awareness towards personal hygiene, surgical cotton industry has registered a steady growth rate and is picking up pace with the spread of education and also economic growth of towns and villages.

Until 2005, India had 2 mha of Land under cultivation of surgical cotton. But today, less than 1% area is under surgical cotton cultivation. Besides the Indian market, there's also an enormous export potential in various countries. Today, in India - Market exploitation is the biggest challenge faced by the surgical cotton growers. Another factor affecting the surgical cotton growers is a lack of proper ginning machinery suitable for short staple cotton, especially the *Gossypium arboreum.*In order to meet all these requirements, cultivation of more surgical cotton is needed which mainly derives from desi cotton i.e., *Gossypium arboretum* which is ideal for this purpose because of its better absorption capacity and coarse and 20 mm fibre length (short staple) and micronaire value of 6. This demonstrates the fact that *arboreum* cotton cultivars are likely to open up a huge export market for surgical cotton, giving a remunerative alternative to cotton farmers in rainfed areas of countries like India.

In cotton, main trait governing yield is fibre/ lint. To attain more yield, boll weight should be increased, which directly produces more fibre. In order to produce more boll weight, improving this particular trait is much needed as this provides lucrative opportunities to the Indian farmers in terms of more production and also profits from surgical cotton industries which gives more income.Identifying tightly linked markers for boll weight will have future prospects in the introgression breeding programme. Hence, development of cotton with higher boll weight along with better fibre quality will be of major use for further breeding programme which not only boost the surgical industry but also increases the income of *desi* cotton growers.

PP 27

Climate resilient long staple zero monopodial cotton amenable for mechanized cultivation under rainfed

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Climate variability is necessitating breeding of climate resilient crops that abiotic stress efficiently to complete life cycle and to sustain the higher productivity and farm income. The major breeding traits that influence adaptation to climate change are phenology, plant physiological response to abiotic stress, shorter duration and plant architecture for effective utilization of water and climatic factors besides response to input resources. Modification of morphoframe provides opportunity for altering plant density and to facilitate the mechanized operations importantly machine picking/harvesting andto make easy cultural management practices. To develop ideal genotype, the breeding strategies was drawn to develop short duration determinate cotton with narrow window of flowering phase coupled with short sympodial branches to achieve the morphoframe. Breeding program was carried out including identified parents namely Suraj and TCH 1816 and their derived segregating breeding material which were evaluated under rainfed during 2014-19 at Cotton Research Station, TNAU, Veppanthattai. The sequential pedigree evaluation of segregating materials led to the development of zero monopodial plant with short sympodial branches. The derived genotype TVH 002 possessed narrow window flowering with a crop duration of 125- 130 days. It has an average of 10-12 short sympodial branches possessing 15-20 bolls each weighing 4.0g. The development of such determinant genotype facilitates flowering in a short phase and no flowering occurs during boll maturity phase as usually appear in the normal cotton. Besides, this plant type favours increasing the population in the range of 50000 to 100000 or three to five times than the normal cotton depending on the environment under closer spacing of 100 x 10 cm/ 75 x 20 cm that was accommodate 100000 /66600 per hactare. Seed cotton yield is set to increase around 30% higher and recorded yield of 1950 kg/ha under rainfed in multilocation trial conducted during 2019-20 and thus increasing productivity on per day basis. This culture

recorded staple length of 30.5 mm with fibre strength of 28.2 g/tex and micronaire of 3.7µg/inch which provides 80 counts and suits to modernized spinning mills. Moderately resistant to leaf hoppers and grew well under moderately drought or water stress conditions with reduced input applications of fertilizers and pesticides and with lesser duration it facilitates better penetration of sunlight and wind. This cultures was tested in AICRP compact cotton rainfed trial under initial and coordinated varietal trials in central and south zones during 2019-2020 and recorded 7.6 % increase seed cotton yield over zonal check Suraj.

PP 28

Developing climate resilient high ginning cotton harboring leaf hopper resistance suiting drought prone areas

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Cotton is cultivated in India in an area of 12.06 million hectaresof which central zone consists of major growing area accounting for 6.81 million ha in the states of Maharashtra, Gujarat and parts of Madhya Pradesh followed by south zone accounting for an area of 3.30 million ha comprising of southern States except Kerala (AICRP 2019-20). Abiotic stress occurs frequently due to failure of monsoon, elevated temperature causes negative physiological growth responses thus impacting seed cotton yield. Besides, drought and hot climatic condition favours sucking pests build up which further aggravates the damage to the crop and the crop yield is severely affected. These biotic and abiotic stresses sometimes devastate the crop and results in failure of the crop. In view of the requirement of suitable genotypeto manage the biotic and abiotic factors, breeding program was executed with identification and validation parental lines to develop a genotype for rainfed farming including Suraj X AKH08 at Cotton Research Station, Parambalur. The derivatives were evaluated during 2014-2019 under rainfed. A promising genotype namely TVH 007 derived from the above cross was observed to grow well under rainfed and hot temperature conditions. It possessed dark green leaves and also resistant to major sucking pest leaf hopper as it recorded the score of 1.85. The yield potential was far better than check varieties under rainfed and summer. It has moderate seed index and recorded high ginning percentage of 37 %. This culture was tested in AICRP cotton rainfed trials and recorded the highest yield of 2138 kg/ha during 2019-20 among the 34 entries tested. It had medium superior staple (28.7mm) with fibre strength of 27.4 g/tex and micronaire of 3.8 µg/inch. Its ginning percentage was the highest among the AICRP test entries recoding 37%. Besides, it recorded more than 20 % higher seed cotton yield in University multilocation trials over zonal check BGDS 1063 during 2020-21 and also showed 7.7% higher yield over non *Bt* private hybrids.

PP 29

Development of a high yielding long staple cotton for rainfed ecosystem of Tamil Nadu

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Cotton is an important fibre and commercial crop that caters to the need of human clothing fabricated by textile and modern garments industry. The cotton cultivation gained momentum among the farmers due to demand of raw material coupled with an increase of lint/yarn prices. The minimum support price stands at 63.per kg for long staple cotton while market prices are still higher in range of 20-30 percent. Modern spinning mills require mostly long staple cotton with good strength for speed spinning. In central and southern states of India, the cotton area is around 10.0 million ha and of which 70 % area is cultivated under rainfed. Availability of high yielding genotypes of long staple with fine fibre qualities suitable to rainfed ecosystem particularly in Tamil Nadu is necessarily required for the textile industry and to increase profitability of farmers' income since it fetches higher prices. The earlier prominent variety was MCU5 bred by TNAU and released in 1968 served across India and sustained well with environment for three decades. Development of such long staple cotton is of paramount importance to meet the requirement of textile industry since one third of industries are present in Tamil Nadu. Breeding program was carried out including parental lines Suraj, CPD 1452 to derive population that harbors abiotic tolerance traits along with long staple fine fibre. Evaluations of progenies and families have done under rainfed ecosystem for selection. A promising genotype namely TVH 003 derived from the cross Suraj X CPD1452 was found with better performance under rainfed. It recorded 27.9 percent higher yield over CO 14 check in University multilocation trial under rainfed. Its duration was 150 days and possessed moderate resistance to leaf hopper with a score of 5.27 representing scale 2. The fibre length was 29.9mm with a fibre strength of 28.5 g/tex and a micronaire of 3.6 µg/inch (AICRP 2020-21). Besides it recorded 7.9 % higher seed cotton yield over non *Bt* private hybrid. This genotype suitable to Tamil Nadu meeting the requirements textile industries using modern spinning machines and importantly to farmers for higher income.

PP 30

Genetic investigations for understanding the colour and quality fibre development in cotton

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Coloured cotton is known to mankind as early as 2500 BC and it is available in different colours such as brown, black, mahogany red, pink, blue, green and white in four species of the genus *Gossypium*. Compared with white cotton, naturally coloured lints are short, coarse and weak. They are amenable only for hand spinning. However, with the advent of power looms and ginning machines after the Industrial Revolution, the scene was changed. White cotton, with its soft, long and strong fibres was easily adapted to mechanization. Moreover, the production of multi-coloured fabrics from white cotton with the help of synthetic dyes was found to be immensely lucrative but the negative effects it had on the environment were overlooked. Coloured cotton being naturally coloured completely ruled out the process of dyeing, making it eco-friendly. Moreover, the susceptibility of white cotton against sucking pest is a big menace to the farming community. Though naturally coloured cotton is eco-friendly and moderately resistant to sucking pests, its fibre quality traits need to be improved on par with white linted ones and also has to be made amenable for use with modern ginning equipments. Hence this study was programmed at Dept of cotton, Tamil Nadu Agricultural University, Coimbatore, to develop a coloured cotton genotype with better fibre quality traits and good lustre by crossing three brown-coloured cotton lines (HP 166, P-15, EC 34) and two green-coloured cotton lines (P 15 and EC 25) with agronomically superior white cotton lines (KC3, MCU7, CO17, SVPR6, CO14 & MCU 5) with an objective to identify the best genotype with superior fibre quality, improved colour fastness and good lustre in the segregating population.

PP 31

Correlation and heritability study for seed cotton yield and fiber quality parameters in upland cotton (*Gossypium hirsutum* L.) genotypes

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Correlation and heritability estimates for seed cotton yield and fibre quality traits were determined for fourteen different traits using thirty-five cotton (*Gossypium hirsutum* L.) genotypes at Cotton Research Station, Sardarkrushinagar Dantiwada Agricultural University, Talod during *kharif*-2020. The association analysis revealed positive and highly significant correlation of seed cotton yield per plant with number of boll per plant and boll weight at both genotypic and phenotypic level whereas, the trait plant height exhibited positive and significant correlation with seed cotton yield per plant only at genotypic level. This type of correlation is desirable by cotton breeders and these characters could be considered as criteria for improving seed cotton yield. The path coefficient analysis revealed that the characters *viz.*, plant height, number of sympodia per plant, boll weight, upper half mean length, fibre fineness and fibre strength recorded high and positive direct effect towards seed cotton yield per plant. Present findings for path analysis suggests that for the traits bearing positive direct effects with seed cotton yield per plant, the direct selection would be rewarding for improvement in yield. The broad-sense heritability estimates of the yield, yield components and fibre quality traits were high for number of monopodia per plant (84.61 %) followed by seed cotton yield per plant (81.95%), number of boll per plant(78.85%), lint index (65.0 %) and boll weight(61.54%),they could be considered as indicators of the yield and fiber quality improvement in cotton.

PP 32

Characterization of cotton (*Gossypium hirsutum L.*) germplasm for yield, fibre quality and Jassid resistance

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Cotton was one of the earliest vegetable fibres utilised for textile and it is the world's most significant non-food agricultural product. Many varieties and hybrids are available that can provide large yields and profits, but they are extremely uniform and have a narrow genetic base, which has hampered the progress of fulfilling the demands of producers and industry in recent years and also reported to be widely affected by the leafhoppers which leads to the highly economic losses. Thus, the study was conducted to determine the diversity present among the 100 cotton germplasm accession along with 5 checks and to assess the genotypes for leafhopper resistance. High heritability along with high genetic advance as percentage of mean was observed in number of monopodia per plant demonstrating that the trait was governed by additive gene action and selection will be effective. Number of sympodia per plant, number of bolls per plant and boll weight witnessed significant positively correlated with single plant yield. The genotypes *viz.,* D 16, TCH 1742, Stardel, Acala-1577-D and D 4 performed better the above mentioned traits. Thus, these genotypes can be used in hybridization programme to improve yield. Study on leafhopper resistance revealed 19 genotypes were on par with a resistant check (KC3). The genotypes*viz.,* KC 2, JR 23, Samaru-26-T, D 4, TCH 1728, RS 253, SH 469 were found to be highly resistant to jassid and can be effectively used in an extensive hybridization programme to increase the levels and broaden the sources of resistance. Fibre quality assessment revealed the genotypes SA 344, RS 212, Tamcot 216, HT-5(74/44), F1861, SH 269, RS 275, RS 216, T-23, AR 9, SICIDS and Alabar-637 were found to be superior for almost all the fibre quality traits. Thus, these genotypes can be used in hybridization programme to improve fibre quality.

PP 33

Genetic study of F_2 population to improve fibre quality in naturally coloured cotton

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The research study was conducted to execute genetic studies in direct and reciprocal crosses made between Lusiana Brown and CO14 during *Kharif* 2019 at Department of cotton, Tamil Nadu Agricultural University, Coimbatore. A total of 11 plant characters and 5 fibre quality characters were recorded.In both direct and reciprocal crosses, high PCV and GCV were obtained for number of monopodia/plant, number of sympodia/plant, number of bolls/plant, seed cotton yield/plant and fibre fineness.High heritability coupled with high genetic advance as per cent of mean was observed for plant height, number of bolls/plant, boll weight, seed cotton yield/plant and fibre fineness.A significant positive correlation was recognized between seed cotton yield/plant on one hand and other independent components like plant height, number of bolls/plant, boll weight, number of seeds/boll, lint index and fibre fineness in both the crosses. The direct positive effects of chlorophyll index, number of bolls/plant, boll weight, lint index, elongation per cent, fibre fineness and bundle strength on seed cotton yield/plant were registered by path analysis. The platykurtic curves were produced for number of sympodia/plant, chlorophyll index, elongation per cent and uniformity ratio. On combining per se performance, variability and frequency distribution studies, traits like plant height, number of bolls/plant, boll weight, seed cotton yield/plant and fibre fineness were taken into consideration for selection. Coloured linted plants exhibiting high mean values of the above characters were selected in both the crosses and forwarded to subsequent generations.

PP 34

Biotechnological approaches for cotton improvement

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The productivity of crop plants is highly influenced by abiotic stresses leads to significant losses in crop yield. The modern technology of genetic engineering has enabled to move genes from distant sources into crop plants against abiotic stresses. The genes encoding of economic importance like tolerance to drought, salinity and chilling stress are being introduced in cotton plants using transformational technology. The signaling and regulatory pathways have been elucidated using advanced molecular approaches. Biotechnology tools make it possible to isolate stretches of DNA from one organism and transfer to another by cloning in a bacterial host.

In the molecular approach, genes encoding functional proteins such as chaperones and transporters are identified for abiotic stress tolerance and transferred to plants. In metabolic engineering, to target multiple steps of signals, enzymatic fusions are used to manage stress. Signal peptides for organelles were made to work in their particular location. The transcription factors and signaling pathway factors provides novel routes for engineering drought tolerance by enhancing regulatory ability and activate the expression of many target genes. Genes at the mRNA level can be upregulated and downregulated by using specific promotors. Transgenic plants with individual genes confer some degree of drought tolerance, and regulated expression of more genes / transcription factors can lead to sustained tolerance. The transcription factor through mutations or repression domains enhances regulatory ability of many target genes controlling correlated characters. The down regulation of *GhHB12* gene, a HD-ZiP transcription factor subfamily I gene, enhance the tolerance to abiotic stresses in cotton, suggesting that knockout of this gene can help developing drought tolerant cotton lines with strong environmental adaptability

RNAi is a gene silencing technology, a successful tool for controlling the insect pests of important crops. RNA interference technology makes use of double stranded RNA to interfere the gene function and directed against messenger RNA (mRNA) of specific gene target(s) or its promoter region resulting in post

transcriptional gene silencing (PTGS). Transgenic technology silenced a gene in the cotton plant that produces a toxin, called gossypol and made cotton seed edible.U.S. Department of Agriculture approved this genetically engineered cotton so that the seeds are safe to eat. A new piece of DNA was introduced into the cotton plant which in the plant's seeds, it turns off a key gene, the one responsible for producing gossypol. The gene stayed active in the rest of the plant. Gossypol is present in leaves of the genetically engineered plant, to protect against insects. The invention promises to open new markets for cottonseed, and it could give cotton farming a big boost. Because cotton plants are prodigious seed producers and every pound of cotton fiber, or lint, comes with 1.6 pounds of seed. Each seed is the size of a small peanut.

Genome editing is the recent development of the CRISPR/Cas9 system using single guide RNA molecules (sgRNAs) to direct precise double strand breaks in the genome. This technology has the potential to revolutionize Agriculture. It is an important tool for functional studies of the gene as well as crop improvement.CRISPR trialsare going on in 41 food crop species, 15 industry crops, six oil seed crops, eight ornamental crops and one fibre crop. CRISPR genome editing opens up new possibilities for morphological characters, biofortification and quality improvement characters, managing self incompatibility, male sterility, resistance to biotic and abiotic stresses, flowering and yield, haploid induction, translation modification etc. in crops. Several varieties such as waxy corn maize, New Kasalath rice, New TeTe Pu rice and modified Swarna Rice,special sun-dried tomato packed to the leaves with vitamin D fulfilling the desired traits. Further, the tool would overcome constraints of stress tolerance, inbreeding depression, embryo breakdown in the crops. CRISPR works reported are related to quality improvement and disease resistance of crops (which are governed by mono or oligogenic genes) rather than growth and yield characters (governed by polygenic genes). CRISPR/Cas9 knock out miR156 in cotton; resulted in the miR156 knockout lines of cotton showed restricted growth and are also found sensitive to abiotic stresses, including drought, salinity, and water logging. Improving the cotton plant morphology with deep root system, the cotton plants will uptake more nutrients and water from the deeper layers of soil. Thus, a cotton plant can sustain drought stress with stronger and healthy roots help plant variety of abiotic and biotic stresses. Nitric oxide (NO) is an important

regulator for root development in plants. NO concentration makes plant to produce more lateral and adventitious roots. In plant, nitric oxide synthase (NOS) catalyzes the synthesis of NO. Arginase competes with NOS for arginine (ARG) substrate. Overexpression of arg significantly inhibits the NO accumulation in cotton root and then decreased the formation of lateral roots. Knockout of *arg* gene by CRISPR/Cas9 technology significantly enhanced root development in cotton. CRISPR/Cas9 genome editing is also employed to improve agronomically important traits in cotton. Mutations in the two genes Cloroplastosalterados 1 (GhCLA1) and vacuolar H^+-pyrophosphatase (GhVP) were detected in cotton protoplasts, with one nucleotide insertion and one substitution in GhCLA1 and one deletion in GhVP. CRISPR/Cas9 knockout of cotton gland formation 3(*cgf3*), transcription factor gene, resulted in the genome-edited cotton plants with glandless phenotype. CRISPR/Cas9 knockout of cotton gland formation 3(*cgf3*), transcription factor gene, resulted in the genome-edited cotton plants with glandless phenotype. Gene silencing of *CGP1* gene (involves in gland formation) by CRISPR/Cas technology and the genome-edited plants exhibited glandless-like phenotype. It was also revealed that level of gossypols and associated terpenoids compounds were substantially depress in expression of genes involved in biosynthesis of gossypol was reported in the genome-edited plants. The calcium sensor CBL2 and its interacting kinase CIPK6 are involved in plant sugar homeostasis via interacting with tonoplast sugar transporter TST2. CRISPR/Cas9-mediated knockout of *GhTST2* resulted in significantly decreased Glc content in cotton. CRISPR genome editing will be a very effective and useful tool for crop improvement integrated with conventional methods leading to drastic developments in agriculture, industry and farming community.

PP 35

Methylobacterium infused chitosan composite nanofibre seed coating for enhancing seed quality in cotton

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Plant growth promoting methylotrophic bacterium, *Methylorubrum aminovorans* was infused *in* electrospun CS/PVA composite nanofibre matrix and used for seed coating as a novel approach to enhance the germination, seedling growth and vigour in cotton var. surabhi. The e-spin solution of chitosan (2.5%) and PVA (10%) was prepared and subjected to electrospinning with optimized operational parameters. *M. aminovorans* cells were successfully loaded in CS/PVA composite nanofibre. SEM and TEM results confirmed the morphology and microbial cell loading by increasing the nanofibre size. The FT-IR spectral results further evidenced the microbial infusion in nanofibre by showing the spectral band shift. Enumeration of *M. aminovorans* loading in nanofibre was assessed by microbial plating method which indicated about 73% microbial population was encapsulated in nanofibres.

As a novel seed coating approach, the quantity of microbial cells added polymer e-spin cocktail required to develop nanofibre for coating per kg of seeds was optimized by evaluating seed quality under laboratory condition. For this study, bacterial cells infused polymer blend (CS/PVA) was e-spun in vertical electrospinning unit with seed coating device. The results showed higher seed coating (2.6%) and microbial cells encapsulation efficiency (50.7%) in composite nanofibre developed from 25 ml of e-spin blend/kg. Regarding seed quality, seeds coated with bacterial cells loaded composite nanofibre developed from e-spin cocktail at 20 ml/kg registered minimum mean germination time, maximum seed imbibition rate, speed of germination, germination, root and shoot length, dry matter production and seedling vigour index under controlled condition.

Theme Area II

Crop Production and Mechanization

PP 36

Influence of intercropping of pulses on productivity and economics of cotton - an experience from front line demonstrations in Southern Tamil Nadu

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Thirty five Front Line Demonstrations (FLDs) on cotton intercropping with pulses were carried out in total 35 hectares of 35 farmers' fields in 22 villages in Madurai, Virudhunagar, Dindigul and Tenkasi Districts of Southern Tamil Nadu during winter irrigated and rainfed seasons during 2020 – 21 and 2021 – 2022. The FLD on cotton intercropping with black gram and green gram were compared with farmers' practice. In FLD, latest cotton varieties (SVPR 4, SVPR 5, SVPR 6 and CO 17), black gram (VBN 8) and green gram (CO 8) intercropping, balanced fertilizer application and integrated pest management practices were adopted. In farmers' practice, use of mixed varieties, broadcasting, without intercropping, unbalanced fertilizer application and irregular use of insecticides were followed. The results revealed that adoption of improved varieties and integrated management practices recorded higher mean kapas yield of 1703 and 1383 kg ha^{-1} during 2020 -21 and 2021 – 2022 respectively as compared to famers method of cultivation (1510 and 1190 kg ha^{-1}). Thus the yield advantage of 14.9 per cent than farmers practice was observed. Among the varieties, SVPR 6 performed better than other varieties during both the years of study. The Land Equivalent Ratio under inter cropping of pulses was more than one indicating the higher efficiency of yield production of cotton with intercropping than sole cotton. Higher mean net profit of Rs.41,790 ha^{-1}and Rs.60,096 ha^{-1} respectively were associated with the use of high yielding varieties and improved production technologies than farmers practice (Rs.25,540 and Rs.40,150 ha^{-1}). Higher benefit cost ratio (1.71 and 1.94 during 2020-2021 and 2021-2022 respectively) were also realized under inter cropping than farmers' practice. Thus cultivation of new varieties with improved production technologies gained an additional economic benefit of Rs.16,350 and 19,946 ha^{-1} as compared to existing varieties with farmers' method. It can be concluded from the Front Line Demonstrations that adoption of modern varieties of cotton with intercropping lead higher yield, better land use efficiency and higher economic benefits which will pave way for sustainable cotton production.

PP 37

Nanoformulation of essential oils for weed management

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Herbicides are chemicals used to kill weeds and continuous application results in herbicide tolerance. They are difficult to eradicate or more chemicals are required for their management. In order to overcome the issue of herbicide tolerance and to develop botanical herbicide to be used in the organic production system, an attempt is made to design and fabricate nano-bioherbicide using the allelopathic chemicals that are naturally produced by a group of plant species. The present study employs nanoencapsulation of volatile allelochemicals including clove and thyme essential oil for weed management. Gas Chromatography-Mass Spectrometry (GC-MS) profiling of the essential oils was performed and the major constituents of clove oil and thyme oil were found to be eugenol (49.44 %) and thymol (28.01%) respectively. Oil in water nanoemulsion system was developed using aqueous phase, organic phase (essential oils) and surfactants, and then subjected to ultra-sonication technique. The developed nanoemulsion system was characterized using a particle size analyzer with a particle size of 909.4 nm and zeta potential of -48.9 mV. Also, *insilco* docking studies were carried out using clove oil and thyme oil components against *Cyperus rotundus* target sites. Further validation of the nanoemulsion has to be carried out against different weed species. In future, by employing the principles of allelopathy and nanotechnology there exists an enormous prospect for the development of nano-bioherbicide with effective action against noxious weeds.

PP 38

Mechanical weed management studies in cotton under high density planting system

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Field experiment was conducted during 2021-22 to study the effect of different weed management practices on yield and economics of high density cotton at ARS, Kovilpatti under rainfed condition. Experiment was laid out in randomized block design with three replications. The treatment combinations comprised of five weed management practices viz., Control (No weeding), pre emergence herbicide application of pendimethalin @1.0kg a.i ha^{-1} on 2-5 DAS fb one hoeing on 40-45 DAS, pre emergence herbicide application of pendimethalin @1.0kg a.i ha^{-1} on 2-5 DAS fb POE herbicide application of pyrithiobac-sodium @62.5g a.i ha^{-1} on 20-25DAS fb one hoeing on 40-45 DAS, Weeding by power weeder on 25 DAS and 45 DAS, and pre emergence herbicide application of Pendimethalin @1.0kg a.i ha^{-1} on 2-5 DAS fb POE herbicide application of pyrithiobac-sodium @62.5g a.i ha^{-1} on 20-25 DAS fb weeding by power weeder on 40 and 60DAS. Among the broad leaved weeds *Abutilon hirtum, Acalypha indica, Alysicarpus rugosus, Aristolochia bracteata, Celosia argentea, Corchorus olitorius, Desmodium triflorum, Digera muricata, Hibiscus vitifolius, Parthenium hysterophorus Trianthema portulacastrum, Vernonia cinerea,* sedge *Cyperus rotundus* and grassy weed like *Aristida funiculata, Rottboellia cochinchinensis* were observed in the experimental field. The results revealed that, among the weed management practices, pre emergence application of pendimethalin 1.0 kg ha^{-1} recorded significantly lower weed density and weed dry weight on 20 DAS. During 40 DAS pre emergence herbicide application fb POE herbicide application on 20-25DAS fb one hoeing on 40-45 DAS (T_3) and pre emergence herbicide application fb POE herbicide application on 20-25DAS fb weeding by power weeder / power tiller on 40 and 60 DAS (T_5) recorded lower total weeds (48 and 49 nos./m^2) and lower weed dry weight (87 and 89 g/m^2) respectively. Higher weed control efficiency of 82% was recorded by T_3 and T_5 during 40 DAS. Pre emergence herbicide application fb POE herbicide application on 20-25 DAS fb one hoeing on 40-45 DAS recorded higher symbodial branches (12.Nos.), number of bolls (16 nos), Boll weight (3.22 g) and seed cotton yield (1150 kg ha^{-1}), gross return (Rs. 57500 ha^{-1}), net return (32224 kg ha^{-1}) and B: C ratio (2.27).

PP 39

Effect of multi-tier cropping system on cotton

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Cotton, an important fibre and cash crop of India, is grown in about 12 million ha with a production of 35.9 million bales (170 kg each) and productivity of 510 kg ha^{-1}. Intercropping is one of the profoundly encouraging methodologies for improving crop yields and profitability from unit land area. However, the current cotton production systems encourage monoculture, replacing biodiversity with few cultivars having a narrow genetic diversity. Such systems are not sustainable in the long run. On the other hand, an efficient cotton based intercropping system has the potential to restore sustainability through enhanced crop diversification, efficient resource management and soil fertility build up.As a widely spaced crop, cotton provides ample scope for adoption of intercropping system. Keeping these above facts, the experiment was formulated to study the effect of multi-tier cropping system on cotton. Field experiment was conducted under irrigated ecosystem in the department of cotton farm. The study design wasRandom Block Design (RBD) with twelve treatments and replicated thrice. Genotype used in system was RCH 625BGII. Treatment details:T_1. Sole Bt cotton, T_2 .Paired row planting of Bt cotton with two rows of intercrop (A) T_3 .Paired row planting of Bt cotton with two rows of intercrop (B) T_4 .Paired row planting of Bt cotton with two rows of intercrop (C) T_5 .Paired row planting of Bt cotton with one rows (A) +one row (B) T_6 Paired row planting of Bt cotton with one rows (B) +one row (C) T_7 Paired row planting of Btcotton with one rows (C) +one row (A) T_8 Paired row planting of Bt cotton with one rows (A) +one row (B) +one row (C) T_9 .Farmers practice T_{10} .Recommended intercropping. Intercrops used in study was Cluster bean (A) , Beetroot (B) and Coriander (C) Growth and yield parameters was observed. The results revealed that with respect to plantheight(118.9 cm),Boll weight(4.33g) and seed cotton yield(2089 kg/ha) was recorded higher with T 2 .Paired row planting of Bt cottonwith two rows of intercrop (A).Higher equivalent yield(3645.07 kg/,ha) and BCR (2.68) was recorded with T_2 .Paired row planting of Bt cotton with two rows of intercrop (A). It can be concluded that paired row planting of Bt cotton with two rows of cluster bean was suitable intercropping system for western agroclimatic zone of Tamil Nadu.

PP 40

Multi tier cropping system to enhance resource utilization, profitability and sustainablity of Bt cotton (*Gossypium hirsutum*) production system

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Field experiment was conducted during 2020-21 to study the effect of different intercropping system on yield and economics of hybrid cotton at ARS, Kovilpatti under rainfed condition. Experiment was laid out in randomized block design with three replications. The treatment combinations comprised of sole Bt cotton, paired row planting of Bt cotton with two rows of Inter crop (A- Clusterbean), paired row planting of Bt cotton with two rows of Inter crop (B- Radish), paired row planting of Bt cotton with two rows of Inter crop (C- Onion), paired row planting of Bt cotton with one row (A) and one row (B), paired row planting of Bt cotton with one row (B) and one row (C), paired row planting of Bt cotton with one row C) and one row (A), paired row planting of Bt cotton with one row (A), one row (B) and one row (C), farmers practice and recommended intercropping. Among the different cropping system, sole Bt cotton recorded significantly higher number of symbodial branches plant^{-1} (9.9 nos.), number of bolls plant^{-1} (19.3 nos.) and boll weight (3.57 g). Significantly higher cotton crop equivalent yield (2859 kg ha^{-1}) was recorded by paired row planting of Bt cotton with one row cluster bean and one row radish and one row onion which was followed by paired row planting of Bt cotton with two rows of inter crop cluster bean.

Among the different intercropping system, significantly higher LER (1.64) was recorded paired row planting of Bt cotton with two rows of inter crop cluster bean. With regard to economics higher gross return of Rs. 1,28,669 ha^{-1} was recorded by paired row planting of Bt cotton with one row of cluster bean, one row of radish and one row of onion but higher net return (96442 kg ha^{-1}) and B:C ratio (4.65) were recorded by paired row planting of Bt cotton with one row of cluster bean and one row of radish. From the experiment it was concluded that, intercropping of Bt cotton with one row of cluster bean and one row of radish giving higher net return and B: C ratio under dryland condition.

PP 41

Yield response of *Bt* cotton to irrigation water quality and N fertigation levels on a coarse textured soil under drip irrigation

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A field experiment was conducted for four years to study the effect of different qualities of irrigation water namely canal water (CW), alternate CW and saline water (CW-TW) and CW irrigation up to germination and subsequent irrigation with SW (CW_g-TW) and three fertigation levels [100% (N_{100}), 80% (N_{80}) and 60% (N_{60}) of recommended dose of N (RDN)] on growth, yield and water use efficiency of Bt cotton under surface drip system at Jodhpur farm of PAU Regional Research Station, Bathinda. The experiment was laid out in split design with four replications in paired row geometry (50-85-50 cm) with drip lateral placed in the middle of paired rows having in-line emitter spacing of 30 cm and discharge rate 2.4 L hr^{-1}. The results of pooled data revealed that seed cotton yield was at par when irrigating with good quality canal water (CW) alone and alternate of canal & poor quality tube well water (TW; EC: 3.8 - 4.2 dSm^{-1}, RSC: 1.36 meq L^{-1}) and was significantly higher than irrigation with tube well water (CW up to germination and subsequent all irrigations with TW) alone. It suggests that canal water and poor quality saline water can be used conjunctively for irrigation to cotton under drip. Seed cotton yields were at par when 80% and 100% of recommended dose of nitrogen was applied and were significantly higher than application of 60% recommended dose of nitrogen indicating saving of 20% fertilizer N. Water use efficiency (WUE) was higher in CW irrigation followed by CW/TW and least in CW_g-TW with same amount of irrigation water applied.

PP 42

Effect of drip fertigation on physiological characteristics and yield of cotton

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Cotton, the widely known 'white gold' is a highly demanded fibre cum cash crop and the backbone of Indian textile industry. Drip fertigation is the application of fertilizers in dissolved form along with irrigation water through a drip system and it is an efficient and agronomically sound method to maximize the yield and quality of crops.The field experiment was carried out during the winter irrigated season of 2019-2020 at the department of cotton, Tamil Nadu Agricultural University, Coimbatore to investigate the effect of drip fertigation on physiological characteristics and yield of cotton under high density planting system. The experiment was laid out in RBD with eight treatments and three replications. Fertigation was given with 75%, 100% and 125% levels of recommended doses of straight fertilizers (Urea, SSP and MOP) in treatment T_1 to T_3 and through water soluble fertilizer (19:19:19) in treatments T_4 to T_6, respectively. Drip irrigation with band application of fertilizers were given for the remaining two treatments *ie*, 100% of RDF (80:40:40) for T_7 and STCR based fertilizer application for T_8. CO 17 seeds were dibbled at a spacing of 75 cm x 15 cm with an assured population of 88,888 plants/ha.There was an increasing trend in the values of physiological parameters viz. chlorophyll index (SPAD), CGR, RGR and NAR from T_1 to T_3 and T_4 to T_6 since the recommended dose of fertilizers increased. Increased level of RDF might have resulted in more number of functional leaves per plant along with dry weight of plant.In drip fertigation, seed cotton yield increased linearly with increased doses of fertilizer. Nalayani *et al.* (2012) and Kakade *et al.* (2017) have reported similar findings that fertigation with 125% recommended dose of N and K increased yield attributes than other lower levels and soil application of fertilizers. High density system of planting in cotton applied with drip fertigation of 125% RDF as WSF recorded better growth, yield and physiological parameters at different crop growth stages. All the parameters recorded from 125% RDF of straight fertilizer were comparable with that of 100% RDF through WSF. Hence, WSF was more efficiently utilized by cotton plants in drip fertigation and it could save 25% of fertilizer.

PP 43

Evaluation of different weed detection techniques and weed management through altered herbicide doses on weed parameters and yield of cotton

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A field experiment was conducted in Agricultural college and Research institute, Madurai during 2019-2020 to study weed control options in cotton as influenced by various weed detection techniques. Experiment design is Split plot and replicated thrice. Treatments tested were, three weed detection techniques *viz.*, Manual method (M_1), Image detection with manually operated camera (M_2) and Image detection with drone camera (Heli-cam) (M_3) as main plot treatments combined with eight weed management practices with altered herbicide doses as sub plot treatments. The weed detection technique and altered herbicides doses exerted a significantly effect on weed parameters like weed density and weed dry matter. Image detection with drone camera and the application of 75% dosage of Quizalofop ethyl @ 50 g a.i ha^{-1} + Pyrithiobac Sodium @ 62.5 g a.i ha^{-1} as early post emergence herbicide on 15 DAS followed by Post emergence application of Fluazifop butyl @ 140 g a.i ha^{-1} + Fenoxaprop ethyl @ l40 g a.i. ha^{-1} on 40 DAS based on weed rating 2 (M_3S_5) recorded the minimum weed density (26.39 m^{-2}) at 60 DAS. These treatments combination were also registered least weed dry matter (63.11 kg ha^{-1}). Different weed detection techniques and dosages of herbicides at various level of time period were significantly enhanced the seed cotton yield. Weed image detection through drone camera and the application of 75% dosage of Quizalofop ethyl @ 50 g a.i ha^{-1} + Pyrithiobac Sodium @ 62.5 g a.i ha^{-1} as early post emergence herbicide on 15 DAS followed by Post emergence application of Fluazifop butyl @ 140 g a.i ha^{-1} + Fenoxaprop ethyl @ 40 g a.i. ha^{-1} on 40 DAS based on weed rating 2 (M_3S_5) recorded highest yield (1752 kg ha^{-1}) and the lowest yield was found with manual weed scouting in control plot (554 kg ha^{-1}).

PP 44

Impacts of foliar nutrition on yield and quality of cotton under dry land condition

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Field experiment was conducted at Ryot's field, Pinnanur village, Thalaivasal Block, Salem District during summer season (March to August, 2020) to find out the effect of foliar nutrition on yield and quality characters of cotton. The experiment was laid out in randomized block design with three replications. The experiment consisted of twelve treatments of foliar application of nutrients at flowering and boll development stages *viz.*, control (T_1), 2% $MgSO_4$ (T_2), 2% DAP (T_3), 0.5% borax (T_4), 1.5% K_2SO_4 (T_5), 2% urea (T_6), 1% PPFM (T_7), 2% $MgSO_4$ + 1% PPFM (T_8), 2% DAP + 1% PPFM (T_9), 0.5% + borax 1% PPFM (T_{10}), 1.5% K_2SO_4 + 1% PPFM (T_{11}) and 2% urea + 1% PPFM (T_{12}). Among the different treatments, higher seed cotton yield of 3185 kg ha^{-1}, total nutrient uptake *viz.*, 124.40, 63.90 and 62.40 kg ha^{-1} and post harvest soil available nutrient status of 186.60, 13.18 and 149.46 kg ha^{-1} of nitrogen, phosphorus and potassium, respectively were noticed with foliar application of 2% urea + 1% PPFM at flowering and boll development stages (T_{12}). Similarly, the treatment T_{12} significantly registered the higher quality characters such as ginning out turn of 35.82 per cent, lint index of 6.79, seed index of 12.78, 2.5% staple length of 30.41 mm, 50% staple length of 14.75 mm, uniformity ratio of 48.50, fibre strength of 24.13 g tex^{-1}, count strength product of 2343, micronaire of 4.03 µg $inch^{-1}$, fibre elongation of 4.35 per cent and short fibre index of 6.20. The lower amount of total nutrient uptake, post-harvest soil available nutrient status and poor qualities of ginning and fibre properties were associated with the control treatment (T_1- no foliar nutrition).

PP 45

Optimising fertiliser requirement of monostem compact cotton - Co 17 for rainfed eco-system of coastal soils of Ramanathapuram district

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The two field experiments were conducted *viz.,* one at Coastal Saline Research Centre, Ramanathapuram and another at Agricultural Research Station, Paramakudi to optimize the fertilizer requirement of monostem compact cotton-Co 17 for rainfed ecosystem of Ramanathapuram. The field was laid out in Randomised block design with a plot size of 4x3M. The seeds were sown at a spacing of 100 x 10 cm for seven treatments and replicated thrice. The treatments were Absolute control (T_1), STCR based for Yield target 1.2 t ha^{-1} + $ZnSO_4$ @ 25 kg/ha (T_2), STCR based for Yield target 1.5 t ha^{-1} + $ZnSO_4$ @ 25 kg/ha (T_3), Yield target 1.2 t ha^{-1} with STCR alone (T_4), Yield target 1.2 t ha^{-1} with STCR + Zinc lysinate @2.5 kg / ha (T_5), Yield target 1.5 t ha^{-1} with STCR alone (T_6) and Yield target 1.5 t ha^{-1} with STCR + Zinc lysinate @2.5 kg / ha (T_7). The application of NPK @ 40: 20:20 kg ha^{-1} with Zinc Lysinate @ 2.5 kgha^{-1} for STCR Yield target of 1.2 t ha^{-1}, has recorded the highest seed cotton yield (1193 kg ha^{-1}) and BCR (2.60) at CSRC, Ramnad where as application of NPK @ 30: 15: 15 kg ha^{-1} for STCR Yield target 1.2 t ha^{-1} along with Zinc Lysinate @ 2.5 kg ha^{-1} has recorded the highest seed cotton yield (1123 kg ha^{-1}) and BCR (2.45) at ARS, Paramakudi.

The application of NPK @ 49: 20:20 kg ha^{-1} with Zinc Lysinate @ 2.5 kgha^{-1} for STCR Yield target of 1.5 t ha^{-1}, has recorded the highest seed cotton yield (1467 kg ha^{-1}) and BCR (3.19) at CSRC, Ramnad whereas application of NPK @ 41: 15: 15 kg ha^{-1} for STCR Yield target 1.5 t ha^{-1} along with Zinc Lysinate @ 2.5 kg ha^{-1} has recorded the highest seed cotton yield (1389 kg ha^{-1}) and BCR (3.02) at ARS, Paramakudi.

PP 46

Effect of different intercrops on growth and yield parameters of *deshi* cotton in skip row planting under rainfed condition

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A field experiment was conducted to find out the effect of different intercrops on growth and yield parameters of *deshi* cotton in skip row planting during *kharif* season of 2018-19 at Agronomy Farm, College of Agriculture, Dhule, Maharashtra. The experiment was laid out in randomized block design, replicated thrice with seven treatments *viz*., sole cotton, sole skip row planting of cotton, skip row planting of cotton + intercropping of green gram (2:1), skip row planting of cotton + intercropping of black gram (2:1), skip row planting of cotton + intercropping of soybean (2:1), skip row planting of cotton + intercropping of sesamum (2:1) and skip row planting of cotton + intercropping of pearl millet (2:1). The results revealed that green gram, black gram, soybean and sesamum did not show any influence on growth parameters (plant height, leaf area, dry matter accumulation plant^{-1}) of cotton. However, pearl millet reduced growth parameters of cotton drastically and shown its dominance. The intercrops in skip row planting of cotton and both the sole cropping pattern proved similar in producing number of sympodial branches in flowering stage and they were superior to pearl millet as intercrop in skipped row. However, soybean was inferior than black gram in later stages. Sole skip row planting of cotton registered the highest seed cotton yield (1966.48 kg ha^{-1}) than skip row planting of cotton + pearl millet (925.70 kg ha^{-1}), however, it is on par with rest of the treatments. Similar trend was observed in respect of yield of stalk kg ha^{-1}. There was a drastic reduction in seed cotton yield ha^{-1} due to pearl millet intercropping (52.9 %) as compared to sole skip row planting of cotton. The lowest reduction in yield of cotton was noticed with black gram (3.06 %) and green gram (3.62 %) as intercrop.

PP 47

Sequential application of herbicides on weed density, weed dry weight and yield of cotton

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Weeds are the most critical crop pest, which cause the highest yield reduction in field crops. Weeds compete with crop for growth resources, which resulted in reduction of growth and yield of cotton. Controlling of weeds in cotton during the critical period assumes great importance for realizing higher yield. Unavailability of timely labour in time necessitated the use of herbicides in cotton. A field experiment was conducted to evaluate the effect of sequential application of herbicides on weed density, weed dry weight and yield of cotton during 2019 at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai. Among different weed management treatment, weed free check recorded the lesser number of weeds (no/m^{-2}) and weed dry weight (g/m^{-2}) and was followed by lay by application of pre- emergence pendimethalin at 1.0 kg ha^{-1} at 3 DAS followed by one hand weeding at 30 DAS and pendimethalin 1.0 kg ha^{-1}. The highest seed cotton yield and yield parameters were obtained in weed free check which was statistically on par with treatment pre-emergence application of pendimethalin at 1.0 kg ha^{-1} at 3 DAS followed by one hand weeding at 30 DAS followed by pendimethalin 1.0 kg ha^{-1} (Lay by application). During the experimentation the highest B:C ratio was obtained in Lay by application of pre-emergence pendimethalin at 1.0 kg ha^{-1} at 3 DAS followed by one hand weeding at 30 DAS followed by pendimethalin 1.0 kg ha^{-1}.

PP 48

Nanofibre seed coating - an innovative seed invigouration technique to improve germination and vigour of cotton

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In rainfed cotton, germination and seedling establishment are very critical issue, which ultimately results in low productivity due to continuous drought. In order to overcome the moisture stress, seed invigouration with hormones is one of the strategies. This dissertation is focused on to develop innovative delivery system to infuse growth promoting hormone (GA_3) using electrospun nano-fibre, which is a novel and versatile technology being used for entrapping bio-active molecules. It is hypothesized to develop electrospun fibre matrix for encapsulating growth hormone to release slowly to the germinating seeds so as to ensure germination under rainfed conditions. In this experiment, nanofibre was developed from synthetic hydrophilic polymer polyvinyl alcohol (PVA), and under process parameters set for electrospinning, 15% PVA found to produce nano-fibre. The E-spin mix of PVA and hormone (GA_3) was prepared and delivered by mono-axel mode to get the perfect fortified nano-fibres. The SEM images exhibited that nano-fibres had the dimension in the range of 106.2 to 275.6 nm, initially. After loading of hormones, the fibres got widened to 131.3 - 296.4 nm. Further, the hormone loading pattern was confirmed with EDAX analysis where C, H, O and N were registered higher besides UV-Vis spectroscopy confirmed the presence of spectral peaks corroborating with gibberellic acid at 213 nm. The seeds were coated with hormones loaded nano-fibres and the seed quality was assessed under *invitro* condition. The result revealed that nano-fibre with GA_3 had registered higher germination (88%) and vigour index (2734) than control which registered the lowest values (75 % & 1925). Our study clearly demonstrated that electrospun nano-fibre could be a potential technology to deliver hormones in cotton thereby germination can be ensured under rainfed conditions.

PP 49

Plant growth analysis of defoliation in cotton (*Gossypium hirsutum)*

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The two years studies were conducted to know the effect of different defoliants and application time to enhance the defoliation of cotton for improving mechanical harvesting efficiency, reducing the time of handpicking, reduce trash content in lint, and improve fiber quality of cotton. The first year study was conducted in cotton CO 17 variety under field condition during 2018. The matured cotton plants were sprayed with seven different foliar treatments S_1 – Control, S_2 – 2, 4- D (0.5 %), S_3 – Ethephon (0.5 %), S_4– Ethephon (0.5 %) + TIBA (0.05%) ,S_5- Sodium chlorate (0.9 %), S_6- 6-BAP (0.1 %) , S_7– Thidiazuron + Diuron (0.03 %) as subplot. The different defoliants sprayed at different times of spray for identifying the effectiveness comprised of three stages of defoliant spray (M_1 -spray at 120 DAS, M_2 -spray at 127 DAS, and M_3 -spray at 134 DAS) as main plot. Different parameters associated with defoliation were recorded. The second year study was conducted during 2019 aimed for confirmation of previous year study results through foliar application of defoliants same as on first year study.

PP 50

Effect of macronutrient fertilizer mixtures on nutrient uptake, use efficiency and yield in cotton (var. CO-14)

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A field study was conducted to assess the effect of macronutrient fertilizer mixtures over the nutrient uptake, nutrient use efficiency and yield of cotton in farmer's field at Deenampalayam taluk of Coimbatore district under Tamil Nadu Agricultural University. There were nine different treatment combinations of fertilizer mixtures from eight different sources of macronutrients (as for nitrogen (urea and calcium nitrate), for phosphorus (single superphosphate), for potassium (muriate of potash and sulphate of potash) and for nitrogen and phosphorus (mono ammonium phosphate, di ammonium phosphate and ammonium sulphate phosphate)). It was observed that, application of calcium nitrate containing fertilizer mixture (calcium nitrate + di-ammonium phosphate + muriate of potash), helped to increase nutrient uptake (63.14 kg N ha^{-1}, 32.62 kg P ha^{-1} and 43.01 kg K ha^{-1} at boll bursting stage) and agronomic nutrient use efficiency (14.12 kg kg^{-1}, 28.24 kg kg^{-1} and 28.24 kg kg^{-1} for nitrogen, phosphorus and potassium use efficiency respectively) in cotton, which in turn resulted in higher yield (2118 kg ha^{-1}).

PP 51

Policy reforms and growth of cotton crop in India

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Cotton is a major fibre crop of India that contributes significantly to the nation's economy by satisfying both domestic and export demands. In terms of farm income, employment, and export earnings, it makes a significant contribution to both agriculture and industry. India has the highest area under cotton cultivation which is about 37% (12.35 million hectares) of the world's area and is one of the largest producer of cotton in the world accounting for about 22% of the world cotton production during 2020-21. The domestic textile industry is one of the largest industry in the country and has witnessed a remarkable growth in the last two decades in terms of installed spindlage and yarn production. The significant reasons of this growth includes installation of open-end rotors and setting up of export-oriented units. Technology-wise, Indian spinning industry has been able to keep pace with the international technology trends. India has become one of the largest consumer of cotton i.e., about 22% of World Cotton Consumption. Despite being one of the world's top producers of cotton, India has not yet reached the full extent of its potential to dominate the export of raw cotton. The volume and revenue earnings of exports, area and the production of cotton in the country at this time are highly variable and inconsistent. So, to stabilize the area, production and to maximize the revenue from the export of the crop, Government of India has introduced several policy reforms or schemes like Pradhan Mantri Fasal Bima Yojna (PMFBY), Krishi Sinchayee Yojna, Technology Mission on Cotton and National Food Security Mission (NFSM).

PP 52

Effect of seed priming with various organic and inorganic compounds on cotton seed germination and seedling development

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This study was conducted to evaluate the effects of seed priming with various organic and inorganic compounds on cotton seed germination. The experiment was conducted in Department of cotton, AC & RI, TNAU, Coimbatore in 2022. in Completely randomized design The acid delinted seeds were treated with 10 different organic and inorganic priming materials and treatments are T_1- Hydropriming, T_2- Panchagavya 5%, T_3- Panchagavya 10%, T_4- Cow urine 3%, T_5- Cow urine 6%, T_6- KNO_3 2%, T_7- Mepiquat chloride 200 ppm, T_8- Mepiquat chloride 300 ppm, T_9- Salicylic acid 100 ppm, T_{10}- Salicylic acid 200 ppm. Seeds were soaked in priming materials for 12 hours and shade dried for 3 hours and following observations were made, Germination percent (%), Root length (cm), Shoot length (cm), Seedling length (cm), Number of lateral roots, Seedling fresh weight (g), Seedling dry weight (g), Seedling Vigor Index I, Seedling Vigor Index II and were taken between 10 days interval i.e., 10,20,30 DAS Maximum germination percent (100%) was recorded under treatment T_4- Cow urine 3%, T_5- Cow urine 6% and T_{10}- Salicylic acid 200 ppm. Maximum root length (9.3, 10.1 and 18.4 cm), shoot length (9.9, 18.8 and 26.0 cm), seedling length (19.2, 28.9, 44.4cm) were recorded with T_5- Cow urine 6%. Seedling fresh weight (0.75, 2.26, 6.97 g), seedling dry weight (0.075, 0.39, 0.83 g) were found highest in the treatment T_5- Cow urine 6% in all observations. Number of lateral roots (25, 28, 38) and vigor indices I (1920, 2893, 4437) & II (7.53, 39, 83.3) were recorded higher with T_5- Cow urine 6%. Among seed priming with various organic and inorganic compounds, seed priming with 6 percent cow urine outperformed all other treatments and recorded highest seedling vig

PP 53

Compact cotton varieties under HDPS in irrigated situations: A potential means to bridge gap in productivity in India compared to developed nations

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Despite the fact that over 90% of farmers are using cutting-edge BG II hybrids, cotton yield in India has stagnated at 473 kg/ha over last ten years compared to Brazil (1727 kg/ha), China (1943 kg/ha) and USA (909 kg/ha). In India, cotton witnessed deceleration in productivity as cotton is grown under varied agro-ecological niches with shortfall of soil moisture supply due to climate change-induced aberrations in rainfall pattern and irrigation, low plant density, outdated Bt cotton technology, acute biotic & abiotic stresses *etc*. Under these conditions, High Density Planting System (HDPS) offers a viable alternative for obtaining higher yield. In HDPS, main goal is to produce high yield by increasing plant density/unit area, keeping the number of bolls/plant at 10-15, and maximizing the number of bolls/unit area. Crop module which can suite HDPS can be developed through ideotype breeding. It offers unique opportunities to select or modify plant architectural traits for developing cotton plant types to deploy under HDPS. Hence, present study was planned to understand performance of twelve stabilized *hirsutum* lines (four compact, four tall-erect and four tall spreading genotypes purely classified on the basis of visual appearance and past performance) under three spacing situations *viz*., E_1 (60 × 15 cm), E_2 (75 × 15 cm) and E_3 (90 × 15 cm) with an aim of identifying genotypes with suitable ideotype for HDPS under irrigated ecology. Results described that compact types absolutely dominated, tall erect types were the ranked second while tall spreading plant types were lowest yield recorded under three different situations. It was established that 90×15cm is preferable than closer spacing since three ideotypes performed well in E_3. In E_3, two compact types (RACH-1408 (4333 kg/ha) and RACH 1400 (4188 kg/ha)) had the highest yield whilst, tall erect (RACH-1238 (3703 kg/ha)) and tall spreading

(RACH-1554 (3083 kg/ha)) genotypes were found to be more potential in E_2 and E_1, respectively. Intriguingly, two genotypes (RACH-1408 and RACH-1238) which yielded higher seed cotton had markedly higher boll weight, number of bolls per plant, boll retention, and fibre quality under all three circumstances. The three ideotypes exhibited the highest percentage of boll retention (> 60%) in E_3, along with the number of reproductive nodes and the number of bolls per plant. The highest recorded yield was therefore driven by the higher number of bolls per plant. Present study directed to conclude that compact plant types can be deployed in HDPS with optimum inter-plant (15 cm) and inter-row spacing (90 cm) to unleash their high yielding potential in irrigated situations.

PP 54

Integrated weed management in cotton

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Cotton (*Gossypium hirsutum* L.) is an important commercial crop of India. It sustains the cotton textile industry which perhaps the largest segment of organized industries in the country. Weeds are generally vigorous growers and their nutrient requirements are often greater than that of crop plants. It necessitates formulating suitable recommendations and combinations of integrated weed management practices for cotton. The field experiments were conducted during 2017-2018, 2018-2019 and 2019-2020 at Agricultural Research Station, Vaigai Dam using cotton variety MCU 5. The treatment consisted of Pre emergence application of Pendimethalin 30 % EC @1.0 a.i.kg/ha + Hand weeding on 30 DAS, (T_1); Pre emergence application of Pendimethalin 30 % EC @1.0 kg a.i./ha + Early Post emergence application of Quizalofop-ethyl @ 50 g a.i./ha at 2 - 4 leaf stage+ Hand weeding on 45 DAS (T_2) and Early post emergence application of Pyrithiobac sodium @ 62.5 g a.i./ha +Quizalofop-ethyl @ 50 g a.i./ha at 2 - 4 leaf stage + Hand weeding on 45 DAS (T_3); The major weed flora of the experimental field consisted of grasses, sedges and broad leaved weeds. The major grassy weeds are *Dinebra retroflexa*, *Echinoclova colonam Dactyloctenium aegiptium* and *Panicum flavidum*. *Cyprus rotundus* was the only sedge and *Corchorus olitorius*, ,*Digera arvensis*, *Cleome viscosa*, *Phyllanthus niruri, Euphorbia hirta* , *Trianthema portulacasturm, Eclipta alba, Pterocarpus jamaisensis*, *Parthenium histerophorus, Euphorbia hirta,, Bohavia diffusa* and *Phyllanthus madras petensis* were the major broad leaved weeds. All the weed management practices exhibited influence on the weed population and weed biomass on 30 and 60 DAS in cotton. Among the integrated weed management practices, pre emergence application of Pendimethalin 30 % EC @1.0 kg a.i./ha with addition of Early post emergence application of Quizalofop-ethyl @ 50 g a.i./ha at 2-4 leaf stage and followed by one Hand weeding on 45DAS recorded the minimum weed count (5.0 Nos.m^{-2}) and weed dry weight (6.04g/m^{-2}). Weed management practices have exhibited

influence on yield attributes viz., more number of sympodial branches/plant (28.0), Bolls/plant (46), Boll weight (4.1g) and cotton yield (1820 kg ha^{-1}) was recorded with pre emergence application of Pendimethalin 30 % EC @1.0 kg a.i. /ha coupled with Early post emergence application of Quizalofop-ethyl @ 50 g a.i./ha at 2-4 leaf stage and one hand weeding on 45DAS. Preference of herbicides by the farmers mainly depends on the weed control efficiency and economics. Generally hand weeding is more expensive than the chemical weed control. Pre emergence application of Pendimethalin 30 % EC @1.0 kg a.i./ha with addition of early post emergence application of Quizalofop-ethyl @ 50 g a.i./ha at 2-4 leaf stage + one Hand weeding on 45 DAS has recorded higher gross return (Rs.72,800 ha^{-1}), Net return (Rs.43,850 ha^{-1}) and B:C ratio (2.51). It could be the concluded from the results, that the integrated weed management practices with pre emergence application of Pendimethalin 30 % EC @1.0 kg/ha + early post emergence application of Quizalofop-ethyl @ 50 g a.i./ha at 2-4 leaf stage with one Hand weeding on 45DAS is efficient weed management practices for control of weeds and higher yield and economic returns.

PP 55

Improved production technology in cotton for obtaining higher productivity under irrigated ecosystem

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Alarming water scarcity during critical period of crop growth, maintaining optimum population load per unit area, prevent mortality rate & productivity loss owing to soil borne pathogen, weed and pests infestation, paucity of skilled labourers and steep increase in wages, tends cotton farmers to search for improved management practices in cotton for ensuring optimum population density, drudgery reduction, enhancing water use efficiency, water productivity, productivity and monitory returns. Consequently, Best Management Practices (BMP) in cotton under drip irrigation is gaining momentum in Tamil Nadu and therefore, it is imperative to study the efficient and inexpensive planting techniques, water regime, inter cropping under drip fertigation to enhance the system productivity and improve the monitory returns of cotton farmers. Considering this, On-Farm Experimental trials were conducted in Mettur - Noyyal Confluence sub basin area of Edapadi Block of Salem District, Tamil Nadu, India during *Summer* 2020 Season under TNIAMP - Phase II - Mettur-Noyyal Confluence scheme. The experiments consisted of Best Management Practices (BMP) and were compared with Farmers Practice. The On Farm experiment was conducted through cluster approach at 60 different locations of Edapadi Block of Salem District on large scale trials during Summer Season. The results revealed that the higher productivity of 3144 kg/ha was archived under Best Management Practices (BMP) over Farmers Practice (2414 kg/ha). Based on above findings, it could be concluded that Best Management Practices gave higher monitoring returns (Rs.141018/ha) and benefit cost ratio (5.42) over farmers practice (Rs.99003/ha) besides conserving the natural resources and minimizing the environmental pollution.

PP 56

Influence of foliar nutrition on growth, yield attributes and seed cotton yield of cotton MCU 5 under winter irrigated condition

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Cotton regarded as the 'white gold' is an important commercial crop throughout the world. It is the chief source of raw material to the textile industry. The growth and yield of cotton is governed by the interaction of environment with the genetic makeup of the variety or hybrid, various inputs, such as water, fertilizer, pesticides etc. Among the various inputs, fertilizers play a major role in influencing the plant growth and development of cotton. Generally major nutrients viz., N, P and K are supplied to the crop through soil and the micronutrients and growth promoting substances applied as foliar feeding. The yield of cotton is affected due to many reasons viz., flower and boll shedding due to imbalance in nutrients, hormones etc., Foliar fertilization can be used to improve the efficiency and rapidity of utilization of a nutrient urgently required by cotton crop for maximum growth and yield. A field experiment was conducted to study the influence of foliar application of nutrition on growth, yield attributes and yield of cotton MCU 5 at Agricultural College and Research Institute, Kudumiyanmalai during Ag-Feb 2020-21 under winter irrigated condition. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising seven treatments replicated thrice. The treatment structure comprises *viz.* Control (T1), Boron 0.1 % 3 foliar sprays (T2), MgSo4 1.0 % 3 foliar sprays (T3), ZnSo4 0. 5 % 3 foliar sprays (T4), Boron 0.1 % + ZnSo4 0.5 % 3 foliar sprays (T5), Boron 0.1 % + MgSo4 1.0 % 3 foliar sprays (T6) and MgSo4 1.0 % + ZnSo4 0.5 %3 foliar sprays (T7). Three foliar sprays were done at flowering, squaring and boll development stages. The result revealed that foliar application of MgSo4 1.0 % + ZnSo4 0.5 % 3 foliar sprays (T7) recorded significantly higher plant height (127.2 cm), Monopodia plant^{-1} (3.2), Sympodia plant^{-1} (23.7), total dry matter production (29.7 g plant^{-1}), number of bolls plant^{-1} (46.1), Single boll weight (5.24 g boll^{-1}) and seed cotton yield (1824 kg ha^{-1}) as compared to other nutritional treatments.

Theme Area III

Crop Protection

PP 57

Field evaluation of label claim insecticides against bollworm complex on cotton

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Cotton is a cash crop that's affected by many pests. Bollworms are the most devastating pest affecting the cotton crop. Evaluation of the latest label claim insecticides for bollworm complex damage was performed in an experimental plot at the Department of Cotton, TNAU, Coimbatore through AICRP programme during August 2021–February 2022 in a randomized block design with three replications and thirteen treatments. Observations on pest incidence were recorded in a cumulative basis due to the lack of boll setting during the season. After three rounds of spraying, the bollworms and their damage were recorded as per standard protocols. The boll worms like *Helicoverpa armigera*, *Erias vittela* and *Erias insulana* have not been observed this season. But, the pink bollworm, *Pectinophora gossypiella* is the only boll worm that was noticed and damage was recorded as per the standard protocol. All treatments resulted in a considerable reduction in damage when compared to the untreated control check. The effectiveness was measured by the lowest percentage of damage caused by bollworms. The descending ranking of chemicals based on their effectiveness against bollworms is: Chlorantraniliprole 18.5 SC @150 ml/ha (12.38%), Cypermethrin 25 EC @200 ml/ha (12.46%), Profenofos 50 EC @2000 ml/ha (13.27%), Emamectin benzoate 5 SG @220 g/ha (13.10%), Spinetoram 11.7 SC @420 ml/ha (14.63%), Bifenthrin 10 EC @800 ml/ha (14.35%), Indoxocarb 14.5 SC @200 ml/ha (15.85%), Spinosad 45 SC @165 ml/ha (15.67%), Ethion 50 EC @2000 ml/ha (15.68%), Fanpropathrin @750 ml/ha (16.76%), Flubendiamide 39.35 SC @100 ml/ha (16.82%), Pyridalyl 10EC @750 ml/ha (17.83%) and Control (22.42%).

PP 58

Feeding preference of the cotton stem weevil to different varieties of cotton

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Cotton is a significant cash crop which is affected by numerous pests, leading to higher usage of pesticides in the ecosystem. Next to bollworms, cotton stem weevils are the devastating pests affecting the cotton crop in South India. The feeding preference of the cotton stem weevil to different varieties of cotton was conducted in a laboratory in which MCU 3, KC 3 and MCU 5 were tested. The number of feeding punctures increased from 3 days after release (DAR) to 9 DAR of weevil. The minimum feeding punctures/plant was recorded in MCU 3 (1.20), followed by KC 3 (2.31 feeding punctures/plant). The maximum was recorded in MCU 5 (3.48 feeding punctures/plant).The results revealed that MCU 3 was resistant to cotton stem weevil, which arrested the grub's movement inside the infested galleries and killed the grub by the production of gummy exudates. It recorder the minimum feeding preference of cotton stem weevil. The results concluded that, MCU 3 was resistant to cotton stem weevil, prevented the grub from producing gummy exudates, which prevented them from being digested. It has been shown that the cotton stem weevil prefers to consume the smallest possible amount of food.

PP 59

Screening of cotton genotypes against leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) under irrigated condition

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The study was carried out for preliminary screening trial of 74 cotton genotypes with check entries with Bunny NCS Bt, Bunny Non Bt, Bunny NCS Bt 2, NDLH 1938 (Leaf hopper resistant), DCH 32 (Susceptible to leafhopper and bollworm) laid out in Cotton Research Station, Srivilliputtur under All India Coordinated Cotton Improvement project (AICCIP on Cotton) during 2018-2019. The entries were sown in two rows with 10 plants per row. Cotton entries were left unsprayed with any pesticides. Leafhopper population was recorded from three leaves (top, middle, bottom), and injury grade was assessed as follows: 1 – no damage (highly resistant), 2 – light injury (moderately resistant), 3 – medium injury (susceptible), 4 – severe injury (highly susceptible) (visual symptoms evaluated across the entire plot). The population of leafhopper and Leaf Hopper Injury Grade (LHIG) were recorded twice (45 and 60 DAS) and the maximum grade and population were reported. The populations of other sucking pests *viz*., thrips (top, middle and bottom) and whiteflies (3^{rd}, 5^{th} and 7^{th} leaf) were also recorded from three leaves. The results revealed that among the 74 breeding materials evaluated for leafhopper resistance. Among them seven entries (RHC 1307, H 1523, CSH 3012 and F 2668, SVPR 5,GSHV 185 and LAHH 34 was found to be highly resistant to leaf hopper with grade 1. Three cotton genotypes viz., CSH 31292, GISV 298 and RHC HD 1420 were found to be moderately resistant to leaf hopper with grade 2 .

PP 60

Weather parameters affect sucking pest population dynamics on Bt cotton in Thiruvarur district of Tamil Nadu

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Cotton (Gossypium sp.) is India's most important natural fibre and oil seed crop, second in production after China and a source of revenue security for Indian farmers. Cotton is grown on 560 acres in Valangaiman, Nannilam, Thiruvarur, Kudavasal, and Koradacherry blocks of Thiruvarur district. After the introduction of Bt cotton, thrips, aphids, jassids, whiteflies, and other sucking pests increased. Bt cotton made these minor pests economically significant. During the Rabi season of 2011, Krishi Vigyan Kendra, Needamangalam conducted an experiment on the influence of weather parameters on sucking pest population dynamics on Bt cotton in Thiruvarur, Tamil Nadu. The main field was planted with 120 cm x 60 cm RCH 20 Bt cotton. Crop damage from Aphids (Aphis gossypii), Jassids (Amrasca biguttula biguttula), Whiteflies (Bemisia tabaci), Thrips (Thrips tabaci), and Mealybug (Phenococcus gossypii) was recorded weekly from randomly selected plants and correlated with weather parameters. Maximum temperature showed a highly significant positive correlation with aphids(0.806**), thrips(0.808**), jassids(0.841**), whiteflies(0.937**), and mealybugs (0.890**) populations, while minimum temperature showed a highly significant positive correlation with whiteflies(0.797**) and mealybugs (0.845**) except aphids. Aphids (0.762**), thrips (0.700**), and jassids (0.769**) had a highly significant positive correlation with relative humidity, while whiteflies (-0.676**) did not. Except for whiteflies and mealybugs, rainfall favoured aphids, thrips, and jassids. Except for whiteflies and mealybugs, sunshine hours correlated positively with aphids, thrips, and jassids. Multiple regression equations were used to predict sucking Bt cotton pests. The sucking pests, aphid, thrips, jassid, whitefly, and mealybug, were predicted to 89, 90, 91, 91, and 87 percent, respectively. Correlation and regression analysis showed how important weather is for predicting sucking pest infestations in Bt cotton in Thiruvarur.

PP 61

Impact of weather factor with key pests of cotton in Salem district

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Cotton, *Gossypium hirsutum* L. (Malvaceae), is a commercially important fibre crop, but insect pests reduce its yield. To study the seasonal incidence of insect pests and their natural enemies in cotton and their correlation with weather factors, a roving survey was conducted in farmers' fields from September 2021 to January 2022 in Salem district to record sucking pests and bollworm activity. Thrips were positively correlated with temperature, relative humidity, and rainfall. Jassids, aphids, and whiteflies were positively correlated with minimum temperature, relative humidity, and rainfall (0.12-0.19, 0.10-0.32, and 0.11-0.29, respectively), but negatively with minimum temperature (-0.35 - -0.66) Mealybugs, mired bugs, and coccinellids were high with maximum temperature (0.22 and 0.52 and 0.29). Pink bollworm incidence correlated negatively with all weather factors (-0.12 to -0.75), while spider incidence correlated positively with relative humidity (0.17). In a fixed plot survey of cotton Var: CO 17 sown in Navapatti village of Salem district, sucking pests such as jassids, thrips, aphids, and whiteflies were recorded throughout the experimental period (1.20 -9.50 per 3 leaves). Mealybug was observed from SMW 44 and miridbug from SMW 46. Jassids, aphids, whiteflies, mealybugs, and mirids were positively correlated with maximum temperature (0.14-0.59) but negatively with relative humidity (-.010 - -0.98). Thrips was positively correlated with relative humidity (0.49). The weather negatively affected stem weevil, bollworm incidence, and trap catches. All weather parameters were positively correlated with Coccinellids and spiders.

PP 62

Bio-efficacy of five leaf herbal extract against major sucking pests in organic cotton

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Bio-efficacy studies were conducted at Eastern Block Farm, TNAU, Coimbatore during *Rabi*, 2017 and 2018 to evaluate five leaf herbal extract against major sucking pests of organic cotton. The five-leaf herbal extract of neem (*Azhadiracta indica*), notchi (V*itex negundo*), adathoda (*Adathoda viscosa*), ailanthus (*Ailanthus excelsa*) and zatropha (*Zatropha curcus*) with cow urine, oil-based formulations of neem, pungam and Mahua and NSKE (standard check) were prepared and used for the study.Two rounds of sprayings were given when the pest population crossed the ETL. All the tested botanicals were significantly superior over untreated control in reducing the sucking pest population *viz.,*thrips and leafhoppers in organic cotton. In first sprayat 7 DAS, the thrips population was ranged from 3.90 to 6.37 in various treatments against 14.04 per three plants in untreated control. Whereas, the leafhopper populations were ranged from 2.82 to 4.14 against 6.84 per three plants in untreated control. In second spray at 7 DAS, the thrips population was ranged from 2.19 to 4.16 in various treatments against 22.33 per three plants in untreated control. Whereas, the leafhopper populations were ranged from 3.13 to 4.89 against 8.88 per three plants in untreated control.

The per cent reduction over control was more for thrips when compared to jassids. For thrips, the overall per cent reduction was more in first spray than second spray. Among treatments, the per cent reduction was more in foliar spray of 5 leaf herbal extract 10% which was 75.58 and 64.02 per cent, respectively for first and second sprays which was comparable with NSKE 5% application. For jassids also the per cent reduction was more during first spray when compared to second spray. Among the treatments, the foliar

spray of five leaf herbal extract 10 % perform better in reducing the jassid population with the per cent reduction of 62.43 and 57.25, respectively for first and second sprays. The next best treatment was NSKE 5% followed by five leaf herbal extract 5% sprays. The kapas yield was more (18.57 qtl./ha) in foliar spray of five leaf herbal extract 10% which was on par with NSKE 5 % spray (17.32 qtl./ha) when compared to the untreated check (9.52 qtl./ha). Results concluded that the cow urine based five leaf herbal extract at 10 per cent concentration might be the best alternative for the management of sucking pests in organic cotton ecosystem.

PP 63

Antibiosis and antixenosis resistance to aphids, *Aphis gossypii* Glover (Aphididae: Hemiptera) in desi cotton, *Gossypium arboreum* L.

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Cotton-melon aphids, *Aphis gossypii* Glover (Aphididae: Hemiptera) has been emerging as a potential threat to cotton cultivation in India. *A. gossypii* alone is responsible for 14 to 80% of yield loss in cotton due to direct feeding injury and indirect transmission of leaf roll and number of viral diseases in cotton. Desi Cotton, *Gossypium arboreum* L. holds a unique place in cotton industry because of its inherent ability to withstand drought, salinity and remarkable resistance to sucking pests and viruses. We screened eighty seven *G. arboreum* in comparison with twenty *G. hirsutum* genotypes against aphids under natural field conditions. Twenty six selected genotypes were tested for antixenosis, antibiosis and pressure over time under glasshouse conditions. No-choice, free choice and population buildup studies were conducted to categorize the level of resistance. *G. arboreum* genotypes, GAM156, PA785, CNA1008, DSV1202, FDX235, AKA2009-6, DAS1032, DHH05-1, GAM532 and GAM216 expressed antibiosis. No-choice experiment revealed significant negative effect of *G. arboreum* genotypes on aphid development time, longevity and fecundity. Antixenosis was not found to be a resistant mechanism is some *G. arboreum* genotypes *viz.,* CISA111 and AKA2008-7. Resistance in *G. arboreum* genotypes may be attributed mainly by antibiosis and in certain cases by antixenosis mechanisms. Therefore, these resistant *G. arboreum* genotypes can be explored further and utilized for introgression hybridization to develop aphid resistance in commercially cultivated *G. hirsutum* genotypes.

PP 64

Validation the IPM module for management of pink bollworm, *Pectinophora gossypiella* (Saunders) in cotton

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The study was conducted for the validation of the IPM module for Pink bollworm in cotton at the Cotton Research Station, Srivilliputtur, under the All India Coordinated Cotton Improvement Project (AICCIP on Cotton) during the year 2018-2019. A field trial was laid out with randomized block design with cotton hybrid Bt JADOO and recommended the agronomic practice was followed. The treatments are the timely sowing, Installation of pheromone traps at 45 DAS @ 5-10 per hectare, Neem based formulation@1500ppm, Release of *Trichogramma* (thrice at weekly intervals) starting 50 DAS@1.5 lakh / ha, ETL (10 % fruiting body damage) based application of recommended insecticides, Timely termination of crops and comparing to farmers' practice. Observation was pink bollworm damage *viz.,* Rossete flower, green boll damage, locule and boll damage, yield. The results revealed that mean percentage of pink boll worm damage was low in IPM module {rosette flowers (4.50 %), Pink bollworm larvae/20 green bolls (1.67%), green boll damage (15%) and open boll damage (5%)} compared to farmer practice. Locule damage was also low (2.67 %) compared to farmers practice (21.33 %) and also the pheromone trap catches were low in the IPM module (1.03 nos/week) than in farmer's practice (3.15 nos/week) and also the highest yield of cotton was recorded in the IPM module (23.21q/ha.) compared to farmer's practice (18.65 q/ha.).

PP 65

Fluorescent *Pseudomonad* strain mixtures enhance the expression of defense enzymes and pathogenesis-related proteins in cotton plants against root rot and wilt pathogens

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The bioformulation of fluorescent pseudomonad strains (APKP4, KYIP5 and VPNP5) was evaluated individually and in combinations for their efficacy against root rot and wilt disease and the effect of the interaction between fluorescent pseudomonads and cotton soil-borne pathogens *viz. Rhizoctonia solani* and *Fusarium oxysporum* f.sp. *vasinfectum*in the expression of defense enzymes andpathogenesis-related proteins (PR-proteins) in cotton. Among the various bioformulations, APKP4+KYIP5+VPNP5 formulation significantly reduced the incidence of root rot and wilt disease when compared to untreated control. A significant increase in theenzymatic activity of peroxidase, polyphenol oxidase, phenylalanine ammonia-lyase, chitinase, β-1,3-glucanase, superoxide dismutase, catalase and phenolics in cotton plants treated with APKP4+KYIP5+VPNP5 bioformulation mixture and challenge inoculated with *R. solani* and *F. oxysporum* f.sp. *vasinfectum*. Native gel electrophoresis also revealed the expression of more is of orms of peroxidase, polyphenol oxidase and catalase in plants treated with APKP4+KYIP5+VPNP5 mixture challenged with *R. solani* and *F. oxysporum* f.sp. *vasinfectum*.The present study reveals that sustained and timely induction and accumulation of the sedefense enzymes and PR-proteins enhance the resistance in cotton plants against root rot and wilt disease.

PP 66

Analysis of weather and disease interaction pertaining to *Alternaria* leaf blight in cotton

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Though many diseases afflict cotton in a bigger way, the incidence of *Alternaria* leaf spot is dangerous and it can bring devastating effect on the production and productivity of cotton. The weather parameters play a pivotal role in bringing diseases including *Alternaria* leaf blight. A study was taken up with the objective of finding the correlates and contribution of weather parameters towards PDI of *Alternaria* leaf blight, Weather parameters namely maximum temperature, minimum temperature, RH Morning, RH Evening, rainfall, sunshine and solar radiation during Standard Meteorological Weeks (SMW) were collected from Agro Climatic Research Centre, TNAU, Coimbatore. Per cent disease index was calculated using observations collected from the trial plots in different years. The design of the research was Randomized Block Design (RBD) laid in 36 m2 plot with 75 cm X 30 cm spacing. There were 8 rows with a row length of 6.0 m. In different year, different controls were used. Trend for this data was worked out for ten years starting from 2007 to 2016. The results of the study revealed that during 2009 and 2013, maximum temperature was found to be significantly contributing to PDI whereas during 2010 and 2013, evening RH contributed significantly to PDI. In the year 2012, minimum temperature was found to be significantly contributing to PDI. One pertinent point is that all these variables contribute significantly in negative direction to PDI. Almost in all the entries, the disease incidence occurred on or after six weeks of sowing irrespective of the sowing SMW. In most of the hybrids and varieties, the symptoms of *Alternaria* leaf blight and incidence of the disease touched the peak during 40th SMW to 2nd SMW which coincides with cooler months (November, December and January). The varieties, in general, were found to be less susceptible to ALB than hybrids. A common trend observed was that during the initial years (2007, 2008 and 2009), the *Alternaria* leaf blight was not that much progressive, but in the later years (2011, 2012, 2013 and 2015), the incidence was found to be more pronounced. From the study it is suggested that studies on correlation of weather parameters with all diseases of cotton can be taken up along with ALB in different centres and the results can be collated for comprehensive disease forewarning in future.

PP 67

Evaluation of elite lines of American cotton for different economic traits and their reaction to cotton leaf curl virus disease

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Cotton Leaf curl Virus disease (CLCuD) is one of the major constraints in cotton production in North zone of India The present study was aimed to evaluate the amount of variability present for agronomic traits and reaction of cotton leaf curl virus disease in the 13 elite Bt cotton lines developed by Punjab Agricultural University viz. PBH Bt 4, PBH Bt 13, PBHBt 17, PBH Bt 24, PBH Bt 11, Fbt 1905, Fbt 1907, Fbt 1915, Fbt 1916, Fbt 1913, Fbt 1904, PAU Bt 2 and PAU Bt 3alongwith checks i.e. non *Bt* released variety F 2228 and popularly *Bt* cotton hybrid RCH 773BG II in Northern zone. The experiment was conducted at experimental area, Regional Research Station, Bathinda during *Kharif* season of 2021and the data were recorded on various agronomic parameters like plant height, monopods/plant, sympods /plant, bolls/plant, boll weight, seed cotton yield, lint yield, lint index and ginning outturn and intensity of CLCuD. The results showed that, four entries (PBH Bt 4, PBH Bt 17, FBT 1916 and RCH 773BG II have shown the resistant reaction and rest of the entries have shown the moderately resistant reaction to CLCuD Significant differences were observed all the parameters studied. The Bt variety PBHBt 24 recorded seed cotton yield of 3234Kg/ha followed by 3062Kg/ha of PBH Bt 17which were statistically as par with 3553 Kg/ha of Bt cotton hybrid RCH 773 BG II. The Lint yields of these lines were also at par with 1222 Kg/ha lint yield of RCH 773BG II, 1201 Kg/ha lint yield of PBH Bt 24 and 1135 kg/ha lint yield of PBH Bt 17. Ginning outturn (GOT) which is a useful indicator to evaluate the performance of cotton genotypes in cotton production and marketing is recorded higher for PBHBt 24 and PBH Bt 17 i.e. 37.14% and 37.09% respectively... The superior PAU developed Bt genotypes were promoted to next year trial for further investigation.

PP 68

Assessment of major diseases of cotton in Tamil Nadu

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Cotton (*Gossypium* spp.) is a unique economically important fibre crop and it is widely cultivated throughout India. Cotton known as "White Gold" contributes to 35 per cent of the global fabric needs and 60 per cent of clothing in India. Diseases caused by fungi, bacteria and viruses are the important constraints in cotton production. Survey and monitoring of diseases in cotton is highly imperative to give timely plant protection advisory services to farmers . Roving survey was carried out in eight cotton growing districts of Tamil Nadu *viz.*, Coimbatore, Dindugal, Virudhunagar, Tuticorin, Tirunelveli, Trichy, Salem and Perambalur during 2021- 2022. The disease *viz.*, collar rot, root rot *Alternaria* leaf blight, bacterial blight and boll rot were recorded in all surveyed villages of above districts The incidence of grey mildew was observed only in six districts and it was not noticed in districts viz., Virudhunagar and Tirunelveli districts . The highest incidence of 6.5 per cent was observed in Veppamthatti village followed by Krishnapuram village (6.1%) of Peranbulur district. The lowest incidence of 2.3 per cent was recorded in Kallakudi village of Trichy district. The collar rot incidence of Coimbatore and Dindigul districts ranged from 3.8 to 5.3 and 4.1 to 5.0 per cent respectively. The collar rot intensity of other surveyed districts ranged from 3.3 to 5.4 per cent .The highest root rot incidence of 12.0 per cent was recorded in Shanmugapuram village of Virudhunagar district.. The root rot incidence of Tirunelveli district ranged from 7.3 to 11.3 per cent and the maximum of 11.3 per cent was found in Sankarankovil. The root rot incidence of other surveyed districts ranged from 2.1 to 10.0 and the lowest incidence of 2.1 per cent was noticed in Nallatumuthoor of Tutukurin district. maximum leaf blight incidence of 15.0 PDI was found in Guvayanayakkanpatti village followed by Kariyagoundanpatti village(14.3 PDI) of Dindigul district. The leaf blight incidence of Salem district ranged from 10.7 to 12. 5 PDI and Coimbatore district from 5.8 to 9.5 PDI . In Perambalur district leaf blight incidence of 9.5 to 11.3 PDI

was recorded. The districts *viz.*, Virudhunagar, Tutukurin and Tirunelveli the incidence ranged from 6.7 to 8.7 PDI. The lowest incidence of 6.0 PDI was recorded in Varakkupai village of Trichy district. The results revealed that the highest bacterial blight incidence of 18.5 PDI (Per cent Disease Index) was recorded in Ramanathapuram village of Coimbatore district. The least incidence of 2.9 PDI was found in Ramalingapuram village of Virudhunagar district. The maximum PDI of 16.0 was found in Salem district and the minimum of 3.5 PDI was recorded in Virudhunagar district during winter season 2021. The grey mildew incidence was maximum (18.5 PDI) at Veppamthattai village of Perambulur district followed by Boothipuram village of Dindigul district which recorded the disease incidence of 18.0 PDI. In Salem district in Valapadi village the disease incidence of 17.7 PDI was noticed. Grey blight incidence was found to be low (1.3 PDI) in Nallaatumuthoor village of Tutukurin district. The disease incidence of 2.3 to 5.0 PDI and 1.7 to 3.0 PDI was recorded in Coimbatore and Trichy district respectively. Boll rot incidence of surveyed villages varied between 2.0 to 5.5 per cent and the high incidence (5.5 %) was recorded in Guvayanayakkanpatti village of Dindigul district and it was found to be low (2.0 %) in Perumalpathi village of Tirunelveli district

PP 69

In vitro efficacy of botanicals and bioagents against *Rhizoctonia* spp inciting root rot in cotton

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Root rot caused by *Rhizoctonia* spp.is the most destructive soil borne disease of cotton (*Gossypium*) which appears every year in cotton fields and causes heavy losses in yield. Hence, the present investigation was undertaken to study the management of *Rhizoctonia* spp. through botanicals and bioagents under *in vitro* conditions in Department of Plant Pathology, CCSHAU, Hisar.Among the botanicals evaluated for their efficacy *in vitro* against *Rhizoctonia*, the phytoextract of *Lantana camara* inhibited maximum mycelial growth of pathogen upto 89.43 per cent at 20 per cent concentration followed by *Parthenium hysterophorus* and garlic (*Allium sativum*) extracts which inhibited upto 87.21 and 57.21 per cent, respectively at 20 per cent concentration. Among the bioagents evaluated for their efficacy *in vitro* against *Rhizoctonia*, which were isolated from different cotton growing districts in Haryana, T-3 isolate inhibited the maximum mycelial growth of the pathogen upto 74.44 per cent which was isolated from Sirsa followed by T2 and T12 which were isolated from Gurugram and Mahendargarh Kvk respectively and showed mycelial inhibition upto 70.00 per cent.

PP 70

In vitro screening of different *Bacillus* sp. strain against the fungal leaf spot pathogens *Alternaria alternata* and *Paramyrothecium roridum*

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The cotton cultivation is affected by various environmental stresses. Among the biotic stresses, losses due to pest and diseases cause economic impact to the farming community. Even in the seedling stage, crop is infected by various phytopathogens *viz*.,fungi, bacteria, and viruses. The fungal diseases *viz*., wilts, boll rots, root rots, and leaf spots play a crucial role. The fungal leaf spot caused by *Alternaria* sp. is ubiquitous, and found in all cotton-growing areas, whereas *Cercospora*, *Myrothecium*, and *Corynespora* leaf spots appear year after year, threatening cotton production. India's average yield loss caused by fungal leaf spots is about 30%. Exploration of antagonistic bioagents viz., Bacillus sp. will suppress plant pathogens, besides promoting its growth. It is also a great substitute to plant growth promoting agrochemicals i.e., fertilizers and synthetic pesticides. Two major leaf spot causing pathogens, *Alternaria alternata* and *Paramyrothecium roridum* were considered for screening against different strains of *Bacillus.* Different Bacillus isolates were obtained from the Department of Plant Pathology, TNAU for screening their antifungal activity against the fungal pathogens by dual culture plate technique using PDA medium. A mycelial disc of thepathogen was placed at one end of the petriplate while the bacterial antagonists, *Bacillus* sp. were streaked near the petriplate's periphery,opposite to the pathogen disc. For each treatment three replications were maintained along with a control. The plates were maintained in room temperature (25 ± 2° C). The pathogen's growth towards the bacterial colony was measured and the per cent inhibition over control was calculated10-15 days after incubation. Among fifteen different *Bacillus* strains, *B. subtilis* strain BST8 had the highest mycelial reduction of 33.7% and 50.2% for *P. roridum* and *A. alternata* while the least was recorded in strain BST18 with 10.0% and 3.9% mycelial reduction of *P. roridum* and *A. alternata*.

PP 71

Biosuppression of bacterial blight of cotton using endophytic *Bacillus*

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Bacterial blight of cotton incited by *Xanthomonas citri*pv. *malvacearum* is one of the important diseases of cotton inflicting yield loss up to 50 per cent .Chemical management of the disease have limited scope because of the undesirable hazardous effects on environment. Use of bio control microbes *viz.Bacillus* with multiple mode of action against target organism is the best alternative. Therefore an attempt was made to identify the novel *Bacillus* sp against bacterial blight of cotton. A total of 15 endophytic isolates were collected from cotton plants and evaluated for their inhibitory action against *X.citri*pv. *malvacearum* by cross streak method under *in vitro* . Among these, the isolate EB 15 exhibited the highest inhibition zone of 11.5 mm followed by isolate EB 3 which showed the inhibition zone of 8.7mm. The growth promoting ability of the above isolates were tested in the laboratory by standard roll towel method and isolate EB 15was found to be the best in enhancing growth parameters which recorded the vigour index 1536.4 as against 735.5 in the untreated control. Based on the morphological, biochemical and molecular characterization the isolate EB 15 was identified as *Bacillus*sp. The presence of lipopeptide antibiotic genes *viz*, surfactin, iturin and fengycin were detected in *Bacillus* sp (EB 15) by PCR amplification with gene specific primer .The talc based formulation of *Bacillus* sp (EB 15) was evaluated against bacterial blight both in the glass house and field condition .The results showed that seed treatment with *Bacillus sp* EB15 @ 10 g/ kg of seed + Foliar spraying @ 0. 5 % at 40 and 60 DAS was effective in reducing the bacterial blight incidence by 65.0 and 62.0 per cent in the glass house and under field condition respectively.

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