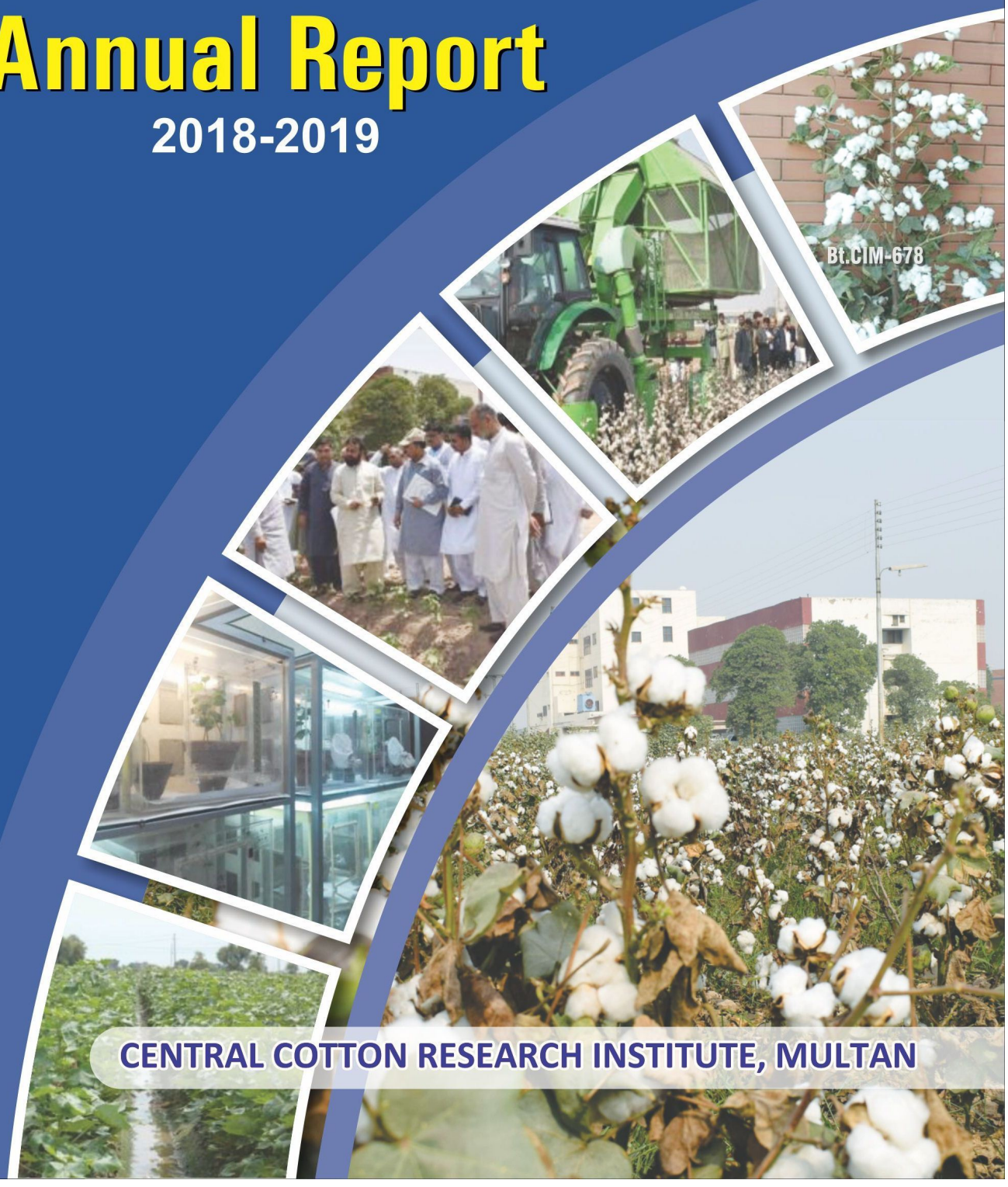
Annual Report

2018-2019



CENTRAL COTTON RESEARCH INSTITUTE, MULTAN

GOLDEN JUBILEE CELEBRATIONS

COTTON CENTRAL RESEARCH INSTITUTE MULTAN

1970 - 2020

Annual Report
2018-19

CENTRAL COTTON RESEARCH INSTITUE, MULTAN

Pakistan Central Cotton Committee

Ministry of National Food Security & Research

Government of Pakistan

CONTENTS

I. EXECUTIVE SUMMARY

i). Introduction

The Central Cotton Research Institute Multan has been endeavoring to conduct fundamental and applied research on cotton since its establishment in 1970. The Institute initially started its activities with five disciplines viz. Cytogenetics, Entomology, Plant Pathology, Plant Physiology/ Chemistry and Statistics. The Institute expanded its research horizon to cover applied research with special focus to address the issues faced by cotton farming community regarding production technology and to enhance cotton production through evolving high yielding varieties with desirable fibre parameters. To achive this mandate, new sections such as Plant Breeding and Genetics (1973), Agronomy (1975), Fibre Technology (1976) and Transfer of Technology (1983) were set up in a period of one decade. The Institute has also been recognized as “Centre of Excellence” in Asia Region by the Organization of Islamic Conference (OIC). Presently nine disciplines are working at the Institute in a coordinated manner.

The Institute has also recently established “Cotton Biotechnology Group” which is formed to focus on application of advanced biotechnological tools for addressing problems of insect pests and diseases and other environmental stresses on cotton crop. The Group has so far performed in streamlining & repair of required equipment, arrangements for the chemicals, established the protocols for different procedures like DNA extraction, GEL electrophoresis, prepared stock solution and working solution, genomic DNA extraction from cotton leaves, Gel electrophoresis for DNA analysis, DNA quantification on the Spectrophotometer, qualitative and quantification testing of cotton sample through ELISA for Cry1AC testing of seed cotton for GMO status.

Moreover, the Institute has also been working on evolution of naturally-grown colored cotton with different color shades and desirable fibre traits. The research work has led to improve fibre length and other quality traits acceptable for textile industry.

In addition, the Institute has also collaborated with Agriculture Department and NGOs for production of organic cotton cultivation in Balochistan. The Institute provided cotton seed for growing as experimental purpose in various districts. The collaborative efforts also resulted in production of 1st organic cotton bale produced by the WWF during the current year.

The research work has been focused on the following main aspects:

1. Study the cotton plant from botanical, genetical, production, physiological, chemical, entomological, pathological and other relevant facets in a coordinated manner.
2. Undertake research work of national importance, handle problems of inter-regional nature.
3. To develop cost-effective cotton production technology.
4. Advance knowledge on the cotton plant responses to environment with a view to better cope with the adverse impacts in the changing climate scenario.
5. Provide education and training on cotton production technology to the agriculture research, extension, teaching staff and other stakeholders.
6. Identify problems of cotton growers and advocate remedial measures.
7. Transfer production technology to the cotton growers.
8. Educate and motivate cotton growers and monitor research outcomes.
9. Provide technical support to the Pakistan Central Cotton Committee in coordinating and developing a national programme for cotton research and development.
10. Training manpower across the country and other cotton growing countries on “cotton research and development”.
11. Facilitation and research guidance to students at graduate and higher level degree courses.

ii) Staff Position

A total of 129 staff members including 33 officers and 96 other staff members remained at the Institute during the period under report. The position of technical staff during the year 2018-19 is given in **Appendix-II**.

iii) Budget

The sanctioned budget from the year 2016-17 to 2018-19 is given below:

(Rs. Million)

Sr. #	Detail	2016-17	2017-18	2018-19
1.	Pay & Allowances	67.622	61.860	74.859
2.	Medical	3.413	2.930	0.500
3.	Traveling Allowance	1.500	1.800	2.200
4.	Group Insurance	0.795	0.617	0.653
5.	Utility Bills*	7.060	7.160	9.835
6.	Contingencies	25.485	48.200	40.806
	Total	**105.875**	**122.567**	**128.853**

* Include Electricity, Gas, WASA, Phone, Internet, and electricity charges for new building

iv) Income

The income of the Institute from the year 2016-17 to 2018-19 is given below:

(Rs. Million)

Sr. #	Head	2016-17	2017-18	2018-19
1.	Farm Produce	3.381	4.000	3.331
2.	Non-Farm Produce	1.161	1.200	0.950
	Total	**4.548**	**5.200**	**4.231**

* Period from 1st July to 28th February

II RESEARCH ACTIVITIES

i) Research Experiments

The Institute carried out following research experiments, being conducted by various sections during crop season 2018-19:

Section		Experiment	Year of Experiment
Agronomy	1.	Effect of time of sowing on productivity of advanced genotypes	2nd
	2.	Effect of time of sowing on production of transgenic cotton	2nd
	3.	Yield response and nitrogen use efficiency of transgenic vs. conventional cotton cultivars to nitrogen application	2nd
	4.	Modeling the cotton genotypes performance at temporal variations	1st
	5.	Cotton yield response to residues management and tillage systems in cotton-wheat cropping system	1st
	6.	Cotton yield and fiber quality response to high density planting system (HDPS)	1st
	7.	Efficacy of stale bed technology and pre-emergence herbicides on initial weed control in cotton	1st
Plant Breeding & Genetics	1.	Testing of New Strains Developed at CCRI, Multan	Continuous
	2.	Varietal Trials (MVT, SVT, NCVT, PCCT)	Continuous
	3.	Propagation and Selection from Hybrids	Continuous
	4.	Testing of Advanced Strains at Farmers' Fields (ZVT)	Continuous
	5.	Performance of Promising Strains in Bigger Block	Continuous
	6.	Screening of Breeding Material against CLCuD	Continuous
	7.	Maintenance of Genetic Stock of World Cotton Collection	Continuous

AGRICULTURAL RESEARCH SUB COMMITTEE (ARSC) MEETING 2018

Dr. Khalid Abdullah, Cotton Commissioner/Vice President, Pakistan Central Cotton Committee (PCCC) chairing the Agricultural Research Sub Committee meeting of PCCC held at CCRI Multan on March 20-22, 2017. Dr. Tassawar Hussain Malik, Director Research PCCC, Dr. Muhammad Ali Talppur, Director Marketing and Economic Research, PCCC, Dr. Zahid Mahmood, Director CCRI Multan and Dr. Waris Sanjrani, Director CCRI Sakrand and other researchers and stakeholders also present.

Section		Experiment	Year of Experiment
Cytogenetics	1.	Collection & maintenance of *Gossypium* germplasm	Continuous
	2.	Species hybridization	Continuous
	3.	Colchiploidy	1st
	4.	Search for Aneuploids/haploids	Continuous
	5.	Search for *Bt* homozygous resistance against CLCuD under field conditions	Continuous
	6.	Testing of New Strains	2nd
	7.	Testing of Cyto-material in VT, MVT	2nd
	8.	Mapping population development for Fibre Quality	1st
	9.	Production of Pre-basic Seed	Continuous
	10.	Evaluation of new strain under varied ecological zones	2nd
Entomology	1.	Impact of sowing period on the Pink Bollworm infestation	Continuous
	2.	Monitoring of population dynamics of lepidopterous pests	Continuous
	3.	Studies on tolerance level of cotton genotypes to insect pest	Continuous
	4.	National Coordinated Varietal Trials	Continuous
	5.	Comparative efficacy of insecticides against dusky cotton bug	1st
	6.	Monitoring of insecticide resistance	Continuous
	7.	Screening of new insecticides	Continuous
	8.	Execution of PARB funded projects (PBW and Whitefly)	1st
Plant Pathology	1.	Survey on Prevalence Collection of Diseased Plant samples	Continuous
	2.	Evaluation of Breeding Material against CLCuD	Continuous
	3.	Epidemiological Studies of CLCuD	Continuous
	4.	Evaluation of Advanced Strains in National Co-coordinated Varietal Trial (NCVT) in tolerance to Cotton Diseases	Continuous
	5.	Studies on Seed and Seedling Disease of Cotton and Their Control Measure	1st
Plant Physiology / Chemistry	1.	Studies on genotype - Environment Interactions	Continuous
	2.	Plant Nutrition	Continuous
	3.	Soil-Plant-Water Relationships	Continuous
	4.	Seed Physiology	Continuous
Fibre Technology	1.	Testing of Lint Samples	Continuous
	2.	Study the effect of different moisture content levels on fibre characteristics of cotton cultivars	Continuous
	3.	Study the effect of Potassium fertilizer & water stress on quality characteristics of cotton fibre	1st
	4.	Response of cotton quality characteristics to magnesium application by fertigation and foliar methods	1st
	5.	Quality survey of lint collected from ginning factories	Continuous
	6.	ICA-Bremen Cotton Round Test Program, Faser Institute	Continuous
	7.	Survey of Pakistan's Spinning Industry	2nd
Transfer of Technology	1.	Integrated Multi-Media Publicity Campaign	Continuous
	2.	Training Programs, Seminars, Exhibitions	Continuous
Statistics	1.	Statistical Analysis and Experimental Design	Continuous
	2.	Maintenance of Cotton Statistics	Continuous

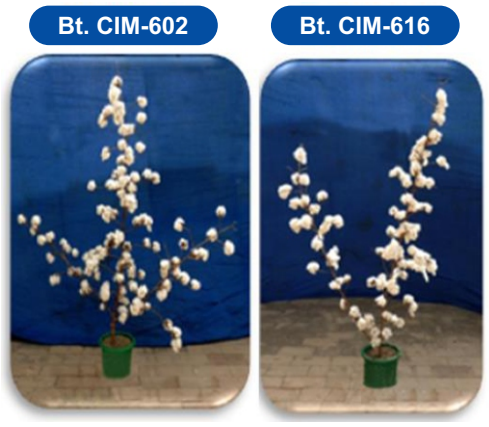
ii) Approval of Cotton Varieties by Punjab Seed Council

The Expert Sub-Committee (ESC) of the Agriculture Department Punjab, during its 77th meeting held at Ayub Agricultural Research Center, Faisalabad on March 15, 2018 recommended two cotton varieties of CCRI Multan; Bt.CIM-632 (Bt) and CIM-610 (conventional) to the Punjab Seed Council for approval of general cultivation in the Punjab province. Dr. Zahid Mahmood, Director CCRI Multan was the member of Variety Recommendation Committee while, Dr. Muhammad Idrees Khan Peer, Head Plant Breeding & Genetics Section presented cases of varieties.

Bt.CIM-632 possess excellent fibre quality characteristicis with ginning outturn 41.6%, staple length 28.8 mm, Micronaire value 4.3 mg inch^{-1}, fibre strength 100.4 tppsi. Moreover, the variety also has yield potential of 3376 kg per hectare.

CIM-610 is a non-Bt cotton variety also have better fibre quality characteristics with ginning outturn 40.2%, staple length 28.8 mm, Micronaire value 4.3 mg inch^{-1}, and fibre strength of 101.9 tppsi. The yield potential is above 2500 kg per hectares.

iii) Approval of Cotton Varieties by Sindh Seed Council



The Experts Sub-Committee of the Sindh Seed Council recommended cases of two cotton varieties Bt.CIM-602 and Bt.CIM-616 from CCRI, Multan for approval by the Council in a meeting held at the Directorate of Agricultural Research, Tandojam, Sindh on November 11, 2018 under the chairmanship of Mr. Noor Muhammad Baluch, Director General Agriculture (Research), Sindh.

Bt.CIM-602 possess excellent fibre quality characteristicis with ginning outturn 40.7%, staple length 29.0 mm, Micronaire value 4.3 mg inch^{-1}, fibre strength 95 tppsi. Moreover, the variety also has yield potential of 3574 kg per hectare.

While, Bt.CIM-616 possess excellent fibre quality characteristicis with ginning outturn 41.0%, staple length 28.3 mm, Micronaire value 4.8 mg inch^{-1}, fibre strength 101.3 tppsi. Moreover, the variety also has yield potential of 3737 kg per hectare.

iv) Research work on Naturally-Grown Colored Cotton

Naturally ccoloured cotton including dark brown, medium brown, light brown and green cotton was grown for testing improvement in morphological, economic and fibre characteristics. The performance of this material is given below.

Performance of coloured cotton strains during 2018

Coloured Cotton	Yield/plant (gm)	Ginning out turn (%)	Staple length (mm)	Fineness µg/in-^{1}	U.R (%)	Strength (g/tex)
Light Brown (interspecific) {*G. hirsutum* × 2(*G. arboreum* × G. *anomalum*)}	75.2-207	31.5-44.0	24.0-29.0	4.1-5.0	80.0-85.0	27.4-36.7
Light Brown	82.3-105	34.3-42.5	26.5-28.2	3.9-4.9	78..6-83.0	29.5-32.0
Medium Brown	75.0-111.o	31.0-40.5	25.4-28.9	3.5-5.0	80.0-85.5	25.8-34.0
Dark Brown	109.6-180	38.1-44.0	27.0-29.0	3.8-5.5	80.9-83.0	25.0-30.9
Green	46.0-150	31.5-41.9	24.0-28.5	4.1.5.5	78.0-82.0	25.8-35.0

All Coloured cotton strains exhibit excellent performance with improved seed cotton yield & fibre length. Green cotton also maintained better fibre traits. This material will be a base for high-quality organic cotton breeding programme.

v) Activities under Research Projects

Pink bollworm Project : A comprehensive integrated scientific approach for the development of sustainable management strategies of Pink Bollworm (*Pectinophora gossypiella*)

In order to manage Pink bollworm through integrated pest management, molecular approaches and development of resistant cotton germplasms; the Punjab Agricultural Research Board (PARB), Government of the Punjab has initiated a three-years project “A comprehensive integrated scientific approach for the development of sustainable management strategies of Pink Bollworm (*Pectinophora gossypiella*)” starting from 2018-2020. Under the projects, Pink bollworm rearing laboratory was established in Entomology Section at the Institute for the first time in the country. For rearing of Pink bollworm, cotton seed based artificial diet has been developed. Pink bollworm collected from ginning waste and left over bolls is being successfully reared on locally developed artificial and natural diets. Now, efforts are being made for its mass rearing. Moreover, to determine the impact of sowing time on the PBW infestation or population dynamics, sowing date trial was also conducted during 1st week of March, April and May, respectively. Male moth activity of Pink bollworm, *Pectinophora gossypiella* was monitored through sex pheromone baited traps at CCRI, Multan and farmer’s field at Chak 116/10R Jahanian, District Khanewal throughout the year.

Whitefly Project: Management of whitefly by integrated strategies and development of resistant cotton germplasm through genetic engineering

In order to manage cotton whitefly through an integrated approach, the Punjab Agricultural Research Board (PARB), Government of the Punjab has initiated a three-years project “Management of whitefly by integrated strategies and development of resistant cotton germplasm through genetic engineering” starting from 2018-2020. The main objective of the project is the characterization of whitefly through conventional and molecular approaches, development of whitefly management strategies based on natural enemies and integrated pest management strategies and development of resistant cotton germplasms against whitefly by RNA interference. Under this project, CCRI Multan carried out surveys in major cotton growing districts (Lodhran, Khanewal, Multan, Bahawalpur and Vehari) for population dynamics of whitefly and its natural enemies. For this purpose various tunnels, nurseries and vegetable, fruits and crop farms or fields were monitored. Leaves were observed visually to record whitefly adult and nymphal population. Moreover, to determine the impact of planting time on the whitefly infestation or population dynamics, trial was conducted on 1st April, 1st May and 1st June, respectively. Furthermore, to isolate cotton cultivars for their response to whitefly on the basis of mechanism of plant resistance, trial was conducted containing different cotton cultivars (FH-142, FH-152, CIM-600, CIM-602, CIM-632, RH-668, NIAB-1048, Crystal-12, Sitara-15). Field experiments were also conducted to check the efficacy of conventional and new chemistry insecticides against whitefly population. Whitefly rearing laboratory was also established in Entomology Section of CCRI Multan and Whitefly is being reared on live cotton plants in this newly established lab.

Pak-US-ICARDA Cotton Project "Screening and maintenance of US cotton germplasm for the development of CLCuV resistant/tolerant genotypes by using traditional breeding approaches at CCRI Multan"

The United States Department of Agriculture (USDA) in coordination with the International Center for Agriculture Research in Dry Areas (ICARDA) initiated a cotton project involving all the cotton research institutions in Pakistan for the evolution of CLCuV resistant/tolerant cotton varieties. Cotton germplasm is being provided by the USDA for screening against Cotton Leaf Curl Virus resistance/tolerance. A total of 180 accessions of US cotton germplasm comprising of Set-V and W (*Gossypium hirsutum* L.) was distributed among CCRI, Multan (Set-W = 45), CRI Multan (Set-W = 45), CRS Vehari (Set-V = 32) and NIBGE, Faisalabad (Set-V = 58). Out of these, 45 accessions were provided to CCRI Multan, 20 were sown in field condition on 2nd July 2018 at CCRI Multan and the remaining 25 accessions were kept in cold room for sowing during next year i.e. 2019-20. The data for various parameters i.e., germination %age, plant population, disease infestation & severity, boll formation, along with physiological, morphological and fibre quality traits were also recorded. One candidate variety i.e. CIM-303 which was obtained from cross between local and US CLCuV resistant germplasm was tested in 1st year in NCVT trial 2018-19 and will also be tested for 2nd year during 2019-20. Two candidate lines, using blood of US CLCuV resistant cotton germplasm are in advanced varietal trials. Moreover, the US cotton germplasm, resistant/tolerant to CLCuV also included in regular cotton breeding program. CCRI Multan also continued to supply the seed of USDA cotton germplasm free of cost to the local cotton research instiutions, academia for research and varietal evolution purpose and foreign institutions as well.

vi) PSDP Projects 2019

The following projects have been prepared and submitted to the Ministry of National Food Security & Research (MNFS&R), for consideration under PSDP program.

Sr.#	Name	Period	Amount (Rs. Million)
1.	Climate Change Impact Studies And Adaptation Strategies For Cotton	3 Years	22.800
2.	An Integrated Approach For Development Of Resistance/Tolerance Against Cotton Leaf Curl Virus (Clcuv) In Cotton Exploiting Field And Molecular Assays.	3 Years	34.510
3.	Genome Wide Association Mapping (Gwas) For Fiber Quality In Upland Cotton	3 Years	38.627
4.	Tranformation & Transcriptomic Analysis Of Fiber Rich Islands To Improve Quality Of Cotton Through Introgression	3 Years	59.444
5.	Natural Enemies As Bio-Control Tool For Cotton Insect Pests; Increasing Farmer's Knowledge And Perception About Economic Value And Impact Of Insecticides On The Fitness Of Natural Enemies	3 Years	52.272
6.	Clcuv Resistance That Could Be Used As One Parental Line For Hybrid Development In Collaboration With Pakistan Agricultural Research Council (Parc).	3 Years	19.510
7.	Screening Of Cotton (Gossypium Hirsutum L.) Germplasm For Evolution Of Heat/ Drought Tolerant Varieties	3 Years	37.350
8.	Gap Analysis Of Cotton Value Chain From "Fibre To Yarn" To Makeit Sustainable For Stakeholders And Technological Advancement.	3 Years	59.998
9.	Cotton Yield And Fibre Quality Response To High Density Planting Sytem	3 Years	16.205
	Identification And Characterization Of Cotton Genotypes For Heat Tolerance Under Different Agro Ecological Zones	3 Years	34.136

vii) ALP Projects

The following projects have also been prepared and submitted to the Pakistan Agricultural Research Council (PARC) for funding under the Agricultural Linkage Program (ALP) 2019-2020.

Sr. No.	Name	Period	Amount (Rs. Million)
1.	Integrated Approach for the Development of Resistance/Tolerance against Cotton Leaf Curl Virus (CLCuV) in Cotton Exploiting Field and Molecular Assays	3 Years	34.51
2.	Sustaining Soil Health and Improving Cotton-Wheat Productivity by Integrated Minimum Tillage, Crop Residues, Compost and Biochar Addition	3 Years	8.00
3.	Screening of Cotton (Gossypium hirsutum L.) Germplasm and Evolution of Heat / Drought Tolerant, High Yielding Varieties through Classical Breeding Approach	3 Years	50.00
4.	Sustainable Cotton Production through High Density Planting System (HDPS)	3 Years	16.21
5.	Transformation & Transcriptomic Analysis of Fibre Rich Islands to Improve Quality of Cotton through Introgression	3 Years	59.44
6.	Sustainable Cotton Produciton through Integrated Management of CLCuV in Changing Climate	3 Years	27.0
7.	Genome Wide Association Mapping (GWAS) for Fibre Quality in Upland Cotton	3 Years	27.84

viii) Establishment of Insect Rearing Laboratories

An insect rearing laboratory with controlled temperature light and humidity is established in Entomology Section in which culture of Whitefly is being maintained on living plants along with developing its susceptible strain. Culture of Pink bollworm is also maintained on semi-syntehetic and natural diets. In addition, work on developing susceptible strain of armyworm (Spodoptera litura) is also underway.

ix) Insecticide Resistant Management Program

The Institute continued to conduct studies on Insecticide Resistance Management program in the past. Now, the program has again been started during the year 2018-19. Insecticide has been tested against various insect pests both under laboratory and field conditions. The most effective pesticides were advised for sprays to the cotton farmers.

x) Formation of Cotton Biotechnology Group

“Cotton Biotechnology Group” has been formed at the Institute to focus on application of advanced biotechnological tools for addressing problems of insect pests and diseases and other environmental stresses on cotton crop. The group of comprises of scientists from Plant Breeding, Cytogenetics, Plant Pathology and Entomology Sections led by Dr. Zahid Mahmood, Director of the Institute. The group also coordinates with other researchers for evolving transgenic cotton varieties resistant to insect pests and diseases. The Group has so far performed in streamlining & repair of required equipment, arrangements for the chemicals, established the protocols for different procedures like DNA extraction, GEL electrophoresis, prepared stock solution and working solution, genomic DNA extraction from cotton leaves, Gel electrophoresis for DNA analysis, DNA quantification on the Spectrophotometer, qualitative and quantification testing of cotton sample through ELISA for Cry1AC testing of seed cotton for GMO status.

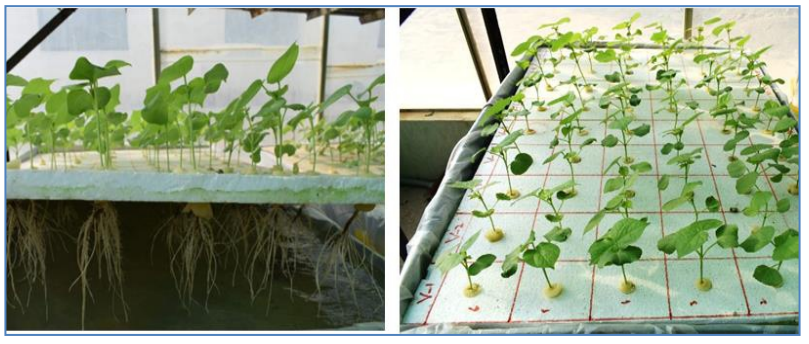
xi) Provision of Seed for Organic Cotton Cultivation in Baluchistan

The Institute collaborated with WWF Pakistan and Agriculture Extension Department, Balochistan for production of organic cotton in Balochistan. The scientists of the Institute provided training to the officials from WWF-Pakistan and Agriculture Research and Extension officials from Balochistan in advanced cotton production technology. Moreover, the Institute also provided non-GMO cotton seed to the WWF-

Pakistan for experimentation purpose. After experimentation, the WWF-Pakistan introduced 1st bale of organic cotton duly certified by the international agencies.

Sr. No.	Variety	Quantity of Seed (Kgs)
1.	CIM-496	20
2.	CIM-573	40
3.	CIM-620	150
4.	CIM-554	150
5.	CIM-608	15
6.	Cyto-124	85

xii) Growing Cotton in Hydroponics for Nutrient-Efficiency Studies at CCRI, Multan



The Institute has initiated study of growing cotton in hydroponics to screen germplasm for potassium uptake efficiency. The study focuses to identify potassium efficient and in-efficient cotton genotypes under low to high levels of applied potassium. A couple of pot and field trials will follow later on to evaluate the role of K in drought tolerance and its impact on nitrogen uptake. The study is being conducted in collaboration with Department of Soil & Environmental Sciences, MNS University of Agriculture, Multan.

xiii) Publication of Book Chapter "Genetic Mapping in Cotton"

The scientists of the Institute contributed in publishing of Chapter "Genetic Mapping in Cotton" in the Book entitled "Past, Present and Future Trends in Cotton Breeding" (ISBN: 978-1-78923-077-2). The Book was published by the InTech Publishers, UK. The authors of the book included Adem Bardak, Khezir Hayat, Oktay Erdogan, Zahid Mahmood, Noor-ul-Islam Khan, Muhammad Atif Iqbal, Halil Tekerek and Mehboob-ur-Rahman. The book was jointly sponsored by PARB, Lahore and Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey. The Book Chapter was submitted for publication in July 24th 2017, reviewed on January 26th 2018 and finally published on May 2nd 2018. The web link is: http://mts.intechopen.com/articles/show/title/genetic-mapping-in-cotton.

xiv) Collaborative Program on Colored Cotton

CCRI Multan is working for the development of colored cotton on regular basis and the scientists have successfully evolved colored cotton with a spinable staple length and beyond with different color shades (light brown, brown, light green and dark brown). To explore the feasibility of growing naturally-grown colored cotton with its varying color shades, Mr. Ejaz Sheikh, Consultant, EMS R&D Solutions Ltd., England, visited CCRI Multan on 28.11.2018. Mr. Ejaz Sheikh who is working on a project "Water Pollution Prevention" with an objective of preventing water-borne diseases, preserving fast receding precious resource of drinkable water by using less and preventing contaminated water going back into water bed to pollute the rest, reducing pollution, global warming and carbon footprint, earn Pakistan and community prestigious place in the world. While, exploring the potential for developing naturally-colored cotton for development of 10-12 colors of Organic Colored Cotton (Cost, Time etc) for the guaranteed successful outcome. The Institute offered to participate in such collaborative arrangements for developing naturally-colored cotton with different color shades. Mr. Ejaz Sheikh was impressed with the research & development work related to colored cotton and hoped that mutual collaboration will benefit in exploring more colors as well as the market for the colored cotton.

III. EXTENSION & DEVELOPMENTAL ACTIVITIES

i) Training Program for C-4 countries

CCRI Multan hosted a training program for the Four Cotton Producing Countries from Burkina Faso, Chad, Mali and Benin from April 22-May 5, 2018 under Technical Assistance for C-4 countries. 12 delegates from Burkina Faso, Chad, Mali and Benin (4 Ambassadors and 8 scientists or high officials) started from April 22 to May 5, 2018. The scientists of CCRI Multan imparted training in areas of cotton production technology, integrated pest management, cotton leaf curl virus management, cotton wild species and germplasm and fibre properties and testing. The participants also visited cotton research, education and extension institutions, ginning, spinning and textile units of the area, and seed / pesticide associations.

ii) Cotton Crop Management Group Meeting

CCRI Multan continued regularly hosting of the Cotton Crop Management Group (CCMG) meetings during the crop season 2018. The Provincial Minster for Agriculture and Secretary Agriculture chaired the meetings. All stakeholders and representative from agriculture research, extension, education, federal plant protection, seed certification, canal irrigation, MEPCO, Pakistan Meteorological Department, All Pakistan Textile Mills Association, pesticide associations, and progressive farmers attended the meeting. The scientists of CCRI Multan were involved in various sub-committees formed for devising recommendations, weekly advisory for farmers, drafting and circulation of minutes and issuance of letters to the concerned departments and follow up for implementation of decisions taken in the meeting.

iii) National Seminars

The following seminars on various aspects of cotton production have been organized by CCRI Multan in coordination with other cotton stakeholders:

Title	Date	Venue	Number of Participants
Dunya Kissan Dost Mela	Mar 30, 2018	BZU Multan	>1000
National Seminar “Cotton Production Technology”	May 7, 2018	CCRI Multan	~250
3rd National Seminar “Pink Bollworm Management”	Jun 27, 2018	CCRI Multan	~500
2nd SINO-PAK International Conference on “Innovations in Cotton Breeding & Biotechnology”		MNSUA, Multan CCRI Multan	~500
Sarsabz Cotton Seminar “Kapas Ugao, Maeeshat bachao, Zar-e-mubadila kamao” (Grow Cotton, Save Economy and Earn Foreign Exchange)	Jan 07, 2019	Fatima Fertilizers Kissan Ittehad CCRI Multan MNSUA Multan	>3000

iv) Training Programs

CCRI Multan organized training program for the field staff of various government and private sector instittuions working on cotton crop development.

Title	Date	Target Group	Number of Participants
“Use of PB Ropes”	Jun 04, 2018	Agri Ext Deptt	20
“Pink Bollworm Management & Installation of PB Ropes”	Jun 22, 2018	PWQC Staff	18
“Induction Training for New Entrance Agriculture Officers”	Nov 07-11, 2018 Nov 22-11, 2018	PWQC Staff	25
“Cotton Production Technology”	Jul 17-18, 2018	Agri Res & Ext officials from Khyber Pakhtunkhwa and Balochsitan	10
Cotton Production Technology	Jul 23, 2018	Field Officers of Pesticide/ Seed Industry	25
Labeling & Certification	Aug 29-30, 2018	Seed Dealers	>1000
“Non-GMO Cotton Breeding, Preparation of Organic Fertilizer, Testing of Non GMO Yield, and Geotagging of Cotton Fields”	Oct 12-13, 2018	Basti Jandheerwala, Bara Salata, Muzafargarh.	45
Picking Practices for Clean Cotton Production & Fibre Quality	Oct 10, 2018.	WWF Contracted Farmers	58
Cotton Production Technology	Dec 10, 2018 Dec 24, 2018	Master Trainers and Cotton Farmers from Sindh	68
Cotton Production Technology	Mar 05, 2019	Field Officers of Pesticide/Seed Industry	76
Cotton Varietal Development, Agronomy & Plant Protection	Mar 11-12, 2018	Agri Officials from CABI Pakistan	30

v) Farmers Field Day

Village Peer Jaggi Mor, Kot Addu

CCRI Multan organized Farmers Field Day at Village Peer Jaggi Mor, Ch. Farooq Molathia Farm, Kot Addu on July 31, 2018. Around 50 farmers of the area attended the program. Training was imparted for proper application of inputs especially recommended dose of pesticides against pests. Moreover, he also advised that cotton crop is bearing fruit and at this stage of crop, farmers must apply fertilizers judiciously.

CCRI, Multan

CCRI Multan organized Farmers' Field Day on October 16, 2018. More than 300 cotton farmers from Multan, Vehari, Khanewal, Lodhran, Layyah, Mianwali, Rajanpur, DG Khan and Ghotki, Khairpur, Sanghar and Mirpurkhas from Sindh province participated in the program. Training was imparted on cotton production technology of cotton varieties. Later, the farmers were visited different field experimental fields for observing the field performance of advanced cotton lines i.e., CIM-303, CIM-632, Cyto-510, Cyto-511, Cyto-515, CIM-678, CIM-789, CIM-343, CIM-663, and CIM-602. Moreover, the fields of big boll size, long staple, tolerant to CLCuV, heat & water stress tolerant lines and natural colored cotton fields were also visited. Farmers showed enthusiasm and greater interest in cotton varieties developed at the Institute and appreciated the role of cotton scientists for evolution of high yielding varieties.

vi) Application of Advanced Machinery

Mechanical Cotton Picker: CCRI, Multan introduced the following advanced technology at the Institute. Mechanical Cotton Picker has been introduced keeping in view the shortage of labour at the time of cotton picking and environmental issues. Varieties suitable for mechanical cotton picking will also be evolved.

Mechanical Boll Picker: The practical demonstration of mechanical picker for picking leftover bolls of the cotton crop was also arranged at CCRI Multan. The application of mechanical picker for picking leftover bolls will help in not only eradicating larvae of Pink bollworm present in the leftover bolls but will also pick additional 4 to 5 maunds of cotton.

Stick Puller & Shredder: Another machinery Cotton Stick Puller & Shredder also demonstrated for pulling cotton sticks/stuble, cut it and shred in the field. This will be very useful for shredding cotton sticks in the soil which will improve soil health as well.

Mechanical Cotton Picker

Mechanical Boll Picker

Tractor-driven Stick Slasher

vii) Launching of "Pakistan Cottongrower"

CCRI, Multan has initiated publication of a quarterly journal "Pakistan Cottongrower". The journal is bilingual, published in Urdu and English languages. Articles related to cotton agronomy, varietal development, insect pests & diseases management, and post-harvest handling are published. Moreover, weather condition (temperature, rainfall), cotton market news and world cotton outlook of the subject quarter are also regular feature of the Journal. Articles of researchers and technical field officers of private pesticide/seed/fertilizer industry are also encouraged for publication with approval by the Editorial Board. The journal is being widely distributed among cotton researchers, academicians, private pesticide & seed association and most importantly the cotton farmers. Interested researchers, students, technical officers of pesticide/seed industry/NGOs and farmers can subscribe the journal at an annual subscription fee of Rs.350/= (four issues) for receiving regular issues of the journal.

viii) Publication of Monthly Newsletter

The Institute has also started publication of monthly Newsletter for highlighting major activities and events organized during the crop season 2018-19. The newsletter publication are being made on regular basis. The soft copies of the newsletters were also emailed to more than 1000 researchers, policymakers, farmers and other stakeholders. Moreover, the Newsletter was also placed on the website and facebook account of the Institute as well.

ix) TeleCotton

CCRI Multan introduced TeleCotton SMS service for the guidance of the cotton farmers. A short message was sent on daily basis during the crop season 2018-19 related to the aspects of current cotton crop situation viz., varietal selection, seed treatment, land preparation, irrigation, pesticide and fertilizer application, and proper picking. A total 16,868 cotton farmers from all the four provinces were included in the list to receive day to day cotton crop management messages. Moreover, farmers were also replied to their queries with regard to crop management.

x) Website & Social Media

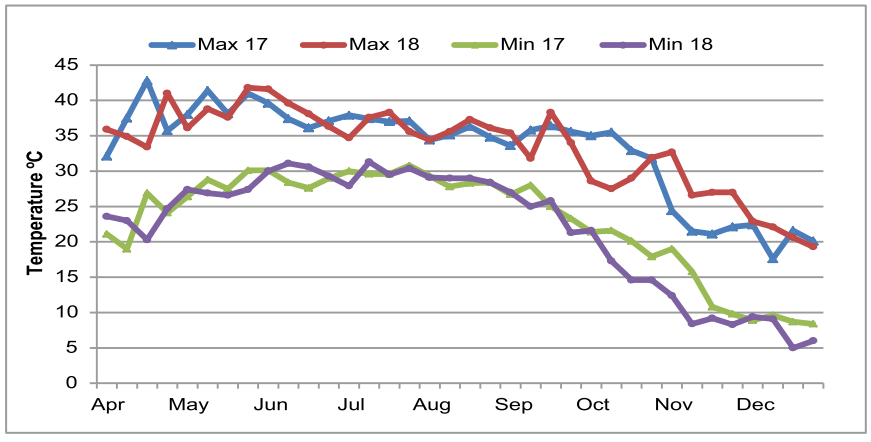
The Institute also initiated highlighting cotton research and development activities carried out during crop season 2018-19 utilizing social media tools (www.facebook.com/CCRIM.PK). This has attracted cotton farmers, researchers, and students very effectively. The followers and members appreciated the activities carried out by the Institute. The Institute has also upgraded the website (www.ccrim.org.pk) of the Institute highlighting major cotton research and development activities, brief program of various disciplines, cotton market rates, weather situation and other related activities.

IV. COTTON CROP CONDITION: PUNJAB

i) Weather

The pattern of maximum temperatures during cotton crop season 2018-19 remained higher during June to August while minimum temperature remained parrel to that of last year.The annual average maximum temperature during 2018-19 remained 33.3 °C while it was 33.1 °C during last year. Similarly the annual average minimum temperature during current year remained at 21.9 °C while it was 22.9 °C during last year.The average relative humidity remained 82.1% during current season while it was 81.5% during last season. A total of 26.8 mm rainfall was recorded during the crop season (Jan-Dec) of 2018 as compared to 139.2 mm rainfall during the last year.

The meteorological data for the year 2018 vis-à-vis 2017 recorded at Central Cotton Research Institute, Multan are illustrated in Fig. 1 and Appendix-I.The comparative maximum/minimum temperatures, relative humidity, rainfall for the year 2018 and 207 are given in Appendix-I.



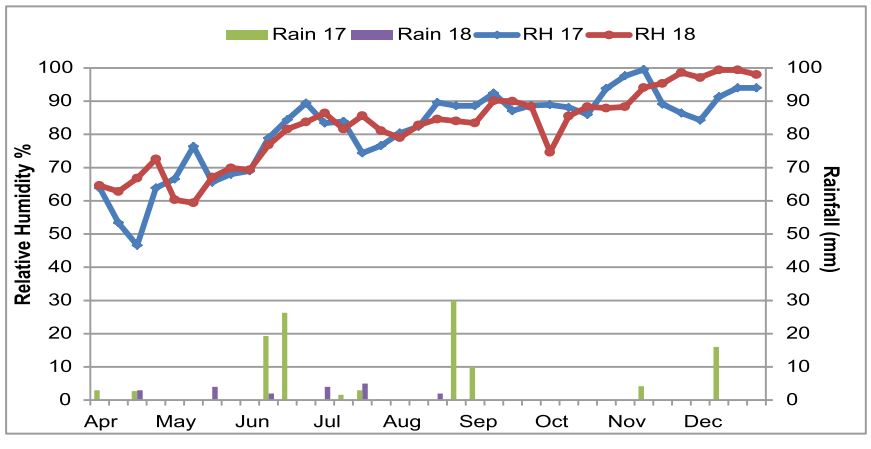


Fig. 1 Weekly Average Temperature, Relative Humidity and Total Rainfall during 2017 and 2018.

ii) Cotton Sowing

The target for cotton area was fixed at 2.955 million hectares with a production of 14.37 million bales at country level. However, cotton crop was sown at an area of 2.406 million hectares. Sowing was affected due to shortage of irrigation water, which led to limiting the area to 0.422 million hectares against target of 0.62 million hectares in Sindh province while sowing was restricted to 1.947 million hectares against target of 2.30 million hectares in the Punjab province. The cotton sowing season started with harsh temperatures (+1-2èC temperatures in June-July) and much lesser rainfall in cotton growing areas (>32%) during July-September badly affected the cotton crop. Moreover, there was also observed 25-40% shortage of canal irrigation water in most of the cotton growing areas.

Position of Irrigation Water Availability in the Punjab during 2018
(Million Acre Feet)

Month	Year	Jehlum-Chenab	Indus	Total
Apr	2018	1.333	0.712	2.045
	2017	2.001	1.404	3.406
	% change	**-33.40**	**-49.29**	**-39.95**
May	2018	1.942	1.480	3.422
	2017	2.907	2.765	5.633
	% change	**-33.21**	**-48.46**	**-39.24**
Jun	2018	2.49	2.37	4.86
	2017	3.00	3.28	6.28
	% change	**-17.06**	**-27.63**	**-22.58**
Jul	2018	2.94	2.95	5.92
	2017	3.29	3.60	6.89
	% change	**-10.44**	**-17.27**	**-14.01**
Total	2018	8.706	7.546	16.252
	2017	11.195	11.051	22.206
	% change	**-22.23**	**-31.72**	**-26.81**

Source: Monthly Bulletin, Supparco, Islamabad

This phenomenon resulted in reduced sowing especially in Sindh province which was dropped by 31% and Punjab dropped by 5% compared with previous season. The overall reasons attributed to shortfall in cotton production included shortage of irrigation water, higher incidence of Pink bollworm and whitefly. However, installation of PB Ropes in cotton areas had been effective in management of Pink bollworm.

According to Second Estimate of Cotton Crop 2018-19 by the Crop Reporting Service Department, Government of the Punjab, the acreage under the crop is placed at 19.47 lac hectares (48.12 lac acres) as against that of 20.53 lac hectares (50.73 lac acres) sown during last year. The area shows a decrease of 5.14 % over the previous year which is due to shortage of canal water about 32% during the sowing period of the crop i. e in the months of April to June.

The production of cotton crop is estimated to be at 7.116 million bales (71.16 Lac bales) during the year 2018-19 against that of 8.077 million bales (80.77 Lac bales) produced last year, which shows a decrease of 11.90**%** over the last year.

The major reasons attributed by the Department for the shortfall included (i) corresponding decrease in area (ii) prolong hot and dry weather produced adverse affect on yield in cotton core areas i.e., Multan, DG Khan and Bahawalpur divisions, (iii) stunting of crop, attack of whitefly, Pink bollworm and other pest/insect also cause of less yield.

COTTON CROP MANAGEMENT GROUP (CCMG)

5th Meeting of the Cotton Crop Management Group (CCMG) was held at CCRI, Multan on 24.09.2018 under the chairmanship of Malik Nauman Ahmad Langrial, Minister for Agriculture, Government of the Punjab, Dr. Khalid Abdullah, Cotton Commissioner, MNFSR, Islamabad; Dr. Zahid Mahmood, Director CCRI, Multan; Prof. Dr. Asif Ali, Vice Chancellor, MNSUA, Muhammad Zafaryab Haider, DG Agri Ext; Dr. Abid Mahmood, DG Research, Irrigation officials, representative from MEPCO, Pakistan Meteorological Department, and Directors of various concerned Institutes, District Officers of Agriculture (Cotton Zone), Pesticides Dealers Association, Crop Life Pakistan, Pakistan Crop Protection Association, Pakistan Cotton Ginners Association, Research Scientists, and progressive grower members attended the meeting.

Cotton Area, Production & Yield in the Punjab 2018 Vs 2017

DIVISIONS/ DISTRICTS	Area (000 ha)		Production (000bales)		Yield (kg/ha)	
	2018-19	2017-18	2018-17	2017-18	2018-17	2017-18
PUNJAB	**1947.31**	**2052.93**	**7116**	**8077**	**621.23**	**668.84**
RAWALPINDI DIV:	**0.4**	**0.4**	**0.38**	**0.4**	**161.5**	**170.00**
Attock	-	-	-	-	-	-
Rawalpindi	-	-	-	-	-	-
Islamabad	-	-	-	-	-	-
Jhelum	0.4	0.4	0.38	0.4	161.5	170.00
Chakwal	-	-	-	-	-	-
SARGODHA DIV:	**54.62**	**72.83**	**169.1**	**220.19**	**526.31**	**513.97**
Sargodha	3.64	5.66	6.3	10.25	294.23	307.86
Khushab	0.4	0.8	0.47	0.96	199.75	204.00
Mianwali	32.37	42.9	101.09	137.73	530.9	545.78
Bhakkar	18.21	23.47	61.24	71.25	571.71	516.08
FAISALABAD DIV:	**63.53**	**78.92**	**180.69**	**219.69**	**483.51**	**473.23**
Faisalabad	21.04	24.69	66.62	77.33	538.28	532.45
T.T. Singh	23.47	31.16	67.92	88.27	491.96	481.58
Jhang	17.81	21.85	43.49	51.48	415.12	400.53
Chiniot	1.21	1.22	2.66	2.61	373.72	363.69
GUJRANWALA DIV:	**0.81**	**0.81**	**0.95**	**0.9**	**199.38**	**188.89**
Gujrat	-	-	-	-	-	-
M.B.Din	0.81	0.81	0.95	0.9	199.38	188.89
Sialkot	-	-	-	-	-	-
Narowal	-	-	-	-	-	-
Gujranwala	-	-	-	-	-	-
Hafizabad	-	-	-	-	-	-
LAHORE DIV:	**3.65**	**6.48**	**7.65**	**15.66**	**356.3**	**410.83**
Sheikhupura	-	0.4	-	0.79	-	335.75
Nankana Sahib	-	0.4	-	0.48	-	204.00
Lahore	-	-	-	-	-	-
Kasur	3.65	5.68	7.65	14.39	356.3	430.69
SAHIWAL DIV:	**90.24**	**101.96**	**295.79**	**321.99**	**557.23**	**536.86**
Okara	10.12	11.33	34.97	36.67	587.44	550.21
Sahiwal	59.08	64.74	188.16	200.19	541.42	525.68
Pakpattan	21.04	25.89	72.66	85.13	587.08	558.98
MULTAN DIV:	**643.84**	**712.23**	**2436.8**	**2885.9**	**643.42**	**688.83**
Multan	142.04	157.42	529.5	622.52	633.73	672.27
Lodhran	165.11	182.91	673.55	691.71	693.5	642.89
Khanewal	170.77	179.68	643.65	769.41	640.75	727.96
Vehari	165.92	192.22	590.13	802.26	604.64	709.52
D.G.KHAN DIV:	**437.86**	**413.99**	**1646.3**	**1809.5**	**639.17**	**743.06**
Muzaffargarh	146.49	140.02	474.18	497.52	550.28	604.05
Layyah	44.51	49.38	146.04	200.64	557.78	690.74
D.G. Khan	99.15	90.24	374.17	415.65	641.54	783.03
Rajan Pur	147.71	134.35	651.88	695.71	750.25	880.32
BAHAWALPUR DIV:	**652.36**	**665.31**	**2378.3**	**2602.8**	**619.78**	**665.05**
Bahawalpur	269.92	267.5	1007.6	1124.6	634.6	714.68
R.Y. Khan	165.92	157.42	666.18	611.5	682.56	660.37
Bahawalnagar	216.52	240.39	704.56	866.68	553.18	612.90

The overall cotton area and production achievement at province level is as under:

Province	Area (Mil. Ha)		Production (Million bales)	
	Target		Target	Estimate 12.09.18
Punjab	2.300	1.947	10.00	8.077
Sindh	0.620	0.422	4.20	2.600
Khyber Pakhtunkhwa	0.005	0.0002	0.020	0.020
Balochistan	0.030	0.037	0.150	0.150
PAKISTAN	**2.955**	**2.406**	**14.370**	**10.847**

Source: Provincial Crop Reporting Departments

iii) Interventions for Cotton Crop Management

The scientists of CCRI Multan remained shoulder to shoulder for training of farmers along with Agriculture Extension Department. Holding of Cotton Crop Management Group (CCMG) meetings on regular basis during the season and dissemination of cotton production management recommendations on weekly basis helped greatly in managing insect pests of cotton. The print and electronic media was also effectively utilized for guiding the farmers. CCRI Multan carried out the following activities during the season for cotton crop management:

i) Training Programs
- › Cotton Production Technology
- › Pink Bollworm Management
- › PB Ropes Installation
- › Seed dealers regarding Seed Act
- › Clean Cotton

ii) Production Technology Seminars
- › Cotton Production Technology
- › Pink Bollworm Management
- › Cotton Leaf Curl Virus Management

iii) Cotton Crop Management Group (CCMG)
- › Weekly Advisory for Farmers
- › On-spot decisions for cotton issues
- › Mega Farmers Gatherings

iv) Crop Monitoring Surveys & On-spot Advisory
- › Advisory for crop management (pests/diseases)
- › Fertilizer application
- › Pheromone traps

v) TeleCotton SMS Service
- › More than 20,000 farmers registered
- › Cotton crop management advisory

vi) Insecticide Resistance Management
- › Pesticide samples tested
- › Most effective pesticide recommended for spray

vii) Extensive Media Campaign
- › Print & Electronic
- › Social Media

iv) Supply of Inputs

Irrigation water supply shortage prevailed through out the cropping season like during previous year and cotton sowing was also affected due to acute shortage of canal water availability.The availability of nitrogenous and phophatic fertilizers remained satisfactory and no shortage was reported.

v) Pesticide Availiability

The availability of cotton pest-specific pesticides remained satisfactory during the season. However, flareup of whitefly, jassid and pink bollworm in some areas limited the achieveable yield potential.

PCPA

The representative from PCPA presented below the pesticide availability position as below:

(EST. QTY IN KG/LTR)

Category Wise Pesticides	Carry Over as on 31-12 2017	Planned Import 2018	Total Expected Availability 2018 (2+3)	Actual Sold 2017	Acutal Import of 2018 (till 31.03.2018)	Total Actual Availability Including Carryover
1	2	3	4	5	6	8
Whitefly Specific	118,726	6,703,500	6,822,226	6,194,774	603,315	**722,041**
Other Sucking	193,192	4,662,400	4,855,592	4,568,808	559,488	**752,680**
Mealy Bug Specific	81,900	560,000	641,900	338,100	22,400	**104,300**
Pink	458,150	1,886,500	2,344,650	1,408,100	37,730	**495,880**
Army Worm	321,200	1,569,500	1,890,700	1,348,800	62,780	**383,980**
Others	541,875	3,412,500	3,954,375	2,765,745	102,375	**644,250**
Miticide/Acaricide	31,350	63,750	95,100	120,650	1,275	**32,625**
Weedicide Total	201,960	2,473,500	2,675,460	2,682,540	1,162,545	**1,364,505**
GRAND TOTAL	**1,948,353**	**21,331,650**	**23,280,003**	**19,427,517**	**2,551,908**	**4,500,261**

CropLife

The representative from CropLife presented below the pesticide availability position as below:

(EST. QTY IN KG/LTR)

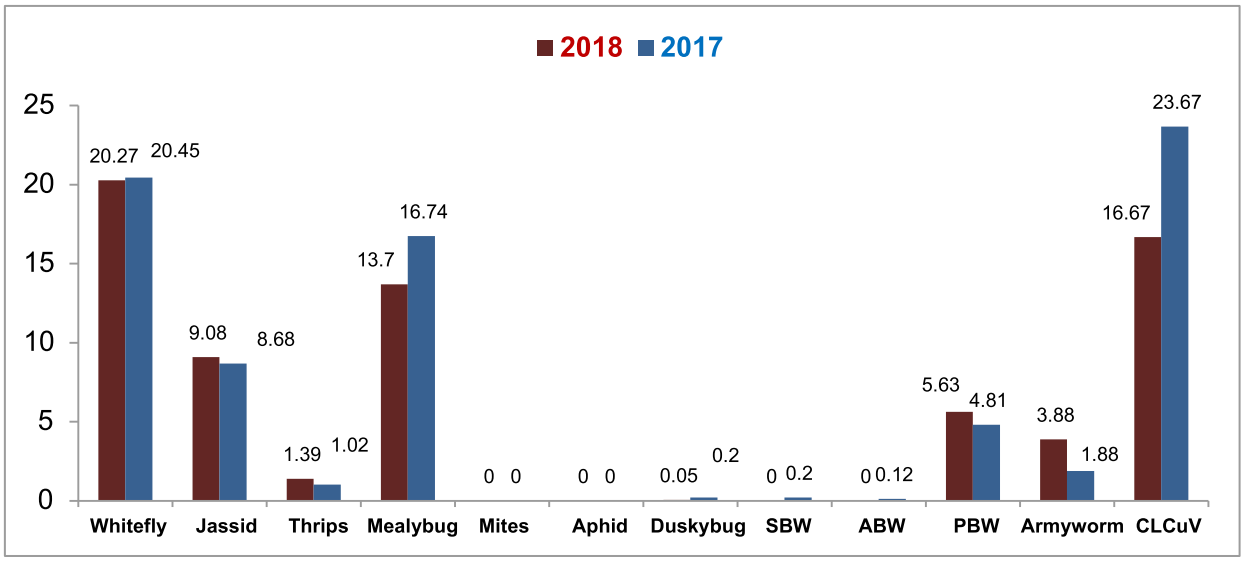
Category Wise Pesticides	Carryover as on 31.12.2017 (Kg/L)	Planned Import for 2018 (Kg/L)	Total Planned availability for 2018 (Kg/L) Col. (2+3)	Actual sold during 2017 (Kg/L)	Actual Imports 2018 upto 10.3.2018 (Kg/L)	Total actual availability Col. (2+6)
1	2	3	4	5	6	7
Heliothis Specific	344,116	1,807,240	2,151,356	1,872,492	941,400	1,285,516
Whitefly Specific	301,152	895,400	1,196,551	966,070	174,690	475,842
Mealy Bug Specific	27,462	88,000	115,462	74,080	-	27,462
Armyworm Specific	133,911	179,457	313,367	250,262	4,500	138,411
Pink / Spotted Bollworm	243,226	1,017,127	1,260,353	1,049,136	162,081	405,307
Others	157,108	344,434	501,542	431,407	45,396	202,504
Miticides / Acaricides	20,460	172,934	193,394	245,425	4,060	24,520
Weedicides	386,042	1,189,955	1,575,997	1,221,113	354,600	740,642
Grand Total	**1,613,477**	**5,694,545**	**7,308,022**	**6,109,984**	**1,686,727**	**3,300,204**

vi) Insect Pests & Disease Situation

The Agriculture Department remained proactive especially in farmers' guidance for cotton crop management including provision of PB Ropes for the control of Pink bollworm, installation of sex pheromone traps at union council level, and announcement of awards for cotton growers. The collective efforts resulted in control insect pest pressure. However, the hot spots of Pink bollworm, Armyworm, Whitefly, Jassid and Thrips were observed in some cotton growing districts.

Whitefly hotspots were observed in Ahmad Pur East, Rajan Pur, Hasil Pur, Jam Pur, Jatoi and Rojhan. Similarly, Pink bollworm hotspots were observed in Mailis, Bhakkar, Kamalia, Sumandari, Vehari, Gojra, Multan, Okara, Sadiq Abad, and Kehror Pacca. The hotspots of Armyworm were also observed in Toba Tek Singh, Bahawalpur, Jatoi, Ali Pur, Sadiq Abad and Kamalia. Moreover, the hotspots of Jassid were also observed in Fort Abbas, Hasil Pur, Ahmad Pur East, Kamalia, Minchana Abad, Arifwala, Sadiq Abad, Chishtian, Samundari and Bahawalnagar.

Cotton leaf curl virus disease incidence level was comparatively less during this year compared with last year. This was due to the adoption of better management practices, proper fertilization and cultivation of relatively tolerant varieties. Higher incidence level of CLCuV was observed in Mailsi, Ahmad Pur East, Vehari, Kot Addu, Darya Khan, Muzafargarh, Multan Sargodha and Arif Wala.



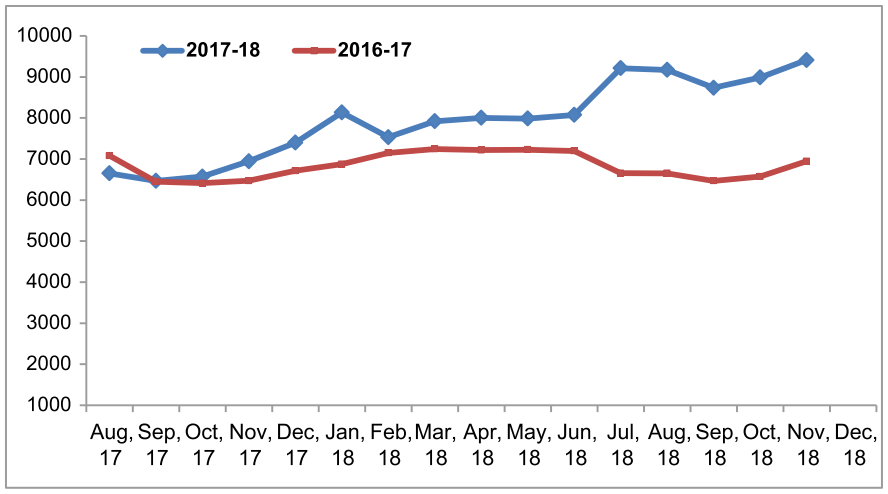
Source: Pest Warning & Quality Control of Pesticides, Punjab

vii) Cotton Market Situation

The important step taken for supporting cotton farmers was holding of a Consultative Forum of cotton stakeholders with the objective to work with the farmers for production of cleaner cotton on premium price. The three major players i.e., farmers, ginners and textile industry simultaneously face challenges related to cotton marketing. Farmers are faced with the problem of lower prices, while ginners raise concern about mixing of inert material in cotton, low GoT, poor quality lint and varietal admixture.

Similarly, textile mills also have problems like yellow pigment cotton, poor yarn quality, low fiber strength and high moisture and inert contents in cotton. Therefore, there is a need to devise a collective strategy for settling issues of each stakeholder. The Consultative Forum recommended strict implementation of Cotton Control Ordinance, 1966, provision of premium price of Rs.200 per kg to the farmers for *Sangli* and Moisture-Free cotton and intervention of Federal Government when prices falling down.

The seasonal cotton prices remained much better with *Phutti* price at Rs.3500-3800 and Lint price at Rs.7574-9076 per 40 kgs during the current season. Moreover, the overall quality of cotton was also excellent and surveyed resulted revealed staple length 27.8mm, micronaire 4.5 with around 4% trash which was acceptable for the ginning and textile industry in the country.



Source: Monthly Cotton Review, PCCC 2018

The cotton arrival into ginning factories reached to 10.701 million bales arrived during current year compared with 11.485 upto 15th February, 2019 depicting shortfall of 6.83%.

Province	2018	2017	% Change over last year
Punjab	6,552,515	7,233,327	- 9.41
Sindh	4,148,481	4,252,414	- 2.44
PAKISTAN	10,700,996	11,485,741	- 6.83

Source: PCGA Arrival 15th Feb, 2019

VISIT OF MEMBER NATIONAL ASSEMBLY, PAKISTAN

Mr. Muhammad Khan Daha, MNA from Khanewal visited CCRI Multan on Feb 15, 2019. Dr. Zahid Mahmood, Director CCRI Multan apprised about the cotton research and development activities carried out by the Institute. Ch. Gohar Ali, Progressive grower also present on the occasion.

V. DISCIPLINE-WISE RESEARCH & DEVELOPMENT ACTIVITIES

1. AGRONOMY

The agronomic experiments aim to take advantage of the ecological principles and test new ideas and approaches which have direct and indirect effects on the yield. The emphasis is given on soil, water, nutrients, weeds management, planting time optimization and planting techniques for candidates and benchmark varieties (GMO's & Non GMO's) evolved by CCRI keeping in view the climatic vagaries. The crop growth model DSSAT (Decision Support System for Agro-Technology Transfer) is being applied to address the climate change issue and to design effective adaptation strategies for sustainable cotton production. Meanwhile, experiments on incorporation of cotton sticks and wheat straw for improving soil health are also in process. The major output of the agronomic experiments appeared in form of improved cotton productivity while minimizing the adverse impacts of various biotic and abiotic stresses and to take advantage of the favourable environment. The daily record of metrological observations is also with the section to be utilized in crop management strategies.

1.1 Effect of time of sowing on productivity of advanced genotypes

Three genotypes i.e. Cyto-161, CIM-717 and CIM-620 were tested at five sowing dates starting from April 15 to June 15 at fifteen days interval. Experimental design was split plot. Sowing dates were kept in main plots and genotypes in sub plots with four repeats. The net plot size was 20 ft x 30 ft. Bed-furrows were prepared after land preparation in dry condition. Sowing was done with delinted seed by dibbling method followed by irrigation. Dual Gold 960 EC @ 2L per hectare was sprayed after sowing on moist beds. Nitrogen at the rate of 150 kg ha^{-1} was applied in three split doses. Other cultural practices and plant protection measures were adopted as per need of the crop. Data on plant height, boll number, boll weight, seed cotton yield and CLCuD incidence percentage are given in table 1.1.

Table 1.1 Effect of sowing dates on plant height, seed cotton yield, yield components and CLCuD incidence

Sowing dates	Genotypes	Plant height (cm)	Number of bolls $plant^{-1}$	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 90 DAS
April 15	Cyto-161	145.4	32	2.46	3102	1.9
	CIM-717	144.5	32	2.80	3191	56.6
	CIM-620	150.2	28	2.52	2689	8.1
May 01	Cyto-161	141.3	27	2.48	2637	12.1
	CIM-717	135.6	30	2.85	2887	66.2
	CIM-620	142.1	26	2.57	2570	20.8
May 15	Cyto-161	135.0	26	2.52	2490	55.7
	CIM-717	127.2	27	2.89	2739	80.1
	CIM-620	131.2	24	2.60	2333	31.3
June 01	Cyto-161	124.3	19	2.57	1792	66.1
	CIM-717	114.3	23	2.93	2263	83.5
	CIM-620	123.2	20	2.65	1864	46.5
June 15	Cyto-161	112.9	17	2.62	1634	100.0
	CIM-717	106.0	18	2.96	1765	100.0
	CIM-620	119.3	17	2.66	1688	100.0

DAS* = Days after sowing

Sub-effects

Sowing dates	Plant height (cm)	Number of bolls $plant^{-1}$	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 90 DAS
April 15	146.7	30.7	2.59	2994	22.2
May 01	139.7	27.7	2.63	2698	33.0
May 15	131.1	25.7	2.67	2521	55.7
June 01	120.6	20.7	2.72	1973	65.4
June 15	112.7	17.3	2.75	1696	100.0

Genotypes	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 90 DAS
Cyto-161	131.8	24.2	2.53	2331	47.2
CIM-717	125.5	26.0	2.89	2569	77.3
CIM-620	133.2	23.0	2.60	2229	41.3
C.D 5%					
Sowing date (SD)	7.42	3.11	ns	149.89	6.65
Genotype (G)	ns	1.42	0.15	143.66	2.77
SD x G	ns	ns	ns	ns	6.20

The data presented in table 1.1 indicated that on overall average basis of sowing dates, genotype CIM-717 produced significantly higher seed cotton yield as compared to Cyto-161 and CIM-620. The genotype CIM-717 produced 10.2% and 15.3% higher seed cotton yields than Cyto-161 and CIM-620, respectively. Average across the genotypes, plant height decreased as the sowing was delayed (Fig. 1). April 15 and May 01 sown crop produced significantly more number of bolls than other sowing dates (Fig. 2). Seed cotton yield decreased as sowing was delayed (Fig. 4). While, boll weight increased as the sowing was delayed (Fig. 3). Among all sowing dates maximum boll weight (2.75 g) was produced from June 15 sown crop. The maximum bolls per plant (30.7) and seed cotton yield (2994 kg ha^{-1}) were harvested from April 15 sown crop.

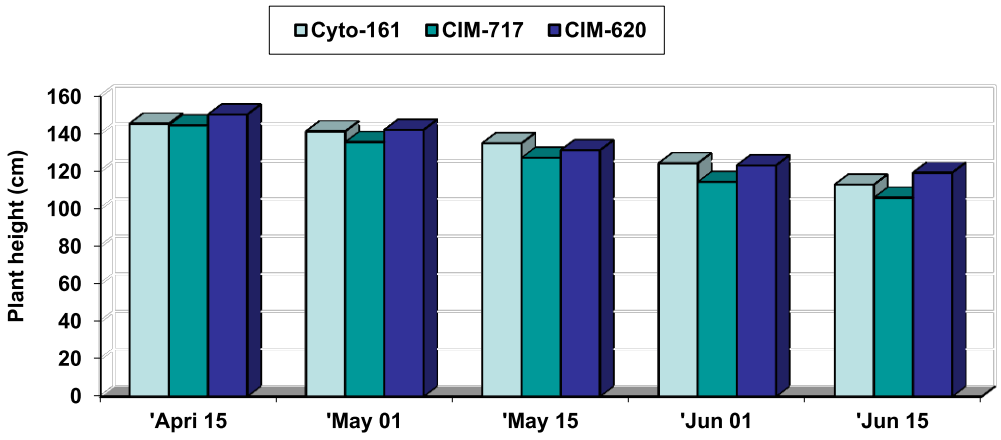


Fig 1 Sowing dates x genotypes interaction on plant height

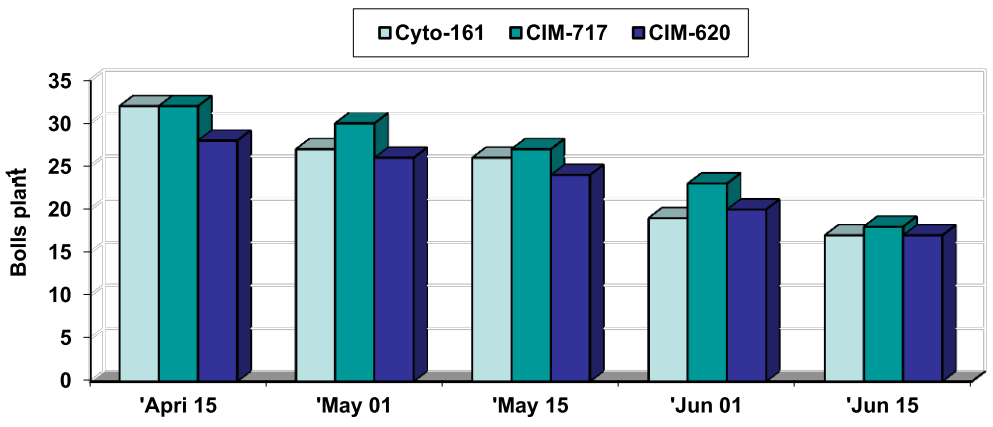


Fig 2 Sowing dates x genotypes interaction on bolls plant^{-1}

COTTON SEMINAR

Sahibzada Muhammad Mehboob Sultan, Federal Minister for Ministry of National Food Security & Research; Syed Fakhre Imam, Member National Assembly, Syed Hussain Jahania Gardezi, Member Punjab Assembly, Mr. Khalid Mahmood Khokhar, Chairman Pakistan Kissan Ittehad, Mr. Khurram Javed Maqbool, Director Marketing and Sales at Fatima Group, Prof. Dr. Asif Ali, Vice Chancellor, MNSUA Multan; Dr. Khalid Abdullah, Cotton Commissioner, and Dr. Zahid Mahmood, Director CCRI Multan chaired the session. Mr. Jahangir Khan Tareen also participated as a Special Guest.

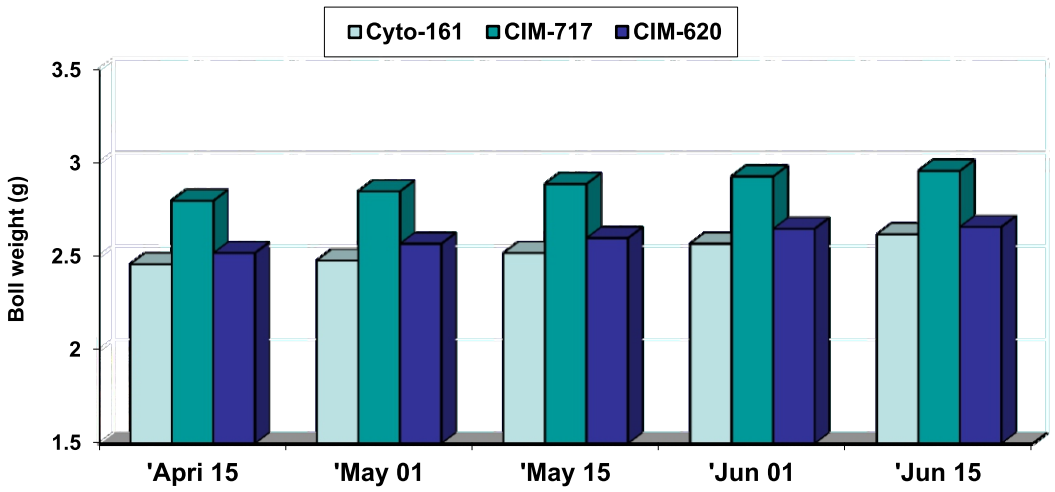


Fig 3 Sowing dates x genotypes interaction on boll weight

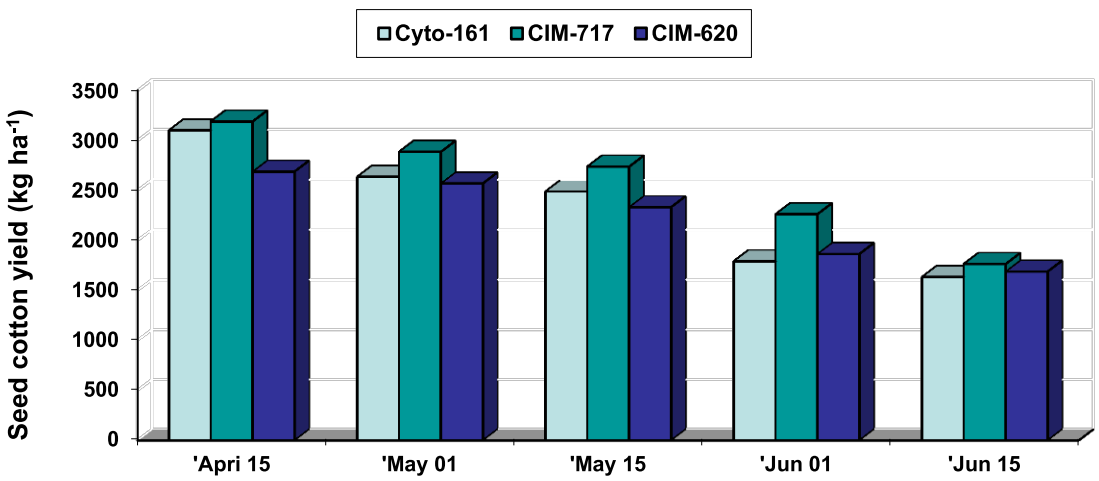


Fig 4 Sowing dates x genotypes interaction on seed cotton yield

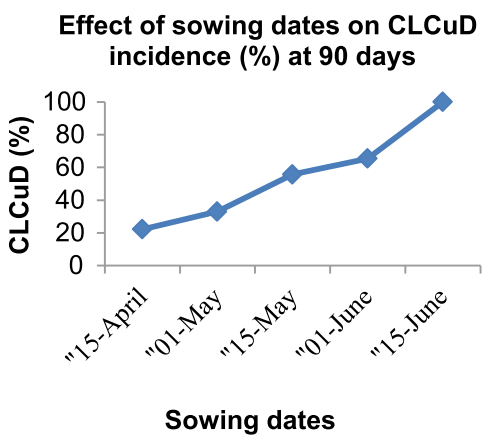


Fig 5. Sowing dates effect on virus infestation at 90 DAS

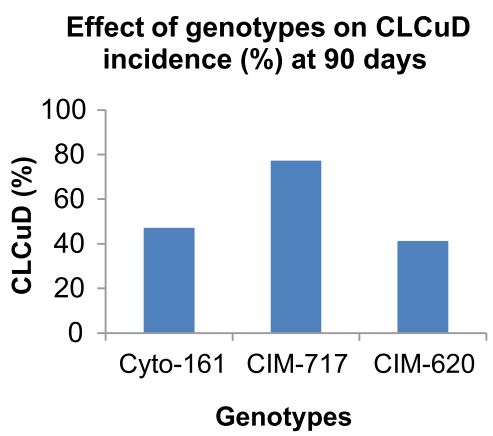


Fig 6. CLCuD incidence in different genotypes

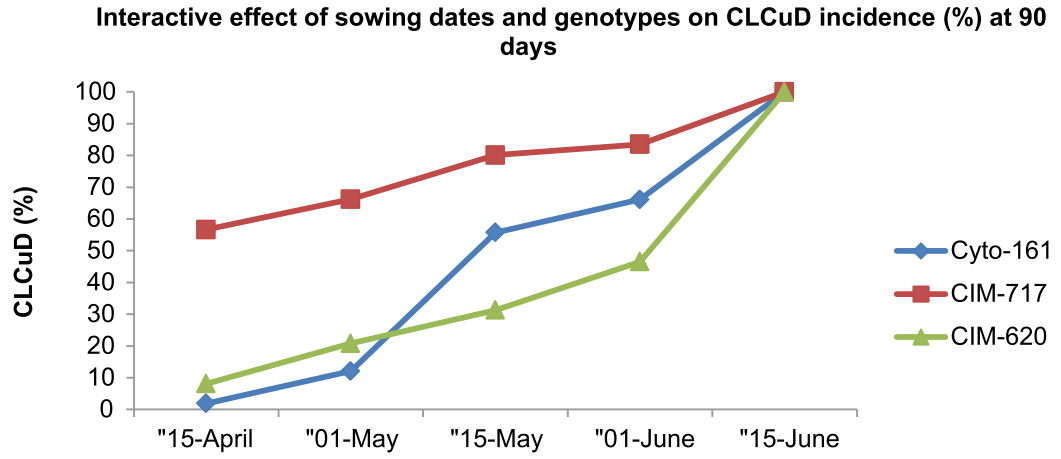


Fig 7. Sowing dates x genotypes interaction for CLCuD incidence (%) at 90 DAS

The data on CLCuD showed that the disease incidence gradually increased as the sowing was delayed from April 15 up to June 15. The incidence of CLCuD at 90 days after sowing was observed 100% in June 15 sown crop. Whereas, April 15, May 01, May 15 and June 01 showed 22.2%, 33.0%, 55.7% and 65.4% virus infestation, respectively (Fig. 5). On the average basis of sowing dates, genotype CIM-620 showed 5.9% and 36% less CLCuD incidence than Cyto-161 and CIM-717, respectively (Fig. 6). The interaction between sowing dates and genotypes is illustrated in (Fig. 7).

1.2 Effect of time of sowing on production of transgenic cotton

Five transgenic cotton genotypes i.e. *Bt.*Cyto-515, *Bt.*CIM-343, *Bt.*Cyto-511, *Bt.*CIM-789 and *Bt.*CIM-663 with one standard *Bt.*Cyto-179 were evaluated at six different sowing dates starting from March 01 to May 15 at fortnightly interval. Experimental design was split plot, sowing dates were kept in main plot and genotypes in sub plots with four repeats. The net plot size was 20 ft x 30 ft. Bed-furrows were prepared after land preparation in dry condition. Sowing was done by manual dibbling of seeds at 22.5 cm plant to plant distance followed by irrigation. Dual Gold 960 EC @ 2L per hectare was sprayed after sowing on moist beds. Other cultural practices and plant protection measures were adopted as per need of the crop. Data on plant height, boll number, boll weight, seed cotton yield and CLCuD incidence percentage recorded are given in table 1.2.

Table-1.2 Effect of sowing dates on plant height, seed cotton yield, yield components and CLCuD incidence

Sowing dates	Genotypes	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 120 DAS
March 01	*Bt.*Cyto-515	147.1	37	2.97	3720	5.9
	*Bt.*CIM-343	143.8	39	2.83	3870	2.2
	*Bt.*Cyto-511	131.1	43	2.85	4314	5.7
	*Bt.*CIM-789	129.3	41	2.92	4078	2.4
	*Bt.*CIM-663	131.4	41	2.93	4102	0.0
	*Bt.*Cyto-179	132.3	40	2.90	3988	9.3
March 15	*Bt.*Cyto-515	139.1	36	3.00	3690	11.4
	*Bt.*CIM-343	141.4	35	2.90	3499	13.2
	*Bt.*Cyto-511	129.5	41	2.90	4061	17.4
	*Bt.*CIM-789	126.7	38	2.96	3862	11.7
	*Bt.*CIM-663	128.2	41	2.93	4098	7.6
	*Bt.*Cyto-179	130.6	36	2.92	3639	9.3

Sowing dates	Genotypes	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 120 DAS
April 01	*Bt*.Cyto-515	135.0	35	3.05	3577	25.4
	Bt.CIM-343	137.3	33	2.97	3279	34.2
	Bt.Cyto-511	121.6	39	2.93	3895	33.9
	Bt.CIM-789	123.5	33	3.00	3332	15.0
	Bt.CIM-663	124.8	33	2.98	3307	25.7
	Bt.Cyto-179	128.1	32	2.96	3196	20.9
April 15	*Bt*.Cyto-515	132.3	33	3.06	3322	58.0
	Bt.CIM-343	133.4	32	3.02	3223	67.8
	Bt.Cyto-511	118.8	37	2.96	3731	60.8
	Bt.CIM-789	120.7	32	3.05	3246	52.6
	Bt.CIM-663	122.7	33	3.03	3349	67.3
	Bt.Cyto-179	122.3	30	3.00	2949	64.4
May 01	*Bt*.Cyto-515	124.6	28	3.11	2893	66.9
	Bt.CIM-343	125.8	33	3.05	3368	83.1
	Bt.Cyto-511	115.7	34	3.00	3431	71.4
	Bt.CIM-789	118.9	31	3.10	3077	72.8
	Bt.CIM-663	117.5	29	3.05	2860	88.0
	Bt.Cyto-179	117.6	27	3.04	2723	86.5
May 15	*Bt*.Cyto-515	120.0	27	3.14	2799	100.0
	Bt.CIM-343	121.2	30	3.07	2998	100.0
	Bt.Cyto-511	107.4	28	3.03	2832	100.0
	Bt.CIM-789	112.8	29	3.13	2933	100.0
	Bt.CIM-663	108.6	28	3.08	2787	100.0
	Bt.Cyto-179	114.2	26	3.05	2632	100.0

DAS* =Days after sowing

Sub-effects

Sowing dates	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	CLCuD incidence (%) at 120 DAS
March 01	135.8	40.2	2.90	4012	4.3
March 15	132.6	37.8	2.94	3808	11.8
April 01	128.4	34.2	2.98	3431	25.9
April 15	125.0	32.8	3.02	3303	61.8
May 01	120.0	30.3	3.06	3059	78.1
May 15	114.0	28.0	3.08	2830	100.0
Genotypes					
Bt.Cyto-515	133.0	32.7	3.06	3334	44.6
Bt.CIM-343	133.8	33.7	2.97	3373	50.1
Bt.Cyto-511	120.7	37.0	2.95	3711	48.2
Bt.CIM-789	122.0	34.0	3.03	3421	42.4
Bt.CIM-663	122.2	34.2	3.00	3417	48.1
Bt.Cyto-179	124.2	31.8	2.98	3188	48.4
C.D 5%					
Sowing date (SD)	9.85	2.20	ns	198.55	3.25
Genotype (G)	8.41	2.15	ns	163.07	2.96
SD x G	ns	ns	ns	ns	7.25

The plant height, bolls per plant and seed cotton yield was decreased while boll weight was increased with delay in sowing (fig 8, 9, 11 and 10). The maximum plant height (135.8 cm), bolls plant^{-1} (40.2) and seed cotton yield (4012 kg ha^{-1}) were harvested from March 01 sown crop. Among all sowing dates maximum boll weight (3.08 g) was produced from May 15 sown crop. On overall average basis of sowing dates, *Bt*.Cyto-511 produced 8.5%, 8.6%, 10.0%, 11.3 and 16.4% significantly more seed cotton yield than *Bt*.CIM-789, *Bt*.CIM-663, *Bt*.CIM-343, *Bt*.Cyto-515, and *Bt*.Cyto-179, respectively.

VISIT OF FEDERAL SECRETARY, MINISTRY OF NATIONAL FOOD SECURITY AND RESEARCH, ISLAMABAD

Dr. Muhammad Hashim Popalzai, Federal Secretary, Ministry of National Food Security & Research, Islamabad. Dr. Khalid Abdullah, VP PCCC/ Cotton Commissioner, MNFS&R and Dr. Tassawar Hussain Malik, Director Research PCCC visiting laboratories at the Institute. Dr. Muhammad Hashim Popalzai appreciated the research work conducted at the Institute.

TRAVELING SEMINAR 2018

Participants of the PCCC Cotton Traveling Seminar 2018 visited CCRI Multan on October 21, 2018.

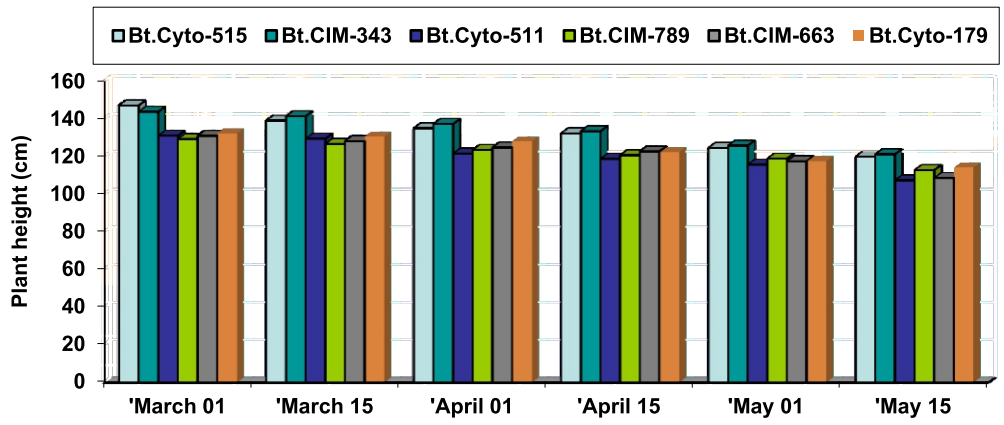


Fig 8 Sowing dates x genotypes interaction on plant height

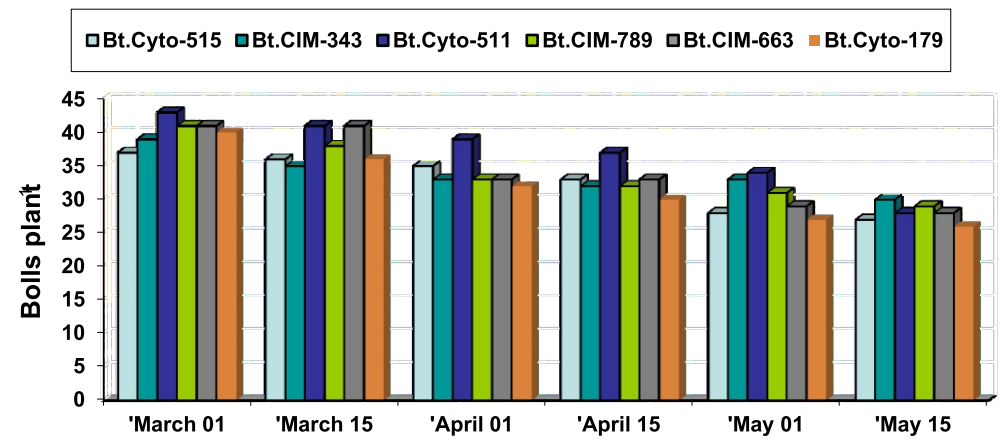


Fig 9 Sowing dates x genotypes interaction on bolls plant^{-1}

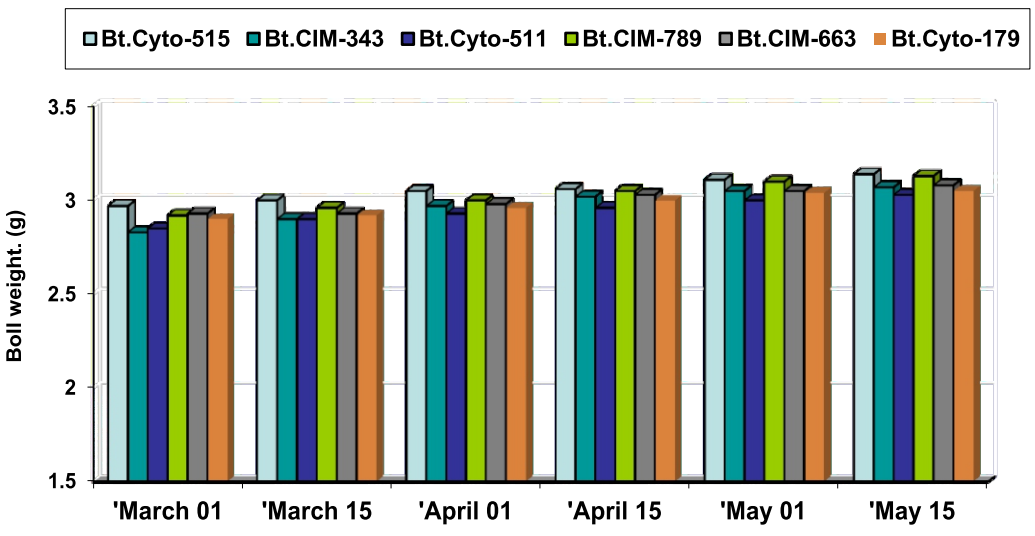


Fig 10 Sowing dates x genotypes interaction on boll weight

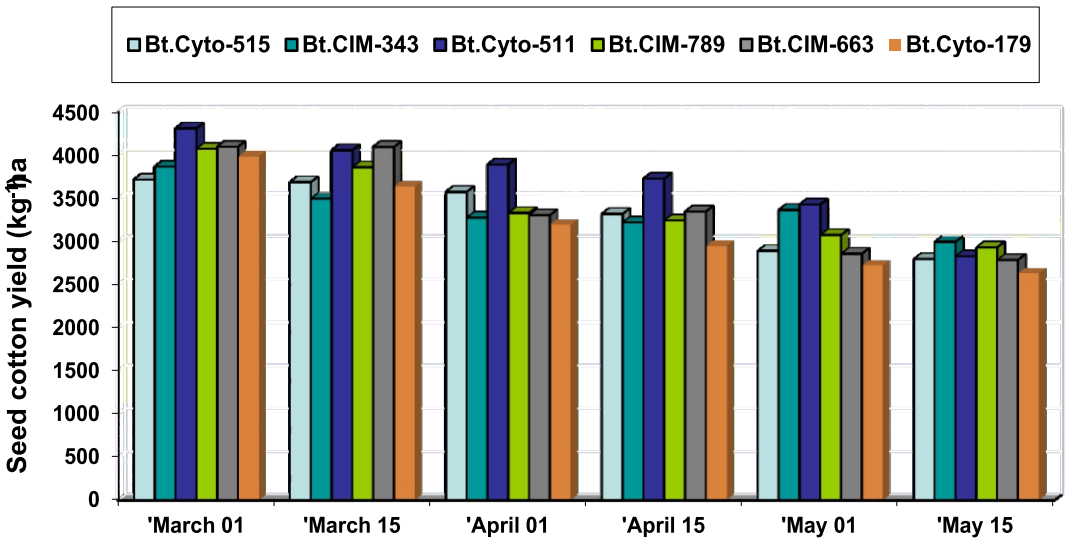


Fig 11 Sowing dates x genotypes interaction on seed cotton yield

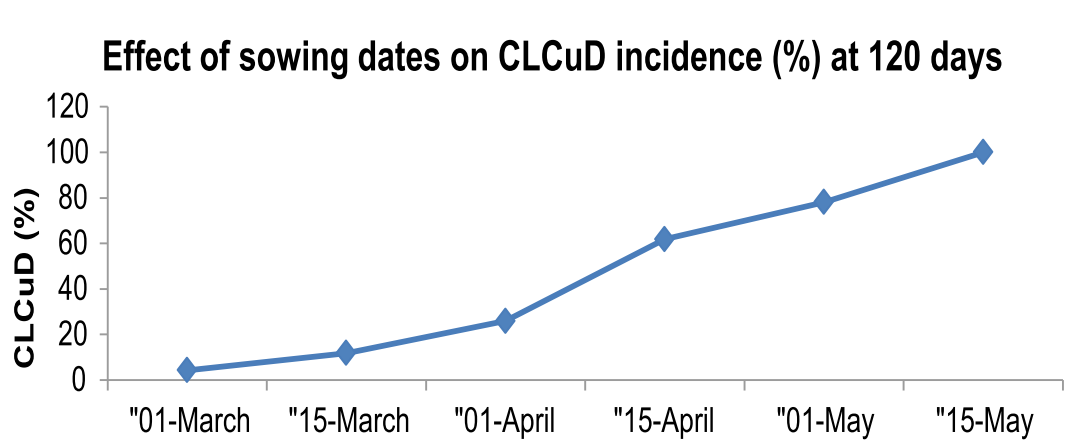


Fig 12. Virus Infestation at 120 DAS at various sowing dates

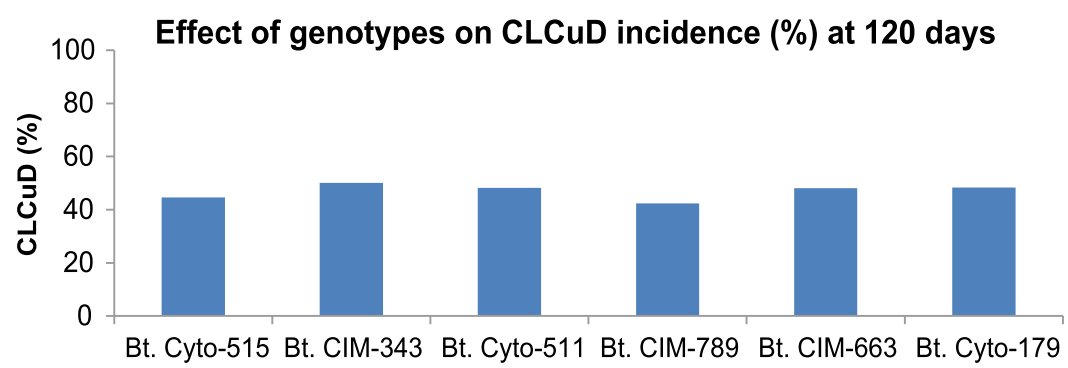


Fig 13. CLCuD incidence (%) in different genotypes

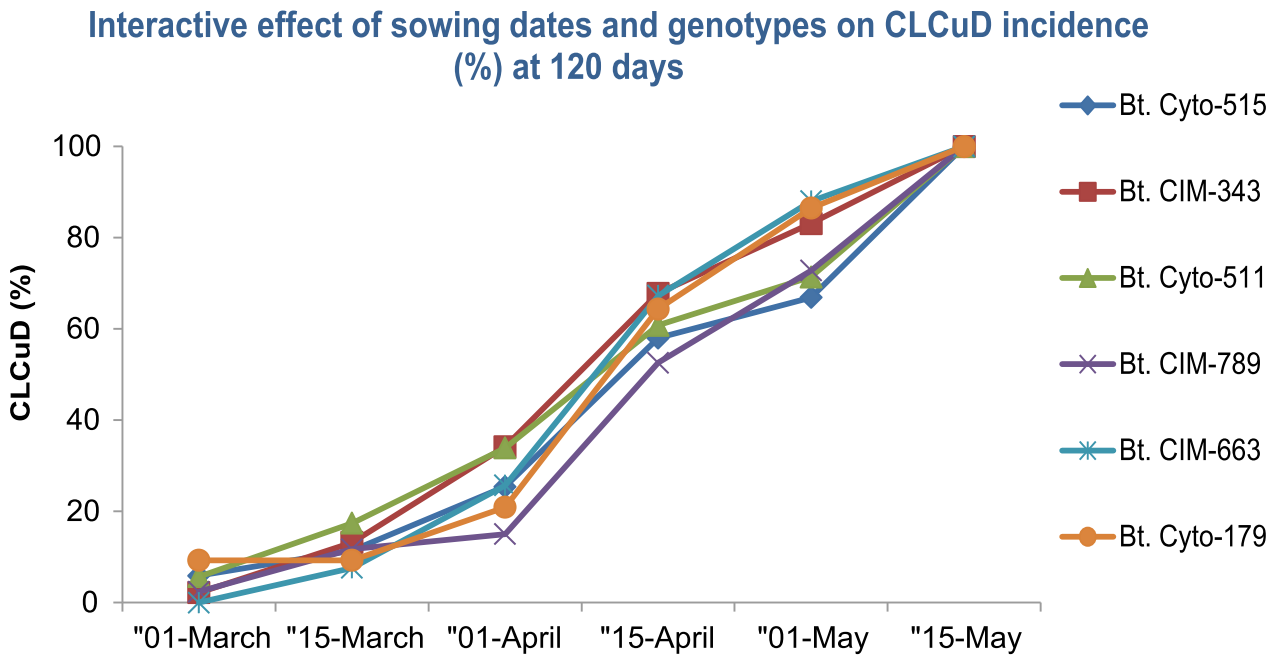


Fig 14. Sowing dates x *Bt.* genotypes interaction for CLCuD incidence (%) at 120 DAS

The data on CLCuD indicated that the disease incidence increased as the sowing was delayed from March 01 to May 15. The incidence of CLCuD after 120 days was observed 78.1% in May 01 and 100.0% in May 15 sown crop. While, March 01, March 15, April 01 and April 15 sown crops showed 4.3%, 11.8%, 25.9% and 61.8% virus infestation, respectively (Fig. 12). On the average basis of sowing dates, genotype *Bt.*CIM-789 showed 2.2%, 5.7%, 5.8%, 6.0% and 7.7% less incidence of CLCuD than *Bt.*Cyto-515, *Bt.*CIM-663, *Bt.*Cyto-511, *Bt.*Cyto-179 and *Bt.*CIM-343, respectively (Fig. 13).The interaction between sowing dates and genotypes is illustrated in Fig. 14.

1.3 Yield response and nitrogen use efficiency of transgenic and conventional cotton genotypes to nitrogen application

Five genotypes i.e CIM-717, Cyto-161, *Bt.*CIM-343, *Bt.*Cyto-515 and *Bt.*CIM-663 were tested at five levels of nitrogen (0, 75, 150, 225 and 300 kg N ha^{-1}). The treatments were laid out according to Randomized Complete Block Design (RCBD) with split plot arrangement and replicated three times. The net plot size was 20 ft x 30 ft. The nitrogen was designated to main plot and genotypes in sub-plots. The land was well prepared using conventional tillage and it was followed by formation of bed-furrows in dry condition. The seeds were manually dibbled on 18.04.2018 at 22.5 cm space on dry beds followed by irrigation. The Dual Gold 960 EC @ 2L per hectare was applied as pre-emergence on moist beds within 24 hours after sowing. The thinning and gap filing operation were completed as per need. The nitrogen fertilizer (75 to 300 kg N ha^{-1}) was applied in respective plots in three splits at 70, 99 and 121 days after planting. Other cultural practices and plant protection measures were adopted as per need of the crop. The data on plant height and boll number were recorded from five randomly selected plants. The boll weight was worked out by selecting 50 bolls from each plot. The whole plot was manually picked and seed cotton weight was converted on hectare basis. The agronomic nitrogen use efficiency was calculated by measuring the yield increase with unit increase in nitrogen supply. The data on plant height, yield & yield components and agronomic nitrogen use efficiency are given in table 1.3.

Table 1.3 Interactive effects of nitrogen fertilizer and genotypes on plant height, seed cotton yield, yield parameters and agronomic nitrogen use efficiency

Nitrogen dose (kg ha^{-1})	Genotypes	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	Agronomic nitrogen use efficiency (kg kg^{-1})
0	CIM-717	121.2	18.0	2.66	1665	-
	Cyto-161	122.3	17.0	2.43	1490	-
	Bt. CIM-343	124.7	21.0	2.78	2086	-
	Bt. Cyto-515	125.7	19.0	2.88	1781	-
	Bt. CIM-663	111.2	20.0	2.78	1998	-
75	CIM-717	130.8	24.0	2.69	2410	9.9
	Cyto-161	131.5	24.0	2.48	2248	10.1
	Bt. CIM-343	132.2	30.0	2.81	2975	11.9
	Bt. Cyto-515	132.4	26.0	2.93	2624	11.2
	Bt. CIM-663	121.1	28.0	2.83	2840	11.2
150	CIM-717	135.1	27.0	2.73	2730	7.1
	Cyto-161	140.8	26.0	2.51	2528	6.9
	Bt. CIM-343	141.8	33.0	2.84	3304	8.1
	Bt. Cyto-515	135.6	29.0	2.96	2932	7.7
	Bt. CIM-663	130.1	32.0	2.85	3155	7.7
225	CIM-717	138.6	28.0	2.76	2810	5.1
	Cyto-161	143.8	27.0	2.53	2596	4.9
	Bt. CIM-343	144.0	35.0	2.86	3523	6.4
	Bt. Cyto-515	137.7	31.0	2.97	3052	5.6
	Bt. CIM-663	133.7	33.0	2.86	3278	5.7
300	CIM-717	140.7	30.0	2.76	2970	4.4
	Cyto-161	145.0	28.0	2.54	2710	4.1
	Bt. CIM-343	146.6	37.0	2.88	3682	5.3
	Bt. Cyto-515	140.1	32.0	2.99	3180	4.7
	Bt. CIM-663	138.1	34.0	2.89	3419	4.7

Sub-effects

Nitrogen dose (kg ha^{-1})	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	Agronomic nitrogen use efficiency (kg kg^{-1})
0	121.0	19.0	2.71	1804	-
75	129.6	26.4	2.75	2619	10.9
150	136.7	29.4	2.78	2930	7.5
225	139.6	30.8	2.80	3052	5.5
300	142.1	32.2	2.81	3192	4.6

Genotypes

CIM-717	133.3	25.4	2.72	2517	6.6
Cyto-161	136.7	24.4	2.50	2314	6.5
Bt. CIM-343	137.9	31.2	2.83	3114	7.9
Bt. Cyto-515	134.3	27.4	2.95	2714	7.3
Bt. CIM-663	126.8	29.4	2.84	2938	7.3

C.D 5%

Nitrogen (N)	6.64	3.35	0.05	292.96	-
Genotypes (G)	7.04	1.96	0.03	177.01	-
N x G	ns	ns	ns	ns	-

The data presented in table 1.3 showed the significant impact of incremental nitrogen on plant height, seed cotton yield and its components. The incremental nitrogen application improved the plant height from 121.0 to 142.1 cm, number of bolls from 19.0 to 32.2 per plant, boll weight from 2.71 to 2.81g and seed cotton yield from 1804 to 3192 kg ha^{-1}. The nitrogen application at the rate of 75, 150, 225 and 300 kg ha^{-1} produced 815, 1126,

1248 and 1388 kg, respectively additional seed cotton yield over unfertilized plots. Increasing nitrogen from 75 to 150 kg resulted significant yield increase and further increase from 150 to 300 kg did not produce significant differences for yield. The higher seed cotton yield was linked with improved yield formation traits. The agronomic nitrogen use efficiency (ANUE) describes the relative yield gains per kg nitrogen applied. The table 1.3 showed that ANUE was initially high and decrease from 10.9 to 4.6 kg kg^{-1} by increasing nitrogen rate from 75 to 300 kg N.

The genotypes also differed significantly with respect to plant height, seed cotton yield and its components. The highest seed cotton yield and number of bolls were recorded for *Bt.*CIM-343 followed by *Bt.*CIM-663. However, the genotype *Bt.*Cyto-515 produced the highest boll weight, hence; its low yield is mainly from a less number of bolls. The lowest boll weight, bolls per plant and ultimately seed cotton yield was obtained from Cyto-161. The *Bt.*CIM-663 was the medium and *Bt.*Cyto-343 was long stature variety. The highest ANUE was obtained from *Bt.*CIM-343 and lowest was for Cyto-161. The treatment interactions were non-significant for recorded observations, meaning that genotypes do not differ in nitrogen requirement.

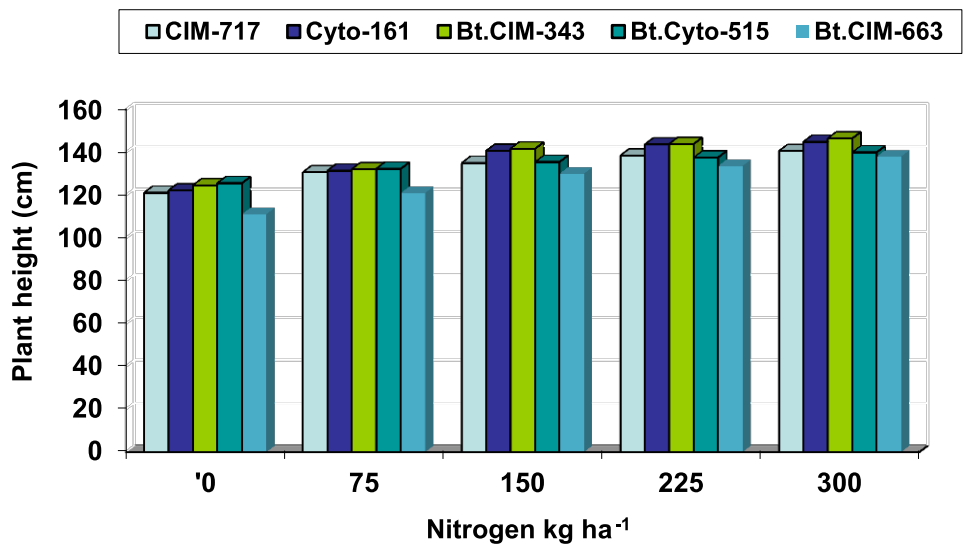


Fig 15 Nitrogen levels X genotypes interaction on plant height

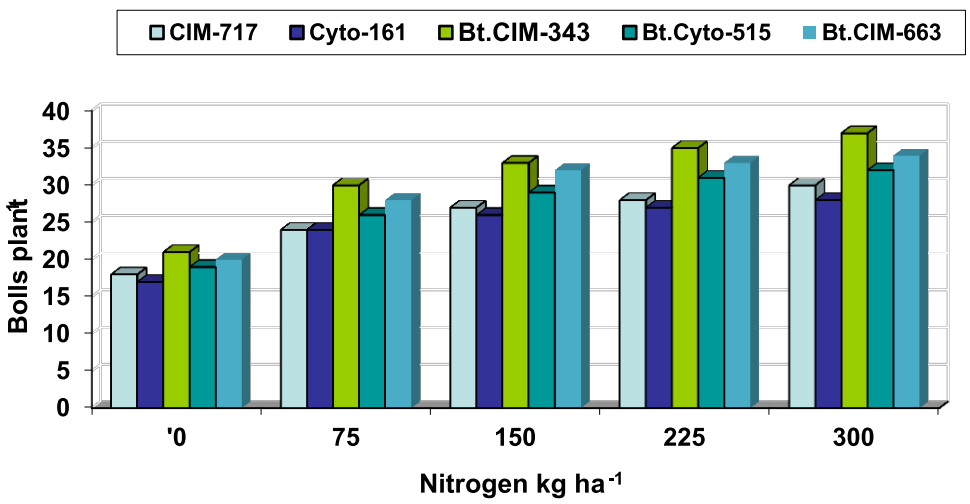


Fig 16 Nitrogen levels X genotypes interaction on bolls $plant^{-1}$

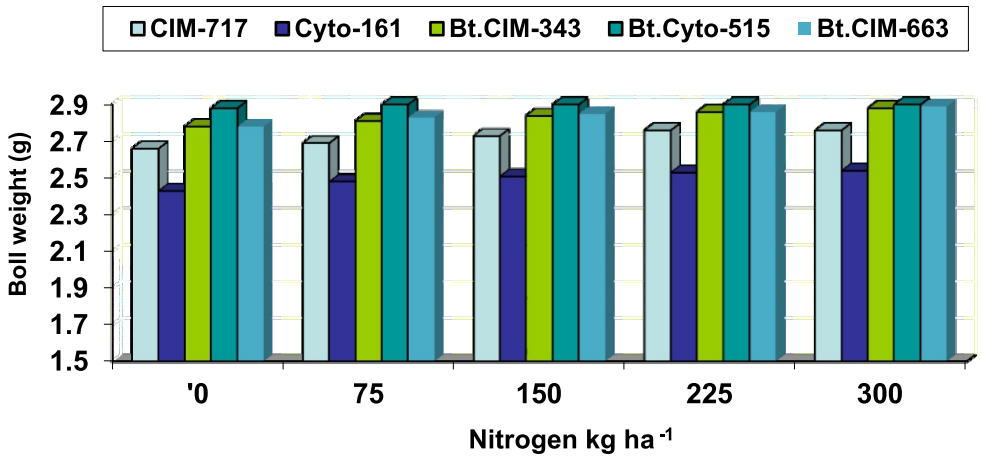


Fig 17 Nitrogen levels X genotypes interaction on boll weight

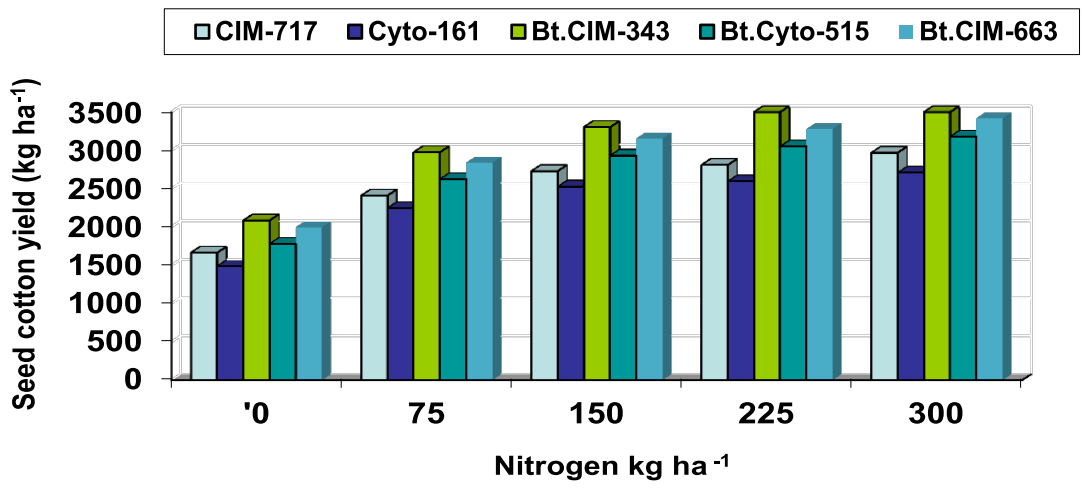


Fig 18 Nitrogen levels X genotypes interaction on seed cotton yield

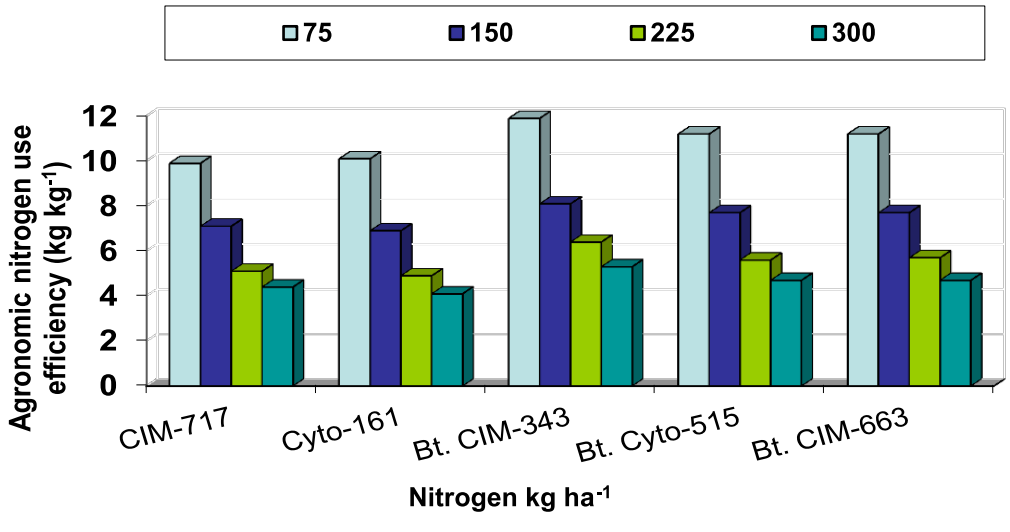


Fig 19. Nitrogen levels X genotypes interaction on agronomic nitrogen use efficiency

1.4 Modeling the cotton genotype performance at temporal variations

The climate change is continuous process and threatening cotton production. Pakistan has been ranked among the most vulnerable countries in the world. The current agronomic practices need a redesigning to effectively address the warming trend issue. Decades are required for such type of experimentation, however, crop growth and simulation models like DSSAT (Decision Support System for Agro-Technology Transfer) generates reliable results after calibration and evaluation using short term field observed data. CSM-CROPGRO-Cotton Model embedded in DSSAT will be used for the assessment of climate change and adaptation strategies. The current study was aimed to optimize planting time and estimate yield performance of genotypes. Three genotypes i.e *Bt*.Cyto-179, *Bt*.Cyto-511 and *Bt*.CIM-789 were planted on March 15, April 15, May 15 and June 15 to generate a range of environmental conditions. The experimental design was Randomized Complete Block Design (RCBD) with split plot arrangement. The planting time was designated to main plot and genotypes to sub-plot. The net plot size measured was 20 ft x 30 ft. The phenology data on days taken for 50% squaring, flowering and boll split initiation was recorded from six randomly selected plant from each plot. The experimental data on phenology, plant height, yield and yield components will be used for calibration and evaluation of the CSM-CROPGRO-Cotton Model. Best performing treatment observed in the results will be used for calibration and remaining results will be used model evaluation. The evaluation of the model will also be carried out by using second year field data. Baseline weather data (1980-2018) and future scenario weather data will be made available through Pakistan Meteorological Department (PMD). Various GCM (General Circulation Model) at RCP 8.5 will be used for assessment of climate change for future scenario and then adaptation strategies will be made for reducing the negative impact of warming trend in future scenario. The crop management data and weather file have been maintained.

Table 1.4: Effect of temporal variations on plant height, phenology, seed cotton yield and its component of various genotypes

Sowing Date	Genotypes	Plant height (cm)	Days taken to 50% squaring	Days taken to 50% flowering	Days taken to first boll split	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Mar 15	*Bt*. Cyto 179	130.6	41.7	59.0	97.0	36	2.92	3639
	Bt. Cyto-511	129.5	41.7	60.0	94.0	41	2.90	4061
	Bt. CIM-789	126.7	42.7	61.0	94.0	38	2.96	3862
Apr 15	*Bt*. Cyto-179	122.3	40.0	57.7	107.0	30	3.00	2949
	Bt. Cyto-511	118.8	40.7	59.0	105.7	37	2.96	3731
	Bt. CIM-789	120.7	38.3	58.0	103.7	32	3.05	3246
May 15	*Bt*. Cyto-179	114.2	51.7	72.0	118.7	26	3.05	2632
	Bt. Cyto-511	107.4	45.7	65.0	110.0	28	3.03	2832
	Bt. CIM-789	112.8	52.0	72.0	123.7	29	3.13	2933
Jun 15	*Bt*. Cyto-179	104.8	43.0	61.0	107.7	19	3.08	1904
	Bt. Cyto-511	101.2	40.0	59.0	105.7	20	3.07	1994
	Bt. CIM-789	102.3	42.7	61.7	101.0	20	3.16	2039

Sub-effects

Genotypes	Plant height (cm)	Days taken to 50% squaring	Days taken to 50% flowering	Days taken to first boll split	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Bt. Cyto-179	118.0	44.1	62.4	107.6	27.8	3.01	2781
Bt. Cyto-511	114.2	42.0	60.8	103.8	31.5	2.99	3155
Bt. CIM-789	115.6	43.9	63.2	105.6	29.8	3.08	3020

Temporal variations	Plant height (cm)	Days taken to 50% squaring	Days taken to 50% flowering	Days taken to first boll split	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
March 15	128.9	42.0	60.0	95.0	38.3	2.93	3854
April 15	120.6	39.7	58.2	105.4	33.0	3.00	3309
May 15	111.5	49.8	69.7	117.4	27.7	3.07	2799
June 15	102.8	41.9	60.6	104.8	19.7	3.10	1979
C.D 5%							
Temporal variation (T)	ns	2.56	2.48	4.90	2.93	ns	454.32
Genotypes (G)	ns	0.85	0.83	1.99	1.62	0.02	75.15
T X G	ns	1.71	1.67	3.98	ns	ns	150.29

The data presented in table 1.4 indicated the significant effect of temporal variations on crop phenology and yield attributes except boll weight. The days taken to 50% squaring and flowering were reduced with delay sowing from March 15 to April 15. However, May 15 took the maximum number of days for advent of 50% squaring, flowering and first boll split. It was again decreased when crop was planted on June 15. The earliest advent of 50% squaring and flowering was recorded for April 15. The plant height, number of bolls and seed cotton yield was reduced from 128.9 to 102.8 cm, 38.3 to 19.7 per plant and 3854 to 1979 kg ha^{-1} with delay in sowing from March 15 to June 15. The effect of genotype was significant for all recorded observation except plant height. Among the genotypes, *Bt.*Cyto-511 took the minimum number of days for completion of various phenological parameters. The highest number of bolls and seed cotton yield was also recorded from *Bt.*Cyto-511.The interactive effect of treatments was significant for phenology and seed cotton yield. The genotype *Bt.*Cyto-511, *Bt.*CIM-789 and *Bt.*Cyto-179 took maximum duration for 50% squaring at April 15, May 15 and June 15 planting, respectively. While for 50% flowering, genotype *Bt.*CIM-789, *Bt.*Cyto-511 and *Bt.*Cyto-179 & *Bt.*CIM-789 require highest days at March 15, April 15 and May 15, respectively. While, genotype *Bt.*CIM-789 require maximum period for 50% flowering at June 15. The genotype *Bt.*Cyto-179 required the highest number of days for first boll split for March 15 and April 15. Whereas, the genotype *Bt.*CIM-789 required more days at May 15 planting. The genotype *Bt.*Cyto-511 was the best yield performer for March 15 and April 15. While, the genotype *Bt.*CIM-789 produced higher yield at May 15 and June 15, planting.

1.5 Cotton yield response to residues management and tillage systems in cotton-wheat cropping system

The cotton-wheat is an important cropping system of south Punjab and Sindh areas which is quite exhaustive for soil health. The surplus residue is often burnt which may be utilized for improvement of soil health. The study aims to quantify the impact of the cotton sticks and wheat straw incorporation in combination with conventional tillage and conventional+chiseling on soil health and crop yield. The experiment will continue for five years from 2018-2023. During first year, the cotton cultivar *Bt.*Cyto-179 was sown on 23rd May 2018 under normal production practice. The treatments included were no residue incorporation (T1), cotton sticks incorporation (T2), cotton sticks & wheat straw incorporation (T3) and wheat straw incorporation (T4). The tillage system was applied following residue incorporation. The post picking left over cotton sticks were incorporated at the rate of 2150 kg ha^{-1} and tillage system was applied according to treatments plan. The pre-incorporation soil samples were collected from field at 0-15 cm, 15-30 cm and 30-60 cm for initial soil profile. The wheat has been sown on 18th December, 2018 following the cotton. The normal agronomic practices are being carried out as per need of the crop. Data on soil analysis are given in table 1.5.

Table 1.5: Soil analysis

Depth (cm)	Saturation (%)	Texture	SAR	pH	Electrical Conductivity (ds/m)	Available Phosphorus (ppm)	Available Potash (ppm)	Organic matter (%)
0-15	36.5	Loam	6.70	8.45	5.13	6.50	202.5	0.53
15-30	36.0	Loam	7.55	8.50	5.20	7.00	187.5	0.53
30-60	35.0	Loam	8.75	8.75	5.40	4.50	124.0	0.48

1.6 Cotton yield and fiber quality response to high density planting system (HDPS)

The yield and fiber quality response of *Bt*.Cyto-313 and *Bt*.CIM-343 was tested at different rows and plant spaces. The row spaces were 60 and 75 cm, while plant spaces were 15, 22.5 and 30 cm. The treatments were compared in Randomized Complete Block Design (RCBD) with split-split arrangement in three replications. The genotypes were kept in main plots, whereas row and plant spaces were adjusted in sub and sub-sub plot, respectively. The net plot size measured was 20ft x 30 ft. The soil was thoroughly prepared with conventional tillage implements and the seeds were sown on beds on 30th May, 2018. The row and plant spaces were maintained according to respective treatments. The pre-emergence application of the Dual Gold 960 EC @ 2L per hectare was carried out on moist beds within 24 hours after planting. Other cultural practices and plant protection measures were adopted as per need of the crop. The data on plant population and number of bolls (m^{-2}) was calculated using desired row length and width. While, boll weight was worked out from 50 selected bolls. Whole, the plot was manually picked, weighted and converted on hectare basis. Data on plant population, plant height, boll number, boll weight and seed cotton yield are given in table 1.6

Table 1.6: Effect of planting density on plant population, plant height, seed cotton yield and its components

Genotypes	Row spacing (cm)	Plant spacing (cm)	Plant population (ha^{-1})	Plant height (cm)	Bolls (m^{-2})	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Bt.CIM-343	75	15.0	73715	97.5	135.5	2.86	3288
		22.5	51560	95.7	125.4	2.92	2965
		30.0	41750	90.2	116.4	3.02	2770
	60	15.0	93367	88.9	110.7	2.82	2428
		22.5	63479	84.4	98.3	2.90	2151
		30.0	49741	82.3	89.5	2.99	1948
Bt.Cyto-313	75	15.0	73389	116.2	146.1	2.84	3464
		22.5	51184	109.0	119.3	2.87	2769
		30.0	42729	106.3	111.5	2.92	2591
	60	15.0	93774	98.3	118.3	2.81	2527
		22.5	63353	92.6	102.1	2.86	2226
		30.0	49741	90.1	95.0	2.90	2057

Genotypes	Plant population (ha^{-1})	Plant height (cm)	Bolls (m^{-2})	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Bt.CIM-343	62269	89.8	112.6	2.92	2592
Bt.Cyto-313	62362	102.1	115.4	2.87	2606

Sub-effects

Row spaces(cm)	Plant population (ha^{-1})	Plant height (cm)	Bolls (m^{-2})	Boll weight (g)	Seed cotton yield (kg ha^{-1})
75	55721	102.5	125.7	2.91	2975
60	68909	89.4	102.3	2.88	2223

Plant spacing (cm)	Plant population (ha^{-1})	Plant height (cm)	Bolls (m^{-2})	Boll weight (g)	Seed cotton yield (kg ha^{-1})
15.0	83561	100.2	127.7	2.83	2927
22.5	57394	95.4	111.3	2.89	2528
30.0	45990	92.2	103.1	2.96	2342
C.D 5%					
Genotypes (G)	ns	9.15	ns	0.02	ns
Row spacing (RS)	6409.80	11.19	11.26	0.02	216.69
Plant spacing (PS)	2702.60	6.30	6.47	0.02	133.62
G x RS	ns	ns	ns	ns	ns
G x PS	ns	ns	ns	0.03	ns
RS x PS	ns	ns	ns	ns	ns
G x RS x PS	ns	ns	ns	ns	ns

The data presented in table 1.6 indicated the significant effects of genotypes for plant height and boll weight. Whereas, the bolls (m^{-2}) and seed cotton yield did not differ significantly between genotypes. The genotype *Bt*.Cyto-313 produced taller plants, more number of bolls and seed cotton yield than *Bt*.CIM-343. However, the row and plant spacing had a significant impact on all recorded parameters. The plant population, plant height, bolls (m^{-2}) and seed cotton yield was decreased by widening the plant to plant spacing. The bolls (m^{-2}) and seed cotton yield was decreased from 127.7 to 103.1 and 2927 to 2342 kg ha^{-1} by increasing plant to plant spaces from 15.0 to 30.0 cm. Whereas, the boll weight showed positive association with plant to plant spacing. Among the row spaces, all the parameters except plant population were higher in 75 cm over 60 cm apart rows. It was concluded from results that narrowing plant spacing was more effective for yield enhancement than row spacing and genotypes.

1.7 Efficacy of stale bed technology and Pre-emergence weedicides on initial weed control in cotton

Stale bed technology was tested for effective initial weed control along with four different pre-emergence weedicides i.e Panida Grandi 43.5 EC, Dual Gold 960 EC, Top Max 96% EC, Panida Grandi + Dual Gold and control (untreated check). The experimental design was Randomized Complete Block Design with split plot arrangement with three replications. The land preparation was kept in main plot and weedicides were in sub-plot. The plot size was 20 ft x 30 ft. Cotton cultivar *Bt*.Cyto-179 was sown on 23.05.2018. Panida Grandi was applied before sowing, while, Dual Gold, Top Max, Panida Grandi + Dual Gold was applied on moist bed during 24 hours. Other cultural practices and plant protection measures were adopted as per need of crop. The data of weeds (g m^{-2}) were taken after 40 days of sowing. The data on dry weight of weeds (g m^{-2}), percent weed control, plant height, number of bolls per plant, boll weight and seed cotton yield are given in table 1.7a and 1.7b

Table 1.7a: Effect of seed bed preparation and pre-emergence weedicides on dry weight of weeds (g m^{-2}) and percent weed control at 40 days after sowing

Treatments	Pre-emergence weedicides	Dry weight (gm^{-2})		% Weed control	
		Broad leaves	Narrow leaves	Broad leaves	Narrow leaves
Stale bed	Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	86.5	29.5	51.8	68.3
	Dual Gold 960 EC @ 2.0 L ha^{-1}	77.5	13.0	56.8	86.0
	Top Max 96% EC @ 1.8 L ha^{-1}	87.0	21.0	51.5	77.4
	Panida Grandi + Dual Gold	83.0	20.0	53.8	78.5
	Control	179.5	93.0	-	-
No Stale bed	Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	86.0	25.0	52.2	71.4
	Dual Gold 960 EC @ 2.0 L ha^{-1}	83.0	12.5	53.9	85.7
	Top Max 96% EC @ 1.8 L ha^{-1}	91.0	22.5	49.4	74.3
	Panida Grandi + Dual Gold	81.0	20.1	55.0	77.0
	Control	180.0	87.5	-	-

Sub-effects:

Pre-emergence weedicides	Dry weight (gm^{-2})		%Weed control	
	Broad leaves	Narrow leaves	Broad leaves	Narrow leaves
Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	86.3	27.3	52.0	69.9
Dual Gold 960 EC @ 2.0 L ha^{-1}	80.3	12.8	55.4	85.9
Top Max 96% EC @ 1.8 L ha^{-1}	89.0	21.8	50.5	75.9
Panida Grandi + Dual Gold	82.0	20.1	54.4	77.8
Control	179.8	90.3	-	-

Treatments	Dry weight (gm^{-2})		%Weed control	
	Broad leaves	Narrow leaves	Broad leaves	Narrow leaves
Stale bed	102.7	35.3	53.5	77.6
No Stale bed	104.2	33.5	52.6	77.1

C.D 5%

Seed Bed (SB)	ns	ns
Weedicides (W)	14.88	5.36
SB x W	ns	ns

The data presented in table 1.7a showed that stale bed gave more control of broad and narrow leave weeds as compared to no stale bed. Similarly, all weedicides gave significant weed control over untreated check. The dry weight of weeds at 40 days after sowing with Pinda Grandi 43.5 EC (pre-sowing weedicide) resulted in 52.0 and 69.9% broad and narrow leave weeds control over untreated. Dual Gold 960 EC (pre-emergence weedicide) resulted in 55.4 and 85.9% broad and narrow leave weeds control over untreated respectively. Top Max 96% EC (pre-emergence weedicide) resulted in 50.5 and 75.9% broad and narrow leave weeds control over untreated respectively. While the combination of Panida Grandi + Dual Gold gave 54.4 and 77.8% broad and narrow leave weeds control over untreated, respectively.

Table 1.7b: Plant height, seed cotton yield and its components influenced by weedicides and seed bed preparation

Treatments	Pre-emergence weedicides	Plant height (cm)	Number of bolls $plant^{-1}$	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Stale bed	Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	99.5	23.5	2.87	2374
	Dual Gold 960 EC @ 2.0 L ha^{-1}	105.4	25.4	2.92	2570
	Top Max 96% EC @ 1.8 L ha^{-1}	96.2	23.8	2.87	2397
	Panida Grandi + DualGold	106.7	24.2	2.92	2416
	Control	84.3	13.6	2.78	1205
No Stale bed	Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	92.0	23.0	2.87	2325
	Dual Gold 960 EC @ 2.0 L ha^{-1}	96.4	25.2	2.91	2544
	Top Max 96% EC @ 1.8 L ha^{-1}	90.6	23.5	2.87	2375
	Panida Grandi + DualGold	98.2	23.5	2.90	2390
	Control	82.4	13.3	2.78	1190

Sub-effects

Pre-emergence weedicides	Plant height (cm)	Number of bolls $plant^{-1}$	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Panida Grandi 43.5 EC @ 2.5 L ha^{-1}	95.8	23.3	2.87	2350
Dual Gold 960 EC @ 2.0 L ha^{-1}	100.9	25.3	2.92	2557
Top Max 96% EC @ 1.8 L ha^{-1}	93.4	23.7	2.87	2386
Panida Grandi + Dual Gold	102.5	23.9	2.91	2403
Control	83.4	13.5	2.78	1198

Treatments	Plant height (cm)	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Stale bed	98.4	22.1	2.87	2192
No Stale bed	91.9	21.7	2.87	2165
C.D 5%				
Seed Bed (SB)	2.40	ns	ns	ns
Weedicides (W)	6.74	2.51	ns	14.88
SB x W	ns	ns	ns	ns

The data presented in table 1.7b indicated that stale bed increased the seed cotton yield and its components. Stale bed produced 1.2% higher yield over no stale bed. All weedicides increased seed cotton yield and its components significantly over untreated check. The Dual Gold 960 EC produced 6.4, 7.1, 8.8 and 113.4% higher seed cotton yield over Panida Grandi + Dual Gold, Top Max 96% EC, Pandia Grandi 43.5 EC and untreated check respectively. The seed cotton yield of all weedicides was significantly higher than control.

1.8 Internship

Agronomy Section provided research facilities to two Ph.D. scholars from faculty of Agricultural Science and Technology, Bahauddin Zakariya University in addition to fifteen students of B.Sc (Hons.) Agriculture (Agronomy) from different Agricultural Colleges/Universities throughout the country. They were facilitated in research activities and internship training under the supervision of experts.

1.9 Cost of Production of One Acre Cotton for the Year 2018-19

Sr. No.	Operations and Inputs	Number/ Quantity	Rate (Rs)	Amount (Rs.)
1.	Seedbed Preparation			**4712**
	a) Cultivation (Ploughing + planking)	4	600/cultivation	2400.00
	b) Leveling	1	500/leveling	500.00
	c) Bed and furrow making	1	600/acre	600.00
	d) Pre-emergence Herbicide	1.2	960/liter	1152.00
	e) Bund making	1	60/acre	60.00
2.	Seed			**1685.00**
	a. Cost	8 kg.	8000/40 kg	1600.00
	b. Transportation	-	25/bag	5.00
	c. Delinting	-	400/40 kg	80.00
3.	Sowing	2 men day	1186/acre	**1186.00**
4.	Thinning	2 men day	1186/acre	**1186.00**
5.	Interculturing and earthing up	4	600/acre	**2400.00**
6.	Irrigation			**11705.00**
	a. Land preparation (3 hours)	1/3 canal		
	b. *Rouni* (4 hours)	2/3 tubewell	500/hour of tubewell	9333.00
	c. Post planting irrigation (21hours)			
	d. Cleaning of water channel and labour charges for irrigation	4 man day	593/man day	2372.00
7.	*Abiana* (Water rates)	-	125/acre	**125.00**

Sr. No.	Operations and Inputs	Number/ Quantity	Rate (Rs)	Amount (Rs.)
8.	Fertilizer			**7093.00**
	a. DAP (Di-Amonium Phosphate)	1 bag	2500/bag	2500.00
	b. Urea	3.0 bags	1300/bag	3900.00
	c. Transportation	4.0 bags	25/bag	100.00
	d. Fertilizer Application Charges	1man day	593/day	593.00
9.	Plant Protection			**6500.00**
	a. Sucking	6	950/spray	5700.00
	b. Bollworm	1	800/spray	800.00
10.	Harvesting (Picking charges)	800 Kg	10.0/kg	**8000.00**
11	Stick Cutting	2 men day	593/man day	+1186.00
11a	Value of cotton sticks			-1186.00
12.	Managerial Charges for 1 acre	7 months	20000/month/100 acre	**1400.00**
13.	Land Rent	7 months	40,000/acre/annum	**23,333.00**
14.	Unforeseen Expenses	-	2000/acre	**2000.00**
15.	Production Expenditure	-	-	
	a. Including Land Rent			**71325.00**
	b. Excluding Land Rent			**47992.78**
16.	Mark-up on Investment	7 months	12.5% for one year	
	a. Including Land Rent			**5200.78**
	b. Excluding Land Rent			**3499.42**
17.	Total Expenditure	--		
	a. Including Land Rent			**76525.78**
	b. Excluding Land Rent			**51491.42**
18.	Income of Seed Cotton	800 kg	3650/40 kg	**73000. 00**
19.	Market expenses	800 kg	100/40 kg	**2000. 00**
20.	Cost of Production at Farm level	-		
	a. Including Land Rent		Per 40 kg	**3826.29**
	b. Excluding Land Rent			**2574.57**
21.	Cost of production at Market	-		
	a. Including Land Rent.		Per 40 kg	**3926.28**
	b. Excluding Land Rent.			**2674.57**

VISIT OF PARTICIPANTS OF THE "26TH MID-CAREER MANAGEMENT COURSE" OF NATIONAL INSTITUTE OF MANAGEMENT ISLAMABAD

A group of 18 member trainees from 26th Mid-Career Management Course (In-land Study Tour) from National Institute of Management, Islamabad visited CCRI Multan on October 18, 2018. Dr. Zahid Mahmood, Director CCRI Multan briefed about the cotton research & development activities carried out at the Institute. Participants also visited cotton fields of the Institute and appreciated the research work conducted by the scientists.

VISIT OF PARTICIPANTS OF THE "26TH MID-CAREER MANAGEMENT COURSE" OF NATIONAL INSTITUTE OF MANAGEMENT LAHORE

A group of 12 member trainees from 26th Mid-Career Management Course (In-land Study Tour) from National Institute of Management, Lahore visited CCRI Multan on October 17, 2018. Dr. Zahid Mahmood, Director CCRI Multan briefed about the cotton research & development activities carried out at the Institute. Later the participants also visited cotton fields and laboratories of the Institute and appreciated the research work conducted by the scientists.

2. PLANT BREEDING & GENETICS SECTION

Plant Breeding & Genetics Section evolves new cotton varieties or lines with desirable fibre properties by utilizing purposeful breeding (crossing) of closely or distantly related genotypes. Plants are crossbred to introduce traits/genes from one variety or line into a new genetic background.

The promising hybrids, *Bt*. and non-*Bt*. strains of all the cotton breeders of the country were evaluated under National Coordinated Variety Testing (NCVT) Programme of Pakistan Central Cotton Committee and Provincial Coordinated Cotton Trial (PCCT) of the Punjab Government. The commercial varieties (*Bt*. and non-*Bt*.) of the country were also tested for their performance under local conditions in standard varietal trial. The breeding materials in different filial generations were screened out for further process. Major emphasis was laid on the selection of material having resistance/tolerance to BSCV along with excellent fibre characteristics. Fresh crosses were also attempted to develop resistance/tolerance to BSCV in new *Bt*. & Non-*Bt* breeding material. Pre-basic seed of commercial varieties viz., CIM-496, CIM-620, CIM-554, CIM-573, *Bt.*CIM-598, *Bt.*CIM-600, *Bt.*CIM-599, *Bt.*CIM-602 and *Bt.*CIM-632 was produced for distribution to public and private seed corporations for further multiplication. The genetic stock of World Cotton collections comprising of 6123 cultivars of four *Gossypium* species is being preserved for short, medium and long term as well as for utilization in breeding program by cotton breeders in the country and abroad. Trainings were also imparted to small farmers, progressive growers and students from different universities. The summary of results is as below.

2.1 Testing of new strains

2.1.1 Varietal Trial-1

Objective: Testing and evaluation of promising medium long staple *Bt*. strains for the development of commercial varieties

Five medium long staple promising *Bt*. strains viz., CIM-673, CIM-674, CIM-666, CIM-667 and CIM-675, were evaluated against two *Bt*. commercial varieties i.e. *Bt*.CIM-602 and FH-142 at CCRI, Multan and Punjab Seed Corporation Farm, Khanewal. Data of seed cotton yield and other parameters are given in **Tables 2.1, 2.2** and **2.3**.

Averaged across the two locations, the strain CIM-667 produced the highest seed cotton yield of 4358 kg ha^{-1} followed by CIM-675 having yield 4115 kg ha^{-1} while the standard varieties FH-142 and *Bt*.CIM-602 yielded 3352 and 3421 kg ha^{-1} respectively **(Table 2.1).**

Table 2.1 Performance of advanced strains in Varietal Trial-1 at two locations

Sr. #	Strains	Seed cotton yield (kg ha^{-1})			Lint Yield (kg ha^{-1})	Av. Boll weight (g)	Plant Pop. (ha^{-1})
		Multan (11/5)*	Khanewal (17/5)	Average			
1	CIM-673	3951	3004	3478	1377	3.0	41964
2	CIM-674	3033	2923	2978	1141	2.9	41695
3	CIM-666	3494	3210	3352	1304	3.6	40978
4	CIM-667	4474	4241	4358	1564	2.9	40798
5	CIM-675	4123	4107	4115	1576	3.3	41426
6	CIM-602	3487	3354	3421	1290	2.8	39543
7	FH-142	3404	3300	3352	1263	2.5	40171

* = Sowing date 11.05.2018

CD (5%) for seed cotton: Locations (L) = 254.78; Varieties (V) = 127.39, L x V = 360.31

The new strain CIM-673 produced the highest lint percentage of 39.6 Followed by CIM-666 having lint percentage values of 38.9 as compared with the standard *Bt*.CIM-602 (37.7%) and FH-142 (37.7%)(**Table 2.2**). The new strain CIM-674 produced the longest staple of 30.1 mm, followed by CIM-667 and CIM-675 with 28.8 mm while the standards *Bt*.CIM-602 and FH-142 produced 28.4 and 26.3 mm staple length, respectively **(Table 2.2).**

Table 2.2 Lint percentage and staple length of advanced strains in Varietal Trial-1 at two locations

Sr. #	Strains	Lint (%age)			Staple length (mm)		
		Multan	Khanewal	Average	Multan	Khanewal	Average
1	CIM-673	38.1	41.0	39.6	29.1	28.5	28.8
2	CIM-674	38.0	38.6	38.3	30.6	29.6	30.1
3	CIM-666	39.6	38.1	38.9	29.5	27.6	28.6
4	CIM-667	34.8	37.0	35.9	29.9	27.7	28.8
5	CIM-675	38.5	38.0	38.3	29.6	28.0	28.8
6	CIM-602	38.1	37.2	37.7	29.1	27.6	28.4
7	FH-142	37.1	38.2	37.7	26.4	26.2	26.3

All the new strains possess desirable micronaire value ranging from 3.8 to 4.6 ($\mu g\ inch^{-1}$) in comparison to *Bt*.CIM-602 with 4.7 ($\mu g\ inch^{-1}$) .The fiber strength of all the new strains and standards are in the desirable range, i.e., 28.7 to 30.8 g/tex **(Table 2.3).**

Table 2.3 Micronaire value and fibre strength of advanced strains in VT-1 at two locations

Sr. #	Strains	Micronaire value ($\mu g\ inch^{-1}$)			Fibre strength (g/tex)		
		Multan	Khanewal	Average	Multan	Khanewal	Average
1	CIM-673	4.5	4.1	4.3	29.2	28.1	28.7
2	CIM-674	5.0	4.1	4.6	30.0	31.6	30.8
3	CIM-666	4.6	4.1	4.4	28.9	29.6	29.3
4	CIM-667	4.2	3.4	3.8	30.7	30.0	30.4
5	CIM-675	4.1	4.0	4.1	29.9	30.3	30.1
6	CIM-602	5.0	4.3	4.7	25.7	27.6	28.7
7	FH-142	4.2	3.6	3.9	28.4	29.4	28.9

2.1.2 Varietal Trial-2

Objective: Testing and evaluation of promising medium long staple strains for the Development of commercial varieties

Five new strains with medium-long staple viz., CIM-661, CIM-663, CIM-676, CIM-303 and CIM-789 were tested at CCRI, Multan and Punjab Seed Corporation Farm, Khanewal against two commercial varieties CIM-602 and FH-142.

Data presented in **Table 2.4** showed that averaged across locations the new strain CIM-676 produced the highest seed cotton yield of 4306 kg ha^{-1}, followed by CIM-663 with 4194 kg ha^{-1} while the standard varieties *Bt*.CIM-602 and FH-142 produced 3259 kg ha^{-1} and 3184 kg yield ha^{-1} respectively.

The strain CIM-676 had the highest lint percentage of 41.2, followed by 39.4% of CIM-663 in comparison to the commercial varieties CIM-602 and FH-142 produced 38.7 and 37.0 lint percentages. The strain CIM-661 and CIM-676 produced the longest staple of 28.8 mm followed by CIM-303 and CIM-663 having 28.7 and 28.2 mm respectively. **(Table 2.5)**

All the strains possess desirable micronaire values ranging from 4.5 to 4.8 $\mu g\ inch^{-1}$**.** The fibre strength of the strains ranged from 26.0 to 29.1 g/tex **(Table 2.6).**

Table 2.4 Performance of advanced strains in Varietal Trial-2 at two locations

Sr. #	Strains	Seed cotton yield (kg ha^{-1})			Lint yield (kg ha^{-1})	Av. boll weight (g)	Plant Pop. (ha^{-1})
		Multan (11/5)*	Khanewal (17/5)*	Average			
1	CIM-661	3839	2538	3189	1340	2.6	38198
2	CIM-663	4352	4035	4194	1710	3.5	40798
3	CIM-676	4442	4170	4306	1781	3.1	38736
4	CIM-303	4326	3918	4122	1653	3.2	34073
5	CIM-789	3418	3936	3677	1302	3.3	27259
6	CIM-602	3701	2816	3259	1340	2.6	39812
7	FH-142	3462	2905	3184	1295	3.1	37929

* = Sowing date 11.05.2018

CD (5%) for seed cotton: Locations (L) = 144.79; Varieties (V) = 72.40; L x V = 204.77

Table 2.5 Lint percentage and staple length of advanced strains in VT-2 at two locations

Sr. #	Strains	Lint (%age)			Staple length (mm)		
		Multan	Khanewal	Average	Multan	Khanewal	Average
1	CIM-661	38.9	36.9	37.9	29.1	28.5	28.8
2	CIM-663	39.3	39.4	39.4	28.1	28.2	28.2
3	CIM-676	40.1	42.2	41.2	29.2	28.4	28.8
4	CIM-303	38.2	39.4	38.8	28.1	29.2	28.7
5	CIM-789	38.1	39.1	38.6	28.2	28.0	28.1
6	CIM-602	36.2	37.7	37.0	28.2	27.8	28.0
7	FH-142	37.4	40.0	38.7	27.2	28.1	27.7

Table 2.6 Micronaire value and fibre strength of advanced strains in VT-2 at two locations

Sr. #	Strains	Micronaire value (µg inch^{-1})			Fibre strength (g/tex)		
		Multan	Khanewal	Average	Multan	Khanewal	Average
1	CIM-661	4.9	4.2	4.6	27.7	30.5	29.1
2	CIM-663	4.8	4.2	4.5	26.2	26.8	26.5
3	CIM-676	4.8	4.5	4.7	27.2	28.9	28.1
4	CIM-303	4.9	4.7	4.8	25.2	26.7	26.0
5	CIM-789	4.9	4.3	4.6	27.0	26.5	26.8
6	CIM-602	4.3	3.9	4.1	26.8	29.6	28.2
7	FH-142	4.3	4.2	4.3	24.9	27.7	26.3

2.1.3 Varietal Trial-3

Objective: Testing and evaluation of promising medium long staple non *Bt*. strains for the development of commercial varieties

Six medium staple promising non *Bt*. Strains CIM-726, CIM-732, CIM-736, CIM-737, CIM-738, CIM-739 were evaluated against commercial varieties, CIM-610 and CIM-620 at CCRI, Multan and Punjab Seed Corporation Farm, Khanewal. Data on seed cotton yield and other parameters are given in **Tables 2.7, 2.8** and **2.9**.

Averaged across locations, the strain CIM-726 produced the highest seed cotton yield of 1707 kg ha^{-1} followed by CIM-736 having yield of 1192 kg ha^{-1} while the standards CIM-610 and CIM-620 produced 1026 kg ha^{-1} and 1010 kg ha^{-1} yield respectively **(Table 2.7).**

Table 2.7 Performance of advanced strains in Varietal Trial-3 at two locations

Strains	Seed cotton yield (kg ha^{-1})			Lint	Av. Boll weight (g)	Plant Pop. (ha^{-1})
	Multan (23/5)*	Khanewal (17/5)	Average	Yield (kg ha^{-1})		
CIM 726	1666	1748	1707	635	3.4	31473
CIM-732	1425	673	1049	561	2.7	23941
CIM-736	1666	717	1192	646	2.9	37660
CIM-737	911	717	814	334	2.7	32101
CIM-738	1677	628	1153	614	3	34791
CIM-739	1097	582	840	398	2.7	29142
CIM-610	1420	632	1026	558	2.8	29949
CIM-620	1078	942	1010	404	2.1	30218

* = Sowing date

CD (5%) for seed cotton: Locations (L) = 82.97; Varieties (V) = 165.94; L x V = 234.68

The new strains CIM-732 produced the highest lint percentage of 40.0, followed by CIM-610 having lint percentage value of 39.9 **(Table 2.8).** The new strains CIM-736 produced the longest staple of 31.3 mm, followed by CIM-739 with 29.8 mm while the standards CIM-610 and CIM-620 produced 28.7and 28.6 mm staple length respectively **(Table 2.8).**

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INDITEX

Community Level Awareness Raising Seminars

for

COTTON GROWING COMMUNITIES

(farmers, workers and their families)

on

Fundamental Principles and Rights at Work (FPRW)

27-28 February 2019 at CCRI, Multan

Under the ILO's Project on "Promoting Fundamental Principles and Rights at Work in the Cotton Supply Chain"
Funded by INDITEX in collaboration with the project on
"Eliminating Child Labour and Forced Labour in the Cotton, Textile & Garment Value Chains: An Integrated Approach" co-funded by the EU.

ILO organized two days awareness program "Community level awareness raising seminar for cotton growing communities" at CCRI, Multan. The small farmers with their families, farm workers, tractor drivers, field staff attended the program.

Table 2.8 Lint percentage and staple length of advanced strains in VT-3 at two locations

Strains	Lint (%age)			Staple length (mm)		
	Multan	Khanewal	Average	Multan	Khanewal	Average
CIM-726	38.1	39.7	38.9	27.5	28.8	28.2
CIM-732	39.4	40.6	40.0	29.0	29.4	29.2
CIM-736	38.8	34.6	36.7	31.0	31.6	31.3
CIM-737	36.7	37.9	37.3	28.2	29.4	28.8
CIM-738	36.6	35.4	36.0	29.2	29.8	29.5
CIM-739	36.3	36.9	36.6	29.2	30.4	29.8
CIM-610	39.3	40.4	39.9	28.1	29.2	28.7
CIM-620	37.5	40.0	38.8	28.0	29.1	28.6

All the new strains possess desirable micronaire values ranging from 4.4 to 4.9 (µg inch^{-1}) while the standards CIM-610 and CIM-620 had 4.3 and 4.7 (µg inch^{-1}) micronaire value respectively. The fibre strength of all the new strains and standards is in the desirable range, i.e. 26.6 to 31.1 g/tex **(Table 2.9).**

Table 2.9 Micronaire value and fibre strength of advanced strains in VT-3 at two locations

Strains	Micronaire value (µg inch^{-1})			Fibre strength (g/tex)		
	Multan	Khanewal	Average	Multan	Khanewal	Average
CIM-726	4.7	4.0	4.4	28.9	27.9	28.4
CIM-732	4.8	4.5	4.7	26.2	26.9	26.6
CIM-736	4.7	4.5	4.6	31.9	30.2	31.1
CIM-737	5.1	4.7	4.9	28.2	29.1	28.7
CIM-738	4.9	4.4	4.7	30.3	29.5	29.9
CIM-739	5.0	4.5	4.8	29.5	29.1	29.3
CM-610	4.6	4.0	4.3	28.1	28.6	28.4
CM-620	4.7	4.7	4.7	27.2	28.5	27.9

2.1.4 Micro Varietal Trial-1

Objective: Testing of newly bulked long staple *Bt.* strains to develop Commercial varieties

Seven newly bulked strains numbering from 1/18 to 7/18 were tested against commercial variety *Bt.*CIM-602 at CCRI, Multan. The new strain 4/18 surpassed all the strains and standard variety in seed cotton yield by producing 4143 kg ha^{-1}, followed by 3/18 with 4053 kg ha^{-1} and 5/18 having 3354 kg ha^{-1} compared with 3389 yield of *Bt.*CIM-602 **(Table 2.10).**

The strain 5/18 produced the highest lint percentage of 38.7 followed by 38.2 percent lint in 3,4/18 while the commercial variety *Bt.*CIM-602 produced the lint percentage of 37.9. The strain 1/18 produced the longest staple of 28.6 mm, followed by 28.5 mm in 6/18 compared with the fibre length of 28.1 mm in commercial variety *Bt.*CIM-602. All the strains have desirable micronaire values except genotype 1/18. The strain 6/18 maintained the maximum fibre strength of 31.1 g/tex, followed by 29.5 g/tex in 3/18 while standard *Bt.*CIM-602 had 28.9 g/tex.

Table 2.10 Performance of advanced strains in Micro Varietal Trial-1 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre strength (g/tex)	Av. boll wt. (g)	Plant Pop. (ha^{-1})
1	1/18	3067	1162	37.9	28.6	5.3	27.3	3.1	39633
2	2	3174	1152	36.3	27.3	4.5	28.3	2.4	40350
3	3	4053	1548	38.2	28.2	4.6	29.5	2.9	40709
4	4	4143	1583	38.2	28.1	4.8	28.3	3.0	40350
5	5	3354	1298	38.7	28.2	4.9	28.8	2.9	41247
6	6	3318	1264	38.1	28.5	3.5	31.1	2.9	41067
7	7	3228	1207	37.4	27.3	4.6	28.6	2.9	39812
8	CIM-602	3389	1284	37.9	28.1	4.2	28.9	2.5	40709

Sowing date = 30.05.2018; CD (5%) for seed cotton: Strains = 400.49; CV % = 6.60

2.1.5 Micro Varietal Trial-2

Objective:Testing of newly bulked medium-long staple *Bt*. strains to develop commercial varieties

Seven newly bulked strains numbering from 8/18 to 14/18 were tested against commercial variety *Bt*.CIM-602 at CCRI, Multan. The new strain 12/18 surpassed all the strains and standard variety in seed cotton yield by producing 4250 kg ha^{-1}, followed by 11/18 with 4161 kg ha^{-1} and 13/18 having 3676 kg ha^{-1} compared with 3515 yield of *Bt*.CIM-602 **(Table 2.11).**

The strain 11/18 produced the highest lint percentage of 38.7, followed by 38.4 percent lint in 10/18 while the commercial variety *Bt*.CIM-602 produced the lint percentage of 37.7. The strain 12/18 produced the longest staple of 28.8 mm, followed by 28.7 mm in 8/18 and 11/18 compared with the fibre length of 27.9 mm in commercial variety *Bt*.CIM-602. All the strains have micronaire values ranging from 4.3 to 5.1 (µg inch^{-1}). The strain 11/18 maintained the maximum fibre strength of 30.7 g/tex, followed by 29.8 g/tex in 13/18 while standard *Bt*.CIM-602 had 29.8 g/tex.

Table 2.11 Performance of advanced strains in Micro-Varietal Trial-2 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple Length (mm)	Micro-naire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. boll wt. (g)	Plant Pop. (ha^{-1})
1	8/18	3551	1335	37.6	28.7	4.6	29.0	2.8	39991
2	9	3336	1251	37.5	28.0	4.4	28.3	2.9	35508
3	10	3515	1350	38.4	28.0	5.0	27.6	2.8	37660
4	11	4161	1610	38.7	28.7	4.3	30.7	3.1	37481
5	12	4250	1628	38.3	28.8	4.9	27.8	3.5	39095
6	13	3676	1393	37.9	28.3	5.1	29.8	2.3	36584
7	14	3246	1188	36.6	27.5	4.8	28.4	2.3	39633
8	CIM-602	3515	1325	37.7	27.9	4.3	29.8	2.6	39453

Sowing date = 30.05.2018; CD (5%) for seed cotton = 365.70; CV. % = 5.71

2.1.6 Micro Varietal Trial-3

Objective: Testing of newly bulked medium-long staple to develop commercial varieties

Ten newly bulked strains numbering from 15/18 to 24/18 were tested against commercial variety CIM-602 at CCRI, Multan. Data presented in **Table 2.12** indicated that the new strain 17/18 surpassed all the new strains yielding 4285 kg ha^{-1}, followed by strains 22/18 and 20/18 which produced 4228 and 4128 kg ha^{-1} seed cotton respectively while the standard CIM-602 yielding 3130 kg ha^{-1}. The new strain 19/18 produced the highest lint percentage of 39.4 followed by 38.8% in 17/18, 38.2% in 20,21 and 22/18 in comparison to CIM-602 having 37.1 lint percentages. The strains 23/18 has the longest staple of 30.1 mm followed by 20/18 and 21/18 with the staple of 29.4 mm and 29.2 mm compared with the staple length of 28.7 mm in standard variety CIM-602. All the genotypes have desirable micronaire value ranging from 3.9 to 4.9 µg inch^{-1}. All the strains were showing fibre strengths ranging from 26.1 to 30.2 g/tex.

Table 2.12 Performance of advanced strains in Micro-Varietal Trial-3 at CCRI, Multan

Sr. #	Strains	Seed cotton yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micronaire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. boll weight (g)	Plant Pop. (ha^{-1})
1	15/18	3121	1108	35.5	26.4	4.2	26.1	2.6	32818
2	16	3398	1261	37.1	28.7	4.8	29.0	2.7	39991
3	17	4285	1663	38.8	28.8	4.1	28.9	4.3	31383
4	18	3669	1328	36.2	28.5	4.5	28.4	3.4	39274
5	19	3834	1511	39.4	28.5	4.9	28.9	3.0	43578
6	20	4128	1577	38.2	29.4	4.7	29.4	2.9	42861
7	21	3812	1456	38.2	29.2	3.9	28.9	3.7	42143
8	22	4228	1615	38.2	28.2	4.7	28.1	2.3	41605
9	23	3878	1454	37.5	30.1	4.2	30.2	2.9	43040
10	24/18	3596	1402	39.0	27.7	4.4	29.0	2.7	39095
11	CIM-602	3130	1161	37.1	28.7	4.1	28.5	2.7	42233

Sowing date = 11.05.2018 CD (5%) for seed cotton = 776.83; CV. % = 12.21

2.1.7 Micro-Varietal Trial-4

Objective*:* Testing of medium long staple *Bt*. strains to develop commercial varieties

Eight newly bulked elite *Bt*. strains from 25/18 to 32/18 were tested against commercial variety *Bt.*CIM-602 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.13**.

The strain 28/18 out-yielded all the strains and standard variety by producing 4084 kg ha^{-1} seed cotton, followed by 27/18 having seed cotton yields of 3965 against commercial variety *Bt.*CIM-602 which produced 3086 kg ha^{-1} seed cotton. The strain 27/18 produced the higher lint percentage of 40.1% followed by 32/18 with 39.7 and 28/18 with 39.2 %.compared with that of 34.4% by *Bt.*CIM-602.

The strain 29/18 produced the longest staple of 30.5 mm, followed by the 30.0 mm of strain 30/18 compared with the 27.1 mm of *Bt.*CIM-602. All the strains have desirable micronaire values ranging from 4.3 to 4.8 (µg inch^{-1}) except 25/18 have undesirable micronaire value 5.0 µg inch^{-1}. The fibre strength of all the new strains were observed within the range i.e. 27.8 to 32.9.

Table 2.13 Performance of advanced strains in Micro-Varietal Trial-4 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple Length (mm)	Micronaire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. boll weight (g)	Plant pop. (ha^{-1})
1	25/18	3391	1248	36.8	27.6	5.0	28.9	3.3	25824
2	26	3292	1258	38.2	28.6	4.7	30.4	3.2	35508
3	27	3965	1590	40.1	28.8	4.7	29.7	3.2	33177
4	28	4084	1601	39.2	29.3	4.8	29.9	3.1	34611
5	29	3503	1377	39.3	30.5	4.3	32.9	2.9	38019
6	30	3672	1300	35.4	30.0	4.4	31.7	2.3	34073
7	31	3552	1250	35.2	27.6	4.5	29.1	2.2	36763
8	32/18	3019	1199	39.7	27.2	4.8	27.8	3.1	34791
9	CIM-602	3086	1062	34.4	27.1	4.4	27.6	2.5	38019

Sowing date = 24.05.2018; CD (5%) for seed cotton = 296.53; CV. % = 4.88

2.1.8 Micro-Varietal Trial-5

Objective*:* Testing of medium long staple Bt. strains to develop commercial varieties

Seven newly bulked elite strains 33/87 to 39/18 were tested against commercial variety *Bt.*CIM-602 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.14.**

The strain 36/18 out-yielded all the strains and standard variety by producing 3460 kg ha^{-1} seed cotton, followed by 37/18 having seed cotton yields of 3457 kg ha^{-1}, respectively against commercial variety *Bt.*CIM-602 which produced 2911 kg ha^{-1} seed cotton. The strains 37/18 and 36/18 produced the higher lint percentage values of 41.2 and 39.8 respectively compared with that of 37.3% by *Bt.*CIM-602.

The strain 39/18 produced the longest staple of 29.3 mm, followed by 29.2 mm in 33/11 compared with the fibre length of 28.7 mm in commercial variety *Bt.*CIM-602. All strains have desirable micronaire values ranging from 4.3 to 4.9 µg inch^{-1} except 36/18 & which have 5.2 (µg inch^{-1}). The strain 33/18 maintained the maximum fibre strength of 29.8 g/tex, followed by 35/18 with 29.6 g/tex while standard *Bt.*CIM-602 had 28.4 g/tex fibre strength.

Table 2.14 Performance of advanced strains in Micro-Varietal Trial-5 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple Length (mm)	Micronaire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. boll weight (g)	Plant pop. (ha^{-1})
1	33/18	3143	1191	37.9	29.2	4.7	29.8	2.5	41605
2	34	3144	1214	38.6	28.7	4.8	28.2	2.5	43399
3	35	2906	1084	37.3	28.9	4.5	29.6	2.9	43040
4	36	3460	1377	39.8	27.9	5.2	28.0	2.9	40529
5	37	3457	1424	41.2	27.7	4.9	27.2	2.2	43578
6	38	3011	1192	39.6	29.1	4.7	28.0	2.6	41247
7	39/18	3113	1227	39.4	29.3	4.5	28.1	2.8	41964
8	CIM-602	2911	1393	37.3	28.7	4.3	28.4	2.4	40888

Sowing date = 11.05.2018; CD (5%) for seed cotton = 646.88; CV. % = 11.38

2.1.9 Micro-Varietal Trial-6

Objective*:* Testing of long staple *Bt.* strains to develop commercial varieties

Nine newly bulked elite strains (40/18 to 48/18) were tested against commercial variety Bt.CIM-602 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.15.**

The strain 44/18 out-yielded all the strains and standard variety by producing 3326 kg ha^{-1} seed cotton, followed by 47/18 and 45/18 having seed cotton yields of 3297 and 2851 kg ha^{-1}, respectively against commercial variety *Bt.*CIM-602 which produced 1700 kg ha^{-1} seed cotton. The strains 47/18 produced the higher lint percentage values of 40.3 followed by 48/18 and 45/18 with 40.0% and 39.0 % lint respectively compared with that of 38.3% by *Bt.*CIM-602.

The strain 43/18 produced the longest staple of 30.7 mm, followed by 30.6 mm in 45/18 compared with the staple length of 28.7 mm in commercial variety *Bt.*CIM-602. All strains have desirable micronaire values raging from 4.3 mm to 4.9 mm. The strain 45/18 produced the maximum fibre strength (29.4 g/tex) followed by 29.3 g/tex of 43/18 as compared to the 28.1 g/tex of standard Bt. CIM-602.

Table 2.15 Performance of advanced strains in Micro-Varietal Trial-6 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple Length (mm)	Micronaire value (µg $inch^{-1}$)	Fibre Strength (g/tex)	Av. boll weight (g)	Plant pop. (ha^{-1})
1	40/18	1338	502	37.5	28.5	4.7	27.2	2.6	35149
2	41	1662	617	37.1	29.0	4.9	27.4	2.7	25824
3	42	1942	722	37.2	29.1	4.8	27.6	2.8	34611
4	43	2790	1080	38.7	30.7	4.8	29.3	3.1	41605
5	44	3326	1287	38.7	30.4	4.9	29.2	3.0	41964
6	45	2851	1112	39.0	30.6	4.8	29.4	2.8	39095
7	46	2028	775	38.2	28.5	4.6	26.9	3.1	38019
8	47	3297	1329	40.3	28.2	4.7	25.7	2.7	40350
9	48/18	2622	1049	40.0	28.5	4.3	27.4	3.5	39453
10	CIM-602	1700	651	38.3	28.7	4.2	28.1	2.4	38915

Sowing date: 09.06.2018, CD (5%) for seed cotton: Strains = 424.67, CV% = 10.51

2.1.10 Micro-Varietal Trial-7

Objective*:* Testing of medium long staple *Bt.* strains with high lint percentage to develop commercial varieties

Eight newly bulked elite strains (55/18 to 62/18) were tested against commercial variety *Bt.*CIM-602 at CCRI, Multan. Data on yield and other parameters are presented in **Table 2.16**.

The strain 56/18 out-yielded all the strains and standard variety by producing 2411 kg ha^{-1} seed cotton, followed by 55/18 and 62/18 having seed cotton yields of 2181 and 2178 kg ha^{-1}, respectively against commercial variety *Bt.*CIM-602 which produced 2035 kg ha^{-1} seed cotton. The strains 58/18 produced the maximum lint percentage values of 43.6 followed by 60/18 which produced 41.3% lint and 37.5% by *Bt.*CIM-602.

The strains 57/18 and 59/18 produced the longest staple of 30.6 mm, followed by 30.0 mm in 60/18 compared with the fibre length of 28.9 mm in commercial variety *Bt.*CIM-602. All strains have desirable micronaire values ranging from 4.2 to 4.6 except 58/18. The strain 59/18 maintained the maximum fibre strength of 31.6 g/tex, followed by 31.4 g/tex in 57/18 while standard *Bt.*CIM-602 had 29.7 g/tex fibre strength.

2.2 Coordinated Variety Testing Programme

2.2.1 National Coordinated Varietal Trial (Set-A)

Objective: - Testing of promising non *Bt.* Strains of different cotton breeders of Pakistan

The cotton seed of nine strains under coded numbers was received from Director Research (PCCC) for evaluation against a Standard commercial variety CIM-620. Data on seed cotton production and other parameters are presented in **Table 2.17**.

The results indicated that the strain CRIS-613 produced maximum yield 2654 kg ha^{-1} followed by CRIS-552 with 2634 kg ha^{-1} of seed cotton yield respectively. GS-Ali-9 produced lowest yield that is 980 kg ha^{-1} while standard CIM-620 produced 1791 kg ha^{-1}.

Table 2.16 Performance of advanced strains in Micro-Varietal Trial-7 at CCRI, Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1}	Lint (% age)	Staple Length (mm)	Micronaire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. boll weight (g)	Plant pop. (ha^{-1})
1	55/18	2181	868	39.8	29.6	4.5	30.3	2.8	43038
2	56	2411	940	39.0	28.0	4.6	28	2.8	42082
3	57	2134	849	39.8	30.6	4.6	31.4	2.6	43516
4	58	1876	818	43.6	28.4	5.4	28	3.5	31083
5	59	1888	776	41.1	30.6	4.2	31.6	2.0	40169
6	60	2024	836	41.3	30.0	4.6	30.6	2.3	37539
7	61	1922	786	40.9	28.4	4.8	28.7	3.0	43277
8	62/18	2178	886	40.7	27.8	4.4	28.4	2.4	40169
9	CIM-602	2035	763	37.5	28.9	4.3	29.7	2.3	42560

Sowing date: 23.05.2018; CD (5%) for seed cotton: Strains = 616.87 CV% = 17.20

The strain CIM-717 produced the highest lint percentage of 39.2%, followed by CIM-620 (Std) and GS-Ali-9 with 38.5%. The strain Cyto-225 produced the highest value of staple length 29.5 mm, followed by CIM-717 which has staple length of 28.7 mm. All the strains having the desirable micronaire value. All values of fibre strength were above the required standard.

Table 2.17 Performance of Cotton Strains in National Coordinated Varietal Trial at CCRI Multan (Set-A)

Sr. #	Strains	Seed cotton yield (kg ha^{-1}	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micro -naire value (µg inch^{-1})	Fibre Strength (g/tex)	Plant Pop. (ha^{-1})
1	CIM-717	2541	996	39.2	28.7	4.7	26.4	36219
2	Cyto-225	2034	716	35.2	29.5	4.6	31.5	39566
3	CRIS-613	2654	878	33.1	26.1	4.3	27.8	41837
4	TH-88/11	1624	516	31.8	25.1	4.4	27.2	38370
5	CIM-620(Std-2)	1791	690	38.5	27.4	4.7	28.5	31437
6	GS-Ali-7	1814	640	35.3	24.5	4.5	25.9	38012
7	CRIS-552	2634	727	27.6	23.7	4.3	27.1	42076
8	NIAB-191	2049	770	37.6	26.3	4.6	26.5	41837
9	NIAB-818	2096	786	37.5	28.5	4.6	28.9	40761
10	GS-Ali-9	980	377	38.5	24.4	4.6	25.4	25939

Sowing date = 23.05.2018

2.2.2 National Coordinated Varietal Trials (Set-B)

Objective: Testing of promising *Bt.* strains of different cotton breeders of Pakistan

Twenty five strains from different cotton breeders of the country were received under coded numbers from Director Research PCCC for evaluated against two commercial varieties at CCRI Multan.

The data presented in **Table 2.18** showed that the FH-490 produced the highest seed cotton yield of 3572 kg ha^{-1}, followed by IR-NIBGE-11(Mac-7) having 3511 kg ha^{-1} seed cotton yield while NIA-85 produced lowest yield 1669 kg ha^{-1}.

Data also revealed that the strain Bahar-07 produced the highest lint percentage of 41.5, followed by ICI-2121 with 41.0%. While strain NS-191 produced the longest staple with 28.7 mm length followed by BS-18 with 28.6 mm.

The ranging of micronaire value is from 4.3 to 5.2 (µg inch^{-1}) . Maximum fibre strength was maintained by NS-191 having 29.3 g/tex, followed by cim-602 with 29.1 g/tex fibre strength.

COTTON FARMERS TRAINING PROGRAM (WWF-CCRIM) FEBRUARY 25, 2019

CCRI Multan organized a one-day training program for the contracted cotton farmers of WWF-Pakistan. Around 100 cotton farmers from Shuja Abad attended the program. Dr. Zahid Mahmood, Director CCRI Multan gave a briefing about cotton research activities conducted by the Institute. Dr. Fiaz Ahmad, Head, Plant Physiology Section delivered a lecture about cotton plant nutrition management and Dr. Naveed Afzal, Head Agronomy talked about best agronomic practices for cotton production. Later, the farmers also visited fields and farm machinery at the Institute.

Table 2.18 Performance of different Bt. Strains of public Sector in National Coordinated Varietal Trial (Set-B) at CCRI, Multan

Sr. #	Strains	Seed-cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (%age)	Staple length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g/tex)	Plant Pop. (ha^{-1})
1	Bahar-07	2243	931	41.5	24.5	4.9	25.6	41964
2	AA-933	2198	833	37.9	27.1	4.9	27.7	42681
3	Auriga-216	3290	1283	39.0	26.0	5.1	25.9	43219
4	Bahar-2017	3021	1169	38.7	25.9	4.8	26.0	42323
5	BH-221	2665	1023	38.4	26.4	4.4	27.2	38915
6	BS-18	3486	1412	40.5	28.6	4.4	25.5	40709
7	Bt. CIM-343	3360	1324	39.4	28.3	4.5	28.1	38557
8	Bt. CIM-663	3357	1319	39.3	28.4	4.3	26.2	40529
9	CIM-602 (Std-1)	2834	1034	36.5	28.5	4.3	29.1	41785
10	BZU-05	2607	965	37.0	26.5	5.0	27.1	34611
11	Cyto-515	3215	1273	39.6	26.2	4.9	26.2	38736
12	Evyol-148	3139	1224	39.0	27.8	5.1	26.6	42143
13	FH-444	2731	948	34.7	26.0	4.7	26.7	42681
14	FH-490	3572	1432	40.1	26.6	4.8	27.4	42861
15	GH-Haadi	3254	1295	39.8	28.5	4.7	26.7	42502
16	GH-Mubarak	3480	1371	39.4	26.3	5.1	26.3	43040
17	ICI-2121	3010	1234	41.0	26.5	4.9	26.6	42681
18	IUB-13 (Std-2)	2675	1054	39.4	26.4	5.1	26.7	34432
19	IR-NIBGE-11(Mac-7)	3511	1190	33.9	27.5	4.8	27.6	42323
20	IUB-69	2269	801	35.3	25.5	4.4	26.6	32101
21	KZ-125	3012	1175	39.0	26.5	5.2	27.1	41605
22	MNH-1020	2943	1124	38.2	27.1	5.0	26.4	42323
23	MNH-1026	3315	1306	39.4	26.8	4.8	26.3	42143
24	NIA-85	1669	631	37.8	26.2	4.5	26.8	42143
25	NIAB-898	3028	1229	40.6	27.5	4.8	27.7	42861
26	NS-191	3208	1254	39.1	28.7	4.4	29.3	41426
27	RH-Afnan	3232	1238	38.3	26.2	4.9	26.5	42681

Sowing date 17.05.2018

2.2.3 National Coordinated Varietal Trials (Set-C)

Objective: Testing of promising *Bt.* strains of different cotton breeders of Pakistan

The cotton seed of twenty eight candidate varieties alongwith with two standards were provided by the Director Research PCCC for evaluation at CCRI Multan. The data presented in **Table 2.19** showed that the strain Weal AG-6 produced the highest seed cotton yield of 3425 kg ha-1, followed by CII-TJ-King with 3318 kg ha-1 seed cotton yield while Tipu-9 was at bottom position in respect of seed cotton yield (1704 kg ha-1).

Data presented in Table 2.19 revealed that CII-ICI-2222 produced the highest lint percentage 39.5 followed by CII-CEMB-101with 39.4%.

While strain Weal AG-6 produced the longest staple with 30.3 mm length followed by CIM-602 (Bt Std-1) with 29.8 mm.

The range of Micronaire value was 3.9 to 5.1 µg inch-1. Whereas strain Weal AG-6 produced the maximum fibre strength with 28.8 g/tex followed by CIM-602 (Bt Std-1) with 28.7 g/tex.

Table 2.19 Performance of different *Bt.* Strains of private sector in National coordinated Varietal Trial (Set-C) at CCRI Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (%age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre strength (g/tex)	Plant Pop. (ha^{-1})/
1	RH-Manthar	2367	857	36.2	28.3	5.1	25.9	27797
2	Sahara-210	2529	956	37.8	27.7	4.3	26.3	36225
3	Shahab-7	2887	1135	39.3	25.8	4.8	24.2	40529
4	Shaheen-16	2941	1079	36.7	27.9	5.1	25.8	38736
5	Sitara-16	2511	937	37.3	27.4	4.7	25.6	40888
6	SLH-19	2798	1044	37.3	28.7	5.0	26.4	39812
7	SLH-6	2313	874	37.8	27.7	4.3	26.8	40709
8	Suncrop-5	2744	1043	38.0	28.6	4.6	26.8	40888
9	CIM-602 (Bt Std-1)	2708	980	36.2	29.8	3.9	28.7	41605
10	Suncrop-6	3120	1167	37.4	28.7	4.5	27.1	38915
11	Tassco-902	2636	967	36.7	26.7	4.3	25.8	42143
12	Tipu-9	1704	656	38.5	25.0	4.7	23.9	37660
13	VH-189	3102	1179	38.0	29.2	5.1	26.8	30307
14	VH-383	2995	1111	37.1	29.3	4.9	27.4	39095
15	Weal AG-5	2475	876	35.4	26.9	4.5	25.6	40171
16	Weal AG-6	3425	1260	36.8	30.3	4.4	28.8	41247
17	Badar-1 (CII)	3031	1140	37.6	27.3	4.7	25.4	41785
18	IUB-13 (Bt Std-2)	2977	1119	37.6	27.9	5.0	26.0	39991
19	CII-CEMB-100	2582	997	38.6	28.4	4.5	26.5	34253
20	CII-CEMB-101	2618	1031	39.4	27.8	4.7	26.0	32639
21	NU-21 (CII)	2654	1032	38.9	27.1	4.5	25.6	37660
22	Sahara-2020 (CII)	2493	975	39.1	26.8	4.4	25.6	39633
23	Tahafuz-10 (CII)	2636	973	36.9	28.4	4.9	26.5	36584
24	TJ-MAX (CII)	2206	801	36.3	29.1	4.5	28.6	39274
25	CII-Badar-2	2403	920	38.3	26.8	5.0	25.4	27976
26	CII-CEMB-102	2385	913	38.3	27.8	4.8	26.3	37122
27	CII-ICI-2222	2923	1155	39.5	25.5	4.8	23.5	40171
28	CII-Suncrop	3102	1142	36.8	27.4	4.8	25.4	39274
29	CII-Tahafuz-12	2864	1085	37.9	28.4	4.9	25.6	40888
30	CII-TJ-King	3318	1284	38.7	26.8	4.7	25.0	39991

Sowing date = 19.05.2018 CD (5%) for seed cotton: Strains = 292.99; CV% = 6.60

2.2.4 National Coordinated Varietal Trials (Set-D)

Objective: Testing of promising *Bt.* strains of different cotton breeders (Public seed sector) of Pakistan

The cotton seed of twenty seven candidate varieties including commercial varieties CIM-602 and IUB-13 were provided by the Director Research PCCC for evaluation their yield potential and fiber characters at CCRI Multan The data presented in **Table 2.20** showed that the strain Bt.CIM-678 produced the highest seed cotton yield of 4480 kg ha^{-1}, followed by Bt.CIM-789 with 4247 kg ha^{-1} seed cotton yield and Bt.CIM-303 with 3895 kg ha^{-1} while Crystal-20 was at bottom position in respect of seed cotton yield i.e. 2604 kg ha^{-1}.

Data presented in **Table 2.20** revealed that Bt.CIM-303 produced the highest lint percentage 39.4 followed by BS-20 with 39.3%.

While strain CKC-ICI-2323, IUB-13 (Bt. Std.2) and PC-1889 produced the longest staple of 28.4 mm length followed by CIM-602 (Bt.Std.-1) and CKC-TJ-Inqilab with 28.3 mm respectively.

The range of Micronaire value was 4.1 to 5.4 µg inch^{-1}. Whereas strain CKC-TJ-Inqilab produced the maximum fibre strength with 30.1 g/tex followed by CIM-602 (Bt.Std.-1) with 29.1 g/tex.

Table 2.20 Performance of different *Bt.* Strains of private sector in National coordinated Varietal Trial (Set-D) at CCRI Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (%age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre strength (g/tex)	Plant Pop. (ha^{-1})/
1	CEMB-Klean Cotton-1 (CKC)	3118	1207	38.7	26.6	4.8	25.7	34073
2	CEMB-Klean Cotton-2	2623	1020	38.9	27.2	4.7	25.8	38198
3	Ghauri-1 (CKC)	3480	1312	37.7	27.9	5.0	28.1	43219
4	Hatf-1 (CKC)	2897	1075	37.1	27.0	5.4	25.0	39991
5	CKC-3	3562	1393	39.1	27.2	5.0	26.0	42861
6	CKC-4	2929	1110	37.9	25.1	4.8	25.6	39812
7	CKC-Clean Flex	2673	944	35.3	26.0	5.1	24.7	38198
8	CKC-Hatf-3	3408	1298	38.1	27.7	5.4	26.4	41247
9	CIM-602 (Bt.Std.-1)	3014	1055	35.0	28.3	4.1	29.1	42681
10	CKC-ICI-2323	3021	1030	34.1	28.4	4.7	27.6	43040
11	CKC-Sahara-Klean	2882	1081	37.5	25.4	5.1	24.4	39991
12	CKC-TJ-Inqilab	2900	1006	34.7	28.3	4.0	30.1	33535
13	BF-1	3603	1348	37.4	28.0	4.4	27.1	41605
14	BH-223	3303	1216	36.8	26.2	5.1	24.6	43757
15	BS-20	3258	1280	39.3	26.6	5.1	25.8	41247
16	Bt.CIM-303	3895	1535	39.4	28.1	4.9	26.8	31921
17	Bt.CIM-678	4480	1738	38.8	28.3	4.1	27.9	39991
18	IUB-13 (Bt. Std.2)	3318	1297	39.1	28.4	4.8	27.8	34970
19	Bt.CIM-789	4247	1665	39.2	28.2	4.6	27.1	39274
20	BZU-07	3417	1316	38.5	28.1	4.6	27.4	41067
21	CRIS-671	3542	1236	34.9	28.4	4.8	28.5	41247
22	CRIS-673	3525	1132	32.1	26.5	4.8	25.4	40888
23	Crystal-20	2604	940	36.1	27.8	4.8	26.3	27797
24	Cyto-510	3329	1268	38.1	26.4	5.1	25.5	39095
25	Cyto-511	2909	1036	35.6	28.2	4.7	28.9	39095
26	Eagle-3	3339	1242	37.2	28.2	4.8	28.2	38019
27	Eye-111	3523	1363	38.7	26.8	4.7	25.8	40350

Sowing date = 17.05.2018

2.2.5 National Coordinated Varietal Trials (Set-E)

Objective: Testing of promising *Bt.* strains of different cotton breeders (Public seed sector) of Pakistan

The cotton seed of twenty six candidate strains including commercial varieties were provided by the Director Research PCCC for evaluation, their yield potential and fiber characters at CCRI Multan The data presented in **Table 2.21** showed that the strain MZM-7 produced the highest seed cotton yield of 3156 kg ha^{-1}, followed by Koh-i-Noor with 3139 kg ha^{-1} seed cotton yield while NS-201 was at bottom position in respect of seed cotton yield i.e. 2316 kg ha^{-1}.

Data presented in **Table 2.21** revealed that NIAB-1011 produced the highest lint percentage 40.3 followed by MNH-1035 with 39.9%.

While strain Rohi-1 and FH-155 produced the longest staple of 28.0 and 27.3 mm length followed by VH-402 with 27.1 mm respectively.

The range of Micronaire value was 4.2 to 5.4 µg inch^{-1}. Whereas strain Rohi-1 produced the maximum fibre strength with 29.4 g/tex followed by Weal AG-8 with 28.5 g/tex.

Table 2.21 Performance of different *Bt.* Strains of private sector in National coordinated Varietal Trial (Set-E) at CCRI Multan

Sr. #	Strains	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (%age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre strength (g/tex)	Plant Pop. (ha^{-1})/
1	Eye-20	2785	1058	38.0	25.1	5.0	26.2	32639
2	FH-155	2767	1043	37.7	27.3	4.8	28.3	27438
3	FH-AM Cotton-2017	2893	1079	37.3	25.3	5.1	25.2	38557
4	FH-Supper Cotton-2017	2600	962	37.0	24.9	4.8	25.8	40171
5	GH-UHAD	2943	1083	36.8	24.5	5.2	24.9	38557
6	ICI-2424	2596	1028	39.6	23.5	5.2	23.9	38915
7	IR-NIBGE-12	2659	971	36.5	24.9	4.5	26.0	39453
8	IR-NIBGE-13	2719	982	36.1	25.3	4.3	27.0	41964
9	CIM-602 (Bt Std-1)	2641	924	35.0	27.0	4.2	28.3	43399
10	IUB-71	2501	885	35.4	24.5	4.6	25.0	26183
11	Koh-i-Noor	3139	1199	38.2	24.3	5.1	24.9	39274
12	MNH-1035	2702	1078	39.9	23.1	5.1	23.0	42502
13	MZM-7	3156	1158	36.7	25.3	4.9	26.4	36584
14	NIAB-1011	2849	1148	40.3	23.8	4.7	25.2	43219
15	NIAB-135	2636	949	36.0	25.3	4.6	26.6	43578
16	NS-201	2316	864	37.3	23.6	4.4	25.0	37839
17	RH-670	2890	1061	36.7	26.5	4.7	27.6	38736
18	IUB-13 (Bt Std-2)	2860	1110	38.8	25.5	4.7	26.5	32280
19	Rohi-1	3046	1100	36.1	28.0	4.6	29.4	41964
20	Rustam-11	2961	1004	33.9	25.1	5.1	26.3	42681
21	SLH-33	2458	836	34.0	26.2	4.6	27.5	31204
22	Tassco-112	3124	1196	38.3	23.8	4.9	25.0	42861
23	Tipu-1524	2931	1079	36.8	24.9	5.4	25.4	43399
24	VH-402	2848	1057	37.1	27.1	4.5	28.1	43757
25	Weal AG-7	2760	988	35.8	24.2	5.0	25.0	41964
26	Weal AG-8	2745	955	34.8	26.8	4.5	28.5	36763

Sowing date = 19.05.2018

2.2.6 Provincial Coordinated Cotton Trials

Provincial Coordinated Cotton Trial-I (*Bt.*)

Objective: Testing of promising strains of different cotton breeders of the Punjab.

Thirty four promising strains of different cotton breeders from the Punjab were evaluated along with standards at CCRI, Multan. Data presented in **Table 2.22** revealed that PC-25 produced the maximum seed cotton yield of 2393 kg ha^{-1}, followed by PC-21 with 2378 kg ha^{-1} while PC-9 (1400 kg ha^{-1}) was at the bottom of the conducted trial.

The Strain PC-14 produced the highest lint percentage of 40.5 followed by PC-22 having 39.3 lint percentages. The strain PC-21 produced the longest staple having 29.1 mm length, followed by the variety PC-22 with 29.0 mm and while the lowest value was recorded for PC-24 (24.1 mm) staple length. Micronaire value of all the strains were in desirable range except PC-25. The fibre strength of all strains were with in the range of 25.0 to 29.1 g/tex.

Table 2.22 Performance of new *Bt.* strains in Provincial Coordinated Cotton Trial-I at CCRI, Multan

Sr. #	Strains	Seed cotton Yield (kg ha^{-1})	Lint Yield (kg. ha^{-1})	Lint (% age)	Staple length (mm)	Micronaire value (µg inch^{-1})	Fibre Strength (g/tex)	Plant Pop. (ha^{-1})
1	PC-1	1678	643	38.3	24.5	4.6	25.7	41247
2	PC-2	1654	640	38.7	25.8	4.6	26.9	38557
3	PC-3	1746	665	38.1	28.1	4.6	28.8	43757
4	PC-4	1730	675	39.0	24.9	4.6	26.3	39453
5	PC-5	1744	661	37.9	25.9	4.9	27.0	41785
6	PC-6	1664	619	37.2	26.1	4.8	27.0	37481
7	PC-7	1930	687	35.6	24.9	4.8	26.0	41067
8	PC-8	1643	585	35.6	25.6	4.9	26.6	36225
9	PC-9	1400	536	38.3	25.2	4.5	26.6	27079
10	PC-10	1457	543	37.3	24.6	4.8	25.9	31204
11	PC-11	1644	567	34.5	25.7	4.6	27.2	31921
12	PC-12	1560	594	38.1	28.1	4.4	29.1	40888
13	PC-13	1567	599	38.2	28.0	4.9	25.0	41605
14	PC-14	1999	810	40.5	24.4	4.9	25.0	40888
15	PC-15	1578	576	36.5	24.5	4.6	25.2	43757
16	PC-16	1767	670	37.9	27.6	4.6	29.1	35508
17	PC-17	1941	740	38.1	28.0	4.8	26.2	40529
18	PC-18	1682	643	38.2	28.1	4.9	26.3	42681
19	PC-19	1500	545	36.3	25.1	4.8	26.0	38377
20	PC-20	1582	566	35.8	25.1	4.7	26.5	39633
21	PC-21	2378	911	38.3	29.1	4.9	25.7	40529
22	PC-22	1839	723	39.3	29.0	4.2	28.2	39453
23	PC-23	1490	568	38.1	25.3	4.8	25.9	36943
24	PC-24	1557	599	38.5	24.1	4.9	25.5	38736
25	PC-25	2393	871	36.4	26.4	5.0	26.0	40529
26	PC-26	1932	752	38.9	25.7	4.7	26.6	42143
27	PC-27	2274	864	38.0	26.8	4.6	28.0	36763
28	PC-28	1480	555	37.5	25.2	4.7	26.3	35329
29	PC-29	1560	495	31.7	25.3	4.4	27.5	39991
30	PC-30	1518	559	36.8	25.2	4.4	26.4	33356
31	PC-31	1487	522	35.1	25.6	4.2	26.7	39991
32	PC-32	1921	711	37.0	25.8	4.7	27.8	41605
33	PC-33	1821	692	38.0	25.2	4.8	26.3	41605
34	PC-34	1840	710	38.6	24.8	4.8	26.3	39274

Sowing date = 23.05.2018

2.2.7 Provincial Coordinated Cotton Trial-II

Objective: Testing of promising strains of different cotton breeders of the Punjab.

Two promising strains of different cotton breeders from the Punjab were compared at CCRI, Multan. Data presented in **Table 2.23** revealed that V-1 produced the maximum seed cotton yield of 1683 kg ha^{-1}, followed by V-2 with 1614 kg ha^{-1}.

The strain V-1 produced the highest lint percentage of 39.5%, followed by the V-2 with 39.1 lint percentage. Both the strains have staple length below the required standard. Micronaire values of the strains were in the desirable range. Maximum fiber strength was observed for V-2 i.e. 28.4 g/tex.

Table 2.23 Performance of new *Bt.* strains in Provincial Coordinated Cotton Trial-II at CCRI, Multan Trial-I

Strains	Seed cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micronaire value (µg inch^{-1})	Fibre strength (g/tex)	Plant Pop. (ha^{-1})
V-1	1683	665	39.5	25.0	4.9	25.0	42502
V-2	1614	631	39.1	27.3	4.7	28.4	36405

Sowing date = 23.05.2018

2.3 Testing of Commercial Varieties

2.3.1 Standard Varietal Trial-1

Objective: To test the performance of commercial varieties of Pakistan under the agro-climatic conditions of Multan

Six commercial Non *Bt*. varieties of the country were tested at CCRI, Multan. Data recorded on seed cotton yield and other parameters are presented in **Table 2.24**. The results indicated that variety CIM-620 excelled among all varieties by producing seed cotton yield 2547 kg ha^{-1} followed by the variety CIM-482 with 2367 kg ha^{-1} and CIM-610 with 2331 kg ha^{-1} seed cotton production. Variety CIM-620 had the highest lint percentage of 39.2, followed by varieties CIM-482 having lint percentage of 38.4. The variety Cyto-124 maintained the longest staple of 28.5 mm, followed by the variety the CIM-610 with 28.3 mm staple length.

Table 2.24 Performance of commercial varieties in Standard Varietal Trial-I at CCRI, Multan

Sr. #	Varieties	Year of released	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. Boll wt. (g)	Plant Pop. (ha^{-1})
1	CIM-482	2000	2367	909	38.4	28.2	4.8	28.8	2.7	41785
2	CIM-707	2004	2188	829	37.9	28.0	4.1	29.4	2.6	39633
3	CIM-573	2012	2152	807	37.5	28.3	4.7	26.6	2.5	38736
4	Cyto-124	2015	2295	870	37.9	28.5	4.7	30.0	2.3	36046
5	CIM-620	2016	2547	998	39.2	28.1	4.8	27.4	2.4	39274
6	CIM-610	2018	2331	890	38.2	28.3	4.8	28.2	2.7	39095

Sowing date: 30.05.2018; C.D. (5%) for seed cotton 290.75 CV% = 7.10

Micronaire values of all the varieties were according to the standard. Fibre strength of all the genotypes was in the desirable range.

2.3.2 Standard Varietal Trial-2

Objective: To test the performance of commercial *Bt.* varieties of Pakistan under the agro-climatic conditions of Multan

Twelve *Bt*. commercial varieties of the country were tested at CCRI, Multan. Data recorded on seed cotton yield and other parameters are presented in **Table 2.25**. The results indicated that variety NIAB-1048 excelled among all varieties by producing seed cotton yield of 2501 kg ha^{-1}, followed by the variety RH-662 with 2169 kg ha^{-1} while *Bt*. CIM-600 produced lowest (1375 kg ha^{-1}) seed cotton production. Varieties FH-142 and CIM-632 had the highest lint percentage of 41.4, followed by NIAB-1048 and Sitara-15 (40.9%) while RH-668 had the lowest (34.9%) lint percentage. Staple lengths of all the varieties were above the standard except FH-142, NIAB-1048 and NIAB-545. Micronaire of NIAB-545 and Sahara-150 were above the standard. Fibre strength of all the varieties was above the standard except NIAB-1048.

Table 2.25 Performance of commercial varieties in Standard Varietal Trial-2 at CCRI, Multan

Sr. #	Varieties	Year of release	Seed Cotton Yield (kg ha^{-1})	Lint Yield (kg ha^{-1})	Lint (% age)	Staple length (mm)	Micro-naire value (µg inch^{-1})	Fibre Strength (g/tex)	Av. Boll wt. (g)	Plant Pop. (ha^{-1})
1	CIM-600	2016	1375	529	38.5	28.8	4.3	28.9	2.2	35865
2	CIM-602	2013	1572	599	38.1	29.1	4.0	29.2	2.5	40647
3	CIM-632	2018	1417	587	41.4	29.6	4.8	28.6	2.3	38017
4	FH-142	2013	1579	654	41.4	27.0	4.6	26.2	2.8	40647
5	RH-668	2018	1880	656	34.9	28.3	4.7	27.5	2.3	39930
6	NIAB-1048	2018	2501	1023	40.9	27.5	4.4	25.8	2.3	39930
7	Crystal-12	2018	1937	775	40	28.0	4.7	27.1	2.9	41364
8	Sitara-15	2018	1660	679	40.9	29.1	4.1	28.9	2.7	42560
9	RH-662	2018	2169	863	39.8	28.8	4.6	28.3	2.6	30366
10	FH-152	2018	1503	573	38.1	29.6	4.3	29.5	2.3	43038
11	NIAB-545	2018	1633	658	40.3	27.0	5.0	26.3	3.3	40408
12	Sahara-150	2018	2103	751	35.7	28.8	5.3	26.8	3.4	32757

Sowing date: 23.05.2018 C.D. (5%) for seed cotton=109.64 CV% = 3.64

2.4 Breeding Material

2.4.1 Selection from Breeding Material

Single plant selections were made from the breeding material in different segregating generations for further testing and screening against biotic and a biotic stresses. The detail of breeding material planted and number of plants selected during 2018-19 is given in **Table 2.26**.

Table 2.26 Detail of single plants selected from breeding material

Generation/Trial	No. of plants Selected	Range	
		Lint (%age)	Staple length (mm)
VT	293	37.6 - 44.8	28.6 - 31.7
MVT	411	39.6 - 44.2	28.6 - 31.2
PRT	403	38.5 - 45.2	28.9 - 31.8
F_{6-7} single lines	1025	39.0 - 44.8	29.1 - 31.7
F_5 single lines	1350	38.5 - 45.1	28.1 - 31.5
F_4 generation	1470	37.9 - 44.1	28.0 - 30.2
F_3 generation	2020	38.0-42.5	28.2 - 30.7
F_2 generation	2736	37.9 - 43.3	28.1 - 30.9
Others	1533	37.8-46.2	28.2 - 32.4

2.5 Maintenance of Genetic Stock of World Cotton Collection

2.5.1 Maintenance/Preservation of Cotton Genetic Stock at CCRI Multan

Six thousand one hundred and twenty three genotypes are being maintained at the Cold Room of CCRI Multan for Long (100 years), medium (50 years) and short term (25years). One third of the seed was planted in the field for production of fresh seed as well as to utilize in the hybridization programme. Detail of genetic stock is given in **Table 2.27.** The seed of genetic stock were also supplied, locally and abroad, to different scientists, cotton growers, academia and different institutes/research stations for their research/breeding programs. The detail is given in **Table 2.28.**

Table 2.27 Detail of Genetic Stock of World Cotton Collection

Local genotypes	1190
Exotic genotypes	4933
Total	**6123**
Species-Wise Detail	
Gossypium herbaceum L.	556
Gossypium arboreum L.	1025
Gossypium hirsutum L.	4433
Gossypium barbadence L.	109

Table 2.28 List of scientists/researchers whom received the cotton germplasm 2018-19

Sr. #	Name of Institute / Research Scientists	No. of stock
1	Mr. Bilal Bajwa, Managing Director, South Asian Sourcing Private Limited, Muzaffargarh	05
2	Director, Cotton Research Institute, Old Shujabad Road, Multan.	02
3	Dr. Muhammad Salman, Assistant Professor of PBG, Muhammad Nawaz Shareef University of Agriculture, Multan	25
4	Dr. Muhammad Rashid, Dea F/o Agriculture, Lasbela University (LUAWMS)Uthal/Lasbela, Balochistan	11
5	Dr. Javaid Iqbal, Assistant Professor, Department of Agronomy, Faculty of Agricultural Sciences, Ghazi University, Dera Ghazi Khan.	06
6	Mr. Muhammad Yousaf Memon, Director, Pakistan Atomic Energy Commission, Nuclear Institute of Agriculture (NIA) Tandojam	15
7	Mr. Abdur Reasheed, Director, Supreme Seed International, 149/B, Block-X, Scheme # 2, Gulshan-e-Iqbal, Rahimyar Khan	11
8	Dr. Syed Bilal Hussain, Assistant Professor, Department of Plant Breeding & Genetics Section, Bahauddin Zakariya University, Multan.	195
9	Dr. Khizer Hayat, Scientific Officer, Cytogenetics Section, CCRI Multan	195
10	Dr. Muhammad Iaqbal, Professor/Chairman, Department of Plant Breeding & Genetics, UCA & ES Islamia University, Bahawalpur	25
11	Dr. Muhammad Asif Saleem, Assistant Professor, Department of Plant Breeding & Genetics Section, Bahauddin Zakariya University, Multan.	30
12	Dr. Waqas Shafqat Chattha, Department of Plant Breeding & Genetics, UCA & ES Islamia University, Bahawalpur	42
13	Dr. Muhammad Asif Saleem, Assistant Professor, Department of Plant Breeding & Genetics Section, Bahauddin Zakariya University, Multan.	30
14	Dr. Muhammad Kashif Riaz Khan, Principal Scientist, Nuclear Institute for Agriculture & Biology, Jhang Road, Faisalabad.	20
15	Dr. Waqas Malik, Assistant Professor, Department of Plant Breeding & Genetics Section, Faculty of Agriculture Science and Technology, Bahauddin Zakariya University, Multan.	25
16	Dr. Sobia Chohan, Assistant Professor, Department of Plant Pathology, Bahauddin Zakariya University, Multan.	10
17	Cotton Botanist, Cotton Research Station, Bahawalpur	08
18	Dr Jodi Scheffler ARS USDA, Stoneville Mississippi USA	10

2.5.2 Early Generation Seed production of commercial varieties

Single lines of *Bt.* (*Bt*.CIM-600, *Bt*.CIM-602, *Bt*.CIM-598, *Bt*.CIM-599 & *Bt*.CIM-632) & Non *Bt*. (CIM-620, CIM-554, CIM-496, CIM-610 & CIM-534) approved varieties were sown in the fields. All the agronomic practices were made sure throughout the crop season. Different observations were taken at different stages of the crop for its purity. Families were tagged on the basis of purity and impurity. At the maturity of the crop pure families were finalized and tagged. These families were picked and ginned for further multiplication of pure seed. The detail is given in **Table 2.29**.

Table 2.29 Detail of pre-basic seed produced during 2018-19

Sr. #	Variety	Family No.	Pre-basic seed produced (kg)
1	CIM-496	1263-1276	24
2	CIM-506	1311-1322	12
3	CIM-554	1217-1228	12
4	CIM-573	1169-1192	23
5	*Bt*.CIM-598	1145-1169	24
6	*Bt*.CIM-599	1121-1144	24
7	*Bt*.CIM-602	1073-1120	48
8	*Bt*.CIM-632	3360-3707	48
9	CIM-620	1229-1252	24

2.6 Pak-US ICARDA Cotton Project CCRI Multan Component

2.6.1 Use of USA cotton germplasm for the evolution of CLCV resistant/tolerant varieties.

A total of 20 accessions received this year from USDA were also screened in field condition for CLCuV infestation and other morphological characters. Similarly 164 promising single plants were selected from different generations (F_2 to F_6). Screening of more than 1925 genotypes in field condition and their seed were also preserved in cold Room Chamber. Beside this, maintaining seed of more than 6000 cotton germplasm at Cold Room for short, medium and long term preservation. A total of 76 accessions out of 3277 which were imported during the Pak-US- ICARDA cotton project were found to be resistant against CLCuV. These 76 accessions were ratooned at CCRI Multan from the last 4 years. Out of these 76 accessions flower induction were started in only few accessions in the month of OCTOBER- December 2018 as detailed in Table 2.30. In Set K only one accession USG-618/14 having flowers and bolls formations while in Set N there are four accessions having bud formation but one accession i.e. USG-2131/14 having only one plant which has flower formations. Accession USG-2269/14 having buds as well as flower formation, while USG-2471/14 and USG-2476/14 are having flower formation. All the flowers were analyzed for their pollens fertility and it was found that the pollens of these flowers were unfertile

Table 2.30 Ratoon crop of resistant accessions of 2013-14 having bud and flower formation

Sr. No.	Set No.	Year	No of total Accessions	Resistant accessions	Accessions having buds and flower formation
1	C	2013	200	9	0
2	D	2013	200	25	0
3	K	2014	200	5	1
4	N	2014	600	37	4
		Total	**1200**	**76**	**5**

All these accessions are properly maintained condition for proper buds and flower formation. Efforts were made to get fertile flowers which will be used in our breeding programs.

FARMERS FIELD DAY

CCRI Multan organized Farmers' Field Day on October 16, 2018. Around 300 cotton farmers participated in the program. Dr. Zahid Mahmood, Director CCRI Multan briefed the visiting farmers about the cotton research and development activities carried out by the Institute. Later, the farmers were visited different field experimental fields for observing the field performance of advanced cotton lines developed at the Institute. Farmers showed enthusiasm and greater interest in cotton varieties developed at the Institute and appreciated the role of cotton scientists for evolution of high yielding varieties.

3. CYTOGENETICS

Cytogenetics section is working to combat diverse upcoming biotic and abiotic intimidation. Plant breeding has profoundly impacted agricultural production through the development and deployment of varieties with increased yield and improved agronomic performance. However, intensive selection that accompanies contemporary breeding strategies has also introduced a very high degree of genetic uniformity in the field, making crops vulnerable to emerging challenges. The extensive use of only a few closely related genotypes of cotton, coupled with the widespread adoption of transgenic cultivars, has greatly reduced the genetic base of the crop. This genetic uniformity makes cotton highly vulnerable to emerging biotic and abiotic challenges. Cytogenetic Section is working on creation of novel genetic variation into the gene pool of cultivated cotton that can buffer the crop against agro-environmental challenges brought about by shifts in climate. The main objective of cytogenetic section is transferring auspicious genes of the wild species to the cultivated cotton for commercial exploitation and to study inter and intra-genomic relationships in the genus *Gossypium*. The genus *Gossypium* to which cotton belongs has more than 50 well-established species, only 4 of which are cultivated. Interspecific hybridization to broaden the genetic base of the existing cultivars and development of new cultivar with all desirable traits is an important endeavor in utilizing the abundant genetic variation from the wild cotton relatives.

3.1 Maintenance of *Gossypium* Germplasm

Thirty species of *Gossypium* (cultivated and wild) are being maintained in living herbarium at CCRI, Multan for exploitation in hybridization program. List is given below.

Table. 3.1. List of wild species maintained at CCRI, Multan during 2018-2019

Sr. No	Species Name	Genome	Habit
1.	*G. hirsutum*	2AD1	Cultivated
2.	*G. barbadense*	2AD2	Cultivated
3.	*G. tomentosum*	2AD3	Wild
4.	*G. mustelinum*	2AD4	Wild
5.	*G. darwinii*	2AD5	Wild
6.	*G. herbaceum*	A1	Cultivated
7.	*G. arboreum*	A2	Cultivated
8.	*G. anomalum*	B1	Wild
9.	*G. capitis-viridis*	B4	Wild
10.	*G. sturtianum*	C1	Wild
11.	*G. nandewarense*	C1-n	Wild
12.	*G. thurberi*	D1	Wild
13.	*G. harknessii*	D2-2	Wild
14.	*G. davidsonii*	D3-d	Wild
15.	*G. klotzschianum*	D3-k	Wild
16.	*G. aridum*	D4	Wild
17.	*G. raimondii*	D5	Wild
18.	*G. gossypioides*	D6	Wild
19.	*G. lobatum*	D7	Wild
20.	*G. trilobum*	D9	Wild
21.	*G. laxum*	D8	Wild
22.	*G. stocksii*	E1	Wild
23.	*G. somalense*	E2	Wild
24.	*G. areysianum*	E3	Wild
25.	*G. incanum*	E4	Wild
26.	*G. longicalyx*	F1	Wild
27.	*G. bickii*	G1	Wild
28.	*G. australe*	G2	Wild
29.	*G. nelsonii*	G3	Wild
30.	*G. lenceolatum*	2AD?	Wild

In addition; twenty five interspecific hybrids (five diploid, six triploid, five tetraploid, two pentaploids and four hexaploid interspecific hybrids) and 3 tri species combinations are also maintained (Table 3.2).

Table.3.2. List of Interspecific hybrids maintained at CCRI, Multan.

Sr. No	Interspecific Hybrids	No
1	Diploid hybrids	5
2	Triploid	6
3	Tetraploid	5
4	Pentaploid	2
5	Hexaploid	4
6	Tri-species combinations	3
Total		**25**

3.1. A. Maintenance of *Gossypium* Germplasm

Through Seed

For the strengthening of *Gossypium* species in living herbarium at CCRI, Multan seeds of twenty-three wild species were germinated in an incubator at 28 ± 2ºC and then shifted in earthen pots in glass house. List of species is given in Table-3.3.

Table 3.3. List of wild species planted in glass house through seed

Sr. No.	Name of Species	No. of seeds planted	No. of seeds germinated
1	*G. anomalum*	5	2
2	*G. capitis-viridis*	7	2
3	*G. sturtianum*	5	3
4	*G. nandewarense*	9	5
5	*G. thurberi*	11	4
6	*G. harknessii*	12	2
7	*G. davidsonii*	7	3
8	*G. klotzschianum*	9	4
9	*G. aridum*	12	5
10	*G. raimondii*	13	2
11	*G. gossypioides*	15	4
12	*G. lobatum*	22	7
13	*G. trilobum*	7	2
14	*G. laxum*	9	2
15	*G. stocksii*	11	6
16	*G. somalense*	14	4
17	*G. areysianum*	24	7
18	*G. incanum*	7	2
19	*G. longicalyx*	9	2
20	*G. bickii*	12	5
21	*G. australe*	17	8
22	*G. herbaceum* (Red)	14	4
23	*G. herbaceum* (Green)	10	6
	Total	**261**	**91**

Fig. 3.1. Germplasm maintanence through seed

3.1. B. Maintenance of *Gossypium* Germplasm

Through Approach Grafting

Approach grafting has been utilized to maintain the already existing wild species. The detail is given below (Table 3.4).

Table 3.4. List of wild Species maintained through approach grafting

Sr. No.	Name of species	No. of grafts
1	*G. somalense*	3
2	*G. incanum*	4
3	*G. tomentosum*	5
4	*G. bickii*	4
5	*G. nelsonii*	2
6	*G. anomalum*	5
7	*G. capitis viridis*	4
8	*G. longicalyx*	3
9	*G. thurberi*	2
10	*G. harknessii*	3
11	*G. klotzschianum*	3
12	*G. aridum*	4
13	*G. gossypioides*	5
14	*G. lobatum*	3
Total		**50**

Fig. 3.2 Germplasm maintanence through approach grafting

3.1. C. Maintenance of *Gossypium* Germplasm

Through Cutting

Cuttings of wild species and interspecific hybrids were planted in earthen pots in glass house to maintain the precious material. The detail is given in below.

Table 3.5. List of species /hybrids maintained through cuttings

Sr. No.	Name of species	No. of Cuttings
1	*G.somalense*	12
2	*G.incanum*	11
3	*G.tomentosum*	13
4	*G.anomalum*	9
5	*G. harknessii*	10
6	*G. klotzschianum*	7
7	*G. aridum*	9
8	*G. gossypioides*	11
9	2(*G. hirsutum* x *G. bickii*) (6n)	9
10	*2(G.hirsutum* x *G.anomalum)* x *G.hirsutum* (5n)	14
11	2(*G.hirsutum* x *G.anomalum*) x *G.barbadense*(5n)	6
12	2(*G.arbo.* x *G.anomulum*) x *G.hirsutum* (4n)	5
13	2(*G.arbo.x G. stocksii*) x *G. hirsutum* (4n)	9
14	*G.hirsutum* x *G.stocksii (4n)*	4
15	*G.hirsutum (red)* x *G.harknessii* (3n)	9
16	*G.hirsutum* x *G.harknessii* (3n)	5
17	*G.hirsutum* x *G.aridum*(3n)	7
18	*(G.arboreum* x *G.thurberii*) x *G.hirsutum*(3n)	9
19	*G.arborerum* x *G.anomalum* (2n)	11
20	*G. arboreum* x *G.australe* (2n)	12
21	*G.arboreum* x *G.herbeceum* (2n)	9
	Total	**191**

Fig.3.3 Germpalsm maintenance through cutting

3.2 Hybridization

A hybridization program was conducted to develop new breeding material with superior characteristic to combat biotic and abiotic stresses. Meanwhile a parallel breeding program was conducted focusing only on extra-long staple, different cross combinations were attempted with the parent lines having extra staple length. Special importance was also given to Non. *Bt* material and maximum parentage were utilized for the development of Non. *Bt* hybrids. A comprehensive *Bt* program was utilized to develop high yielding, early maturing, drought tolerant and good fiber quality for better adoption in changing climatic scenario. Total 7147 pollinations were attempted in 82 combinations.
The detail of hybridization is given in Table 3.6.

Table 3.6. Detail of Hybridization Program conducted during 2018-2019

Sr. No	C. No.	Parentage	No. of pollinations
1.	1	Cyto-516 x cyto-510	72
2.	2	Cyto-516 x cyto-511	69
3.	3	Cyto-516 x cyto-515	72
4.	4	Cyto-516 x C-13	69
5.	5	Cyto-516 x C-19	83
6.	6	cyto-511 x cyto-178	40
7.	7	cyto-511 x cyto-179	40
8.	8	cyto-179 x Cyto-516	42
9.	9	cyto-179 x CIM-303	35
10.	10	cyto-179 x CIM-638	35
11.	11	cyto-124 x CRIS-129	106
12.	12	CRIS-533 x cyto-124	33
13.	13	CRIS-121 x cyto-124	32
14.	14	CRIS-129 x cyto-124	25
15.	M-21	Cyto-516 x FH-490	13
16.	M-22	Cyto-516 x 1016	197
17.	M-23	Cyto-516 x 1020	67
18.	M-24	Cyto-516 x BS-20	73
19.	M-25	Cyto-516 x Cyto-561	51
20.	M-26	Cyto-516 x Cyto-124	58
21.	M-27	CRI-129 x NIAB-878	77
22.	M-28	CRIS-121 X NIAB-878	89
23.	M-29	CRIS-533 X NIAB-878	59
24.	M-30	P2 X P1	213
25.	M-31	P3 X P1	179
26.	M-32	SL-369 X SL-553	76
27.	M-33	Cyto-516 x CIM-343	93
28.	M-34	Cyto-516 x SL-555	47
29.	M-35	Cyto-516 x SL-369	58
30.	M-36	Cyto-124 x NIAB-878	36
31.	M-37	SL-369 X SL555 (A)	159
32.	M-38	Cyto-516 x 60-6/18	115
33.	M-39	SL-369 X FH-490	11
34.	M-40	(*G. hirsutum x G. stocksii*) x Cyto-516	51
35.	41	YB-165 X C-13	15
36.	42	YB-165 X Cyto-516	39
37.	43	YB-165 X C-15	17
38.	44	YB-65 X C-13	9
39.	45	YB-65 X FH-490	11
40.	46	YB-65 X Cyto-516	46
41.	47	YB-42 X Cyto-516	19
42.	48	YB-42 X FH-490	7
43.	49	YB-42 X Cyto-516	11

Sr. No	C. No.	Parentage	No. of pollinations
44.	50	YB-247 X Cyto-516	27
45.	51	YB-247 X C-13	9
46.	52	YB-247 X FH-490	5
47.	59	Cyto-516 X Elite Line	89
48.	60	Cyto-177 X FH-490	9
49.	61	Cyto-161 x SL-65	187
50.	62	Cyto-161 x SL-35	76
51.	63	Cyto-161 x CIM-707	178
52.	64	Cyto-124 x SL-65	134
53.	65	Cyto-124 x SL-35	154
54.	66	Cyto-161 x Cyto-225	237
55.	67	Cyto-161 x CIM-608	173
56.	68	Cyto-161 x Cyto-124	136
57.	69	Cyto-510 x CIM-303	150
58.	70	Cyto-177 x CIM-663	187
59.	71	Cyto-177 x CIM-789	135
60.	72	Cyto-178 x C-17(515)	123
61.	73	Cyto-511 x Cyto-177	112
62.	75	Cyto- 511 x Cyto-515	117
63.	76	Cyto-313 x CIM-303	153
64.	77	Cyto-516 x Cyto-179	75
65.	78	Cyto-178 x Cyto-516	239
66.	79	Cyto-516 x IUB-18	178
67.	80	Cyto-124 x Cyto-225	178
68.	81	Cyto-313 x C-9	101
69.	83	Cyto-177 x Cyto-516	176
70.	85	Cyto-313x Cyto-516	116
71.	86	Cyto-313x CIM-663	172
72.	87	Cyto-510 x 103-6/18	187
73.	88	Cyto179 x CIM-343	117
74.	89	Cyto-179 x (K.H)	13
75.	90	Cyto-179 x C-9	57
76.	91	YB-35 X Cyto-516	24
77.	92	YB-35 X C-13	11
78.	93	YB-35 X FH-490	5
79.	94	Cyto-515 X Cyto-516	177
80.	95	Cyto-515 X FH-490	19
81.	96	Cyto-516 x C9	139
82.	97	Cyto-177 x C-9	123
		Total	**7147**

Total 7147 pollinations were attempted in 82 combinations. The boll setting was achieved in majority of combinations whereas in few interspecific combinations; crossed bolls were retained but seeds were not formed in them and it could be either due to incompatibility among different species or sterility barriers existing at pre and post fertilization stages of hybridization. The hormones viz., Gibberellic acid (GA) and Nephthalene acetic acid (NAA) were exogenously applied at the rates of 50 and 100 mg L^{-1} water, respectively after 24 hours of pollination. The application continued till 72 hours to retain the crossed bolls.

3.3 Chromosomal Studies

A. *G. Stocksii* x *G. hirsutum*.tetraploid was back crossed with *G. hirsutum* and the resulted plants were grown in permanent herbarium block. Chromosomal studies were carried out. Buds were fixed in Carnoy's solution and preserved in 70% alcohol. Chromosomes were counted at Metaphase-1. The results are given below.

Table. 3.7: Chromosomal configurations

PMC No.	I's	II's	III's	IV's	Total	Remarks
3	-	26	-	-	52	Plant was fertile
4	-	26	-	-	52	
Ave.	-	26	-	-	52	

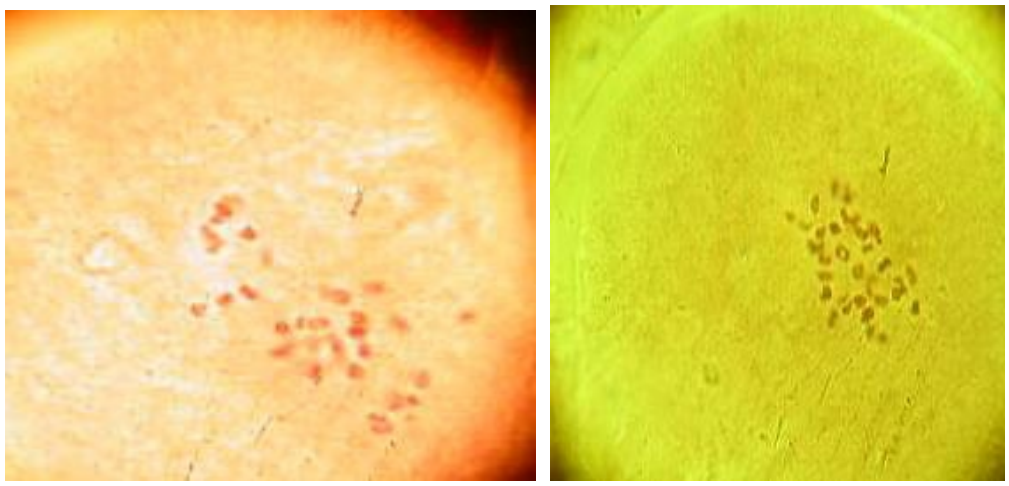


Fig.3. 4. The chromosomal configuration for the above combination at Metaphase-1

B. Buds of *G.arboreum* plant treated with 0.02% colchicine for 24 hours were checked but the plant was still diploid (Fig-5). Buds were fixed in Carnoy's solution, preserved in 70% ethanol and studied at metaphase-1.

Table. 3.8: Chromosomal configurations of *G.arboreum*

PMC No.	I's	II's	III's	IV's	Total	Remarks
1	-	13	-	-	26	Plant was fertile but no effect of cholchicine treatment
2	-	13	-	-	26	
Ave.						

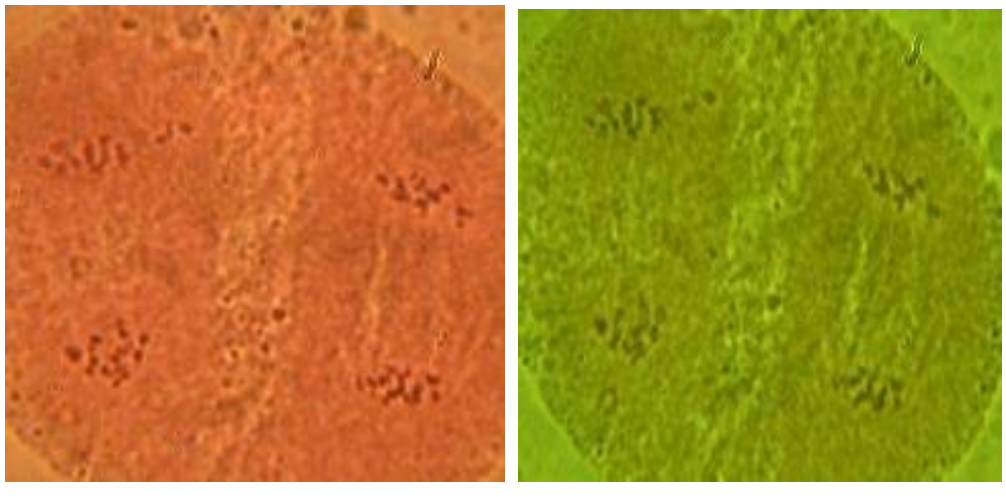


Fig-3.5. Late anaphase of *G.arboreum* going towards sporad formation

3.4. Performance of Filial Generations 2018-19

Single plants with CLCuV Tolerence, good yield and fibre quality traits were selected from the breeding material during 2018-19. The detail of each filial generation is as follows

Table 3.9 Detail of single plants selected from breeding material

Filial Generation	No of Plant Selected	Yield Plant $^{-1}$ (g)	GOT (%)	Staple Length (mm)	Uni. Index	Mic (µgich^{-2})	Fibre Strength
		Range					
F_1	184	90.4-215.5	39.2-40.3	28.7-29.7	78.9-82.9	4.2-4.9	29.9-32.4
F_2	425	45.8-230.1	37.0-44.6	28.0-32.5	82.1-84.5	4.0-4.8	28.5-30.7
F_3	939	55.1-243.9	36.9-40.7	28.3-32.3	82.1-84.8	3.5-4.2	29.6-31.4
F_4	424	44.6-203.0	38.8-42.3	27.7-32.5	84.2-85.5	4.1-4.7	25.8-30.3
F_5	534	46.9-224.2	38.0-42.4	28.5-32.5	83.0-85.3	4.1-4.9	27.8-28.6
F_6	126	75.4-209.8	39.7-40.8	30.0-34.7	82.5-85.2	3.9-4.7	27.3-31.9

3.5 Search for aneuploids/ haploids

In the nature, there is spontaneous occurrence of aneuploids and haploids in *G. hirsutum.* Therefore, efforts continued for search for monosomes to identify individual chromosomes and haploids to make homozygous lines in cotton.

Eight obviously abnormal plants were observed in different field of interspecific Cyto breeding material. Only one plant was hexaploid. One plant was normal diploid and remaining plants were tetraploid. All normal tetraploid plants were transplanted in permanent block for crossing purpose. The studies on morphology and cytology of these abnormal plants during the season were carried out.

3.6 Progeny Row Trial-1

Objective: Testing of promising progenies for long staple length.

Eight single plants possessing good fibre traits were selected from F_6 generation and planted in replicated progeny row trial along with one standard FH-142 during crop season 2018-19. The detail is given in Table 3.10.

Data showed that maximum seed cotton yield was produced by progeny-6 (3249 kg ha^{-1}) followed by progeny-4 (3109 kg ha^{-1}) in contrast to standard FH-142 (2986 kg ha^{-1}). Maximum ginning outturn (G.O.T %) produced by progeny-2 (38.9%) followed by progeny 1 (38.6%) as compared with FH-142 (38.7%).

The progeny-1 produced longest fibre (33.5 mm) followed by progeny-2 (32.8 mm) compared with FH-142 (27.8mm). All the progenies have desirable micronaire values ranging from 3.7 to 4.4 µg inch^{-2}. The maximum fibre strength (34.9 g/tex) produced by progeny-2 compared with 29.1 g/tex of standard FH-142.

Table 3.10 Performance of long staple progenies at CCRI, Multan during 2018-19.

Progeny	Yield kg ha^{-1}	GOT %	Staple length (mm)	Micronaire (µg inch^{-2})	Uniformity index %	Fibre strength (g/tex)
PRT-1	2511	38.6	33.5	3.7	85.9	34.7
PRT-2	2817	38.9	32.8	4.4	86.1	34.9
PRT-3	2272	38.4	30.7	4.0	83.2	33.1
PRT-4	3109	38.2	31.9	3.9	84.3	34.9
PRT-5	2870	35.7	31.8	4.3	83.7	33.8
PRT-6	3249	37.0	30.0	4.3	81.9	31.4
PRT-7	2996	38.3	30.7	4.0	83.9	32.9
PRT-8	2359	38.0	32.4	4.3	85.7	35.1
FH-142 (Std)	2986	38.7	27.8	4.6	82.2	29.1

3.7 Performance of New Cyto-strains in Micro Trials

3.7.1. Micro Varietal Trial-1

Objective: Testing of virus tolerant material for economic and fibre quality traits

Six *Bt*. strains having tolerance against cotton leaf curl virus (CLCuD) viz., MV1, MV2, MV3, MV4, MV5 and MV6 were tested in replicated micro-varietal trial on plot size 15' x 12.5' along with Cyto-179 as standard. The performance of this material is given in Table 3.11.

Table 3.11 Performance of Cyto-strains in Micro Varietal Trial -1 during 2018-19

Strain	Yield (kg ha^{-1})	Plant Population (ha^{-1})	Boll weight (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg/inch^{-2})	Strength g/tex
MV-1	3935	42469	3.2	38.0	30.0	4.2	32.0
MV-2	3670	43233	2.6	38.3	30.0	4.0	30.6
MV-3	3095	42851	2.9	40.6	28.6	4.5	30.0
MV-4	2785	42469	2.5	42.6	28.6	4.2	30.0
MV-5	4363	45529	3.1	38.0	28.3	4.1	30.0
MV-6	3202	42277	3.3	38.0	30.3	4.5	31.0
Cyto-179	3665	44572	3.4	38.3	25.6	4.3	26.0

Table 3.11 showed that maximum seed cotton yield was produced by VM-5 (4363 kg ha^{-1}) followed by MV-1 (3935 kg ha^{-1}) and MV-2 (3670 kg ha^{-1}) compared with standard Cyto-179 (3665 kg ha^{-1}). The line MV-4 (42.6%) found to have highest lint% followed by MV-3 (40.6%) compared with standard Cyto-179 (38.3%).

The line V-6 produced the medium long staple of 30.3 mm followed by MV-1 & MV-2 (30.0 mm) compared with 25.6 mm of Cyto-179. All the strains have desirable micronaire values ranging from 4.0 to 4.5µg inch^{-2}. The maximum fibre strength (32.0g/tex) produced in MV-1 (32.0 g/tex) followed by MV-6 (31.0 g/tex) compared with 26.0 g/tex of standard Cyto-179, respectively.

3.7.2. Micro Varietal Trial-2

Objective: Testing of newly bulked long staple strains against commercial varieties

Six *Bt*. strains viz., V7, V8, V9, V10, V11 & V12 were tested in replicated micro-varietal trial on plot size 15' ×12.5' along with Cyto-179 as standard varieties. The performance of this material is given in Table 3.12.

Data presented in Table 3.14 exhibited that maximum seed cotton yield was produced by MV-12 (3711 kg ha^{-1}) followed by MV-7 (3575 kg ha^{-1}) compared with standard Cyto-179 (3405 kg ha^{-1}). MV-10 (39.7%) Maximum lint % produced followed by MV-7 (39.6%) compared with standard Cyto-179 (37.5%).

The strain MV-8 produced longest staple (30.6 mm) followed by MV-11 (30.3 mm) compared with Cyto-179 (24.5 mm). All the strains have desirable micronaire values ranging from 4.3 to 4.9 mg inch^{-2}. The maximum fibre strength (31.5 g/tex) produced by MV-8 followed by MV-11 (31.3 g/tex) and MV-12(31.0 g/tex) compared with 25.5 g/tex of standard Cyto-179.

Table 3.12 Performance of advanced strains in Micro Varietal Trial-2 during 2017-18

Strain	Yield (kg ha^{-1})	Plant population (ha^{-1})	Boll wt. (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg inch^{-2})	Strength g tex^{-1}
MV-7	3575	41512	3.1	39.6	29.5	4.4	30.5
MV-8	2639	43042	3.1	37.6	30.6	4.3	31.5
MV-9	2946	42851	2.9	37.5	29.6	4.4	30.8
MV-10	2678	43042	2.9	39.7	28.3	4.4	30.2
MV-11	2735	43807	2.7	38.0	30.3	4.7	31.3
MV-12	3711	43233	3.1	38.3	29.5	4.9	31.0
Cyto-179	3405	45146	3.4	37.5	24.5	4.4	25.5

3.7.3. Micro Varietal Trial-3

Objective: Testing of newly bulked long staple strains against commercial varieties

Eight new Bt strains having tolerance against cotton leaf curl virus CLCuD viz., MV-13, MV-14, MV-15, MV-16, MV-17, MV-18, MV-19 & MV-20 were tested in replicated micro-varietal trial on plot size 30' ×12.5' alongwith FH-142 as standard variety. The performance of this material is given in Table 3.13.

Data presented in Table-3.14 exhibited that maximum seed cotton yield was produced by MV-14 (3776 kg ha^{-1}) followed by MV-15 (3224 kg ha^{-1}) compared with standard FH-142 (3053 kg ha^{-1}). Maximum lint % produced by MV-15 (42.6%) followed by MV-17 (40.9%) and MV-13 (40.8%) compared with standard FH-142 (38.9%)

Table 3.13 Performance of Cyto-strains in Micro Varietal Trial -3 during 2018-19

Strain	Yield (kg ha^{-1})	Plant Population (ha^{-1})	Boll weight (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg/inch)	Strength (g tex^{-1})
MV-13	3036	40906	2.2	40.8	28.9	4.3	30.1
MV-14	3776	41977	2.6	40.0	28.8	4.2	30.1
MV-15	3224	40902	2.3	42.6	27.7	4.3	29.0
MV-16	3023	41081	2.4	40.4	29.2	4.2	31.2
MV-17	2988	42167	2.7	40.9	28.4	4.4	29.6
MV-18	3126	41759	2.1	39.7	29.1	4.4	31.1
MV-19	2989	41318	2.4	39.8	29.6	4.8	30.8
MV-20	3096	40960	2.1	38.4	28.5	4.3	29.5
FH-142	3053	41619	2.8	38.9	26.5	4.5	28.4

The strains MV-19 produced the longest staple length of 29.6mm, followed by 29.2 mm of MV-16 compared with 26.5 mm of FH-142. All the strains have desirable micronaire values ranging from 4.2 to 4.8 µg $inch^{-1}$. The maximum fibre strength (31.2 g/tex) produced by MV-16 followed by MV-18 (31.1 g/tex) and MV-19 (30.8 g/tex) compared with 28.4 g/tex of standards FH-142.

3.7.4. Micro Varietal Trial-4

Objective: Testing of newly bulked long staple strains against commercial varieties

Five new *Bt* strains having tolerance against cotton leaf curl virus (CLCuD) viz., MV-21 to MV-25 were tested along with Cyto-179 standard. The performance of this material is given in Table 3.14.

Data presented in Table-3.15 showed that maximum seed cotton yield was produced by MV-24 (4303 kg ha^{-1}) followed by MV-21 (3945 kg ha^{-1}) compared with standard Cyto-179 (4016 kg ha^{-1}). Maximum boll weight (4.2 g) was produced by MV-23 followed by MV-21 (3.5 g) compared with 3.2 g of standard Cyto-179. Maximum lint % produced by MV-24 (41.2%) followed by MV-22 (40.0%) compared with standard Cyto-179 (39.9%).

Table 3.14 Performance of Cyto-strains in Micro Varietal Trial 4 during 2018-19

Strain	Yield (kg ha^{-1})	Plant Population (ha^{-1})	Boll weight (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg/$inch^{-2}$)	Strength g/tex
MV-21	3945	47341	3.5	38.3	29.6	4.4	31.7
MV-22	3658	44471	3.5	40.0	27.4	4.1	28.8
MV-23	3586	47341	4.2	38.0	27.4	4.0	28.8
MV-24	4303	45189	3.1	41.2	30.0	4.7	30.8
MV-25	3442	43037	3.2	39.1	30.5	4.3	31.7
Cyto-179	4016	45189	3.2	39.9	26.4	4.5	25.5

The strains MV-25 and MV-24 produced the longest staple length of 30.5 and 30.0mm, followed by 29.6 mm of MV-21 compared with 26.4 mm of Cyto-179. All the strains have desirable micronaire values ranging from 4.0 to 4.7 µg $inch^{-2}$. The maximum fibre strength (31.7 g/tex) produced by MV-21 & MV-25 followed by MV-24 (30.8 g/tex) compared with 25.5 g/tex of Cyto-179 respectively.

TRAINING PROGRAM FOR AGRICULTURE RESEARCH & EXTENSION OFFICIALS FROM KHYBER PAKHTUNKHWA AND BALOCHISTAN (FEBRUARY 12-13, 2019)

CCRI Multan organized 2-days training program on Cotton Production Technology for the Agriculture Extension and Research officials from Khyber Pakhtunkhwa and Balochistan provinces from February 12-13, 2019. A total of 13 trainees (6 from KPK and 7 from Balochistan) attended the program. Lectures were delivered on profitable agronomic practices, varietal development, nutrient management, insect pests & disease management, fibre testing, and ways and means for technology transfer to the growers. Moreover, implements used in cotton production system including mechanical cotton picker were also introduced to the trainees.

3.8 Performance of New Cyto-strains in Varietal Trials

3.8.1. Varietal Trial-1

Objective: Testing of new advance Bt strains against commercial varieties

Five CLCuD tolerant *Bt*. strains viz., Cyto-510, Cyto-511, Cyto-516, Cyto-555 and Cyto-561 were tested in replicated varietal trial along with Cyto-179 as standard. The performance of this material is given in Table 3.15.

Data presented in Table 3.15 exhibited that maximum seed cotton yield was produced by Cyto-516 (4590 kg ha^{-1}) followed by Cyto-555 (4411 kg ha^{-1}) and Cyto-511 (3873 kg ha^{-1}) compared with standard Cyto-179 (3658 kg ha^{-1}). Maximum lint % produced by Cyto-555 (41.5%) and Cyto-516 (40.3%) compared with Cyto-179 (39.2%).

Table 3.15 Performance of Cyto-strains in VT-1during 2018-19

Strain	Yield (kg ha^{-1})	Plant population (ha^{-1})	Boll wt. (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg $inch^{-2}$)	Strength g tex^{-1}
Cyto-510	3765	40016	3.1	36.9	28.0	4.9	25.5
Cyto-511	3873	40733	3.6	36.3	28.5	4.7	26.4
Cyto-516	4590	43395	4.1	40.3	28.2	4.3	29.5
Cyto-555	4411	41602	3.7	41.5	28.0	3.7	29.0
Cyto-561	2976	43037	3.4	36.7	27.5	4.6	29.0
Cyto-179	3658	42319	2.9	39.2	26.8	4.5	26.1

The strain Cyto-511 produced the medium long staple of 28.5mm followed by 28.2 mm of Cyto-516 compared with Cyto-179 (26.8 mm). All the strains have desirable micronaire values ranging from 3.7 to 4.9µg $inch^{-1}$. The maximum fibre strength (29.5 g/tex) produced by Cyto-516 followed by Cyto-555 (29.0 g/tex) compared with 26.1 g/tex of standards Cyto-179.

3.8.2 Varietal Trial-2

Objective: Testing of new advance *Bt* strains against commercial varieties

Seven CLCuD tolerant *Bt* strains viz., Cyto-534, Cyto-535, Cyto-536, Cyto-537, Cyto-541, Cyto-542 and Cyto-543 were screened in replicated varietal trial on plot size 30' ×10' alongwith Cyto-179 and FH-142 as standard varieties. The performance of this material is given in Table 3.16.

Data showed that maximum seed cotton yield was produced by Cyto-542 (3492 kg ha^{-1}) followed by Cyto-541 (3466 kg ha^{-1}) and Cyto-543 (3294 kg ha^{-1}) compared with standards Cyto-179 (3284 kg ha^{-1}) and FH-142 (2780 kg ha^{-1}). Maximum lint % was produced by Cyto-542 (40.9%) followed by Cyto-543 (39.9%) compared with standards Cyto-179 (39.1%) and FH-142 (39.4%).

Table 3.16 Performance of Cyto-strains in VT-2 during 2018-19

Strain	Yield (kg ha^{-1})	Plant population(ha^{-1})	Boll wt. (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg $inch^{-2}$)	Strength g tex^{-1}
Cyto-534	2936	39812	2.5	37.8	28.2	4.6	29.5
Cyto-535	2093	40961	2.4	37.4	28.3	3.8	30.2
Cyto-536	3146	41738	2.6	36.8	27.0	4.4	28.7
Cyto-537	2908	40676	2.2	39.1	27.8	4.7	28.9
Cyto-541	3466	41669	2.7	39.0	28.6	4.0	30.7
Cyto-542	3492	40831	2.8	40.9	28.2	4.4	29.6
Cyto-543	3294	39164	2.1	39.9	28.1	4.3	28.3
Cyto-179 (Std.)	3284	39916	3.0	39.1	25.2	4.4	26.5
FH-142 (Std.)	2780	40180	2.9	39.4	27.7	4.8	29.8

Cyto-541 produced longest staple of 28.6 mm followed by Cyto-535 (28.3 mm) compared with Cyto-179 (25.2 mm) and FH-142 (27.7mm). All the strains have desirable micronaire values ranging from 3.8 to 4.7 mg $inch^{-1}$. The maximum fibre strength (30.7 g/tex) produced by Cyto-541 followed by Cyto-535 and Cyto-542 (30.2 & 29.6 g/tex) respectively compared with 26.5 g/tex of standards Cyto-179 and 29.8 g/tex of FH-142.

3.8.3 Varietal Trial-3

Objective: Testing and evaluation of promising medium long staple CLCuD tolerant strains for the development of commercial varieties

Six CLCuD tolerant *Bt* strains viz., V1, V2, V3, V4, V5 & V6 were screened in replicated varietal trial having the plot size 35' ×10' along with Cyto-179 as standard variety. The performance of this material is given in Table 3.17.

Data showed that maximum seed cotton yield was produced by V-5 (2648 kg ha^{-1}) followed by V-4 (2581 kg ha^{-1}) and V-1 (2526 kg ha^{-1}) compared with standards Cyto-179 (2498 kg ha^{-1}). Maximum lint % was produced by V3 (40.1%) followed by V5 (39.5%) compared with standards Cyto-179 (36.7%).

Table 3.17. Performance of Cyto-strains in VT-3 during 2018-19

Strain	Yield (kg ha^{-1})	Plant population (ha^{-1})	Boll wt. (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg inch^{-1})	Strength g tex^{-1}
V-1	2526	38745	2.3	37.5	31.0	4.3	32.0
V-2	2476	38257	3.4	37.5	31.5	4.6	31.5
V-3	2503	42275	2.5	40.1	30.5	4.6	31.0
V-4	2581	40553	2.6	38.5	31.5	4.5	32.1
V-5	2648	38257	2.6	39.5	31.0	4.5	31.3
V-6	2476	37396	3.1	37.5	28.5	4.4	30.0
Cyto-179	2498	41500	3.4	36.7	25.2	4.3	26.5

The strain V2 & V4 produced longest staple of 31.5 mm followed by V1 & V5 (31.0 mm) compared with Cyto-179 (25.2 mm). All the strains have desirable micronaire values ranging from 4.3 to 4.6 mg inch^{-1}. The maximum fibre strength (32.1 g/tex) produced by V4 followed by V2 and V5 (31.5 g/tex, 31.3 g/tex) compared with Cyto-179 of 26.5 g/tex.

3.8.4 Varietal Trial-4

Objective: Testing of new advance Non-*Bt* strains against commercial varieties

Four CLCuD tolerant non-*Bt* strains viz., Cyto-122, Cyto-124, Cyto-161, Cyto-164 and Cyto-22 were tested in along with Cyto-124 and CIM-608 as standard varieties. The performance of this material is given in Table 3.18.

Data showed that maximum seed cotton yield was produced by Cyto-225 (2648 kg ha^{-1}) followed by Cyto-122 (2526 kg ha^{-1}) and Cyto-161 (2503 kg ha^{-1}) compared with standards Cyto-124 (2476 kg ha^{-1}) and CIM-608 (2498 kg ha^{-1}). Maximum lint % was produced by Cyto-161 (41.9%) followed by Cyto-164 (40.2%) compared with standards Cyto-124 (39.1%) and CIM-608 (36.0%).

Table 3.18. Performance of Cyto-strains in VT-4 during 2018-19

Strain	Yield (kg ha^{-1})	Plant population (ha^{-1})	Boll wt. (g)	Lint (%)	Fiber Length (mm)	Micronaire (µg inch^{-2})	Strength g tex^{-1}
Cyto-122	2526	38745	2.6	36.9	32.6	4.4	31.3
Cyto-124	2476	38257	2.6	39.1	29.0	4.5	31.3
Cyto-161	2503	42275	2.6	41.9	29.8	4.3	31.7
Cyto-164	2581	40553	2.6	40.2	29.6	4.3	31.3
Cyto-225	2648	38257	2.7	36.9	29.8	4.6	31.0
CIM-608	2498	41500	2.5	36.0	29.5	4.4	31.1

The strain Cyto-122 produced longest staple of 32.6 mm followed by Cyto-161 (29.8 mm) compared with Cyto-124 (29.0 mm) and CIM-608 (29.5mm). All the strains have desirable micronaire values ranging from 4.3 to 4.6 mg inch^{-1}. The maximum fibre strength (31.7 g/tex) produced by Cyto-161 followed by Cyto-164 (31.3 g/tex) compared with 31.3 g/tex of standards Cyto-124 and 31.1 g/tex of CIM-608.

3.9. Mapping population development for CLCuV resistance

Objectives: Development of mapping population for Fiber Quality

Contrasting parents were sown for the development of mapping population. Agronomic and plant protection measures were applied. Hybridization was conducted, and mature bolls were picked. The F1 was grown in glasshouse for generation multiplication.

Fig.3. 6: Mapping Population development

Fig.3.7: DNA extraction

DNA isolation and quantification:

DNA extraction was performed from young leaves of wild species using CTAB according to (Zhang & Stewart, 2000). DNA quantification was checked using 1% gel electrophoresis.

VISIT OF CHINESE DELEGATION

Mr. Xu Zhiyong, Director of Foreign Linkages "China Farm Good Seed", Hubei, P.R. China along with other delegates including Prof. Dr. Shafqat Saeed, Dean, FAS, MNSUA Multan, Dr. Tassawar Hussain Malik, Director Research PCCC and Mr. Shafiq ur Rahman, Kissan Seed Corporation visiting laboratories, meteorological observatory, cold room and cotton fields at the Institute.

4. ENTOMOLOGY

Studies conducted on various aspects in field and laboratory conditions included 1) sowing date impact on the development of pink bollworm, 2) surveys of cotton growing areas for pink bollworm infestation, 3) monitoring of lepidopterous pests with sex pheromone and light traps, 4) host plant tolerance of CCRI, Multan strains against sucking insect pests 5) National Coordinated Varietal Trials on *Bt.*& non-*Bt.* strains and 6) monitoring of insecticide resistance in cotton pests. Mass rearing of pink bollworm on semi-synthetic diet and maintaining the stocks of natural enemies of insect pests of cotton for usage in lab. and field releases were continued. Internship facilities` were provided to students of various Universities.

The section actively participated in training programmes, organized by the Institute for the farmers and staff of Agriculture Extension and Pest Warning & Quality Control (PW&QC) Department and pesticide companies. Scientists also recorded IPM programs for broadcasting on electronic media.

4.1 Studies on Pink Bollworm

4.1.1 Impact of sowing time on PBW infestation

The trial was conducted to assess the level of pink bollworm infestation at different sowing dates. To evaluate three sowing dates, the Set-1 (Early-March) was planted on 6th March, Set-II (Early-April) on 1st April and Set-III (Early-May) on 4th May. Three Bt varieties (Cyto-179, CIM-632 &CIM-602) and two non Bt varieties (CIM-717 & CIM-620) were sown in RCBD with three replicates.

Prevalence of PBW infestation and live larvae in Set-I and Set-II was detected in August and in Set-III during September. Generally, infestation and live larval percentage was higher in October and lower in August. Moreover, Set-I was severely infested with PBW during the study period as compared to other sets **(Fig. 4.1).**

Table-4.1 Seasonal average of pink bollworm damage and live larvae in Bt and non Bt cotton varieties at different sowing dates

	Set I	Set II	Set III	Avr	Set I	Set II	Set III	Avr
Cyto-179	10.3	2.9	3.0	5.4	5.2	2.5	2.4	3.4
CIM-602	17.8	4.6	3.8	8.7	14.9	4.2	3.2	7.4
CIM-632	10.0	3.3	5.0	6.1	5.2	3.3	6.5	5.0
CIM-717 (Non Bt)	17.8	6.1	1.7	8.5	9.5	5.5	2.9	6.0
CIM-620 (Non Bt)	10.3	4.4	4.6	6.5	6.6	4.4	4.5	5.2
Average	13.2	4.3	3.6		8.3	4.0	3.9	

Maximum pink bollworm damage percentage in Set-I was recorded in CIM-602 & CIM-717, in Set II & Set-III it was higher in CIM-717 & CIM-632, respectively. However, percentage of live larvae in Set-I, Set II &Set III was higher in CIM-602, CIM-717 & CIM-632, respectively. On the whole, infestation and live larval percentage was higher in CIM-602 followed by CIM-717 and lower in Cyto-179 as compared to other tested varieties **(Table-4.1).**

Overall, pink bollworm infestation and percentage of live larvae were higher in early-March planting (Set-1) and lower in early-May planting (Set-III). So the farmers are advised to avoid planting cotton before 1st April.

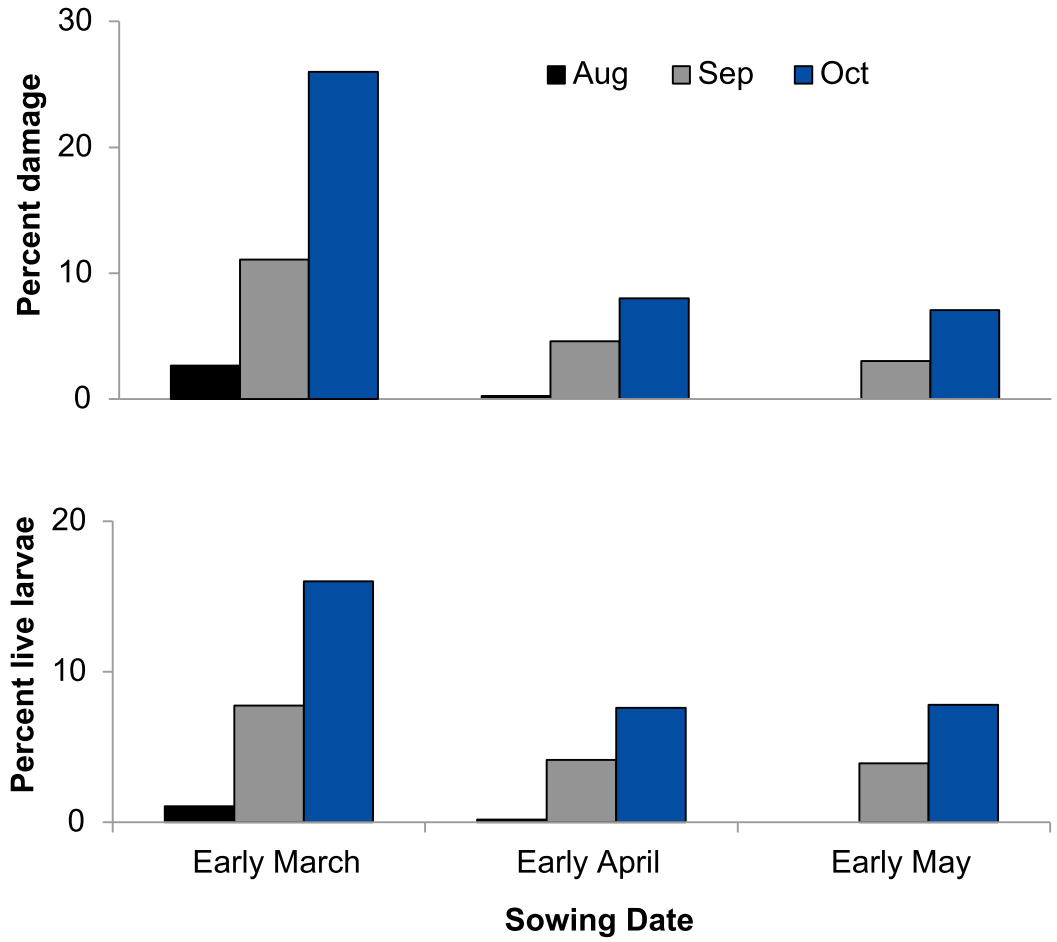


Fig. 4.1 Impact of sowing dates on pink bollworm damage and live larvae

4.1.2 Pink bollworm infestation in green bolls in major cotton growing area

Surveys were conducted in major cotton growing districts of Punjab (Khanewal, Vehari, Lodhran, Bahawalpur, Multan, Muzaffar Garh, DG Khan and Rajan Pur) for crop development and population dynamics of insect pests of cotton. Pink bollworm infestation detected in the bolls collected from the surveyed area during September, October and November is presented here.

All the cotton growing areas were infested with pink bollworm in September, afterwards pink bollworm infestation increased gradually and reached to maximum level during November **(Table-4.2)**. All the surveyed varieties/strains were found to be susceptible against pink bollworm. Maximum pink bollworm infestation was detected in SS-32 followed by CIM-616 and minimum in Cyto-179 as compared to other tested varieties. Percentage of live larvae was higher in SS-32 followed by FH-142 (**Fig. 4.2**).

Overall Maximum boll infestation and live larvae were observed in district Khanewal followed by Vehari as compared to other districts. Comparatively variety SS-32 seems more vulnerable to pink bollworm infestation.

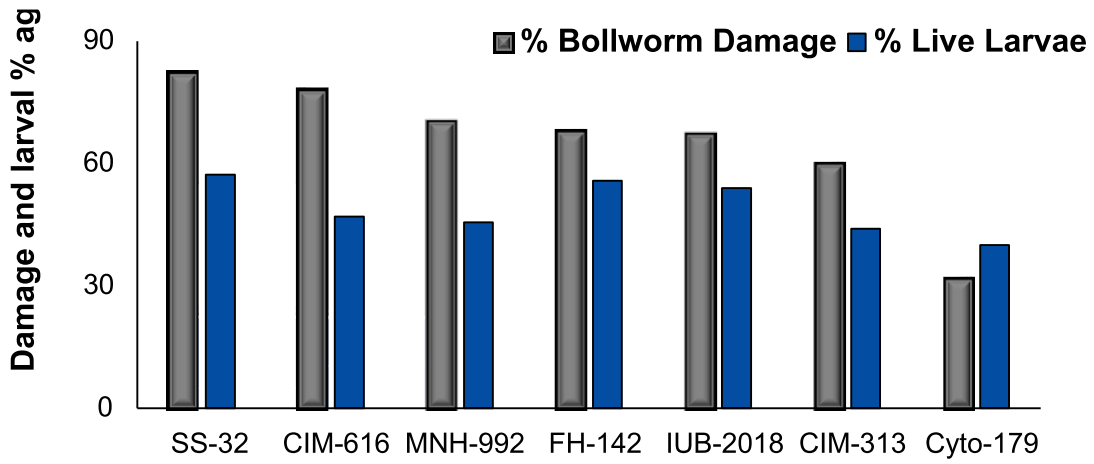


Fig. 4.2 Pink bollworm damage and live larvae in different varieties recorded from major cotton growing districts

Table 4.2 Pink bollworm damage and live larvae recorded during different months from major cotton growing districts

District	September		October		November		Average	
	% Boll damage	% Larvae	% Boll damage	% Larvae	% Boll damage	% Larvae	% Boll damage	% Larvae
Khanewal	68.8	48.8	94.3	78.3	94.5	80.0	85.9	69.0
Vehari	61.6	42.0	77.9	87.2	83.2	69.6	74.2	66.3
Bahawalpur	21.0	17.0	66.7	54.7	74.4	35.2	54.0	35.6
Lodhran	48.0	22.0	68.4	71.6	80.8	45.0	65.7	46.2
Multan	35.3	24.7	80.0	57.3	90.4	108.8	68.6	63.6
Muzaffar Garh	8.8	7.2	57.8	54.3	73.2	51.3	46.6	37.6
D G Khan	6.0	5.5	49.1	37.5	78.3	57.1	44.5	33.4
Rajan Pur	-	-	58.0	52.5	70.0	54.5	64.0	53.5

4.2 Monitoring of lepidopterous pests with sex pheromone traps

Male moth activity of *Pectinophora gossypiella*, *Earias insulana, Earias vittella, Helicoverpa armigera, Spodoptera litura* and *Spodoptera exigua* was monitored with sex pheromone baited traps throughout the year at CCRI, Multan and farmer's field at Chak 116/10R (Khanewal). Overall the declining population trend was detected in *P. gossypiella and Earias* spp, whereas increasing trend was observed in *H. armigera* and *Spodoptera* spp. at both locations as compared to last year. Comparatively, male moth catches of all the species were higher at farmer's field than at CCRI, Multan **(Table-4.3).** Weekly male moth catch activities are given in **Fig. 4.3 (a-f).**

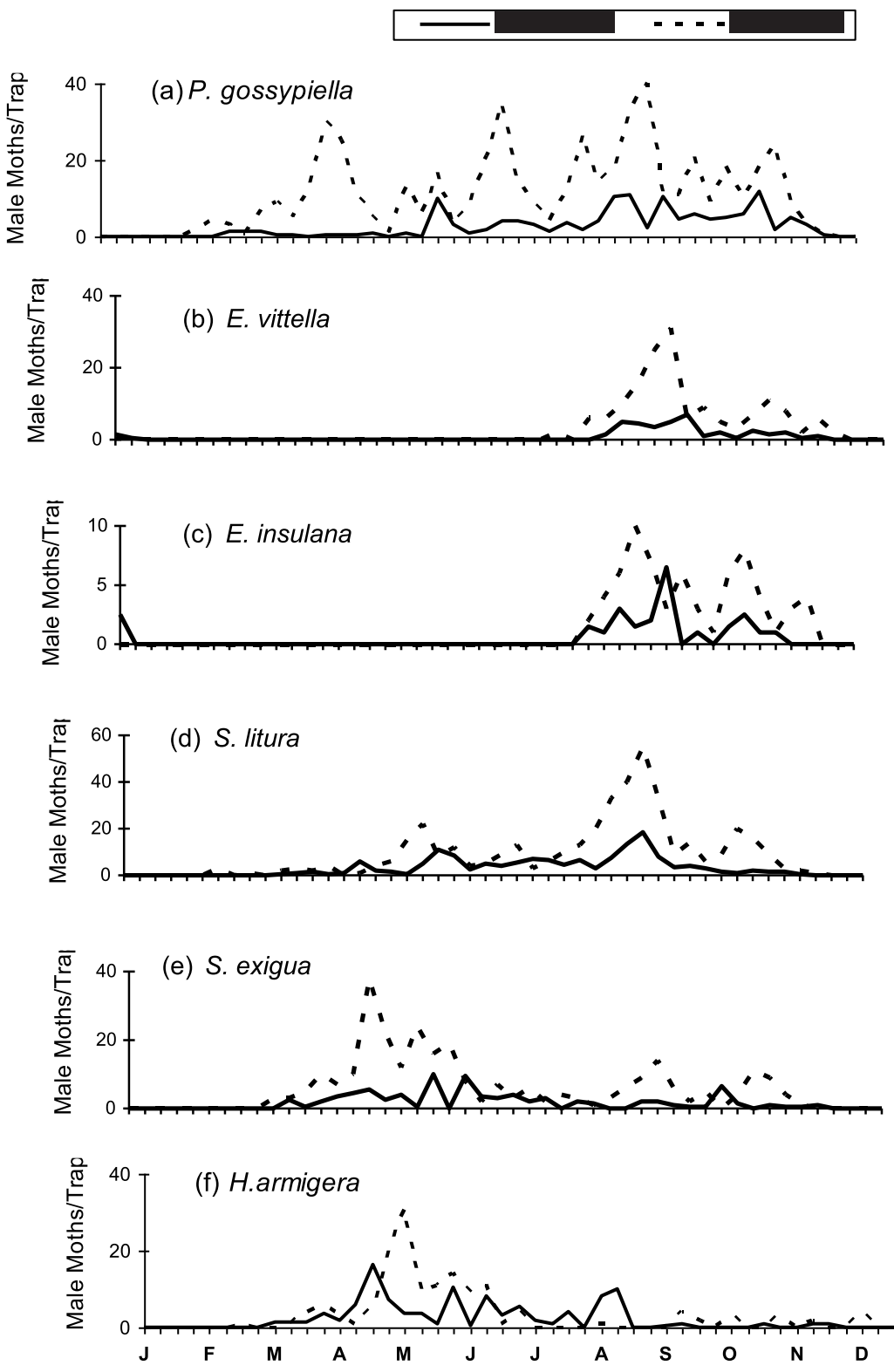


Fig.4.3 Weekly male moth catches of Lepidopterous pests in sex pheromone traps at CCRI, Multan and farmer's field (Khanewal).

4.2.1 *Pectinophora gossypiella* (Pink bollworm)

Male moth catches remained zero upto 1st week of March at CCRI, Multan and 2nd week of February at farmer's field. There was a fluctuating trend in moth activity and maximum catches were recorded in 2nd week of November at CCRI, Multan and 3rd week of September at farmer's field. Moth catches at farmer's field were 77.5% higher than at Multan **(Fig. 4.3b).** Overall, male moth catches were -0.6% and -47.0% lower at Multan and farmer's field respectively as compared to last year **(Table-4.3).**

4.2.2 *Earias vittella* (Spotted bollworm)

Male moth's activity remained zero from 3rd week of January to 2nd week of August at CCRI, Multan and from 1st week of January to 3rd week of July at farmer's field. Moth activity was not consistent and reached at its peak in 4th and 3rd week of September at CCRI, Multan and farmer's field, respectively. Moth catches at farmer's field were -74.5% higher than at Multan **(Fig. 4.3b).** Overall, male moth catches were -207.6% and -34.2% lower at Multan and farmer's field, respectively than that of last year **(Table-4.3).**

4.2.3 *Earias insulana* (Spiny bollworm)

Male moth catches were zero from 2nd week and 1st week of January to 2nd week of August at CCRI, Multan and farmer's field, respectively. Moth's population showed fluctuating trend throughout the season, with its peak intensity in 4th and 2nd week of September at CCRI, Multan and farmer's field, respectively. Moth catches were 63.2% higher at farmer's field than at Multan **(Fig. 4.3c).** Overall, male moth catches were -486.4% and -204.4% lower at Multan and farmer's field, respectively as compared with last year **(Table-4.3).**

4.2.4 *Spodoptera litura* (Armyworm)

Male moth's activity started in 3rd week of March at CCRI, Multan and in in 3rd week of February at farmer's field. Moth activity remained inconsistent and reached at peak in 2nd week of September with fluctuated trend afterwards at both locations. Moth catches at farmer's field were 64.1% higher than at Multan **(Fig. 4.3d)**. Overall, male moth catches were 33.1% and 25.5% higher to that of last year at CCRI, Multan and farmer's field, respectively **(Table-4.3).**

4.2.5 *Spodoptera exigua* (Beet armyworm)

Male moth activity started from 3rd and 2nd week of March at CCRI, Multan and farmer's field, respectively with fluctuating trend afterwards. Maximum catches were recorded in 4th week of May at CCRI, Multan and 4th week of April at farmer's field. Moth catches were 71.0% higher at farmer's field than at Multan **(Fig. 4.3e)**. Overall, male moth catches were 40.7% and 56.6% higher at CCRI, Multan and farmer's field as compared to last year **(Table-4.3).**

4.2.6 *Helicoverpa armigera* (American bollworm)

Male moth activity remained zero upto 4th and 2nd week of February at CCRI, Multan and farmer's field, respectively. Moth population increased afterwards with fluctuating trend and maximum catches were recorded in 3rd week of April at CCRI, Multan and 1st week of May at farmer's field. Moth catches were comparatively 30.0% higher at farmer's field than Multan **(Fig. 4.3f)**. Overall, male moth catches were about 31.0% and 20.7% higher at Multan and farmer's field, respectively to that of last year **(Table-4.3).**

Table-4.3 Comparison of male moth catches of lepidopterous pests in sex pheromone traps

Insect pest	CCRI, Multan			Farmer' field		
	2017	2018	± %age	2017	2018	± %age
P. gossypiella	118.7	118.0	**-0.6**	772.0	525.0	**-47.0**
E. vittella	121.5	39.5	**-207.6**	208.0	155.0	**-34.2**
E. insulana	146.6	25.0	**-486.4**	207.0	68.0	**-204.4**
S. litura	100.0	149.5	**33.1**	310.0	416.0	**25.5**
S. exigua	48.0	81.0	**40.7**	121.0	279.0	**56.6**
H. armigera	72.5	105.0	**31.0**	119.0	150.0	**20.7**

4.3 Monitoring of lepidopterous pests with light traps

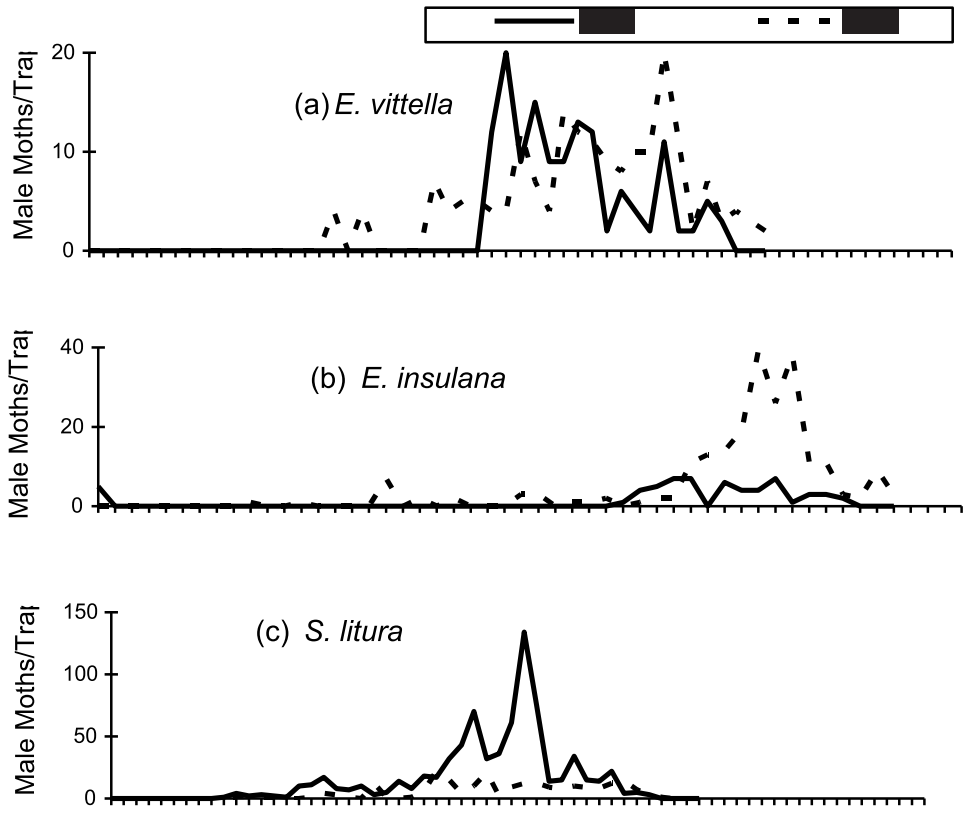
Moth activity of *E. insulana*, *E. vittella*, *S. litura*, *S. exigua* and *H. armigera* was monitored throughout the year with inflorescent light traps at CCRI, Multan. Population tendency of all the pests was almost alike as monitored in sex pheromone baited traps at CCRI, Multan. Increasing population trend was detected in case of *Spodoptera* spp. and *H. armigera,* while decreasing trend in case of *Earias* spp. was observed **(Table-4.4).** Moth catches on weekly basis are given in **Fig. 4.4 (a-e).**

4.3.1 *Earias vittella* (Spotted bollworm)

Male moth catches remained zero from January to 4th week of July. Afterwards population increased and reached at peak in 2nd week of August **(Fig. 4.4b).** Overall number of moth catches was -36.8% lower as compared to last year **(Table-4.4).**

4.3.2 *Earias insulana* (Spiny bollworm)

Male moth catches of this species were almost zero upto 3rd week of August. Moth's population showed fluctuating trend throughout the season **(Fig. 4.4b).** Total number of moth catches was -284.7% lower than last year **(Table-4.4).**



Delegation from Balochistan

Dr. Muhammad Javaid Tareen, Director General Agriculture (Research), and Mr. Inam ul Haq, Director General Agri (Extension) Quetta, Balochistan visited CCRI Multan on 17.01.19. Dr. Saghir Ahmad, Director Cotton Punjab and Mr. Habib ur Rahman, Technical Manager, Bayer CropSciences Multan also participated. Dr. Zahid Mahmood, Director CCRI Multan briefed the guests about cotton research and development activities, training programs for agriculture researchers, extensionists and farmers, and provision of cotton seed. Moreover, PCCC has also established Cotton Research Stations at Lasbela and Sibbi in Balochistan for cotton crop development.

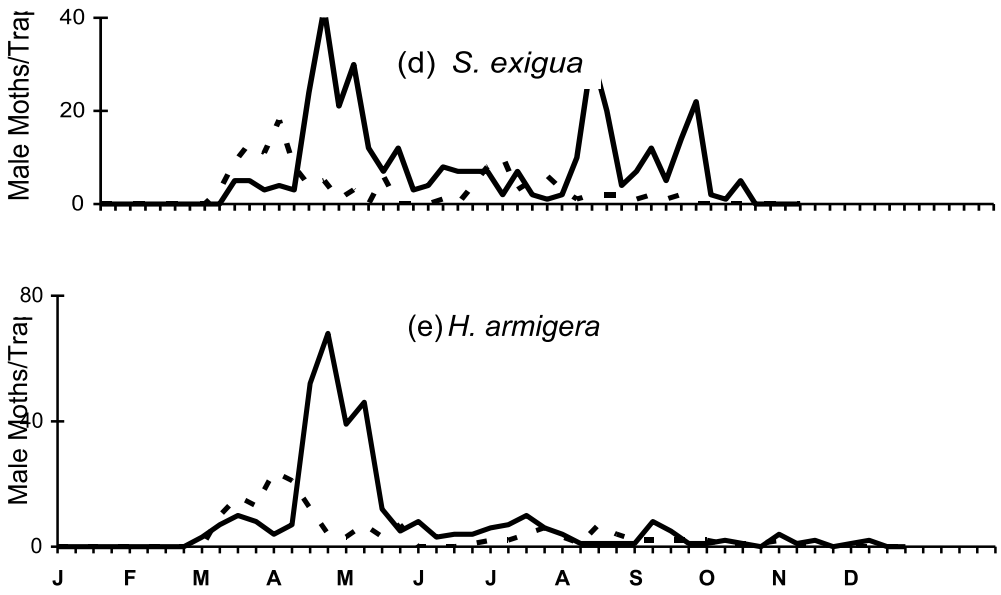


Fig. 4.4 Weekly moth catches of lepidopterous pests in light traps at CCRI, Multan

4.3.3 *Spodoptera litura* (Armyworm)

Moth catches of *S. litura* appeared in 2nd week of March, and reached at its peak in 2nd week of September. Population showing fluctuating trend declined afterwards **(Fig. 4.4c)**. Overall, moth catches were 70.8% higher to that of last year **(Table-4.4).**

4.3.4 *Spodoptera exigua* (Beet armyworm)

Moth's activity started in 1st week of March with inconsistent trend and reached to its maximum during last week of April **(Fig. 4.4d)**.Overall, moth catches were 58.8% higher as compared to last year **(Table-4.4).**

4.3.5 *Helicoverpa armigera* (American bollworm)

Moth activity remained zero upto last week of February. Moth's population showed fluctuating trend throughout the season, with its peak intensity in last week of April **(Fig. 4.4e)**. Total number of moth catches was 52.2% higher than the last year **(Table-4.4).**

Table-4.4 Comparison of moth catches of lepidopterous pests in light traps based on total catches during the year/trap

Insect pest	2017	2018	% change (±)
Earias vittella	186.0	136.0	**-36.8**
Earias insulana	227.0	59.0	**-284.7**
Spodoptera litura	219.0	750.0	**70.8**
Spodoptera exigua	134.0	325.0	**58.8**
Helicoverpa armigera	165.0	345.0	**52.2**

4.4 National Coordinated Varietal Trials (NCVT)

4.4.1 Pest situation in set-A (A-1801-A-11)

In this set ten cotton strains were tested for their tolerance/susceptibility to insect pest complex. Jassid population remained below ETL during growing season on all the tested strains except on TH-88/11 and NIAB-191 respectively. Its intensity was highest on TH-88/11. Whitefly population remained below ETL during August and September on all the testing strains except on Cyto-225, and CRIS-552 respectively. Thrips remained below ETL throughout the season on all the strains while its population was highest on Cyto-225 and lowest on NIAB-818 **(Table-4.5)**. Bollworms population remained zero on all the tested strains.

Table- 4.5 Seasonal population of sucking insect pests in Set A

Strains	Number of sucking insect pests per leaf					
	Jassid		Whitefly		Thrips	
	Aug	Sep	Aug	Sep	Aug	Sep
CIM-717	0.20	0.40	0.90	4.75	1.10	3.90
CYTO-225	0.35	0.50	1.10	5.40	2.20	5.60
CRIS-613	0.40	0.75	3.90	3.20	1.60	3.00
TH-88/11	1.25	0.65	1.30	3.40	0.60	2.50
CIM-620	0.50	0.70	2.10	2.90	0.60	0.30
GS-Ali-7	0.20	0.50	3.10	4.00	2.40	1.75
CRIS-552	0.25	0.90	2.00	5.30	1.50	0.70
NIAB-191	0.50	1.00	4.90	4.50	0.50	0.70
NIAB-818	0.75	0.60	4.00	4.30	0.20	0.90
GS-Ali-9	0.90	0.75	2.40	3.20	1.75	2.50

4.4.2 Pest situation in Set-B (PC-1812-PC-1838)

In this set 27 cotton strains were tested for their tolerance/susceptibility to insect pest complex. Jassid population was below ETL on all the tested strains during study period however, its maximum number was recorded on BS-18. Population of whitefly remained below ETL on all strains except BZU-05 & MNH-1020 during August and on BAHAR-07, AA-933, BS-18, & IUB-13 during September. Overall, its intensity was highest on MNH-1020. Thrips population remained below ETL during August and September on all the tested strains **(Table-4.6)**. Bollworms population remained zero on all the tested strains.

Table-4.6 Seasonal population of sucking insect pests in Set-B

Strains	Number of sucking insect pests per leaf					
	Jassid		Whitefly		Thrips	
	Aug	Sep	Aug	Sep	Aug	Sep
BAHAR-07	0.25	0.30	0.90	4.50	3.00	3.50
AA-933	0.20	0.30	1.10	4.10	0.50	1.10
AURIGA-216	0.60	0.10	1.70	2.80	1.70	2.50
BAHAR-217	0.50	0.10	3.40	3.20	0.20	1.20
BH-221	0.10	0.75	1.70	2.90	3.50	1.80
BS-18	0.60	1.25	3.20	4.20	0.20	0.60
Bt.CIM-343	1.00	0.50	1.90	3.40	1.20	1.90
Bt.CIM-663	0.50	0.30	3.00	3.50	0.70	2.30
CIM-602	0.40	0.20	3.00	3.50	0.90	1.40
BZU-05	0.25	0.50	4.00	2.30	1.50	0.70
CYTO-515	0.40	0.30	3.00	1.80	0.20	1.50
Evyol-148	0.50	1.00	2.80	2.10	0.00	1.10
FH-444	0.10	0.55	3.80	2.60	4.50	0.60
FH-490	0.20	0.40	2.30	3.10	1.00	2.95
GH HADI	0.60	1.20	2.90	3.80	0.25	1.90
GH-Mubarak	0.45	0.50	2.20	3.00	0.60	5.20
ICI-2121	0.50	0.90	3.40	3.00	0.30	0.40
IUB-13	0.70	0.20	3.30	4.30	4.25	0.70
IR-NIBGE-11(Mac-7)	0.52	0.85	2.60	2.20	0.20	0.92
IUB-69	0.10	0.70	1.50	2.10	1.00	1.40
KZ-125	0.25	0.50	1.60	1.50	1.70	3.40
MNH-1020	0.50	0.25	4.20	3.50	0.50	1.60
MNH-1026	0.12	0.20	2.70	3.90	1.00	2.10
NIA-85	0.10	0.75	0.70	3.40	0.70	2.00
NIAB-898	0.90	1.20	0.80	2.50	1.50	3.80
NS-191	0.50	0.75	2.40	2.80	0.20	2.50
RH-Afnan	0.35	0.10	3.80	3.40	1.75	3.00

4.4.3 Pest situation in Set-C (PC-1839-PC-1868)

In this set 30 cotton strains were tested for their tolerance/susceptibility to insect pest complex. Jassid population was above ETL on Tassco-902, NU-21, VH-189, Badar-1(C11), and IUB-13, Suncrop-6, Weal AG-6 respectively in August while it remained below ETL in September on all the tested strains except on Sahara-210, VH-383 and VH-189 respectively. Overall, its intensity was highest on Sahara-210. Population of whitefly remained below ETL during August on Suncrop-6, TJ-MAX (C11), and SLH-6 respectively. While in September it remained below ETL except on Weal AG-6, SLH-19, Tassco-902 Badar-1 (C11) and NU-21 respectively. Overall its highest population was recorded on Weal AG-6. Thrips population remained below ETL during study period on all the tested strains except on NU-21 (C11) and its intensity was higher on NU-21 (C11) and lower on RH-Manthar and C11-ICI-2222 **(Table-4.7)**. Bollworms population remained zero on all the tested strains.

Table-4.7 Seasonal population of sucking insect pests in Set-C

Strains	Number of sucking insect pests per leaf					
	Jassid		Whitefly		Thrips	
	Aug	Sep	Aug	Sep	Aug	Sep
RH-Manthar	0.25	0.60	4.20	2.00	0.60	1.50
Sahara-210	0.90	1.40	2.20	2.75	1.10	0.70
Shahab-7	0.75	0.50	1.80	2.00	3.25	1.25
Shaheen-16	0.30	0.75	2.10	4.00	1.50	1.00
Sitara-16	0.50	0.35	1.50	3.80	1.60	2.80
SLH-19	0.50	0.20	3.30	5.40	1.40	1.8
SLH-6	0.10	0.80	5.30	2.00	2.80	1.00
Suncrop-5	0.60	0.10	2.80	4.00	1.50	2.20
CIM-602	0.20	0.10	3.00	3.70	0.95	1.25
Suncrop-6	1.00	0.75	6.10	4.25	2.00	2.70
Tassco-902	1.50	0.40	2.80	5.00	4.70	1.30
Tipu-9	0.50	0.50	1.40	3.80	3.50	0.70
VH-189	1.30	1.00	4.20	4.20	2.50	0.90
VH-383	0.50	1.20	3.20	4.60	2.60	1.25
Weal AG-5	0.50	0.75	3.10	2.70	4.40	3.10
Weal AG-6	1.00	0.20	3.40	7.40	4.00	6.75
Badar-1(C11)	1.25	0.80	2.00	5.00	6.10	3.20
IUB-13	1.10	0.50	1.70	3.70	3.90	9.25
C11-CEMB-100	0.75	0.30	1.20	5.00	1.50	4.20
C11-CEMB-101	0.45	0.60	3.20	2.80	2.20	5.60
NU-21 (C11)	1.40	0.75	2.80	5.00	4.00	8.50
Sahara-2020 (C11)	0.40	0.90	2.60	2.50	1.10	2.40
Tahafuz-10 (C11)	0.65	0.30	1.30	4.10	1.70	4.20
TJ-MAX (C11)	0.50	0.70	5.60	2.90	4.40	1.30
C11-Badar-2	0.90	0.60	4.40	2.90	2.70	3.45
C11-CEMB-102	0.60	0.29	3.00	2.50	4.00	1.85
C11-ICI-2222	0.25	0.45	2.40	3.60	0.60	1.80
C11-Suncrop	0.40	0.35	4.00	1.90	2.40	1.50
C11-Tahafuz-12	0.75	0.50	1.30	3.40	3.65	0.80
C11-TJ-King	0.30	0.65	2.00	2.50	2.00	1.90

4.4.4 Pest situation in Set-D (PC-1869-PC-1895)

In this set 27 cotton strains were tested for their tolerance/susceptibility to insect pest complex. Jassid population remained below ETL in August and September on all the tested strains except on, CEMB-KleanCotton-1(CKC), Ghauri-1(CKC) and CKC-Sahara-Klean respectively. Overall, its intensity was highest on Ghauri-1(CKC). Population of whitefly was remained below ETL during August and September on all the tested strains except on IUB-13, CRIS-673, BF-1, CAMB-Klean Cotton -1 and CKC-ICI-2323 respectively. Overall, its intensity was highest on IUB-13. Thrips population observed below ETL during August and September on all the tested strains and its intensity was higher on CKC-ICI-2323 and lower on CEMB-Klean Cotton-2 **(Table-4.8)**. Bollworms population remained zero on all the tested strains.

Table-4.8 Seasonal population of sucking insect pests in Set-D

Strains	Number of sucking insect pests per leaf					
	Jassid		Whitefly		Thrips	
	Aug	Sep	Aug	Sep	Aug	Sep
CEMB-Klean Cotton-1(CKC)	1.00	0.50	2.00	4.70	0.50	2.30
CEMB-Klean Cotton-2(CKC)	0.40	0.20	1.80	3.20	0.20	2.00
Ghauri-1 (CKC)	0.60	1.25	3.60	2.30	0.40	1.70
Hatf-1 (CKC)	0.30	0.40	2.70	1.70	0.50	4.50
CKC-3	0.25	0.20	3.90	2.50	1.75	4.30
CKC-4	0.40	0.30	1.80	2.30	0.90	1.00
CKC-Clean Flex	0.60	0.50	3.80	3.00	0.50	1.20
CKC-Hatf-3	0.80	0.30	2.40	2.40	0.50	0.60
CIM-602 (Bt. Std-1)	0.20	0.20	1.60	3.80	0.60	1.30
CKC-ICI-2323	0.50	0.10	4.60	3.20	2.00	4.70
CKC-Sahara-Klean	0.80	1.00	1.90	3.00	0.50	2.10
CKC-TJ-Inqilab	0.60	1.00	2.30	1.50	0.40	2.20
BF-1	0.20	0.40	3.90	5.60	1.00	0.90
BH-223	0.20	0.50	3.10	1.60	0.60	1.60
BS-20	0.30	0.60	2.40	3.80	1.50	1.70
Bt.CIM-303	0.50	0.10	3.30	2.75	2.00	2.80
Bt.CIM-678	0.20	0.40	2.00	2.30	1.50	0.80
IUB-13 (Bt.Std-2)	0.40	0.20	2.50	6.00	0.80	1.90
Bt. CIM-789	0.80	0.60	1.70	1.50	2.80	2.20
BZU-07	0.30	0.50	1.40	3.50	1.50	0.70
CRIS-671	0.90	0.80	1.50	3.40	0.70	1.00
CRIS-673	0.75	0.50	1.80	5.90	0.30	2.10
Crystal-20	0.30	0.10	1.20	3.50	3.70	0.60
Cyto-510	0.20	0.40	2.50	2.10	0.40	1.75
Cyto-511	0.40	0.50	3.30	4.50	0.60	0.60
Eagle-3	0.30	0.20	2.10	3.00	0.70	0.90
Eye-111	0.50	0.40	2.00	2.20	0.50	0.70

4.4.5 Pest situation in Set-E (PC-1896-PC-18121)

In this set 26 cotton strains were tested for their tolerance/susceptibility to insect pest complex. Jassid population was fluctuating during cropping season on all the tested strains. Overall, its intensity was highest on MNH-1035 and lowest on RH-670. Population of whitefly was remained below ETL during August and their population was fluctuating in September on all the tested strains. Overall, its intensity was highest on Eye-20 and lowest on Rustam-11 respectively. Thrips population observed below ETL during August and September on all the tested strains and its intensity was higher on Rohi-1 **(Table-4.9)**. Bollworms population remained zero on all the tested strains.

Table-4.9 Seasonal population of sucking insect pests in Set-E

Strains	Number of sucking insect pests per leaf					
	Jassid		Whitefly		Thrips	
	Aug	Sep	Aug	Sep	Aug	Sep
Eye-20	0.55	0.75	3.20	10.50	2.75	2.30
FH-155	0.25	0.50	3.60	5.75	1.50	2.25
FA-AMCotton-2017	0.40	0.35	2.10	7.60	3.80	3.00
FH-Supper Cotton -2017	0.75	1.00	2.80	4.51	2.75	3.45
GH-UHAD	0.50	0.25	5.50	6.45	1.90	2.75
ICI-2424	0.70	1.20	2.30	5.25	2.50	1.90
IR-NIBGE-12	1.25	1.00	2.90	4.10	4.50	1.30
IR-NIBGE-13	0.50	0.75	2.40	5.62	3.70	1.50
CIM-602 (Bt.Std-1)	1.00	0.50	2.00	4.95	5.20	4.25
IUB-71	0.25	1.60	2.90	5.50	5.50	3.70
Koh-I-Noor	0.60	0.45	2.40	3.25	3.40	4.50
MNH-1035	1.50	1.00	3.20	4.81	2.40	1.00
MZM-7	0.70	0.85	2.10	4.50	1.92	3.50
NIAB-1011	0.25	0.70	2.80	5.75	5.40	4.00
NIAB-135	0.59	0.90	3.00	5.95	4.00	2.30
NS-210	0.75	1.25	2.80	4.82	2.75	3.90
RH-670	0.20	0.50	3.30	5.45	3.50	4.25
IUB-13 (Bt. Std.-2)	0.45	0.25	2.60	4.30	2.25	1.40
Rohi-1	1.00	0.59	2.70	4.25	6.00	4.90
Rustam-11	0.70	1.00	1.60	4.50	5.54	2.75
SLH-33	0.50	0.75	2.80	5.60	4.25	2.60
Tassco-112	0.90	1.25	2.10	4.66	2.00	1.25
Tipu-1524	1.25	0.90	2.00	3.90	3.25	1.55
VH-402	0.60	0.70	3.70	5.65	1.50	1.80
Weal-AG-7	0.75	0.85	2.50	4.70	1.00	1.60
Weal-AG-8	0.80	0.50	3.40	5.00	2.75	0.50

4.5 Studies on tolerance level of cotton genotypes to sucking insect pest complex

During the month of August Jassid populations in untreated plots were above ETL on all tested varieties except on CIM-600, Sitara-15 and NIAB-1048 respectively but during the month of September Jassid populations were below ETL all tested varieties. In the treated plots, Jassid was below ETL on all tested varieties in August and September (Table-4.10). Maximum seasonal population of jassid was noted on CIM-602.

Table-4.10 Jassid Populations in treated and untreated plots

Varieties	Untreated		Treated	
	August	September	August	September
FH-142	1.0	0.1	0.1	0.0
FH-152	1.2	0.1	0.0	0.0
CIM-600	0.6	0.3	0.2	0.0
CIM-602	1.9	0.5	0.3	0.0
CIM-632	1.3	0.0	0.3	0.0
RH-668	1.2	0.3	0.8	0.0
NIAB-1048	0.9	0.3	0.0	0.0
Crystal-12	1.0	0.0	0.2	0.0
Sitara-15	0.8	0.3	0.7	0.0

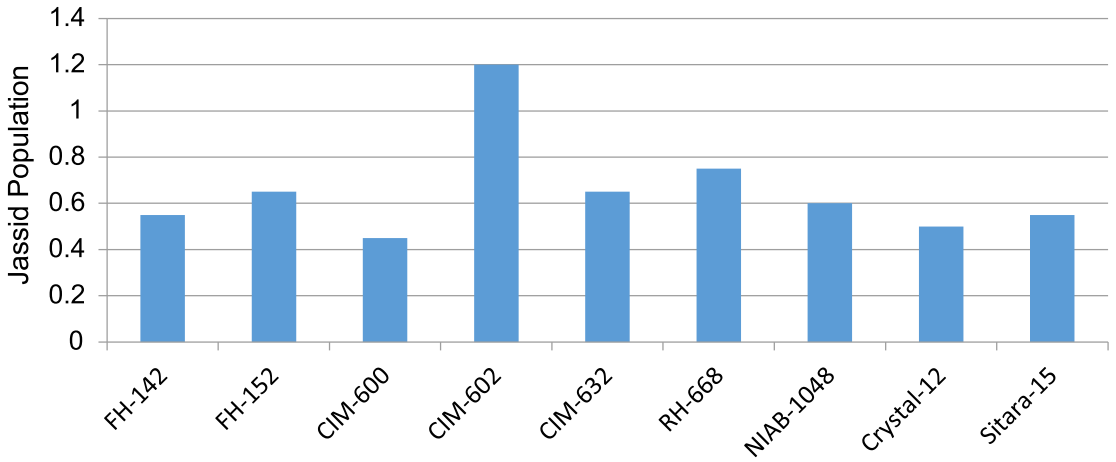


Fig.4.5 Jassid population trend on cotton genotypes

Whitefly

Populations in untreated plots were above ETL on all tested varieties during August and September except on FH-152, CIM-600 and CIM-632 respectively. In the treated plots, their population was below ETL on all tested varieties except on FH-152 in August but their population was fluctuating on all tested varieties during September (Table-4.11). Maximum population was observed on Crystal-12.

Table-4.11 Whitefly Populations in treated and untreated plots.

Varieties	Untreated		Treated	
	August	September	August	September
FH-142	8.8	6.5	2.7	6.1
FH-152	7.9	3.8	5.2	2.3
CIM-600	7.3	4.2	3.4	2.4
CIM-602	7.9	6.3	2.2	6.4
CIM-632	9.3	4.2	2.1	3.8
RH-668	8.2	7.7	3.7	4.2
NIAB-1048	7.2	9.0	2.2	5.1
Crystal-12	11.3	5.1	2.5	4.5
Sitara-15	8.4	7.3	4.9	3.6

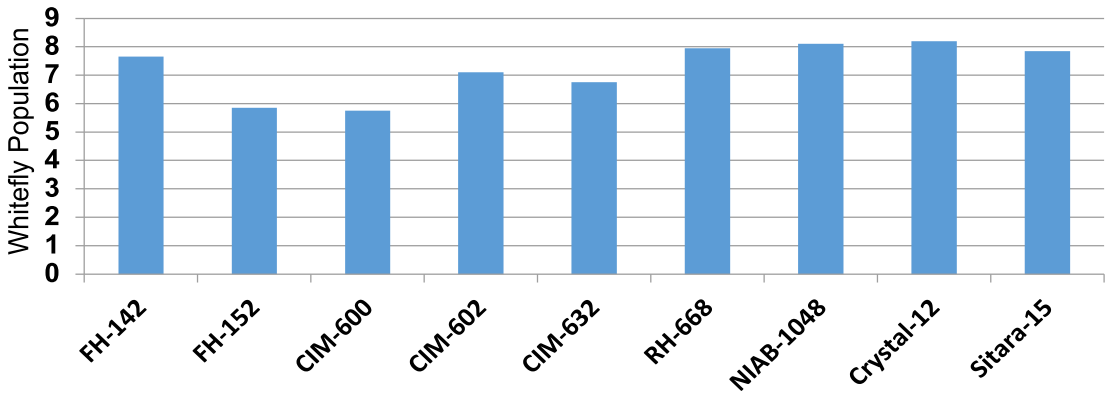


Fig.4.6 whitefly population trend on cotton genotypes

In the treated and untreated plots, thrips population was below ETL on all tested varieties during cropping season. Maximum population was observed on CIM-632.

Table-4.12 Thrips Populations in treated and untreated plots

Varieties	Untreated		Treated	
	August	September	August	September
FH-142	3.5	1.1	3.4	0.0
FH-152	3.5	1.3	1.5	0.0
CIM-600	5.8	2.4	2.0	0.0
CIM-602	6.4	1.2	2.4	0.0
CIM-632	8.4	0.7	1.1	0.0
RH-668	6.7	1.8	1.4	0.0
NIAB-1048	3.9	0.6	2.9	0.0
Crystal-12	4.4	0.5	1.3	0.0
Sitara-15	7.9	0.9	1.5	0.0

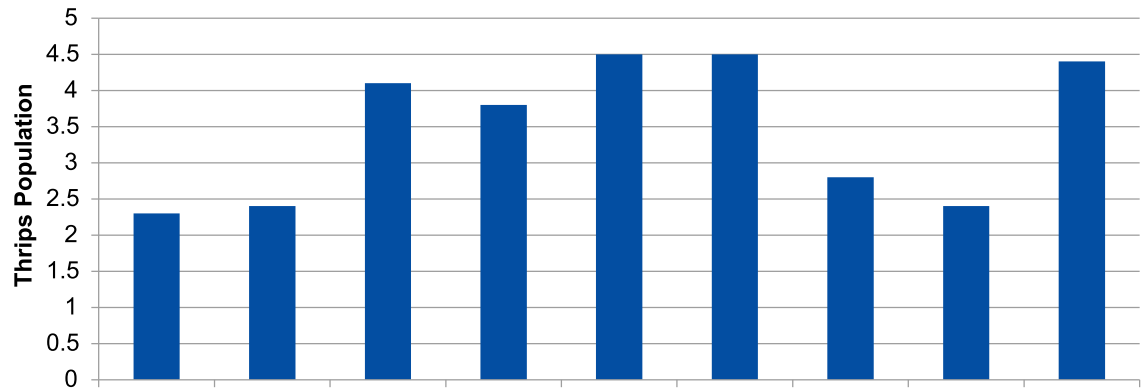


Fig.4.7 Thrips population trend on cotton genotypes

4.6 Evaluation of Foliar Insecticides

4.6.1 Thrips *(Thrips tabaci)*

Twenty insecticides of different groups were evaluated against thrips at CCRI. Hand operated knack sap sprayer was used for insecticide application and untreated check kept for comparison. Sapentoram,120 Sc Fipronil 50 SC, Imidacloprid 20 SL, Imidacloprid + Fipronil 80 WG, Dimathoate 40 EC, Cypermethrin + Profenofos 44 EC and Imidacloprid 70 WS proved most effective after 24 hours of spray and gave more than 76.0% knock down pest mortality. Most of the tested insecticides lose their efficacy upto one week after application even then Imidacloprod + Fipronil 80 WDG proved most effective and gave 87.2 % pest mortality followed by Dimathoate 40 EC, Metrin 0.5 AS and Cypermathrin + Profenofos 44 EC those gave more than 70 % mortality. While other insecticides gave 58 – 69 % pest mortality till one week after application **(Table-4.13).**

Table-4.13 Efficacy of different insecticides against thrips

Common name	Dose acre^{-1} (ml/g)	Mortality %age		
		24 hrs	72 hrs	1 week
Cypermethrin + Profenofos 44 EC	500	76.0	65.0	71.7
Imidacloprid + Fipronil 80 WDG	60	74.4	66.7	87.2
Chlorfenapyr 70 WDG	350	57.3	56.4	61.5
Chlorfenapyr + Emmectin 10.5 SC	250	64.5	52.8	67.1
Imidacloprid 70 WDG	70	61.5	66.7	56.4
Imidacloprid 70 WS	100	76.0	58.1	58.1
Acephate 75 SP	350	70.1	65.8	66.7
Fipronil 50 SC	480	79.5	68.9	66.8
Acetamiprid 20 SL	150	65.8	51.3	65.0
Abamectin 108 SC	300	55.1	51.3	61.9
Spiromesifen + Abamectin 24 SC	100	65.0	54.7	67.6
Chlorfenapyr 36 SC	120	58.2	52.9	61.9
Spentoram 120 SC	50	82.1	88.1	60.6
Spentoram 20 WG	30	71.4	72.2	60.6
Imidacloprid 20 SL	250	79.5	70.9	69.2
Imidacloprid 25 WP	250	67.1	72.7	67.6
Metrin 0.5 AS	500	68.9	74.7	71.8
Dimathoate 40 EC	400	76.9	67.6	72.7
Imidacloprid + Fipronil 80 WG	60	77.8	75.3	65.8
Chlorfenapyr 36 SC	120	52.6	49.1	65.0
-	-	0.00	0..00	0.00
- CD at 5%	**-**	**7.63**	**9.11**	**6.16**

Pretreatment data = 7.8/ leaf

4.6.2 Jassid *(Amrasca devastans)*

Efficacy of twenty one insecticides from different groups was evaluated against jassid at farmer's field keeping untreated check for comparison. Dimathoate 40 EC, Acephate 75 SP, Imidacloprid, 28 WP and Chlorfenapyr + Nitenpyram 50 WDG gave gave more than 80% knock down pest mortality while Imidacloprid + Fipronil 80 WDG, Flonicamid 50 WDG, Dinotefuran 43 WDG and Sulfoxaflor 50 WG proved also effective and gave more than 75% pest mortality. Whareas, Chlorfenapyr + Nitenpyram 50 WDG, Acephate 75 SP and Imidacloprid + Fipronil 80 WDG proved most effective against the post and gave more than 90 % pest mortality till one week after application. Nitenpyram + Clorfentazin 26 WP, Dimathoate 40 EC, Dinotefuran + Chlorfenapyr 43 WDG, Diafenthiuron 80 WDG, Diafenthiuron 50 SC, Sulfoxaflor 50 WG, Flonicamid 50 WG and Dinotefuran 30 SC also proved effective and gave more than 85 % pest mortality. Other tested insecticides moderately effective against the pest and gave 62 – 82 % pest mortality **(Table-4.14)**

4.6.3 Whitefly *(Bemisia tabaci)*

A total of 13 insecticides from different groups and their mixtures were screened against whitefly farmer's field keeping untreated check for comparison. Buprofezin 35 WP, Metrin 0.5 AS. Acetamiprid + Thicyclam Hydrogen Oxilate 28 WP, Diafenthiuron 50 SC and Diafenthiuron 80 WDG proved effective against the pest and gave more than 60 % mortality after 24 hours of application. Acetamiprid 20 Sl and Diafenthiuron 80 WDG proved most effective and gave more than 69 % pest mortality till one week while Buprofezin 35 WP, Pyriproxfen + Daifenthiuron 50 Sc, Flonicamid 50 WG, Metrin 0.5 AS, Diafenthiuron 50 SC and Spirotatramat 240 SC proved also effective and gave more than 60% pest mortality. Abamectin + Thiamethaxam 108 SC, Imidacloprid 25 WP and Acetamiprid + Thiocyclam Hydrogen Oxilate 28 WP proved less effective against this pest till one week of spray **(Table-4.15).**

Table-4.14 Efficacy of different insecticides against jassid

Common name	Dose/ac (ml/g)	% mortality after spray		
		24 hrs.	72 hrs.	1-week
Dimathoate40 EC	400	87.6	91.7	89.7
Imidacloprid + Fipronil 80 WDG	60	77.2	83.4	90.7
Acephate75 SP	300	85.5	81.4	91.7
Imidacloprid 70 WS	100	60.7	56.5	79.3
Nitenpyram +Clofentazin 26 WP	100	68.9	78.2	89.7
Chlorfenapyr + Nitenpyram 50 WDG	150	81.4	89.7	91.7
Imidacloprid 70 WDG	70	56.5	55,5	71.0
Chlorfenapyr 70 WDG	350	46.2	77.2	83.4
Nitenpyram 25 SP	100	62.7	59.6	78.3
Sulfoxaflor 50 WG	30	75.2	83.4	87.6
Dinotefuran 30 SC	75	71.0	90.7	85.5
Nitenpyram + Buprofezin 70 WG	200	61.7	89.7	81.4
Dinotefuron + Chlorfenapyr 43 WDG	150	75.2	89.7	88.6
Nitenpyram + Abamectin 30 WP	75	71.0	87.6	82.4
Imidacloprid 25 WP	250	40.0	58.6	62.7
Acetamiprid 20 SL	150	55.5	64.8	78.3
Diafenthiuron 80 WDG	150	67.9	83.4	88.6
Diafenthiuron 50 SC	200	62.7	85.5	87.6
Flupyradifurone 200 SL	300	64.8	79.3	77.2
Acetamiprid +Thiocyclam Hydrogen Oxilate 28 WP	200	83.4	79.3	76.2
Flonicamid 50 WG	80	77.2	91.7	87.6
-	-	0.00	0.00	0.00
CD at 5%		**10.36**	**5.18**	**6.00**

Pre-treatment population = 4.83/leaf

Table-4.15 Efficacy of different insecticides against whitefly

Common Name	Dose/acre (ml/g)	% mortality after spray		
		24 hrs.	72 hrs.	1-week
Imidacloprid 25 WP	250	52.9	64.9	45.8
Acetamiprid 20 SL	150	57.3	61.6	69.8
Diafenthiaron 80 WDG	150	60.3	66.0	69.5
Diafenthiaron 50 SC	200	61.5	63.0	61.1
Abamectin + Thiamethaxam 108 SC	300	55.2	52.9	36.3
Acetamiprid + Thiocyclam Hydrogen Oxilate 28 WP	200	61.8	53.4	46.6
Flunicamid 50 WG	80	57.4	72.5	66.0
Buprofezin 35 WP	600	64.1	68.5	67.6
Pyriproxifen 10.8 EC	400	34.00	54.6	57.3
Pyriproxifen 10.8 EC + Diafenthiuron 50SC	400+150	45.4	62.6	67.2
Pyriproxifen + Acetamiprid 41.6 EC	250	30.5	54.2	59.5
Spirotatramat 240 SC	125	45.8	67.9	60.9
Metrin 0.5 AS	500	62.6	72.5	63.7
CD at 5%		**5.22**	**5.29**	**5.61**

Pre-treatment population = 8.73/leaf

4.6.4 Pink bollworm *(Pectinophora gossypiella)*

Performance of fifteen candidate insecticides form different groups was evaluated against pink bollworms. Spintoram 12 SL and Profenfos + Cypermethrin gave 60% larval mortality up to one week of application followed by Gamma cyhalothrin, Triazophos + Endoxacarb 43.6 EC, Profenofos + Cypermethrin 40 EC, Spintoram 25 WG, Lamda cyhalothrin + Triazophos and Triazophos + Deltamethin. Flubendamide and Bifenthrin 10 EC gave lowest morality.

Table 4.16 Pink bollworm *(Pectinophora gossypiella)*

Common Name	Dose/acre (ml/g)	% mortality after spray	
		72 hrs.	1-week
Bifenthrin 10 EC	330	39.58	35.10
Bifenthrin 10 EW	330	22.33	39.26
Deltamethrin 10 EC	80	48.21	51.84
Triazophos + Deltamethrin 36 EC	600	43.89	53.82
Spintoram 120 SC	100	38.11	61.92
Spintoram 25 WG	60	30.95	56.75
Traizophos + Betacyfluthrin 41.7 EC	500	35.26	50.32
Lamda Cyhelotrhrin 2.5 EC	400	22.33	45.53
Lamda Cyhelotrhrin 10 WDG	250	26.63	43.21
Profenofos + Cypermethrin 44 EC	600	39.58	60.00
Triazophos 40 EC	1000	39.58	43.50
Lamda Cyhelotrhrin + Triazophos	1000	48.21	55.94
Triazophos + Endoxacarb 43.6 EC	1000	56.84	58.25
Gama Cyhelothrin 60CS	**100**	30.95	59.00
Flubendamide 48SC	**50**	18.00	22.33
CD at 5%	**-**	**4.96**	**4.39**

Pre Treatment population = 35 larvae / 100 bolls

4.7 Insecticide resistance monitoring

4.7.1 Jassid (*Amrasca devastans*)

Amrasca devastans, jassid collected from cotton fields at Khanewal, Bahwalpur, Vehari, Muzaffar Garh, Multan were exposed to five insecticides viz. thiamethoxam, acetamiprid, imidacloprid, acephate and chlorfenapyr using leaf dip method. Adults of *A. devastans* were temporarily immobilized with carbon dioxide and 50-60 adults were exposed to each insecticide treatment concentration. Five to six concentrations for each insecticide were tested and each concentration was replicated eight times. Afterwards, observations on mortality were taken 48 h after treatment. The Multan population of 2001 was used as reference or susceptible population. Resistance ratio (RR) was calculated by dividing LC^{50} of field population with LC^{50} of susceptible population (Sus = 2001 population).

Very high level of resistance to thiamethoxam was detected in tested populations of all the locations as compared to the Sus population. Low to very high levels of resistance were observed for acetamiprid. *A. devastans* showed very low to high levels of resistance to imidacloprid and very low to moderate levels of resistance to acephate compared to the Sus population. While no to low levels of resistance to chlorfenapyr were observed in field populations of all locations. Among the insecticides, thiamethoxam showed high $LC^{50}$and RR values as compared to other tested insecticides, indicating resistance to this insecticide in all locations for *A. devastans* **(Table-4.17)**.

4.7.2 Mealybug *(Phenacoccus solenopsis)*

Phenacoccus solenopsis, mealybug collected from okra fields of Bahawalpur, Fazalpur and Multan were exposed to seven insecticides viz. imidacloprid, acetamiprid, pyriproxyfen, nitenpyram, profenophos, methoxyfenozoid and chlorfenpyr using leaf dip method. 2nd instars of *P. solenopsis* were exposed and observations on mortality were taken 48 h after treatment.

LC^{50} values of neonicotinoids (imidacloprid, acetamiprid and nitenpyramin) and organophosphate (profenophos) were very low. While LC^{50} value of methoxyfenozoid was generally higher in field population of Bahawalpur location as compared to other insecticides, indicating a resistance to this insecticide in this location **(Table-4.18)**.

Table-4.17 Response of *Amrasca devastans* to different insecticides collected from various locations of Southern Punjab

Insecticide	Location	Slope ± SE	95% fiducial limits	LC50 (ppm)	RR
Thiamethoxam	2001	1.46 ± 0.11		0.13	1
	Khanewal	1.53 ± 0.48	73.79–561.83	118.27	909.8
	Bahwalpur	1.40 ± 0.13	380.83–614.69	486.40	3741.5
	Vehari	1.40 ± 0.13	94.82–165.58	129.02	992.5
	Muzaffar Garh	1.72 ± 0.16	225.31–365.21	292.31	2248.5
	Multan	1.42 ± 0.15	515.90–856.50	669.38	5149.1
Imidacloprid	2001	1.04 ± 0.09		1.33	1.0
	Khanewal	2.08 ± 0.60	12.37–21.67	27.25	20.5
	Bahwalpur	0.94 ± 0.08	42.81–2147.71	72.21	54.3
	Vehari	1.51 ± 0.14	460.50–695.20	119.32	89.7
	Muzaffar Garh	1.39 ± 0.14	87.52–151.67	74.34	55.9
	Multan	1.58 ± 0.17	101.24–203.54	277.58	208.7
Acetamiprid	2001	1.30 ± 0.06		6.55	1
	Khanewal	1.51 ± 0.15	19.92–34.11	26.27	4.0
	Bahwalpur	0.75 ± 0.22	52.91–97.02	207.87	31.7
	Vehari	1.83 ± 0.28	92.07–148.08	557.65	85.1
	Muzaffar Garh	1.43 ± 0.14	54.17–96.62	117.65	18.0
	Multan	1.42 ± 0.23	218.58–348.69	135.64	20.7
Acephate	2001	1.14 ± 0.15		27.6	1
	Khanewal	1.44 ± 0.27	534.52–1088.49	733.08	26.6
	Bahwalpur	1.43 ± 0.11	108.53–179.59	141.76	5.1
	Vehari	2.23 ± 0.20	110.32–107.05	134.68	4.9
	Muzaffar Garh	1.70 ± 0.17	87.45–148.01	117.0	4.2
	Multan	1.54 ± 0.15	69.52–122.39	95.44	3.5
Chlorfenapyr	2001	1.47 ± 0.15		2.96	1
	Khanewal	1.12 ± 0.18	24.31–55.31	35.66	13.3
	Bahwalpur	1.65 ± 0.12	9.02–13.69	11.22	4.2
	Vehari	1.06 ± 0.14	3.35–10.48	6.68	2.5
	Muzaffar Garh	0.98 ± 0.22	0.07–2.83	2.98	1.0
	Multan	1.10 ± 0.14	4.15–11.67	7.70	2.9

4.7.3 Whitefly (*Bemisia tabaci*)

Bemisia tabaci, whitefly collected from cotton fields of Multan, Vehari, Muzzafar Garh, Bahawalpur and Khanewal were exposed to twelve insecticides viz. flonicamid, flupyradifuron, spirotetramat + biopower, acetamiprid, imidacloprid, thiamethoxam, buprofezin, pyriproxyfen, diafenthiuron, bifenthrin, cypermethrin and triazophos using leaf dip method. Adults of *B. tabaci* were temporarily immobilized with carbon dioxide afterwards 20-30 adults were exposed to each treated leaf discs laid on layer of agar gel (5mm thick) in plastic petri dishes. Five to six concentrations for each insecticide were tested and each concentration was replicated eight times. Observations on mortality were taken 48 h after treatment.

LC^{50} values of all the tested insecticides were very high except flonicamid & spirotetramat + biopower in Bahawalpur population, and acetamiprid & Bifenthrin in Muzaffar Gahr population. These LC^{50} values indicate resistance development to all the tested insecticides in various locations **(Table-4.19)**. Hence, there is a dire need to develop and imply insecticide resistance management (IRM) strategies.

Table-4.18 **Response of *Phenacoccus solenopsis* to different insecticides collected from various locations of Southern Punjab**

Insecticide	Location	Slope ± SE	95% fiducial limits	LC50 (ppm)
Imidacloprid	Bahawalpur	1.84±0.47	0.81–4.49	2.62
	Fazalpur	2.01±0.45	0.88–3.47	2.16
	Multan	2.98±0.86	0.83–3.06	2.09
Acetamiprid	Bahawalpur	2.28±0.62	1.47–7.98	4.85
	Fazalpur	-	-	-
	Multan	1.92±0.47	2.36–9.82	6.10
Nitenpyram	Bahawalpur	-	-	-
	Fazalpur	2.31±0.62	0.43–2.39	1.44
	Multan	2.77±0.92	0.45–2.71	1.78
Pyriproxyfen	Bahawalpur	1.59±0.34	14.83–37.35	23.42
	Fazalpur	1.45±0.47	13.26–64.00	22.17
	Multan	1.64±0.66	22.21–111.11	39.57
Chlorfenapyr	Bahawalpur	2.54±0.48	4.14–8.46	6.34
	Fazalpur	2.43±0.44	5.39–10.65	7.98
	Multan	1.98±0.50	1.07–5.03	3.19
Profenophos	Bahawalpur	2.24±0.42	2.24–4.80	3.52
	Fazalpur	1.89±0.39	1.49–4.07	2.81
	Multan	1.81±0.36	2.08–5.22	3.64
Methoxyfenozoid	Bahawalpur	2.68±0.70	38.57–77.84	57.40
	Fazalpur	-	-	-
	Multan	1.44±0.43	7.89–36.78	23.19

= represents no population of respective location was tested

Table-4.19 **Response of *Bemisia tabaci* to different insecticides collected from various locations of Southern Punjab**

Insecticide	Location	Slope ± SE	95% fiducial limits	LC50 (ppm)
Flonicamid	Multan	1024 ± 0.15	641.42 – 1176.65	869.47
	Vehari	1.79 ± 0.17	196.21 –322.40	257.38
	Muzaffar Garh	1.23 ± 0.12	189.14 – 366.33	270.82
	Bahawalpur	1.62 ± 0.13	38.87 – 63.07	50.34
	Khanawal	1.34± 0.11	141.63 – 245.46	189.97
Flupyradifuron	Multan	1.43 ± 0.12	320.66– 541.63	424.61
	Vehari	1.38 ± 0.12	286.38 – 515.43	394.24
	Muzaffar Garh	1.04 ± 0.25	14.83 – 509.45	167.53
	Bahawalpu	1.61 ± 0.15	105.97 – 173.44	138.20
	Khanawal	1.51 ± 0.13	423.85 – 721.64	564.95
Spirotetramat + Biopower	Multan	1.28 ± 0.11	470.94 – 808.96	627.04
	Vehari	1.76 ± 0.23	752.63 – 1227.18	972.94
	Muzaffar Garh	1.40 ± 0.28	205.40 – 1576.96	775.76
	Bahawalpur	1.29 ± 0.11	50.97 – 88.52	68.49
	Khanawal	1.49 ± 0.12	244.85 – 423.13	329.01
Acetamipird	Multan	1.42 ± 0.12	307.00 – 562.21	410.19
	Vehari	1.75 ± 0.16	153.83 – 255.37	202.71
	Muzaffar Gahr	1.52 ± 0.23	1207.86 – 4117.58	2411.7
	Bahawalpur	1.62 ± 0.14	375.89 – 625.34	494.84
	Khanawal	1.29 ± 0.12	323.82 – 591.90	448.81
Imidacloprid	Multan	1.26 ± 0.11	455.59 – 801.37	614.86
	Vehari	1.73 ± 0.16	369.84 – 618.76	489.87
	Muzaffar Garh	1.74 ± 0.16	135.56 – 229.44	180.82
	Bahawalpur	1.29 ± 0.11	75.72 – 131.91	101.29

	Khanawal	1.43 ± 0.23	278.34 – 1245.12	686.74
Thiamathoxam	Multan	0.95 ± 0.18	235.06 – 1747.53	734.23
	Vehari	1.34 ± 0.12	198.87 – 348.44	268.57
	Muzaffar Garh	1.44 ± 0.11	343.90 – 380.63	308.31
	Bahawalpur	1.25 ± 0.11	362.39 – 635.89	489.52
	Khanawal	1.17 ± 0.12	467.86 – 892.00	661.45
Buprofezin	Multan	1.52 ± 0.26	559.03 – 2061.18	1194.18
	Vehari	1.63 ± 0.32	235.86 – 1454.12	774.22
	Muzaffar Garh	1.39 ± 0.19	1989.43 – 3061.31	2508.25
	Bahawalpur	1.03 ± 0.11	481.40 – 908.37	660.11
	Khanawal	1.25 ± 0.18	289.24 – 1626.32	1155.33
Pyriproxyfen	Multan	1.39 ± 0.12	471.30 – 795.61	623.13
	Vehari	1.84 ± 0.35	318.23 – 1540.35	882.26
	Muzaffar Garh	1.42 ± 0.12	722.00 – 1147.65	917.68
	Bahawalpur	1.61 ± 0.31	227.34 – 1357.22	711.29
	Khanawal	1.48 ± 0.12	217.89 – 369.77	289.70
Diafentiuhron	Multan	1.59 ± 0.13	148.72 – 240.08	192.08
	Vehari	1.19 ± 0.13	306.61 – 573.20	427.12
	Muzaffar Garh	1.62 ± 0.12	162.45 – 242.44	200.04
	Bahawalpur	1.34 ± 0.18	104.07 – 402.30	231.14
	Khanawal	1.41 ± 0.13	166.69 – 289.64	244.43
Bifenthrin	Multan	1.85 ± 0.15	134.19 – 204.54	167.90
	Vehari	1.75 ± 0.16	316.01 – 531.07	420.09
	Muzaffar Garh	1.47 ± 0.14	41.17 – 121.97	77.43
	Bahawalpur	1.29 ± 0.11	120.40 – 204.14	159.38
	Khanawal	1.44 ± 0.12	127.23 – 218.39	170.13
Cypermathrin	Multan	1.33 ± 0.15	1034.93 – 1809.88	1387.63
	Vehari	1.59 ± 0.16	262.87 – 445.35	350.22
	Muzaffar Garh	1.22 ± 0.89	294.88 – 487.09	383.82
	Bahawalpur	1.30 ± 0.10	163.04 – 273.28	214.37
	Khanawal	1.55 ± 0.17	966.85 – 892.00	1281.13
Triazophos	Multan	2.44 ± 0.22	87.15 – 126.61	106.53
	Vehari	1.48 ± 0.16	334.37 – 577.41	448.04
	Muzaffar Garh	1.56 ± 0.22	161.44 – 539.23	329.56
	Bahawalpur	1.67 ± 0.23	24.60 – 59.56	42.17
	Khanawal	2.01 + 0.29	62.60 – 192.84	123.55

Table-4.20 Response of *Bemisia tabaci* (Whitefly) to different insecticides collected from Southern Punjab

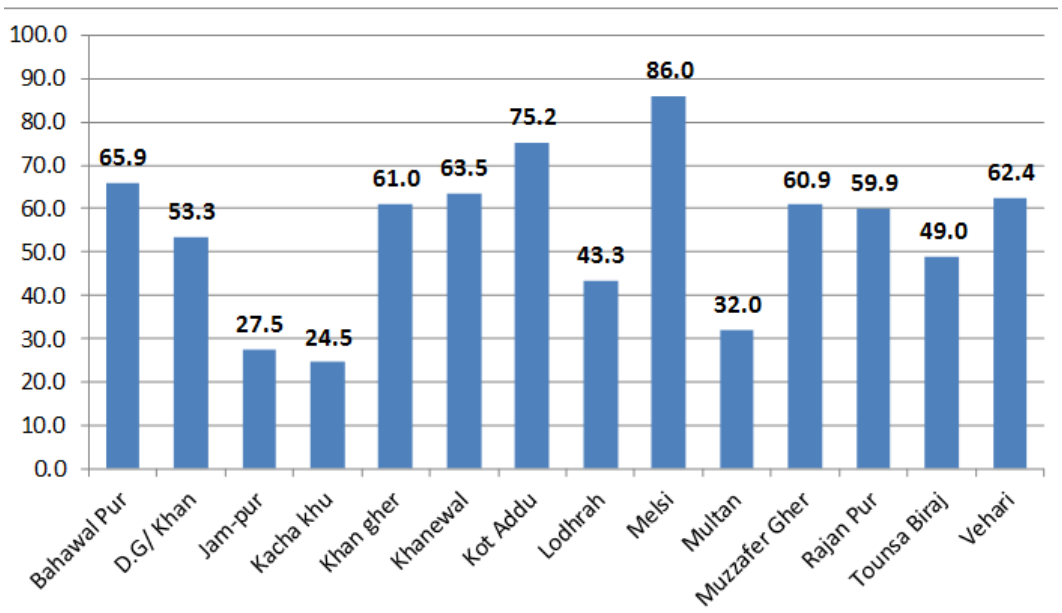
Insecticide	Slope ± SE	95% fiducial limits	LC50 (ppm)
T riazophos	1.17 0.13	239.69–461.21	341.06
Cypermethrin	1.49 0.18	357.92–635.27	490.01
Bifenthrin	1.89 0.23	229.77–370.69	297.61
Pyriproxyfen	1.40 0.17	189.41–346.03	261.31
Buprofezin	1.59 0.16	86.97–147.71	115.89
Acetamiprid	1.45 0.28	242.14–513.41	332.92
Imidacloprid	1.29 0.16	83.94–157.01	116.18
Thiamethoxm	1.34 0.14	203.39–372.41	282.65
Diafenthiuron	1.54 0.17	346.60–602.62	467.67
Flonicamid	1.48 0.29	251.69–536.20	343.72
Spir	1.18 0.14	49.35–97.62	71.5
Flupyradifeurone	1.22 0.14	38.39–73.71	54.64

5. PLANT PATHOLOGY SECTION

Research studies were carried out on the prevalence, management and control strategy of various cotton diseases, viz., cotton leaf curl, boll rot, and wilting of cotton. Experiments were conducted under greenhouse and field conditions. The promising strains under Pakistan Central Cotton Committee's (PCCC) i.e. National Coordinated Varietal Trial (NCVT) and Punjab Government Trial i.e. Provincial Cotton Coordinated Trial (PCCT), for Bt. and non Bt. varieties were screened for their reaction to various diseases. The results obtained there in are reported as under.

5.1 Estimation of Cotton Diseases

A survey was conducted during cotton cropping season to record the prevalence of cotton leaf curl (CLCuV) disease in different parts of the Punjab. The incidence of cotton leaf curl disease (CLCuD) was maximum in areas of, Melsi kot addu, Bahawal Pur and minimum in cotton areas of Kacha khu, Multan, Jam Purr. Overall position of CLCuD with crop cultivation period from March to June indicates that the crop cultivated from the month of April showed minimum disease incidence and severity level whereas crops cultivated during the month of May showed maximum level of disease incidence and severity.



The incidence of boll rot varied from 0 to 1 percent. Boll rot due to secondary pathogens was observed only on a few spots. The occurrence of stunting phenomenon was.1-2% during the month of April The prevalence of bacterial blight and leaf spot of cotton was very low. Blackening of leaves due to whitefly was observed in all spots

5.2 Screening of Breeding Material against CLCuD

5.2.1 Screening under field conditions

The advanced strains/genotypes of this Institute included in varietal, micro varietal trials and various national coordinated varietal trials were screened for their reaction to CLCuD under field conditions. Two hundred sixty-three families were screened during the year. Data present in **Table-5.1** revealed that all families of breeding material, showed symptoms of the CLCuD under filed conditions except one family showed highly tolerance against CLCuD, in MVT-6

Table 5.1 Screening of Breeding Material under field condition

Experiment	No. of Families Screened	No. of Families showing Res. to CLCuD	Disease index Range	Name of strain Resistance or Tolerance
VT-1	7	0	40.15 ~ 74.26	
VT-2	7	0	64.35 ~76.67	
VT-3	8	0	38.17~ 76.48	*
MVT-1	8	0	55.70~79.49	
MVT-2	8	0	35.46 ~ 80.19	
MVT-3	11	0	45.65 ~ 76.79	
MVT-4	9	0	49.70 ~79.17	
MVT-5	10	0	37.83~77.65	
MVT-6	11	0	**8.11** ~82.11	
MVT-7	10	0	68.46~ 78.74	
NCVT-A	11	0	58.82 ~76.19	
NCVT-B	27	0	24.8~77.3	
NCVT-C	30	0	71.00~78.97	
NCVT-D	27	0	73.62~78.05	
NCVT-E	26	0	76.40~79.71	
PCCC-I	34	0	44.03~81.52	
PCCC-II	2	0	49.61~71.33	
SVT-I	7	0	76.34~84.12	
SVT-II	18	0	73.84~83.89	
Total	**263**	**0**		

VT = Varietal Trial PCCT = Punjab Coordinated Cotton Trial
MVT = Micro-Varietal Trial NCVT = National Coordinated Varietal Trial
SVT = Standard Varietal Trail

5.3 Evaluation of National Coordinated Varietal Trial against Different Diseases

National coordinated Varietal Trial was planted in five sets, in Set-A eleven strains (non-Bt), in Set-B twenty-seven, in Set C thirty strains/lines, in Set D twenty seven strains and in Set E twenty six strains were tested against stunting, boll rot and Cotton Leaf Curl Disease under field conditions.

NCVT-Set-A

All the NCVT strains found highly susceptible to cotton leaf curl disease. Minimum disease severity and index was recorded in CRIS-613. All strains are free from boll rot incidence except CRIS-613 and NIAB-818 that showed very low (0.27 and 0.49%) and maximum stunting disease ranging (1.67 %) was observed in CRIS-510. (Table 5.3)

NCVT-Set-B

All the NCVT strains found highly susceptible to cotton leaf curl disease. Minimum disease incidence and disease index was recorded in BH-221. Maximum CLCuD severity and disease index stunting was observed in IUB-13(std-2). Incidence of boll rot and stunting was recorded in traces (Table-5.4).

NCVT-Set-C

All the NCVT strains observed highly susceptibility to cotton leaf curl disease. Minimum disease severity and disease index was recorded in Badar-1 (CII) Maximum, disease severity and disease index and boll rot incidence(1%) was observed in VH-383 Maximum stunting was recorded in CII-TJ-King and VH-383 (2.08%,2.02%) f (Table-5.5)

NCVT-Set-D

All the NCVT strains found highly susceptible to cotton leaf curl disease. Minimum disease incidence and disease index was recorded in Eagle-3. Maximum CLCuD severity and disease index was observed in Cyto-510 Incidence of boll rot was recorded in traces (Table-5.6).

NCVT-Set-E

All the NCVT strains observed highly susceptibility to cotton leaf curl disease. Minimum disease severity and disease index was recorded in CIM-602(Bt-std-1) Maximum disease severity and disease index was observed in FH-655 All strains are free from boll rot incidence Table-5.7).

5.4 Epidemiological Studies on CLCuD

5.4.1 Incidence of Cotton Leaf Curl Disease (CLCuD) in Sowing Date Trial

Effect of sowing dates on *Bt*-Strains

Six advanced genotypes i.e.Cyto-511, Cyto-515 CIM-789, and CIM-663 CIM-343 with one standard cyto-179 were tested at six different sowing dates to observe the response to CLCuD with collaboration of Agronomy section of the Institute. The planting was done from 1st March till 15th May at 15 days interval. Experimental design was split plot (main plots: Sowing time; sub-plot: genotype). Data on CLCuD incidence were recorded fortnightly at day 30 from each planting date during the season. The results are given in **Fig-5.1**.

It is seen from the Fig-5.1 that the disease did not appear on crop planted from 15th March to 15th April with in 60 DAP The disease incidence remained low up to end of May (0.7 %) and reached maximum level (82.2 %) on 15th September in 1st March planting. Where as in 15th March planting CLCuD started to appear during the month of June (0.1 %) and then rapidly increase and attained its maximum level (77.9 %) during the mid of September.

In 1st April planting, disease incidence was 2.8 in the mid of June and reached 83 % at the mid of September. Whereas in 15th April planting disease incidence was 5.1% at the mid of June, 60.6 % during mid of august and reached 100 % at the mid of September,

In 1st May planting incidence started within 60 DAP (end of June) then increased sharply i.e. 44.7 to 100% during mid of July to mid of September whereas in 15th May planting disease symptoms appeared 0.8% within 30 days and disease incidence recorded 100% during the month of September (within 65 DAP)

Table-5.3 Stunting, Cotton Leaf Curl Disease Incidence, Severity, Disease Index and Boll Rot of Cotton on NCVT Set-A

NCVT Set A Strain	Stunting %age	Cotton Leaf Curl Disease			Boll Rot (%)
		Disease % age	Disease Severity	Disease Index	
CRIS-510 (Std-1)	1.67	100.00	2.99	74.64	0.00
CRIS-613	0	**77.64**	**3.03**	**58.82**	0.27
NIAB-818	0.33	100.00	2.97	74.19	0.49
CRIS-552	0	**100.00**	**3.05**	**76.19**	0.00
CIM-717	0	100.00	2.88	72.01	0.00
NIAB-191	0	100.00	3.01	75.15	0.00
Cyto-225	0	100.00	2.97	74.32	0.00
GS-Ali-7	0.67	100.00	2.93	73.24	0.00
GS-Ali-9	0	100.00	2.93	73.24	0.00
CIM-620 (Std-2)	0	85.88	2.91	62.93	0.00

Disease Severity

*__0__ = Complete absence of symptoms
__1__ = Small scattered vein thickening
__2__ = = Large groups of veins involved
__3__ =All veins involved
__4__ = All veins involved and severe curling

Disease Index= Disease percentage x Disease severity/maximum severity value (4)

Those crops which were planted earlier showed less disease incidence till July. All the cultivars showed minimum level of incidence when planted during the month of 15th March. As compare to 1stMarch sowing. All the varieties showed minimum level of disease when planted during the month of 1st April when compared to others which were planted during 15th April showed 41.5% incidence during the end of July and reached up to 100% at the end of the season. Whereas in 1st May and 15th May planting

all the cultivars showing highly susceptibility (63 to 79.8 %) at the end of August and reached 100% at the end of September (Fig-5.2).

Averages across planting dates there is no varietal difference in all sowing dates. All genotypes showed same behavior i.e. performed better in early planting as compared to late planting (Fig-5.3).

Table-5.4; Stunting, Cotton Leaf Curl Disease Incidence, Severity, Disease Index and Boll Rot of Cotton on NCVT Set-B

NCVT Set B Strain	Stunting %age	Cotton Leaf Curl Disease			Boll Rot (%)
		Disease % age	Disease Severity	Disease Index	
GH-Haadi	1.75	100.00	2.96	74.02	0.00
ICI-2121	0.00	100.00	3.03	75.82	0.00
IR-NIBGE-11(Mac-7)	2.33	100.00	2.89	72.24	0.00
BS-18	0.00	100.00	2.98	74.38	0.00
FH-490	0.00	100.00	3.02	75.39	0.00
Auriga-216	2.63	100.00	2.93	73.21	0.00
NIAB-898	0.00	100.00	3.03	75.77	0.00
GH-Mubarak	0.00	100.00	3.01	75.30	0.00
MNH-1026	0.00	100.00	2.97	74.16	0.00
RH-Afnan	0.00	100.00	2.97	74.17	0.00
Bt. CIM-663	0.00	100.00	2.97	74.29	0.00
CIM-602 (Bt Std-1)	2.50	100.00	3.03	75.82	0.28
Bt. CIM-343	0.00	*100.00*	*3.01*	*75.21*	0.00
KZ-125	2.33	100.00	2.88	72.04	0.00
AA-933	0.00	100.00	2.94	73.55	0.00
MNH-1020	0.81	100.00	2.96	73.97	0.00
Evyol-148	0.00	100.00	3.01	75.19	0.00
BH-221	0.00	**33.67**	3.00	**24.85**	0.00
Bahar-07	0.00	100.00	2.73	68.36	0.00
FH-444	0.00	100.00	2.98	74.46	0.00
NS-191	0.83	100.00	3.00	75.06	0.00
Bahar-2017	0.00	100.00	3.09	77.27	0.63
Cyto-515	0.00	100.00	2.97	74.20	0.31
IUB-13 (Bt Std-2)	2.38	**100.00**	**3.10**	**77.58**	0.00
IUB-69	0.00	100.00	2.87	71.70	0.00
BZU-05	0.00	100.00	2.97	74.15	0.00
NIA-85	2.50	100.00	3.00	74.99	0.00

Disease Index= Disease percentage x Disease severity/maximum severity value (4)

Table-5.5 Stunting, Cotton Leaf Curl Disease Incidence, Severity, Disease Index and Boll Rot of Cotton on NCVT Set-C

NCVT Set C Strain	Stunting %age	Cotton Leaf Curl Disease			Boll Rot (%)
		Disease %age	Disease Severity	Disease Index	
VH-383	2.02	**100**	**3.16**	**78.97**	1.00
VH-189	1.19	100	3.03	75.69	0.00
Tahafuz-10 (CII)	0.00	100	3.06	76.48	0.00
Weal AG-6	0.00	100	3.11	77.84	0.00
Tassco-902	0.00	100	3.04	75.95	0.00
Badar-1 (CII)	0.00	**100**	**2.84**	**71.00**	0.00
CII-TJ-King	2.08	100	3.00	74.92	0.00
RH-Manthar	0.00	100	3.03	75.64	0.00
Sahara-210	0.00	100	3.08	76.99	0.00
Shaheen-16	0.00	100	3.12	78.03	0.00
CIM-602 (Bt Std-1)	0.00	100	3.06	76.52	0.00
Suncrop-6	0.00	100	3.14	78.54	0.00
CII-Suncrop	0.00	*100*	*3.07*	*76.64*	0.00
Weal AG-5	0.00	100	3.13	78.21	0.00
Sitara-16	0.00	100	3.09	77.30	0.00
Shahab-7	0.00	100	2.96	73.97	0.00
IUB-13 (Bt Std-2)	0.00	100	3.10	77.59	0.00
NU-21 (CII)	0.00	100	3.11	77.63	0.00
CII-CEMB-101	0.00	*100*	*3.11*	*77.63*	0.00
CII-CEMB-100	0.88	100	3.06	76.48	0.00
CII-ICI-2222	0.00	100	3.07	76.81	0.00
SLH-19	0.00	100	3.08	76.93	0.00
Tipu-9	0.00	100	3.03	75.69	0.00
Suncrop-5	0.79	100	3.07	76.69	0.00
CII-Tahafuz-12	0.00	100	2.97	74.25	0.00
CII-Badar-2	**1.08**	100	2.96	74.10	0.00
CII-CEMB-102	**0.85**	100	3.04	76.10	0.00
Sahara-2020 (CII)	0.00	100	3.07	76.81	0.00
TJ-MAX (CII)	0.90	100	3.07	76.73	0.00
SLH-6	0.78	100	3.03	75.68	0.00

Disease Index= Disease percentage x Disease severity/maximum severity value (4)

Table-5.6 Stunting, Cotton Leaf Curl Disease Incidence, Severity, Disease Index and Boll Rot of Cotton on NCVT Set-D

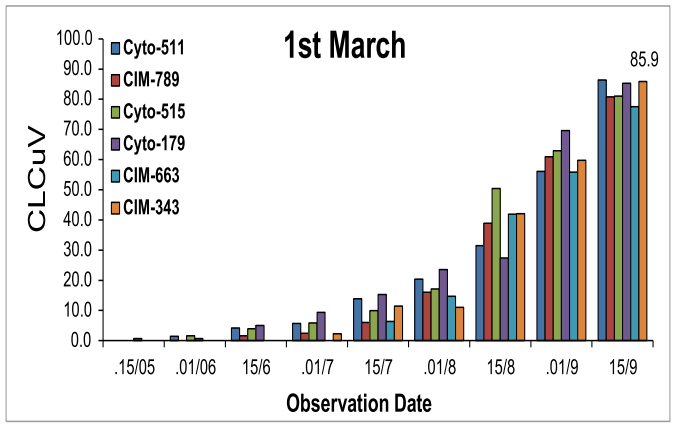
NCVT Set C Strain	Cotton Leaf Curl Disease			Boll Rot (%)
	Disease % age	Disease Severity	Disease Index	
Bt. CIM-678	100.00	2.98	74.62	0.00
CRIS-671	100.00	3.03	75.68	0.00
Ghauri-1 (CKC)	100.00	2.98	74.60	0.00
Eagle-3	**100.00**	**2.94**	**73.62**	0.00
IUB-13 (Bt Std-2)	100.00	3.06	76.58	0.00
Eye-111	*100.00*	*3.00*	*75.00*	0.41
BH-223	100.00	3.03	75.66	0.00
BZU-07	100.00	3.08	76.96	0.00
Cyto-511	100.00	3.08	77.12	0.00
Bt. CIM-789	100.00	3.10	77.47	0.43
Bt. CIM-303	100.00	3.05	76.22	0.00
CRIS-673	100.00	3.10	77.61	0.00
BS-20	100.00	2.96	73.94	0.00
BF-1	100.00	3.04	76.04	0.00
CIM-602 (Bt Std-1)	*100.00*	*3.04*	*75.98*	0.44
CEMB-Klean Cotton-1 (CKC)	100.00	3.11	77.83	0.00
CKC-Hatf-3	*100.00*	*2.98*	*74.62*	0.00
CEMB-Klean Cotton-(CKC)	*100.00*	*3.11*	*77.83*	0.00
Cyto-510	**100.00**	**3.12**	**78.05**	0.00
CKC-3	100.00	3.02	75.59	0.46
CKC-Sahara-Klean	100.00	3.12	78.05	0.00
CKC-TJ-Inqilab	100.00	3.02	75.41	0.00
Hatf-1 (CKC)	100.00	3.02	75.60	0.00
CKC-4	100.00	3.05	76.16	0.00
CKC-ICI-2323	100.00	3.08	77.12	0.00
Crystal-20	100.00	3.05	76.32	0.00
CKC-Clean Flex	100.00	3.03	75.80	0.00

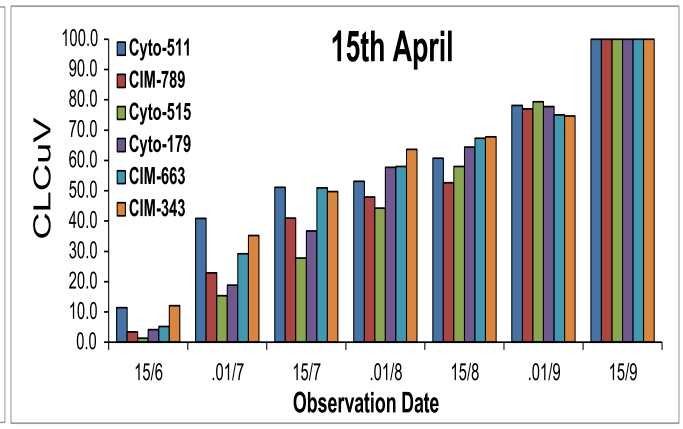
Disease Index= Disease percentage x Disease severity/maximum severity value (4)

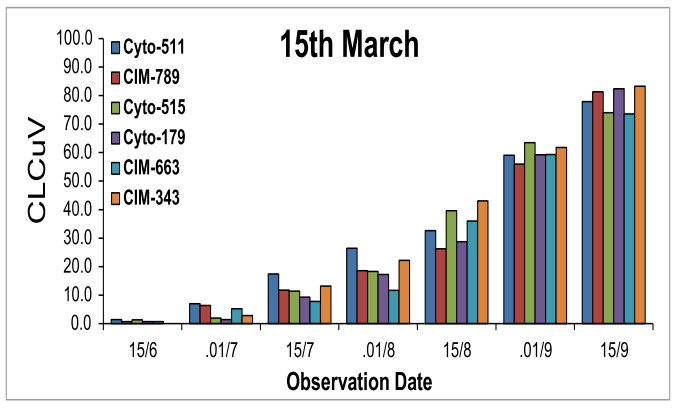
Table-5.7 Stunting, Cotton Leaf Curl Disease Incidence, Severity, Disease Index and Boll Rot of Cotton on NCVT Set-E

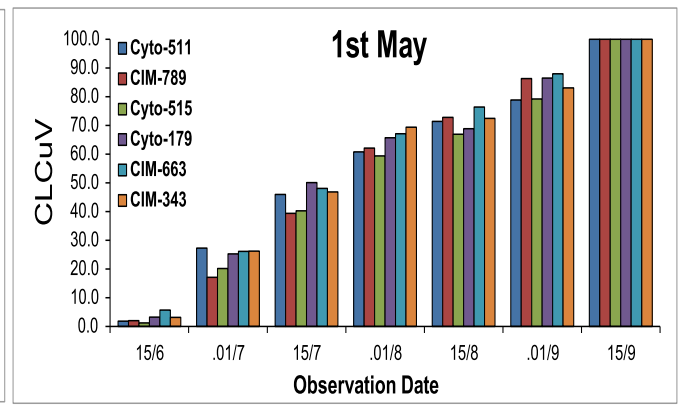
NCVT Set E Strain	Cotton Leaf Curl Disease			Boll Rot (%)
	Disease % age	Disease Severity	Disease Index	
Rohi-1	100	3.08	77.12	0.00
Weal AG-8	100	3.06	76.43	0.00
NIAB-135	100	3.11	77.74	0.00
Tipu-1524	100	3.03	75.76	0.00
VH-402	100	3.00	75.06	0.00
GH-UHAD	*100*	*3.03*	*75.69*	0.00
RH-670	100	3.04	75.93	0.00
Weal AG-7	100	3.00	74.92	0.00
IR-NIBGE-13	100	3.04	76.06	0.00
FH-Supper Cotton-2017	100	3.08	77.06	0.00
Rustam-11	100	2.98	74.58	0.00
FH-AM Cotton-2017	100	2.98	74.57	0.00
NIAB-1011	100	3.05	76.24	0.00
MNH-1035	100	3.05	76.21	0.00
CIM-602 (Bt Std-1)	**100**	**2.98**	**74.40**	0.00
FH-155	**100**	**3.19**	**79.71**	0.00
Tassco-112	*100*	*3.09*	*77.13*	0.00
ICI-2424	100	3.05	76.32	0.00
Eye-20	*100*	*3.01*	*75.22*	0.00
Koh-i-Noor	100	3.13	*78.32*	0.00
IR-NIBGE-12	100	3.09	*77.21*	0.00
IUB-13 (Bt Std-2)	100	3.06	76.50	0.00
MZM-7	100	3.01	75.21	0.00
IUB-71	100	3.08	76.88	0.00
SLH-33	100	3.02	75.41	0.00
NS-201	100	3.10	77.60	0.00

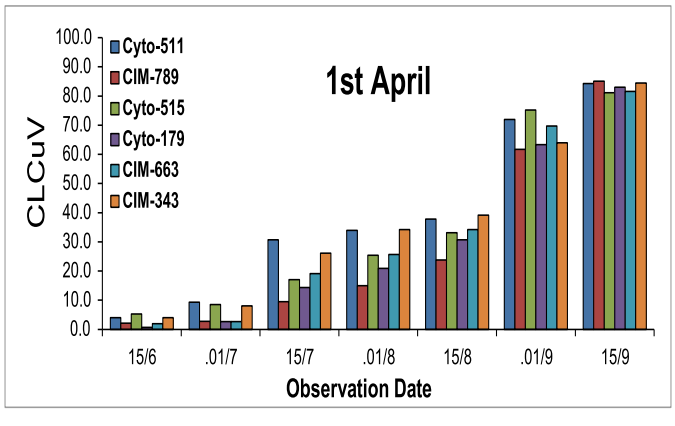
Disease Index= Disease percentage x Disease severity/maximum severity value (4)











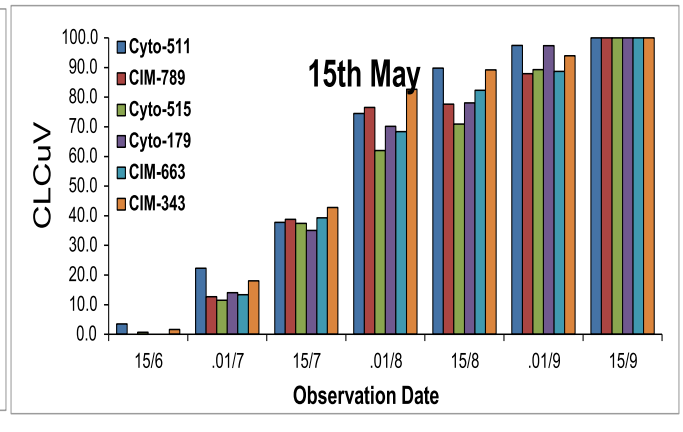


Fig-5.2 Incidence of CLCuD as influenced by planting Dates and strains on Bt-cotton

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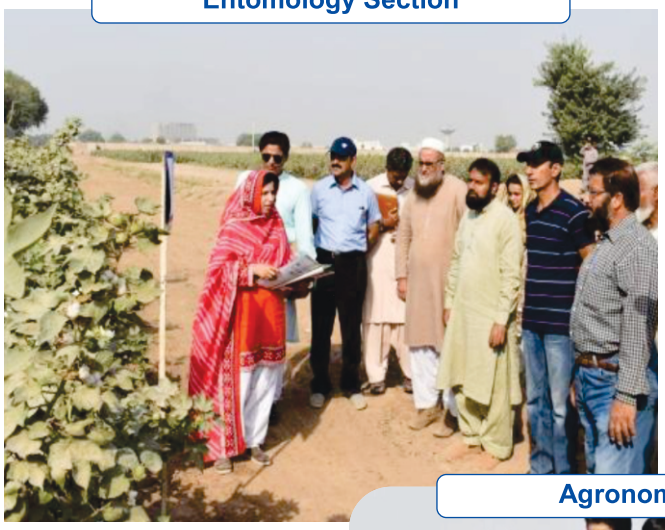
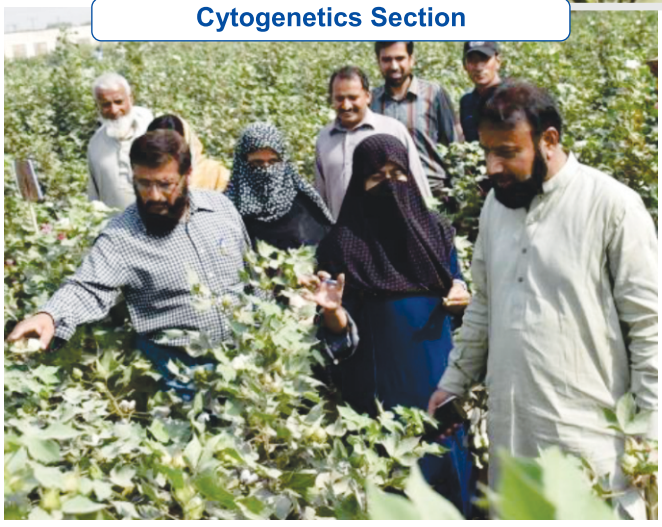
Entomology Section



Plant Physiology/Chemistry Section

Agronomy Section

Cytogenetics Section



Breeding Section

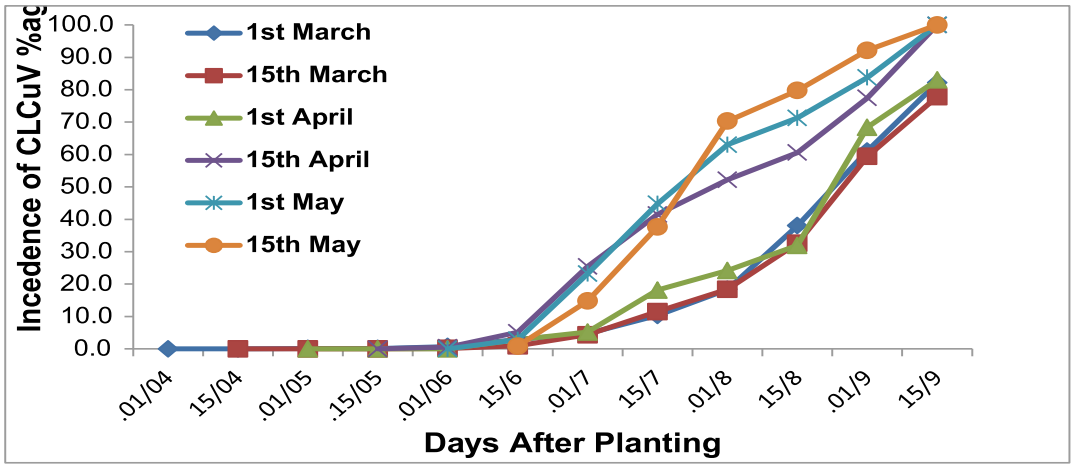


Fig-5.3 Effect of CLCuD Incidence as influenced by planting dates and Bt-strain

Data on incidence and severity were recorded during the end of September from each treatment and computed for disease index. Average across cultivars, the minimum disease index 60.5 and 56.8 % was recorded on crop planting on 1st and 15th March respectively as compare to other planting dates. Average planting dates, no significant difference was recorded in all genotypes Table-5.10

Table 5.8 Disease index of Cotton Leaf Curl on cultivars planted at different times

	Planting Dates						Average
	1st March	15th March	1st April	15th April	1st May	15th May	
Cyto-511	60.8	56.0	59.6	71.1	71.6	70.2	68.1
CIM-789	63.4	58.9	62.7	73.2	75.0	73.7	71.1
Cyto-515	62.3	55.3	63.1	77.2	76.7	77.4	73.6
Cyto-179	61.6	59.9	60.3	73.4	73.0	72.4	69.8
CIM-663	54.7	51.9	57.8	72.0	71.7	71.0	68.1
CIM-343	60.4	58.7	59.7	71.3	71.0	70.6	68.2
Ave	60.5	56.8	60.5	73.0	73.2	72.5	

D.I = Disease Index, Disease incidence **x** Severity/ maximum severity value (4)
CD 5% Sowing Dates = 12.6 Varieties = 4.38

On an average basis of sowing dates, maximum level of fortnightly increase of disease was recorded from end July to end August. Among environmental parameters the maximum temperature range was 33.6~ 37.2°C minimum temperature 23.4 ~ 30.0°C with the relative humidity 81.9 %~ 89.1 % during the above mentioned period. It's indicated that during that period the late sown crop was more affected than earlier (Table-5.9).

Table.5.9 Relationships between Fortnightly Increase in CLCuD and Temperature and humidity on Bt Cotton

Sowing date	1-15/4	16-30/4	1-15/5	16-31/5	1-15/6	16-30/6	1-15/7	**16-31/7**	**1-15/8**	**16-31/8**	1-15/9
1st March	0.0	0.1	0.0	0.6	2.2	1.7	5.6	8.0	19.7	23.1	21.1
15th March	0.0	0.0	0.0	0.1	0.8	3.4	7.1	6.9	14.2	26.8	18.4
1st April		0.0	0.0	0.0	2.8	2.4	12.9	6.1	7.8	36.4	14.6
15th April			0.0	0.5	4.6	20.3	16.1	10.7	8.4	16.9	22.5
1st May				0	2.8	20.4	21.6	18.3	8.2	12.5	16.2
15th May					0.8	13.9	22.9	32.6	9.4	12.4	7.8
Average	**0.00**	**0.03**	**0.00**	**0.25**	**2.81**	**12.44**	**17.24**	**16.53**	**13.55**	**25.61**	**20.15**
Temp Max C	35.4	37.2	37.4	39.7	40.6	37.2	35.0	36.7	33.6	36.1	33.6
Temp Min C	23.3	22.5	27.2	27.0	30.6	30.0	29.1	28.7	26.0	23.4	26.0
Difference	12.1	14.7	10.3	12.7	10.0	7.3	6.0	8.0	7.6	12.6	7.6
RH %age	63.7	69.7	59.8	68.5	73.0	82.5	80.9	84.6	86.8	89.1	86.8

5.4.2 Effect of Sowing Time on Non Bt. Trial

In the changing climate scenarios establishment of superior germplasm and its acclimatization is the dire need of time. It is hypothized that sowing of newly evolved diverse cotton genotypes at different sowing dates will give best sowing dates of each genotype for management against CLCuD.

Seeds of two elite cotton genotypes i-e CIM-610 and CIM-717 along with one standard variety CIM-620 were sown on five different sowing dates to observe the response to CLCuD with collaboration of Agronomy section of the Institute. The planting was done from 15th April to 15th June at 15 days interval. Experiment design was split plot (main plots: sowing time: sub plots genotypes). Data on CLCuD incidence were recorded fortnightly at day 30 from each sowing date during the season. Results are given in Fig-5.3

Effect of appearance of cotton leaf curl disease and its progression different significantly with sowing dates. Minimum CLCuD infestation was observed in 15thApril Planting in mid-July data i.e. 4.5%. With the advancement of age the infestation level reached 46 % during the mid of September.

A gradual increase in CLCuD incidence was observed in 1st May planting date. The disease started in mid-June with minimum level of incidence of 4.5% which increased moderately and reached to 53.2 % at the mid of September.

Similarly in case of 15th May planting CLCuD incidence was only 1.4% in the mid of June and got its maximum level 100 % in the mid of September (135DAP).

In 1stJune and 15thJune planting the disease started from mid-July (16% and 14.1 %) and reached up to 100 % respectively at the mid of September.

The level of disease incidence in CIM-620 showed less in 15th April and 1st May planting as compare to CIM-610 and CIM-717 Average across planting period. comparison among the varieties revealed There is a no varietal difference All varieties showed Maximum CLCuD infestation in earl planting and late planting during the mid of September (Fig-5.3).

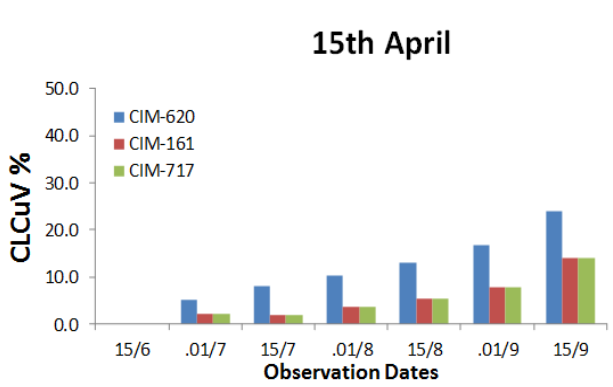
Data on incidence and severity were recorded during the end of September from each treatment and computed for disease index. Average across cultivars, the minimum disease index 33.7 % was recorded on crop planting on 15th April as compare to other planting dates. Average planting dates, minimum disease index level (47.0%) was recorded on genotype CIM-620 Table-5.10

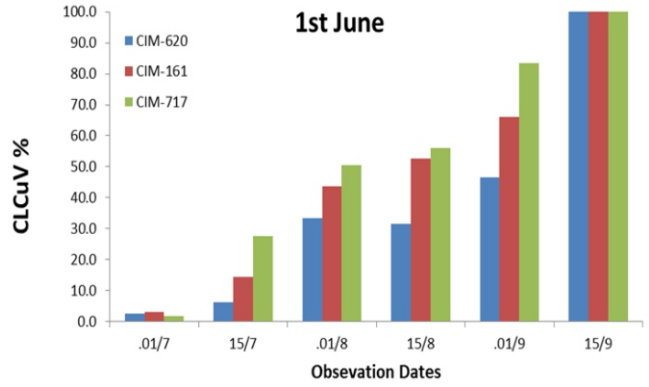
Table-5.10 Disease Index of CLCuD (%) on sowing date trial

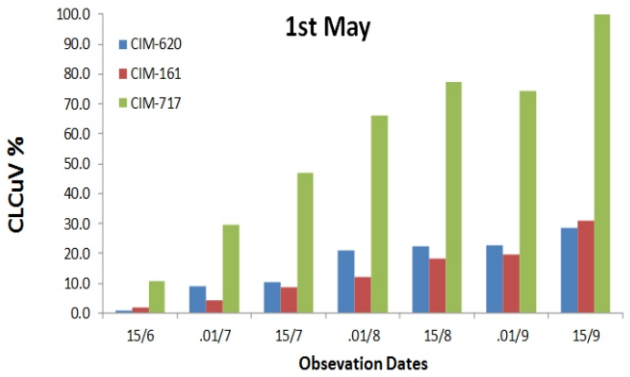
Cultivars	Planting Dates					Average
	15th April	1st May	15th May	1st June	15th June	
CIM-620	14.2	16.1	64.6	66.1	73.8	47.0
CIM-610	11.4	17.7	75.1	77.6	76.4	51.6
CIM-717	75.5	73.9	79.3	77.2	78.1	76.8
AVR	33.7	35.9	73.0	73.6	76.1	

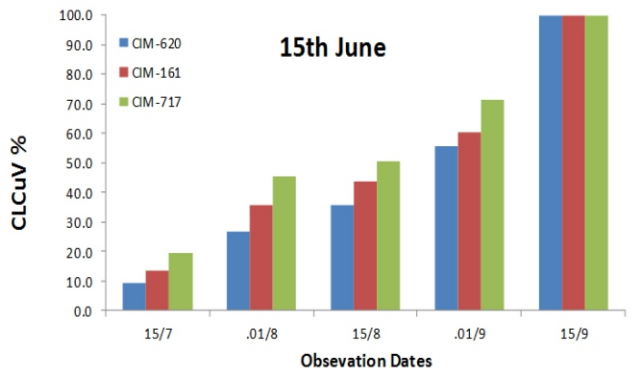
D.I = Disease Index, Disease incidence x Severity/ maximum severity value (4)
CD 5% Sowing Dates = 8.68 Varieties = 5.44

On an average basis of sowing dates, maximum level of fortnightly increase of CLCuD was recorded from mid-July to mid of September .Among environmental parameters the maximum temperature range was 33.6~37.2°C minimum temperature 26.0~30.0°C with the relative humidity 80.9 %~89 % during the above mentioned period. Difference between maximum and minimum temperature was less and humidity was maximum during the month of August which boost up the disease level. It was also confirmed that late sown crops were more affected than early sown due to plant vigor (Table-5.11).









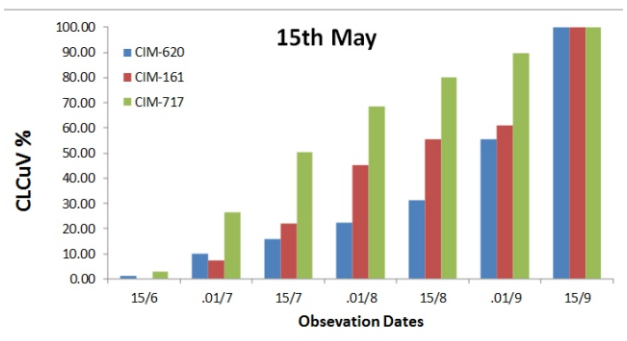


Fig-5.3 Effect of CLCuD Incidence as influenced by planting dates and strain

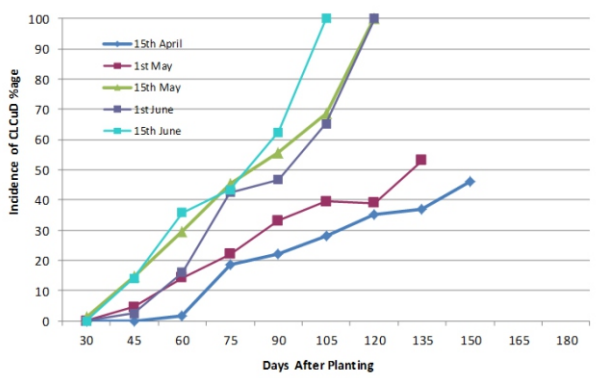


Fig-5.4 Incidence of CLCuD as influenced by planting Dates and strain on Non-Bt-cotton

Table 5.11 Relationship between fortnightly increases in CLCuD with weather parameters during 2018

Sowing Date	16-31/5	-15/6	16-30/6	1-15/7	**16-31/7**	**1-15/8**	**16-31/8**	1-15/9
15th April	*0*	1.6	17.0	3.6	5.9	7.1	1.8	9.0
1st May	0	4.5	9.8	7.7	11.0	6.4	-0.5	14.2
15th May	*0*	0.2	13.3	14.7	16.0	10.3	13.1	31.2
1st June			0	13.6	26.5	4.2	18.7	34.7
15th June				24.1	21.79	7.56	19.05	37.52
Average	0	2.1	10.0	12.7	16.2	7.1	10.4	25.3
Max. °C	39.7	40.6	37.2	36.2	36.9	35	36.7	33.6
Min. °C	27	30.6	30	29.5	29.9	29.1	28.7	26
Difference	12.7	10	7.2	6.7	7	5.9	8	7.6
RH%	68.5	73	82.5	84	83.4	80.9	84.6	86.8

5.5 Boll Rot of Cotton

5.5.1 Sowing Dates Trials

(a) Effect on *Bt*-Strains

An experiment was conducted to quantify the occurrence of boll rot disease in different strains planted at different dates during 1st March, 15th March, 1st April, 15th April, 1st May and 15th May. The results are given in Table 5.12

Averaged across sowing dates, Boll rot was recorded in traces or most of cultivars are free from boll rot incidence only three cultivars Cyto-511 and CIM-663 and Cyto-515 showed more than 1% boll rot disease incidence. On an average basis, the crop planted during 15th May was not affected by boll rot as compared to other planting times. On an average basis, boll rot disease ranged from 0.00 to 0.75 % in different sowing dates (Table-5.12).

(b) Effect on Non-*Bt*-Strains

Another experiment (non *Bt* varieties) was conducted to quantify the boll rot disease in different strains planted during 15th April to 15th June with fortnightly interval. The boll rot disease was recorded and results are given in Table 5.13.

Averaged across the varieties, no significant differences were noted in any crop planted during different timing. However March planting showed more disease was recorded as compared to others. Similarly averaged across sowing dates, all varieties showed boll rot less than 1 %. The boll rot disease ranged from 0.2 to 0.5% in all sowing dates on an average basis (Table 5.13).

Table-5.12 Effect of Boll Rot of Cotton Disease (%) on cultivars planted at different times

Cultivars	1st March*	15th March	1st April	15th April	1st May	15th May	Average
Cyto-511	1.25	0.00	0.00	0.00	0.00	0.00	**0.21**
CIM-789	0.80	0.00	0.34	0.84	0.00	0.00	**0.33**
Cyto-515	0.00	0.00	1.15	0.00	0.46	0.00	**0.27**
Cyto-179	0.50	0.86	0.90	0.00	.0.00	0.00	**0.07**
CIM-663	1.20	0.84	0.90	0.00	0.00	0.00	**0.49**
CIM-343	0.40	0.00	0.00	0.00	0.00	0.00	**0.07**
AVR	**0.75**	**0.34**	**0.60**	**0.21**	**0.11**	**0.00**	

Table-5.13 Effect of Boll Rot of Cotton Disease (%) on cultivars planted at different times

Cultivars	15th April*	1st May	15th May	1st June	15th June	Average
CIM-620	0	0.5	0.2	0.0	0.2	0.2
CIM-610	0.2	0.2	0.4	0.4	0.4	0.3
CIM-717	0.6	0.2	0.8	0.2	0.6	0.5
AVR	**0.3**	**0.3**	**0.5**	**0.2**	**0.4**	

5.6 Seedling disease of Cotton

To see the effect of different fungicides and effect of soil temperature against seedling disease of cotton, an experiment was conducted during April and May Five fungicides i.e. Argyl supper, Combinex, Dynesty, Topsin M and carbendazim were used along with control. All seeds were treated with fungicides @ 3mg/kg of cotton seed. The data revealed that seedling mortality decreased with the increased of soil temperature. Similarly all fungicides reduced the seedling mortality. Dynesty and Topsin-M showed best performance as compare to control in April planting. Average across the fungicides treatment, In May sowing mortality was low due to high temperature as compare to April sowing when temperature was low.

Table -5.14 Effect of different fungicides on seedling mortality cotton

Fungicides	1st April		1st May	
	Seedling Mortality (%age)	Soil Temp °C	Seedling Mortality (%age)	Soil Temp °C
Argyl supper	8.3	27.4	0	29.2
Combinex	8.3	27.4	0	29.2
Dynesty	0.0	27.4	0	29.2
Topsin-M	0.0	27.4	0	29.2
Carbendazim	8.3	27.4	8.3	29.2
Control	22.2	27.4	0	29.2
Ave	**7.86**	**27.4**	**1.38**	**29.2**

1st Organic Cotton Bale & Supply Chain

Dr. Zahid Mahmood, Director CCRI Multan attended the “1st Organic Cotton Bale & Supply Chain” meeting organized by WWF Pakistan on 30.01.2019 at AA Cotton Industries, Sadiq Abad. WWF-Pakistan is implementing Organic Cotton Production project in three districts of Balochistan in collaboration with Agriculture Extension Department Govt. of Balochistan since 2016. CCRI Multan also contributed in the provision of non-GMO seed for planting in Balochistan and endures to cooperate with WWF for organic cotton production in future as well.

6. PLANT PHYSIOLOGY /CHEMISTRY SECTION

Studies were carried out on plant nutrition, seed physiology, plant-water relationships and thermal stress tolerance in cotton.

6.1 Plant nutrition

6.1.1 Cotton response to Magnesium application by fertigation and foliar methods

Magnesium (Mg) is an essential macronutrient required for the normal growth and development of plants. It plays many various physiological and molecular roles in plants, such as being a component of the chlorophyll molecule, a cofactor for many enzymatic processes associated with phosphorylation, dephosphorylation, and the hydrolysis of various compounds, and a bridging element for the aggregation of ribosome subunits necessary for protein synthesis. For example, numerous key chloroplast enzymes are strongly influenced by slight variations in Mg^{2+} levels in the cytosol and the chloroplast, indicating the significance of maintaining Mg homeostasis in plants. The availability of Mg to plants depends on various factors: the distribution and chemical properties of the source rock material and its grade of weathering, site specific climatic and anthropogenic factors and, in agricultural systems, to a high degree on the management practices established at the specific production site including the cultivated crop species and crop rotation, cropping intensity and organic and mineral fertilization practice. The importance of Mg in crop production was underestimated in the last decades. Indeed, compared to other nutrients little attention has been paid on this mineral nutrient by scientists in the last decades. Therefore, the term 'the forgotten element' was introduced and used for this element. Mg deficiency is common phenomenon in crop production; typical Mg deficiency symptoms are leaf interveinal chlorosis, degradation of chlorophyll and loss of plastic pigments that cause dramatic yield reduction. Crop productivity and yield can be improved by balance nutrition and efficient application method. The objective of this study was to investigate the role of Mg in improving cotton productivity and its efficient method of application.

The crop was sown on 5th of May 2018 in a Randomized Complete Block Design with Split Plot arrangement. Magnesium sulphate for Mg source was applied either through foliar @ 0, 3, 6 kg ha^{-1} or by fertigation @ 0, 10, 20 kg ha^{-1}. Cotton genotypes CIM-343 (Bt) and CIM-610 (non-Bt) were used as test crop. The NPK fertilizers were applied according to recommended fertilizer doses. Standard production and management practices were adopted.

Pre-plant composite soil samples were collected from the plough layer of experimental field before imposition of treatments. Physical and chemical characteristics of the soil were determined. The results indicated that the soil is silt loam in texture and alkaline in reaction. The soil is medium in organic matter, extractable phosphorus, extractable potassium and available magnesium (Table 6.1).

Table 6.1 Physical and chemical characteristics of soil at pre- planting

Characteristics	Values
pH	8.20
ECe (dSm^{-1})	2.14
Organic matter (%)	0.94
$NaHCO_3$-P (mg kg^{-1})	10.5
NH_4OAc-K (mg kg^{-1})	108
Available Mg (mg kg^{-1})	46
Textural class	silt loam

Data on plant structure development were recorded at maturity. In plots where Mg was applied by foliar method, the main stem height, number of nodes on main stem and inter-nodal length remained higher as compared to fertigation method (Table 6.2). Averaged across genotypes, main stem height varied from 111 to 129 cm in foliar applied Mg and 112 to 121 cm in fertigation method among different treatments. As concentration of Mg increased in foliar and fertigated methods the main stem height and number of nodes on main stem also increased, in general, in both genotypes that indicate the direct relationship between Mg dose and plant growth. A comparison between genotypes revealed that CIM-610 produced greater height and larger inter-nodal length than CIM-343, irrespective of Mg application methods.

The uptake of Mg in different plant parts was determined from oven dried plant material. Data revealed that Mg uptake in leaf samples varied from 1.48 to 1.88 kg/ha with average value of 1.64 in CIM-343 and 1.48 to 1.82 kg/ha with average value of 1.61 in CIM-610 in plots where magnesium sulfate was applied through fertigation. The corresponding values of Mg uptake where Mg was applied by foliar method were relatively increased that ranged from 1.49 to 1.95 kg/ha with average value of 1.68 in CIM-343 and from 1.47 to 1.86 kg/ha with average value of 1.64 in CIM-610. Similar trends of Mg uptake were observed in stalk and fruit of both genotypes. The Mg uptake by cotton plant increased with the increasing dose of applied Mg. The maximum Mg uptake was observed in fruit portion. The uptake of Mg was observed in following order fruit > leaves > stalk. The maximum total uptake of Mg 9.05 kg/ha was observed in CIM-343 with 6.0 kg magnesium sulfate dose applied through foliar method (Table 6.3).

Table 6.2 Effect of applied magnesium by fertigation and foliar methods on plant structure development at maturity in two cotton genotypes

Mg- dose	Height (cm)			Node			Internodal distance (cm)		
	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean
Fertigation of Mg (kg ha^{-1})									
0	110	114	**112**	45	41	**43**	2.44	2.78	**2.61**
S-control	111	116	**114**	45	42	**44**	2.47	2.76	**2.62**
10	116	125	**121**	47	47	**47**	2.47	2.66	**2.57**
20	117	119	**118**	46	44	**45**	2.54	2.70	**2.62**
Mean	**114**	**119**		**46**	**44**		**2.48**	**2.73**	
Foliar applied Mg (kg ha^{-1})									
0	108	113	**111**	46	43	**45**	2.35	2.63	**2.49**
S-control	112	114	**113**	44	42	**43**	2.55	2.71	**2.63**
3	121	125	**123**	48	47	**48**	2.52	2.66	**2.59**
6	125	132	**129**	41	52	**47**	3.05	2.54	**2.80**
Mean	**117**	**121**		**45**	**46**		**2.62**	**2.64**	

Table6.3 Effect of foliar applied and fertigated magnesium sulfate on Mg uptake by Bt.CIM-343 and CIM-610

Mg-dose	Leaves			Stalk			Fruit			Total		
	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean
Fertigated Mg (kg ha^{-1})												
0	1.48	1.48	**1.48**	1.35	1.35	**1.35**	5.09	5.03	**5.06**	7.92	7.86	**7.89**
S-control	1.50	1.49	**1.50**	1.37	1.35	**1.36**	5.20	5.11	**5.16**	8.07	7.95	**8.01**
10	1.71	1.66	**1.69**	1.42	1.38	**1.40**	5.32	5.30	**5.31**	8.45	8.34	**8.40**
20	1.88	1.82	**1.85**	1.46	1.40	**1.43**	5.43	5.40	**5.42**	8.77	8.62	**8.70**
Mean	**1.64**	**1.61**		**1.40**	**1.37**		**5.26**	**5.21**		**8.30**	**8.19**	
Foliar applied Mg (kg ha^{-1})												
0	1.49	1.47	**1.48**	1.37	1.35	**1.36**	5.14	5.06	**5.10**	8.00	7.88	**7.94**
S-control	1.52	1.50	**1.51**	1.38	1.35	**1.37**	5.21	5.11	**5.16**	8.11	7.96	**8.04**
3	1.77	1.72	**1.75**	1.44	1.40	**1.42**	5.45	5.37	**5.41**	8.66	8.49	**8.58**
6	1.95	1.86	**1.91**	1.49	1.44	**1.47**	5.60	5.48	**5.55**	9.05	8.79	**8.92**
Mean	**1.68**	**1.64**		**1.42**	**1.39**		**5.35**	**5.26**		**8.46**	**8.28**	

Seed cotton yield, number of boll per plant and boll weight varied among different Mg doses, cotton genotypes and the application methods. Seed cotton yield and its components increased with the concurrent increase in Mg doses. The maximum seed cotton yield was observed with higher dose of Mg both in foliar applied and fertigated methods. A comparison of the Mg application methods revealed that seed cotton yield was higher in foliar application as compared to fertigation of Mg. The plots with foliar applied Mg produced yield in the range of 2477 to 3639 kg ha^{-1} seed cotton, 30 to 40 bolls per plant and 1.89 to 2.24 g boll weight as compared to Mg fertigated plots where the yield ranged from 2467 to 3538 kg ha^{-1}, bolls per plant from 28 to 37 and boll weight from 1.88 to 2.28 g, irrespective of cotton genotypes. Among the genotypes CIM-343 produced higher seed cotton yield (Table 6.4).

The data of fiber characteristics revealed that staple length ranged from 25.2 to 27.2 mm, uniformity from 82.1% to 84.4%, micronaire from 4.8 to 5.2 ug/inch and strength from 25.7 to 26.8 g/tex in Mg fertigated plots irrespective of genotypes. Plants from one-meter square area were harvested at maturity and partitioned into leaf, stalk and fruit portions. The dry matter yield of leaf, stalk and fruit organs increased with the increasing dose of Mg fertilizer both in foliar and fertigation methods. The corresponding values of fiber characteristics relatively increased in the plots where Mg applied by foliar method. A comparison between two methods revealed that by foliar application of Mg improve fiber characteristics as compared to fertigation method (Table 6.5).

Table No. 6.4 Effect of applied magnesium through foliar and fertigation methods on cotton productivity in two genotypes

Mg-dose	Bolls/plant			Boll weight (g)			Seed cotton yield (kg ha^{-1})		
	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean
Fertigation of Mg (kg ha^{-1})									
0	35	28	**32**	2.12	1.88	**2.00**	3138	2467	**2803**
S-control	36	29	**33**	2.13	2.05	**2.09**	3218	2532	**2875**
10	36	29	**33**	2.26	2.15	**2.21**	3396	2656	**3026**
20	37	30	**34**	2.28	2.20	**2.24**	3538	2727	**3133**
Mean	**36**	**29**		**2.20**	**2.07**		**3223**	**2596**	
Foliar applied Mg (kg ha^{-1})									
0	35	30	**33**	2.12	1.89	**2.01**	3150	2477	**2814**
S-control	36	30	**33**	2.12	2.00	**2.06**	3243	2558	**2901**
3	38	31	**35**	2.22	2.14	**2.18**	3512	2740	**3127**
6	40	31	**36**	2.24	2.20	**2.22**	3639	2820	**3230**
Mean	**37**	**31**		**2.18**	**2.06**		**3386**	**2648**	

Table 6.5 Effect of applied magnesium through foliar and fertigation methods on cotton fiber characteristics in two genotypes

Mg-dose	Staple length (mm)			Uniformity Index (%)			Micronaire (ug/inch)			Strength (g/tex)		
	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean	CIM-343	CIM-610	Mean
Fertigation of Mg (kg ha^{-1})												
0	25.2	26.7	**26.0**	83.4	83.5	**83.5**	5.1	4.8	**5.0**	26.3	26.2	**26.3**
S-control	25.5	27.0	**26.3**	82.4	84.2	**83.3**	5.1	5.0	**5.1**	26.1	26.5	**26.3**
10	25.7	27.2	**26.5**	82.1	83.3	**82.7**	4.9	5.0	**5.0**	25.7	26.6	**26.2**
20	26.1	27.2	**26.7**	84.4	83.6	**84.0**	5.2	4.6	**4.9**	25.9	26.8	**26.4**
Mean	**25.6**	**27.0**		**83.1**	**83.7**		**5.1**	**4.9**		**26.0**	**26.5**	
Foliar applied Mg (kg ha^{-1})												
0	25.3	26.8	26.1	82.2	84.0	83.1	5.0	4.8	4.9	26.0	26.3	26.2
S-control	25.5	27.0	26.3	82.4	84.2	83.3	5.1	5.0	5.1	26.1	26.5	26.3
3	26.9	27.4	27.2	81.8	83.4	82.6	5.1	4.6	4.9	26.7	28.0	27.4
6	25.8	27.6	26.7	82.0	84.3	83.2	5.3	5.0	5.2	25.0	27.6	26.3
Mean	**25.9**	**27.2**		**82.1**	**84.0**		**5.1**	**4.9**		**26.0**	**27.1**	

6.2 Seed physiology

6.2.1 Exploring the role of antioxidants and growth hormone in cotton plant growth, cottonseed health and productivity

Cotton plant encounter a complex set of abiotic and biotic stresses very frequently during the growing season. Abiotic stresses, being unavoidable, have major negative impact on crop production worldwide. These stresses such as inadequate and inconsistent rainfall, salinity, water shortage, extreme temperature, and some other factors are not only limiting crop yields but also seem to be inevitably worsening. Considering present situation, it is imperative to switch to some more sophisticated techniques that shall combat abiotic environmental challenges and improve crop yield efficiently. Among these, seed priming is a commonly utilized technology in enhancing seed vigor and stress tolerance. Seed priming involves the attainment of a specific physiological state by synthetic or natural compounds.

Cotton plant raised from primed seeds exhibit instant cellular response against abiotic stresses. Primed seed acquire resistance through various cellular and metabolic pathways which involve cascades of signaling networks. Studies, till date, have confirmed that primed seeds have several advantages over traditionally used methods which include uniform germination, reduction in germination and emergence time, and broad range of tolerance against disease and environmental stresses. Seed priming methods are widely used as an emerging technology to produce tolerant crop varieties against abiotic stresses. Seed priming involves soaking of seed in water, nutrients or other salts like antioxidants i.e. ascorbic acid, citric acid and growth hormones e.g. Gibberellic acid for a certain period that leads to changes in metabolic profile of the seed.

Ascorbic Acid (AA), a small water-soluble antioxidant molecule, acts as a primary substrate in the cyclic pathway for detoxification and neutralization of superoxide radicals and singlet oxygen. Ascorbic acid (vitamin C) is one of the key products of D-glucose metabolism which play multiple roles in plant growth and development such as cell division, cell wall expansion, electron transport system and other developmental processes. The foliar spraying with ascorbic acid contributed in protecting the photosynthetic machinery from the damaging effects of stress. The application of ascorbic acid mitigated the adverse effect of salt stress on plant growth which may be due, in part, to increased leaf area, improved chlorophyll and carotenoid contents and enhanced proline accumulation. Exogenous application of ascorbic acid enhanced vegetative growth which may contribute to increased plant biomass and yield.

Citric Acid (CA) is an organic compound belonging to the family of carboxylic acids. Citric acid is present in all plants. It is one of a series of compounds involved in the physiological oxidation of fats, proteins and carbohydrates to CO_2 and water. Effects of citric acid on growth and yield of crops include plant height, yield and its components as well as protein content. The ascorbic and citric acids appeared to act in a concert which indicates a complete set of antioxidant defense system, rather than protection by a single antioxidant under stressful conditions. The foliar spray of citric acid significantly increased shoot fresh weight, shoot dry weight, root fresh weight and root dry weight.

Gibberellic acid (GA), one of the plant hormones, is produced by the scutellum (cotyledon) of the embryo, stimulates the production of amylase by the aleuronic layer amylase hydrolyzes starch to simple sugars absorbed by scutellum and translocated to embryo for growth. It is often used to overcome seed dormancy, mainly through the activation of embryo growth, mobilization of reserves, and weakening of the endosperm layer. GAs play important roles in many essential plant growth and development processes like shoot length, root length, and seedling weight, stem elongation, leaf expansion, flower and fruit development, and floral transition.

The aim of this investigation was to evaluate the response of cotton in terms of growth, cottonseed health and productivity to seed priming or foliar spray with antioxidants and growth hormone. In one set seed priming with antioxidants and growth hormone was done prior to sowing while in the other set foliar sprays were initiated when the crop reached fruiting phase i.e. 35-40 days old. Subsequent foliar sprays were done after 15 days' intervals.

The detail of treatments applied is given below:

Treatments	Seed Priming	Foliar Application
	(mg/L)	
T1	Water alone (Control)	Water alone (Control)
T2	AA (50)	AA(200)
T3	CA (100)	CA (400)
T4	GA (10)	GA(50)
T5	AA (50) + CA (100)	AA (100) + CA(200)
T6	AA (50) + GA (10)	AA (100) + GA (25)

Composite soil samples from the plough layer were collected before imposition of treatments. Physical and chemical characteristics of the soil were determined. The results indicated that the experimental soil has silt loam texture, alkaline pH, medium levels of organic matter, available-P, extractable-K, extractable-Zn and B (Table 6.6).

Visit of Agriculture Minister, Punjab

Sardar Tanveer Ilyas Khan, Minister for Agriculture, Punjab visited CCRI Multan on 06.07.2018. Dr. Zahid Mahmood, Director CCRI Multan briefed about the activities and achievements of the Institute. The Minister appreciated role of CCRI Multan in cotton research and development especially contributions for the betterment of farming community. Later the Minister also visited fields and labs of the Institute.

VISIT OF JOURNALISTS

A delegation of journalists from print and electronic media visited CCRI Multan. The team comprises media persons from Geo TV, Abtak, Rohi TV, Jang, Nawa-i-waqt, Khabrain, Dunya, Pakistan and Daily Aftab. Dr. Zahid Mahmood, Director CCRI Multan briefed the media persons about cotton research and development activities of the Institute. The media persons also visited fields of advanced lines developed by the Institute.

Table 6.6 Physical and chemical characteristics of soil at pre- planting

Characteristics	Values
pH	8.21
ECe (dSm^{-1})	2.08
Organic matter (%)	0.96
$NaHCO_3$-P ($mg\ Kg^{-1}$)	10.1
NH_4OAc-K($mg\ Kg^{-1}$)	113
AB-DPTA-Zn ($mg\ Kg^{-1}$)	0.95
Hot water extractable-B ($mg\ Kg^{-1}$)	0.55
Textural class	silt loam

Plant structure development in different treatments was recorded at maturity. Main stem height, nodes on main stem and inter-nodal length varied among different treatments. In seed primed plots, main stem height varied from 103 to 119 cm, number of nodes on main stem from 36 to 42 and inter-nodal length from 2.83 to 2.89 cm in different treatments while in foliar sprayed plots, main stem height varied from 105 to 121 cm, number of nodes on main stem from 37 to 43 and inter-nodal length from 2.74 to 2.90 cm in different treatments (Table 6.7).

Table 6.7 Effect of seed primed or foliar applied antioxidants and growth hormone on vegetative development at maturity

Treatments	Main stem height (cm)	Nodes on main stem	Inter-nodal length (cm)
		Seed primed	
T1: Water alone (Control)	103	36	2.86
T2: AA (50)	113	40	2.83
T3: CA (100)	107	37	2.89
T4: GA (10)	119	42	2.83
T5: AA (50) + CA (100)	116	41	2.83
T6: AA (50)+GA (10)	115	40	2.88
LSD	**6.21***	**3.64 ns**	**0.30 ns**
		Foliar Applied	
T1: Water alone (Control)	105	37	2.84
T2: AA (200)	119	41	2.90
T3: CA (400)	110	39	2.82
T4: GA (50)	121	43	2.81
T5: AA (100) + CA (200)	118	43	2.74
T6: AA (100)+GA (25)	116	42	2.76
LSD	**7.92***	**3.93 ns**	**0.23 ns**

Seed cotton yield differed significantly ($p<0.05$) among various treatments. In seed primed plots, seed cotton yield varied from 3505 to 3864 kg ha^{-1} while in foliar sprayed plots seed cotton yield ranged from 3545 to 4143 in different treatments. The maximum seed cotton yield was produced in Gibberellic acid (GA) treated plots (T4) either applied by seed priming (@10 mg/l GA) or by foliar application (@ 50 mg/l GA) as compared to other treatments. The ginning outturn did not vary significantly among different treatments. The GOT in different treatments varied from 35.4 to 37.5% in seed primed and from 35.9 to 38.1% in foliar applied method (Table 6.8).

Table 6.8 Effect of seed primed or foliar applied antioxidants and growth hormone on seed cotton yield and GOT

Treatments	Seed Cotton Yield (kg ha^{-1})	GOT%
	Seed primed	
T1: Water alone (Control)	3505	35.4
T2: AA (50)	3585	36.3
T3: CA (100)	3625	36.0
T4: GA (10)	3864	35.4
T5: AA (50) + CA (100)	3784	37.0
T6: AA (50)+GA (10)	3644	36.9
LSD	**243.6****	**1.80** ^{ns}
	Foliar Applied	
T1: Water alone (Control)	3545	35.9
T2: AA (200)	3605	36.4
T3: CA (400)	3665	36.2
T4: GA (50)	4143	38.1
T5: AA (100) + CA (200)	3904	37.4
T6: AA (100)+GA (25)	3824	37.1
LSD	**257.2****	**1.51** ^{ns}

The assessment of seed quality parameters was done from the mature cotton seeds. Results indicated that seed primed and foliar applied antioxidants (ascorbic acid and Citric acid) and growth hormone (Gibberellic acid) improved parameters such as seed germination, seed index, oil and crude protein content. Biochemical analysis of the oil revealed that the free fatty acids were within safe limits i.e. less than1.0%. In seed primed treatments, seed germination varied from 70-85%, seed index from 6.57-7.44g, oil content from 10 to16 % and crude protein from 21.0 to 27.7 % in different treatments. While in foliar sprayed treatments seed germination varied from 77-87%, seed index from 6.91-7.87g, oil content from 11 to 18% and crude protein from 22.0 to 28.9 % in different treatments (Table 6.9).

Table 6.9 Effect of seed primed or foliar applied antioxidants and growth hormone on seed quality parameters

Treatments	pH	EC (µS cm^{-1})	Na (%)	K (%)	Seed index (g)	Germination (%)	Oil (%)	Free fatty acid (%)	Crude protein (%)
					Seed priming				
T1: Water alone (Control)	6.0	164	0.47	0.60	6.57	70	10.0	0.94	21.0
T2: AA (50)	6.4	121	0.44	0.64	6.95	78	13.0	0.67	24.5
T3: CA (100)	6.3	107	0.56	0.67	6.73	73	12.5	0.72	20.7
T4: GA (10)	7.2	197	0.61	0.87	7.44	85	16.0	0.50	27.7
T5: AA (50) + CA (100)	5.6	179	0.50	0.65	7.26	80	14.5	0.60	26.5
T6: AA (50)+GA (10)	5.7	142	0.57	0.61	7.20	79	15.0	0.66	25.9
Mean	**6.2**	**160**	**0.53**	**0.67**	**7.03**	**77**	**13.5**	**0.68**	**24.4**
					Foliar Applications				
T1: Water alone (Control)	4.0	154	0.49	0.65	6.91	77	11.0	0.87	22.0
T2: AA (200)	6.1	104	0.55	0.70	7.02	84	14.0	0.59	23.8
T3: CA (400)	4.0	96	0.58	0.74	6.97	80	13.0	0.67	21.0
T4: GA (50)	3.9	179	0.66	0.91	7.87	87	18	0.41	28.9
T5: AA (100) + CA (200)	4.1	146	0.52	0.69	7.58	84	16.5	0.50	27.4
T6: AA (100)+GA (25)	4.1	162	0.59	0.62	7.06	81	15.5	0.64	26.3
Mean	**4.4**	**138**	**0.57**	**0.72**	**7.25**	**82**	**14.6**	**0.61**	**24.9**

Data on fibre characteristics indicated that seed primed or foliar applied antioxidants (ascorbic acid and Citric acid) and growth hormone (Gibberellic acid) improved staple length, fibre strength, fibre fineness and uniformity index among different treatments. In seed primed treatments, staple length ranged from 25.6 to 27.6 mm, fibre strength from 26.0 to 28.6 G/Tex, uniformity index from 81.2 to 83.4 and fibre fineness from 4.6 to 5.0 µg inch^{-1} .In foliar sprayed treatments, staple length ranged from 25.2 to 26.7 mm, fibre strength from 25.7 to 27.7 G/Tex, uniformity index from 79.9 to 83.2 % and fibre fineness from 4.6 to 4.9 µg inch^{-1} (Table 6.10).

Table 6.10 Effect of seed primed or foliar applied antioxidants and growth hormone on fiber characteristics in different treatments

Treatments	Staple length (mm)	Uniformity index (%)	Micronaire (µg inch^{-1})	Strength G/Tex (1/8")
Seed primed				
T1: Water alone (Control)	25.6	81.2	4.6	26.0
T2: AA (50)	26.2	82.4	4.7	27.1
T3: CA (100)	26.1	82.1	4.7	27.1
T4: GA (10)	27.6	83.4	5.0	28.6
T5: AA (50) + CA (100)	26.5	82.6	4.9	27.6
T6: AA (50)+GA (10)	26.3	82.6	4.8	27.5
Mean	**26.4**	**82.4**	**4.8**	**27.3**
Foliar Applied				
T1: Water alone (Control)	25.2	79.9	4.6	25.7
T2: AA (200)	25.8	81.6	4.7	26.5
T3: CA (400)	25.3	81.0	4.7	25.8
T4: GA (50)	26.7	83.2	4.9	27.7
T5: AA (100) + CA (200)	26.2	82.5	4.8	27.5
T6: AA (100)+GA (25)	26.0	81.8	4.7	27.4
Mean	**25.9**	**81.7**	**4.7**	**26.8**

6.3 Soil-Plant-Water Relationships

6.3.1 Screening of advanced genotypes for drought tolerance

The potential of any crop variety is subjected to various environmental conditions and a large fraction of the potential yield cannot be attained. It is speculated that crop attains less than 25 % of the potential yield due to the adverse environmental conditions, and low water availability affected crop productivity nearly as much as all the other environmental factors. Amongst the abiotic stresses, deficiency of soil water constitutes a primary limitation to crop productivity in many regions of the world. Water deficit is not only the cause of differences between actual yield and the potential yield, but it also results in yield instability of crops. Both surface and ground water resources in world are inadequate to meet the growing requirements for irrigation of agricultural crops. Drought has a very critical effect on growth, yield and quality characters. Limited water supply and high-energy costs can also decrease the yield of irrigated cotton. Root characteristics can be significant in predicting the response of plants to drought. Drought effect not only decreases plant height, shoot growth rate, and yield but also diminishes root growth. It has been found from earlier studies that varieties/cultivars in each species vary from one another in their actions under drought conditions, signifying that drought tolerance in these groups can be improved through breeding. Physiological traits linked with drought tolerance in cotton have strong relationship with yield parameters. For example, photosynthetic rate; which significantly decreases with the imposition of water stress, can be effectively used for germplasm screening under drought conditions. Since, the response of germplasm with genetic variability may exhibit differential response under normal and water deficit conditions, regular screening of emerging germplasm need to be carried out for better adaptability and sustainable production. The following studies were, therefore, to evaluate advanced cotton genotypes for drought tolerance characteristics under field conditions. This study will help to understand the relationship of different physiological and growth traits of cotton and their direct and indirect effects related to cotton productivity.

A field experiment was conducted at the experimental area of Central Cotton Research Institute, Multan during the cotton crop season 2018-19. A total of sixteen cotton genotypes viz. CIM-303, BH-223, NIAB-898, CIM-717, CIM-789, NIAB-191, CIM-343, CYTO-511, NIAB-135, CIM-663, NIAB-114,CYTO-510, BH-221, CRIS-613, CIM-678, and NIAB-818 were evaluated for their performance under two water regimes i.e. 80% water applied (normal irrigation) and 50% water applied (water stressed).

The treatments were laid out in RCBD with split-plot arrangement (water stress main plots; genotypes: sub-plots). Crop was sown on April 30, 2018. Water stress was imposed at squaring phase i.e. at 30 days after planting that continued till crop maturity. Leaf water potential was continuously monitored by employing Pressure Chamber Technique. The quantity of irrigation water applied was measured through "Cut Throat Flume" during the season. Total quantity of water applied was 3237 m^3 in 80% of normal irrigated plots and 2266 m^3 in 50% of normal irrigated (water stressed) plots. The precipitation remained very low during the crop growth period.

Data on plant structure and development were recorded at maturity. Main stem height, nodes on main stem and inter-nodal length varied significantly with water stress treatments and among the genotypes. Main stem height varied from 64.3 cm to 102.7 cm, nodes on main stem from 29 to 42 and inter-nodal length from 1.79 to 2.57 cm in different genotypes. Averaged across water regimes, main stem height varied from 74.0 to 93.7 cm, nodes on main stem from 35.5 to 39.5 and inter-nodal length from 1.96 to 2.40 cm. Imposition of water stress caused a decrease of 17.4% in main stem height, 9.8% in nodes on main stem and 9.4% in inter-nodal length (Table 6.11).

Proline levels and relative water content (RWC) varied significantly among genotypes and between water regimes. The proline content ranged from 7.6 - 15.9 (µg g^{-1} FW) and RWC ranged from 79.5 - 94.7% in different genotypes, irrespective of water regimes. The imposition of water stress increased proline content from 10.0 to 13.3 (µg g^{-1} FW) and decreased RWC from 90.6 to 82.7% on overall basis (Table 6.12).

Table 6.11 Plant structure at maturity in different cotton genotypes under two water regimes

Genotypes	Height (cm)			Node			Inter-nodal Length (cm)		
	80%	50%	Avg	80%	50%	Avg	80%	50%	Avg
CIM-303	87.3	70.7	79.0	39	36	37.5	2.24	1.96	2.10
BH-223	83.3	66.3	74.8	39	37	38.0	2.14	1.79	1.96
NIAB-898	97.7	78.7	88.2	40	37	38.5	2.44	2.13	2.28
CIM-717	95.0	83.0	89.0	41	38	39.5	2.32	2.18	2.25
CIM-789	99.0	68.0	83.5	42	29	35.5	2.36	2.34	2.35
NIAB-191	97.3	86.7	92.0	41	37	39.0	2.37	2.34	2.36
CIM-343	97.7	79.7	88.7	42	37	39.5	2.33	2.15	2.24
CYTO-511	95.7	80.0	87.8	42	37	39.5	2.28	2.16	2.22
NIAB-135	98.3	89.0	93.7	40	38	39.0	2.46	2.34	2.40
CIM-663	82.3	72.3	77.3	41	37	39.0	2.01	1.95	1.98
NIAB-1114	94.0	73.3	83.7	38	35	36.5	2.47	2.09	2.28
CYTO-510	79.0	85.3	82.2	36	35	35.5	2.19	2.44	2.32
BH-221	83.7	64.3	74.0	38	35	36.5	2.20	1.84	2.02
CRIS-613	90.0	64.3	77.2	39	34	36.5	2.31	1.89	2.10
CIM-678	102.7	80.7	91.7	40	39	39.5	2.57	2.07	2.32
NIAB-818	92.3	75.3	83.8	38	34	36.0	2.43	2.21	2.32
Mean	**92.2**	**76.1**		**39.8**	**35.9**		**2.32**	**2.12**	
Genotypes	*			ns			ns		
Water regimes	*			*			*		
Interaction	**			*			*		

*significant at p≤0.05; **significant at p≤0.01

Table 6.12 Proline level and relative water content in different genotypes under two water regimes

Genotypes	Proline (µg g^{-1} FW)			RWC		
	80%	50%	Avg	80%	50%	Avg
CIM-303	7.6	10.6	9.1	91.3	85.1	88.2
BH-223	9.4	13.5	11.5	86.4	81.0	83.7
NIAB-898	12.2	15.0	13.6	92.8	80.6	86.7
CIM-717	10.3	13.5	11.9	88.1	83.2	85.6
CIM-789	9.5	14.5	12.0	93.3	85.7	89.5
NIAB-191	9.5	14.2	11.8	89.0	81.1	85.0
CIM-343	10.0	12.5	11.2	91.3	87.2	89.2
CYTO-511	8.5	15.9	12.2	89.0	82.4	85.7
NIAB-135	8.6	15.5	12.0	91.4	84.1	87.8
CIM-663	12.6	15.4	14.0	93.1	82.1	87.6
NIAB-1114	10.3	10.8	10.5	94.7	84.0	89.3
CYTO-510	11.3	12.4	11.9	89.6	79.5	84.6
BH-221	10.5	11.5	11.0	89.3	82.0	85.7
CRIS-613	9.8	12.3	11.1	85.3	82.0	83.7
CIM-678	10.2	14.1	12.1	91.6	79.5	85.5
NIAB-818	8.9	11.4	10.2	93.0	83.4	88.2
Mean	10.0	13.3		90.6	82.7	
Genotypes		*			*	
Water regimes		*			*	
Interaction		**			*	

*significant at p≤0.05; **significant at p≤0.01

Data revealed that seed cotton yield, number of bolls per plant and boll weight varied significantly among the genotypes. Seed cotton yield and boll weight decreased significantly under water stress regime, irrespective of genotypes. The number of bolls per plant varied from 13 to 27, boll weight from 1.86 to 2.62 g and seed cotton yield from 1211 to 2334 kg ha^{-1}, in different genotypes, irrespective of water regimes. Seed cotton yield decreased from 2154 to 1884 kg ha^{-1}, bolls per plant from 22 to 21 and boll weight from 2.32 to 2.15 g irrespective of the genotypes. The decrease, due to water stressed regime was 12.5% in seed cotton yield, 7.3% in boll weight and 4.5% in bolls per plant. The genotype CIM-678 produced the maximum seed cotton yield 2334 kg ha^{-1} with 26 bolls per plant and boll weight of 2.20 g in normally irrigated (80%) plots. The genotype Cyto-510 surpassed in yield over all other genotypes irrespective of water stressed regime (50%). The positive interactions among water regimes and genotypes for yield parameters reveal that the genetic variability and their differential response to varied conditions can help in varietal selection for better yield performance and use of identified desirable traits in breeding programs (Table 6.13).

The observations regarding gas exchange characteristics like stomatal conductance (C), transpiration rate *(E)* and net photosynthetic rate *(P_N)* varied significantly with water regimes and among the genotypes. Irrespective of water regimes, C varied from 101.0 to 233.6 m mol CO_2 m^{-2} s^{-1}, *E* from 5.11 to 11.8 m mole H_2O $m^{-2}s^{-1}$ and P_N from 19.0 to 43.9 µ mol CO_2 $m^{-2}s^{-1}$ in different genotypes. Imposition of water stress caused 23.0% decrease in C, 28.0% decrease in *E* and 30.1% decrease in P_N. Among the genotypes, C varied from 117.8 to 206.6 mmol CO_2 $m^{-2}s^{-1}$, *E* from 6.55 to 10.5 m mol H_2O $m^{-2}s^{-1}$, P_N from 23.3 to 37.6 µ mol CO_2 $m^{-2}s^{-1}$, irrespective of water regimes. On overall basis across water regimes, the genotype CIM-343 maintained the highest stomatal conductance while CIM-789 maintained the highest net photosynthetic rate (Table 6.14).

Table 6.13 Seed cotton production by different genotypes under two water regimes

Genotypes	No of bolls per plant			Boll weight (g)			Seed cotton yield (kg ha^{-1})		
	80%	50%	Avg	80%	50%	Avg	80%	50%	Avg
CIM-303	22	21	22	2.54	1.91	2.22	2284	1893	2089
BH-223	21	21	21	2.25	2.15	2.20	1991	1878	1934
NIAB-898	19	19	19	2.45	2.19	2.32	1958	1770	1864
CIM-717	23	21	22	2.25	2.19	2.22	2142	1971	2056
CIM-789	19	18	19	2.56	2.44	2.50	2022	1877	1949
NIAB-191	22	22	22	2.13	2.02	2.08	1967	1885	1926
CIM-343	21	19	20	2.48	2.39	2.44	2164	1949	2057
CYTO-511	23	23	23	2.32	1.86	2.09	2272	1769	2021
NIAB-135	27	22	25	2.03	1.86	1.95	2293	1707	2000
CIM-663	20	20	20	2.52	2.42	2.47	2093	2023	2058
NIAB-1114	23	21	22	2.26	2.16	2.21	2164	2017	2091
CYTO-510	21	21	21	2.62	2.36	2.49	2312	2184	2248
BH-221	26	22	24	2.14	2.14	2.14	2310	1930	2120
CRIS-613	25	25	25	2.02	1.93	1.98	2070	1985	2027
CIM-678	26	23	25	2.20	2.16	2.18	2334	2092	2213
NIAB-818	22	13	18	2.32	2.15	2.23	2093	1211	1652
Mean	**22**	**21**		**2.32**	**2.15**		**2154**	**1884**	
Genotypes	*			*			*		
Water regimes	ns			*			*		
Interaction	*			**			**		

*significant at p≤0.05; **significant at p≤0.01

Table 6.14 Effect of water regimes on gas exchange parameters in different genotypes

Genotypes	*Net Photosynthesis rate* P_N (µmol CO_2 $m^{-2}s^{-1}$)			*Transpiration rate* E (mmol H_2O $m^{-2}s^{-1}$)			*Stomatal Conductance* C (mmol CO_2 $m^{-2}s^{-1}$)		
	80%	50%	Avg	80%	50%	Avg	80%	50%	Avg
CIM-303	35.1	29.8	32.4	8.53	7.11	7.82	166.2	137.0	151.6
BH-223	37.3	24.1	30.7	10.4	6.71	8.57	194.9	119.1	157.0
NIAB-898	27.5	19.0	23.3	11.8	6.51	9.17	140.5	118.3	129.4
CIM-717	34.7	25.3	30.0	8.61	5.76	7.18	150.0	127.6	138.8
CIM-789	42.6	32.6	37.6	9.13	7.95	8.54	233.6	179.3	206.5
NIAB-191	37.5	21.8	29.7	9.15	6.57	7.86	212.6	188.4	200.5
CIM-343	34.1	31.1	32.6	9.84	8.46	9.15	233.3	180.0	206.6
CYTO-511	41.7	24.4	33.1	8.98	7.34	8.16	189.7	157.9	173.8
NIAB-135	42.1	24.7	33.4	9.00	5.21	7.11	132.3	103.3	117.8
CIM-663	36.9	29.9	33.4	8.42	5.43	6.93	198.3	159.0	178.7
NIAB-114	34.7	25.0	29.9	10.1	6.42	8.26	171.5	103.2	137.3
CYTO-510	36.2	28.3	32.2	8.00	5.11	6.55	166.1	147.1	156.6
BH-221	38.3	23.5	30.9	9.46	6.79	8.13	141.4	104.4	122.9
CRIS-613	35.6	26.5	31.1	10.7	8.17	9.42	150.4	104.4	127.4
CIM-678	37.0	26.7	31.9	8.60	6.82	7.68	173.7	123.9	148.8
NIAB-818	43.9	23.4	33.6	11.7	9.32	10.5	145.9	101.0	123.5
Mean	**37.2**	**26.0**		**9.52**	**6.85**		**175.0**	**134.6**	
Genotypes	*			*			*		
Water regimes	*			*			*		
Interaction	**			**			**		

*significant at p≤0.05; **significant at p≤0.01

REFRESHER COURSE ON "COTTON PRODUCTION TECHNOLOGY" FOR THE FIELD OFFICERS OF PESTICIDE & SEED COMPANIES & NGOS ON MARCH 05, 2019

CCRI, Multan organized one day refresher course on Cotton Production Technology for the field officers of pesticide &seed companies and NGOs. Around 80 participants attended the program. Dr. Khalid Abdullah, VP, PCCC chaired the program.

6.3.2 Cotton response to potassium application under water stress

Balanced crop nutrition is a primitive step to mitigate abiotic stress in cotton production. Drought is the most devastating abiotic stress factor affecting growth and yield of various crops. Among the other environmental stresses, it is by far adversely reducing the crop productivity; however, different mechanisms have been reported to cope with drought. Water stress prevails longer in arid and semi-arid environments besides other factors which cause the reduction in crop growth and yield. Reduction in productivity and impaired crop growth are caused when plants suffer from drought stress. Besides various adaptive mechanisms; potassium (K) application under drought condition can improve the tolerance of crop plants to various types of abiotic stresses, and it also improved subsequent growth and yield. It has also been observed that K improves physiological processes by the regulation of turgor pressure and photosynthesis; translocation of cations and enzymes activation, furthermore plant suffering from drought stress required more internal K. Yield limiting effect of water deficit could be overcome by increasing K supply. The objective of present work was to study the possible role of K applied on cotton under water stress, in mitigation of stress in terms of improving growth and yield in cotton.

The crop was sown on 5th of May 2018 in a Randomized Complete Block Design with Split Plot arrangement. Sulphate of potash was applied as source of K @ 0 and 50 kg ha^{-1} by fertigation. Cotton genotypes CYTO-124, CIM-554, BH-212, BS-13 and FH-142 were used as test crop. The NPK fertilizers were applied according to recommended fertilizer doses. Standard production and management practices were adopted.

Pre-plant composite soil samples were collected from the plough layer of experimental field before imposition of treatments. Physical and chemical characteristics of the soil were determined. The results indicated that the soil is silt loam in texture and alkaline in reaction. The soil is medium in organic matter (0.91%), extractable phosphorus (10.5 mg/kg), extractable potassium (98 mg/kg) and available magnesium (50 mg/kg).

Data on plant structure were recorded at maturity. In different genotypes, main stem height ranged from 73-94 cm in non-K (control) while it varied from 88-115 cm in plots with applied K (@ 50 kg K_2O/ha), irrespective of water stress. A positive relationship between genotypes and applied potassium was observed in all genotypes showing concurrent increase in main stem height and number of nodes on main stem. Among the genotypes, CIM-554 produced greater height, more number of nodes on main stem and larger inter-nodal length as compared to other genotypes (Table 6.15).

Plants from one-meter square area were harvested at maturity and partitioned into leaf, stalk and fruit portions. The dry matter yield of leaf, stalk and fruit organs increased with applied K in all genotypes, irrespective of water stress. Applied K improved the drought tolerance in all genotypes thereby increasing dry matter of leaves from 111 to 133 gm^{-2}, stalk from 161 to 262 gm^{-2} and fruits from 321 to 419 gm^{-2} by addition of K as compared to without K addition under water stress condition (Table 6.16).

The concentration of K in different parts of cotton plant was determined from the oven dried plant material. Data revealed that K concentration in different plant organs varied non-significantly among the genotypes, water stress and applied-K. However, K concentration increased with applied K as well as with the imposition of water stress in leaf, stalk and seed portions. The maximum K concentration was observed in leaf followed by stalk and seed (Table 6.17).

Table 6.15 Effect of water stress and applied K on plant structure development at maturity

K-Level		Main stem height (cm)			Nodes on main stem			Inter-nodal length (cm)		
	Genotype	NS	WS	Mean	NS	WS	Mean	NS	WS	Mean
Control	Cyto 124	99	89	**94**	39	37	**38**	2.54	2.41	**2.47**
	CIM-554	103	86	**95**	40	36	**38**	2.58	2.39	**2.48**
	BH-212	75	71	**73**	30	33	**32**	2.50	2.15	**2.33**
	BS-13	88	76	**82**	35	28	**32**	2.51	2.71	**2.61**
	FH-142	97	83	**90**	37	36	**37**	2.62	2.31	**2.46**
	Mean	**92**	**81**		**36**	**34**		**2.55**	**2.39**	
50 kg K_2O/ ha	Cyto 124	121	94	**107**	40	37	**39**	3.03	2.54	**2.78**
	CIM-554	128	101	**115**	41	39	**40**	3.12	2.59	**2.86**
	BH-212	98	79	**88**	33	29	**31**	2.97	2.72	**2.85**
	BS-13	111	87	**99**	36	34	**35**	3.08	2.56	**2.82**
	FH-142	118	95	**106**	40	36	**38**	2.95	2.64	**2.79**
	Mean	**115**	**91**		**38**	**35**		**3.03**	**2.61**	
K-application (K)		*			ns			*		
Genotype (G)		*			ns			*		
Water regime (WR)		*			ns			*		
K x Genotype		ns			ns			ns		
K x WR		*			ns			*		
G x WR		*			ns			*		
K x G x WR		ns			ns			ns		

*Significant at p≤0.05; **Significant at p≤0.01; ns: non-significant
NS (no stress @ -1.6±0.2 MPa); WS (water stress @ -2.4±0.2 MPa)

Table 6.16 Effect of water stress and applied K on dry matter production (g m^{-2}) at maturity

K-level		Leaves			Stalk			Fruit		
	Genotypes	NS	WS	Mean	NS	WS	Mean	NS	WS	Mean
Control	Cyto 124	146	122	**134**	209	178	**194**	465	357	**411**
	CIM-554	143	119	**131**	206	176	**191**	460	321	**391**
	BH-212	108	80	**94**	160	120	**140**	290	250	**270**
	BS-13	135	112	**124**	201	156	**179**	422	331	**377**
	FH-142	139	122	**131**	204	173	**189**	455	345	**400**
	Mean	**134**	**111**		**196**	**161**		**418**	**321**	
50 kg K_2O/ha	Cyto 124	196	145	**171**	287	270	**279**	561	445	**503**
	CIM-554	185	140	**163**	272	261	**267**	554	435	**495**
	BH-212	128	109	**119**	210	202	**206**	355	320	**338**
	BS-13	176	132	**154**	272	250	**261**	536	427	**482**
	FH-142	183	137	**160**	269	279	**274**	558	470	**514**
	Mean	**174**	**133**		**262**	**252**		**513**	**419**	
K-application (K)		*			*			*		
Genotype (G)		**			*			**		
Water regime (WR)		**			*			**		
K x Genotype		*			ns			*		
K x WR		*			*			ns		
G x WR		ns			*			*		
K x G x WR		ns			ns			ns		

*Significant at p≤0.05; **Significant at p≤0.01; ns: non-significant
NS (no stress @ -1.6±0.2 MPa); WS (water stress @ -2.4±0.2 MPa)

Table 6.17 Effect of water stress and applied K on K concentration (%) in different plant organs at maturity

K-Level		Leaves			Stalk			Seed		
	Genotypes	NS	WS	Mean	NS	WS	Mean	NS	WS	Mean
Control	Cyto-124	2.12	2.14	2.13	1.13	1.15	1.14	1.09	1.11	1.10
	CIM-554	2.06	2.07	2.07	1.05	1.06	1.06	1.04	1.06	1.05
	BH-212	1.95	1.98	1.97	1.02	1.04	1.03	0.95	0.99	0.97
	BS-13	2.02	2.04	2.03	1.04	1.06	1.05	1.01	1.05	1.03
	FH-142	2.08	2.10	2.09	1.11	1.13	1.12	1.05	1.05	1.05
	Mean	**2.05**	**2.07**		**1.07**	**1.09**		**1.03**	**1.05**	
50 Kg K_2O/ ha	Cyto 124	2.31	2.41	2.36	1.23	1.28	1.26	1.14	1.23	1.19
	CIM-554	2.12	2.36	2.24	1.19	1.26	1.23	1.09	1.18	1.14
	BH-212	2.05	2.09	2.07	1.07	1.18	1.13	1.01	1.05	1.03
	BS-13	2.09	2.31	2.20	1.16	1.25	1.21	1.08	1.14	1.11
	FH-142	2.25	2.38	2.32	1.22	1.26	1.24	1.11	1.20	1.16
	Mean	**2.16**	**2.31**		**1.17**	**1.25**		**1.09**	**1.16**	

NS (no stress @ -1.6±0.2 MPa); WS (water stress @ -2.4±0.2 MPa)

The observations regarding gas exchange characteristics like net photosynthetic rate *(P_N)*, transpiration rate *(E)* and stomatal conductance (C) varied significantly with K application, water stress and among the genotypes. Averaged across water stress, P_N ranged from 12.8-22.0 & 15.6-28.6 µmol CO_2 m^{-2} s^{-1}, *E* from 1.91-2.35 & 3.48-4.49 mmole H_2O $m^{-2}s^{-1}$ and *C* from 9.1-14.9 & 11.6-17.0 mmol CO_2 $m^{-2}s^{-1}$ in control and applied K (50 kg) treatments, respectively. Imposition of water stress decreased P_N from 21.3 to 17.7 µ mol CO_2 m^{-2} s^{-1} and *E* from 2.26 to 2.10 and C from 14.2 to 11.3 m mol CO_2 m^{-2} S^{-1} in control (0-K) plots on average basis of genotypes. Added K improved gas exchange characteristics over 0-K (Table 6.18).

Table 6.18 Effect of water stress and applied K on gas exchange characteristics

K-level	Net photosynthetic rate *(P_N)* (µ mol CO_2 $m^{-2}S^{-1}$)				Transpiration rate *(E)* (µmole H_2O $m^{-2}S^{-1}$)			Stomatal conductance *(g_s)* (m mol CO_2 $m^{-2}S^{-1}$)		
	Genotype	NS	WS	Mean	NS	WS	Mean	NS	WS	Mean
Control	Cyto-124	24.0	18.7	**21.4**	2.36	2.10	**2.23**	15.5	11.0	**13.3**
	CIM-554	23.4	20.5	**22.0**	2.45	2.24	**2.35**	16.2	13.6	**14.9**
	BH-212	13.8	11.8	**12.8**	1.97	1.85	**1.91**	10.8	7.4	**9.1**
	BS-13	20.8	18.3	**19.6**	2.14	2.10	**2.12**	13.4	11.3	**12.4**
	FH-142	24.4	19.2	**21.8**	2.38	2.22	**2.30**	15.1	13.2	**14.2**
	Mean	**21.3**	**17.7**		**2.26**	**2.10**		**14.2**	**11.3**	
50 Kg K_2O/ ha	Cyto-124	28.0	23.3	**25.7**	4.73	4.25	**4.49**	17.2	14.9	**16.1**
	CIM-554	31.8	25.3	**28.6**	4.84	4.18	**4.51**	18.1	15.8	**17.0**
	BH-212	16.4	14.8	**15.6**	3.76	3.19	**3.48**	12.7	10.4	**11.6**
	BS-13	26.2	20.1	**23.2**	4.55	3.95	**4.25**	15.3	13.2	**14.3**
	FH-142	32.5	23.7	**28.1**	4.84	4.07	**4.46**	18.2	15.3	**16.8**
	Mean	**27.0**	**21.4**		**4.54**	**3.93**		**16.3**	**13.9**	
K-application (K)		*			*			*		
Genotype (G)		**			*			*		
Water regime (WR)		*			*			ns		
K x Genotype		*			*			*		
K x WR		ns			*			*		
G x WR		*			*			ns		
K x G x WR		ns			ns			ns		

*Significant at p≤0.05; **Significant at p≤0.01; ns: non-significant
NS (no stress @ -1.6±0.2 MPa); WS (water stress @ -2.4±0.2 MPa)

Data revealed that seed cotton yield, number of bolls per plant and boll weight varied significantly with K addition, water stress and among genotypes. The number of bolls per plant varied from 17 to 28, boll weight from 1.98 to 2.48 g and seed cotton yield varied from 1498 to 2800 kg ha^{-1} in different genotypes, irrespective of applied K and water regimes. Seed cotton yield, number of bolls per plant and boll weight decreased with the imposition of water stress. Consequently, average seed cotton yield decreased from 2043 to 1851 kg ha^{-1}, bolls per plant from 21 to 19 and boll weight from 2.24 to 2.12 g irrespective of the genotypes. Added K caused a variable increase in seed cotton yield and its components in different genotypes both in no stress and water stressed conditions. The average increase in yield across the genotypes was 22.8% and 29.8%, respectively in no stress and water stressed conditions. Among the genotypes, CYTO-124 produced the maximum seed cotton yield and boll weight in all treatments (Table 6.19).

Table 6.19 Effect of water stress and applied K on seed cotton yield and its components

K-Level	Seed Cotton yield (kg ha^{-1})				Number of bolls per plant			Boll wt (g)		
	Genotype	NS	WS	Mean	NS	WS	Mean	NS	WS	Mean
Control	Cyto-124	2234	2035	**2135**	23	21	**22**	2.31	2.20	**2.26**
	CIM-554	2126	1936	**2031**	22	20	**21**	2.29	2.17	**2.23**
	BH-212	1723	1498	**1611**	19	17	**18**	2.12	1.98	**2.05**
	BS-13	1914	1765	**1840**	20	18	**19**	2.18	2.06	**2.12**
	FH-142	2220	2022	**2121**	23	21	**22**	2.30	2.18	**2.24**
	Mean	**2043**	**1851**		**21**	**19**		**2.24**	**2.12**	
50 Kg K_2O/ ha	Cyto-124	2800	2645	**2723**	27	26	**27**	2.48	2.37	**2.43**
	CIM-554	2760	2585	**2673**	28	26	**27**	2.39	2.29	**2.34**
	BH-212	1910	1874	**1892**	21	20	**21**	2.16	2.04	**2.10**
	BS-13	2278	2272	**2275**	25	26	**26**	2.20	2.16	**2.18**
	FH-142	2790	2634	**2712**	28	27	**28**	2.36	2.23	**2.30**
	Mean	**2508**	**2402**		**26**	**25**		**2.32**	**2.22**	
K-application (K)		*			*			ns		
Genotype (G)		**			*			*		
Water regime (WR)		**			*			ns		
K x Genotype		ns			ns			*		
K x WR		*			*			ns		
G x WR		**			*			*		
K x G x WR		ns			ns			ns		

*Significant at p≤0.05; **Significant at p≤0.01; ns: non-significant
NS (no stress @ -1.6±0.2 MPa); WS (water stress @ -2.4±0.2 MPa)

6.4 Heat Tolerance

6.4.1 Adaptability of genotypes to temperature stress

Pakistan is more prone to climate change due to its geographical location. Precipitation is also decreased with the raise in temperature. Mean temperature across the country has increased by 0.5°C in the past 30 years. Heat stress decreases the potential of the crop and it is estimated that crop exhibit only 25% of its potential due to such environmental stress. Cotton growth and development is maximum at 33ºC and significant decline in fruit retention is observed above 36ºC, but cotton is successfully grown at temperatures in excess of 40°C in Pakistan. Higher night temperatures give rise to increase in respiration hence reducing the net gain of cotton yield. Sudden shoot up of air temperatures in cotton crop at the reproductive stage of its life cycle causes significant reductions in the cotton yield despite affecting the apparent health of the crop. In such conditions, heat tolerant genotypes withstand better due to activation of acquired thermo-tolerance until the temperature approaches 37.7–40 ºC. The extent of damage is much higher in heat sensitive genotypes and the entire fields may be wiped out due to rapid loss of water when hot winds blow across the cotton fields. The genotypes recommended for general cultivation in cotton growing areas, occasionally face very high temperature of about 50°C during the month of May and June, which is approximately 20°C higher than the optimum temperature required for normal growth, thus retarding performance to higher extent. Plant growth such as shoot development, flowering and fiber

quality traits are influenced largely due to high temperature. Although adverse temperatures can affect all stages of development, the crop seems to be particularly sensitive to adverse temperatures during reproductive development. The information of advanced strains about thermal stress tolerance can help minimize the damaging effects of the extreme temperature events. Moreover, screening of the available material provides a database of desirable traits to the breeders for future variety development and also in decision making for the varietal zoning.

The screening was carried out by planting cotton genotypes in mid-April to coincide their fruiting phase with the hottest period of season. For this purpose thirty-five cotton genotypes were collected from breeders across the country and planted in the allocated experimental area at CCRI, Multan.

The results revealed that the genotypes showed wide variation in various physiological parameters conferring to heat tolerance in cotton. Genotype M1-18 excelled in heat tolerance considering each trait compared with the other genotypes. Genotype SLH-19 was found to be the most susceptible genotype to heat stress (Table 6.20).

Table 6.20 Physiological traits for determining heat tolerance in different genotypes

Genotypes	AD (%)	PV (%)	FSNN	FSNH	SNNFB	SNHFB	%BSFP	%BSSP	RCIL(%)	EC ($\mu S\ cm^{-1}$)
M1-18	92	94	9	15	16	20	44	38	13	203
BH-221	91	93	9	16	17	20	41	36	19	243
CIM-343	89	92	10	16	17	22	39	33	20	266
Cyto-511	84	91	9	12	15	19	37	31	23	295
N-191	82	90	9	15	17	20	35	29	27	272
SLH-33	81	89	8	16	13	18	33	27	27	301
CIM-663	80	85	10	16	17	21	32	25	29	308
CIM-789	79	83	9	14	16	20	31	22	30	331
N-135	79	80	10	16	19	21	28	22	34	327
CIM-678	77	81	7	11	14	20	24	20	34	334
N-898	66	77	9	14	16	23	23	19	45	365
Cyto-510	66	72	9	14	16	18	22	18	47	342
GH-Uhad	64	70	10	18	16	21	22	17	48	331
CIM-303	64	71	9	13	16	20	21	16	49	359
CIM-717	62	73	9	15	19	24	20	16	51	367
CRS-613	62	70	9	15	17	23	20	15	57	375
N-818	59	67	9	15	15	18	19	14	63	380
N-1114	57	60	9	14	13	18	19	13	65	383
BH-223	56	63	9	15	18	23	17	13	66	389
SLH-55	55	60	8	15	17	21	16	12	72	396
SLH-19	50	55	10	16	15	20	14	10	75	403
LSD	10.99**	14.25**	3.11 ns	6.93 ns	6.03 ns	5.67 ns	10.18**	8.62**	10.13**	44.2**

***significant at p<0.01; ns: non-significant*

AD: Anther Dehiscence
PV: Pollen viability
FSSN: First Sympodial Node No.
FSNH: First Sympodial Node Height
SNNFB: Sympodial Node No bearing 1st Boll
SNHFB: Sympodial Node Height bearing 1st Boll
BSFP: Boll Set on 1st Position
BSSP: Boll Set on 2nd Position
RCIL: Relative Cell Injury Level
EC : Electrical Conductivity

Physiological traits having relevance to heat tolerance were recorded in the genotypes. Results showed that there were positive correlations of pollen viability (r=0.91), percent boll set on first (r=0.95) and second (r=0.96) positions along sympodia with seed cotton yield. There were negative correlations of cell injury (r= -0.93) and electrical conductivity (r=-0.97) with the seed cotton yield. These traits can be taken into account while selecting future genotypes to overcome heat stress problems (Table 6.21).

Table 6.21 Relationship between seed cotton yield and physiological traits determining heat tolerance

Parameters	AD	PV	BSFP	BSSP	RCI	EC	NBPP	BW
PV	0.98							
BSFP	0.97	0.95						
BSSP	0.97	0.95	0.99					
RCI	-0.99	-0.99	-0.95	-0.95				
EC	-0.94	-0.92	-0.97	-0.98	0.93			
NBPP	0.25	0.31	0.28	0.26	-0.27	-0.18		
BW	0.97	0.98	0.95	0.95	-0.98	-0.93	0.28	
SCY	0.93	0.91	0.95	0.96	-0.93	-0.97	0.13	0.94

AD : Anther Dehiscence
PV : Pollen viability
BSFP : Boll Set on First Position
BSSP : Boll Set on Second Position
RCIL : Relative ell Injury Level
EC : Electrical Conductivity
NBPP : Number of Bolls Per Plant
BW : Boll Weight
SCY : Seed Cotton Yield

The dehiscence of anthers declined up to 4th week of July and then showed a gradual increase from 1st week of August reaching up to maximum (100%) later in the 2nd week of September except the 3rd week of August when the dehiscence showed a variable decline in the genotypes. The genotype M1-18 showed the highest while SLH-19 the lowest anther dehiscence during the observation period. The dehiscence of anthers during the season for three genotypes is depicted in Fig. 6.1.

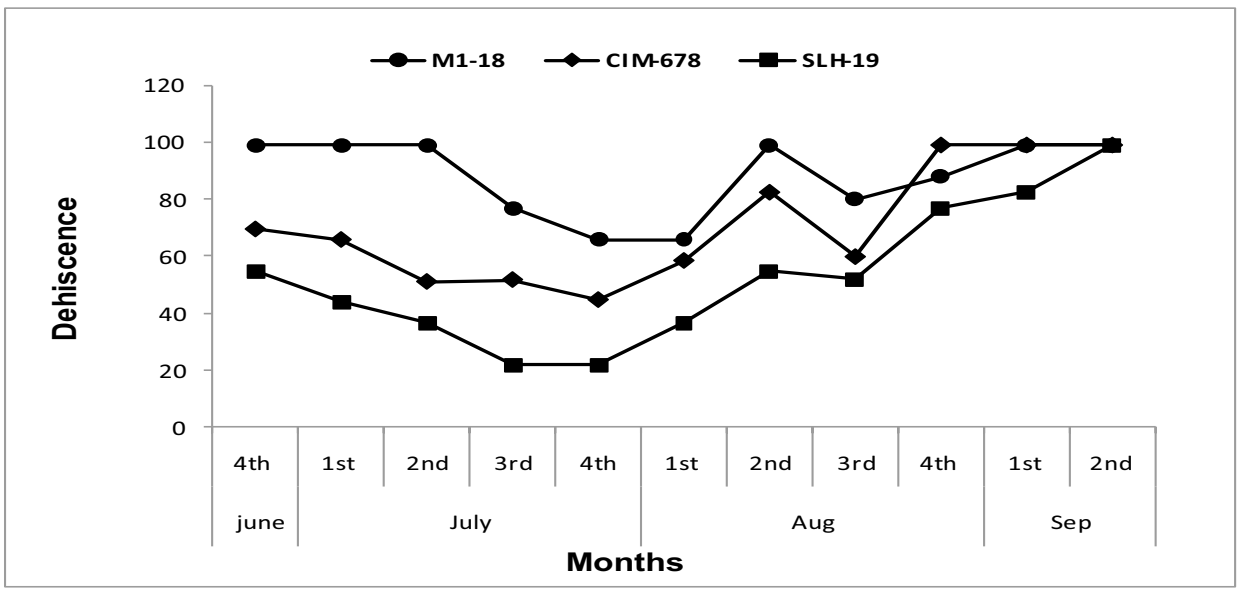


Fig. 6.1 Dehiscence of anthers during the season for three genotypes

Genotypes differed greatly in their yield performance. The genotype M1-18 produced the highest seed cotton yield than the other genotypes tested. Seed cotton yield of different genotypes ranged from 2950 to 4214 kg ha^{-1} (Table 6.22).

Fibre characteristics like staple length, uniformity index, fibre strength and fibre fineness varied marginally among different genotypes. Staple length varied from 23.8 to 27.4 mm, Uniformity Index varied from 78.9 to 84.1%, Micronaire varied from 4.6 to 6.1 µg $inch^{-1}$ and fibre strength varied from 23.6 to 28.4 G/Tex among different genotypes (Table 6.23).

Table 6.22 Seed cotton yield in different genotypes planted in mid-April

Genotypes	Number of bolls per plant	Boll weight (g)	Seed cotton yield (kg ha^{-1})
M1-18	33	2.98	4214
BH-221	34	2.60	3856
CIM-343	33	2.61	3712
Cyto-511	42	1.98	3569
N-191	36	2.28	3554
SLH-33	29	2.82	3551
CIM-663	30	2.71	3515
CIM-789	32	2.52	3479
N-135	42	1.89	3389
CIM-678	31	2.50	3371
N-898	34	2.28	3336
Cyto-510	28	2.68	3330
GH-Uhad	35	2.24	3318
CIM-303	34	2.27	3280
CIM-717	29	2.64	3264
CRS-613	39	1.97	3228
N-818	30	2.42	3156
N-1114	35	2.08	3120
BH-223	32	2.25	3067
SLH-55	26	2.58	2956
SLH-19	24	2.77	2950
LSD	6.33**	0.39**	553.1**

**significant at p<0.01

Table 6.23 Effect of heat stress on fiber characteristics in different genotypes

Genotypes	Staple length (mm)	U.I. %	Micronaire (µg inch^{-1})	Strength G/Tex
M1-18	27.4	84.1	6.1	27.7
N-898	27.3	81.3	5.2	28.4
CIM-343	26.8	84.0	5.3	27.5
N-818	26.2	81.5	5.4	27.5
N-191	25.8	82.1	5.3	26.2
CIM-789	25.8	83.6	5.3	26.2
CIM-678	25.7	81.0	4.6	25.6
BH-221	25.5	82.1	5.3	26.8
CIM-663	25.3	83.4	5.4	25.5
SLH-19	25.2	82.3	5.2	26.3
N-1114	25.2	78.9	5.0	26.1
N-135	25.1	79.7	5.1	26.6
CIM-303	25.0	83.3	5.6	26.7
SLH-33	24.9	83.1	5.8	25.3
Cyto-511	24.5	80.1	4.6	25.6
CRS-613	24.5	82.5	4.7	25.7
SLH-55	24.3	80.3	5.0	24.3
GH-Uhad	24.3	80.9	5.0	24.4
Cyto-510	24.0	81.9	5.4	23.6
CIM-717	24.0	83.1	6.0	24.7
BH-223	23.8	80.5	5.3	24.7

7. TRANSFER OF TECHNOLOGY SECTION

The Transfer of Technology section is playing a pivotal role to disseminate the research activities/findings for the profitable cotton production technology to farming community & other stakeholders through integrated multimedia approach.

7.1 Human Resource Development

7.1.1 Training Programs

The following training programs were conducted during the season:

i) Cotton production technology
ii) Agronomic practices for better cotton yield
iii) Soil health management
iv) Approved seeds are necessary for better yield
v) Cotton varieties, characteristics and their production technology
vi) Role of different cotton varieties in various regions
vii) Advanced lines of CCRI tested under zonal varietal
viii) Insect pest management
ix) Cotton diseases & their control
x) Cotton fibre parameters with special reference to processing
xi) Pink bollworm management and installation of PB-ropes
xii) Strategy against Cotton Leaf Curl Virus(CLCuV)
xiii) "Non-GMO cotton breeding, preparation of organic fertilizer and testing of Non GMO yield
xiv) Importance of cotton fibre properties for yarn manufacturing and processing
xv) Picking practices for clean cotton production

Training programs for Field Staff Agri. (Extension) Department/ farmers & with other departments

Date	Organized/ Coordinated by	Venue	Resource Person	Participants
27.03.2018	Sangtani Organization, NGO	RajanPur	i.Dr. Khalid Abdullah ii. Dr.Fiaz Ahmad	**Total = 278** Farmers= 247 Ginners= 11 F.A = 07 NGO's = 13
05.04.2018	FFC	Vehari	i.Dr. Zahid Mahmood ii.Dr.RabiaSaeed	**Total = 109** Farmers= 103 FFC = 06
08.04.2018	Pakistan Farmers Forum (NGO)	MianChunnu	i.Dr. Zahid Mahmood ii.Dr.M.Idrees Khan iii. Mr.JunaidA.Khan	**Total = 80** Farmers = 67 NGO's = 13
10.04.2018	FFC	Shujabad (Usama Garden)	i.Dr. Zahid Mahmood ii.Dr.RabiaSaeed iii. Mr. Sajid Mahmood	**Total = 94** Farmers= 87 FFC = 07
16.04.2018	CCRI &South Asian Sourcing (SAS) Pvt. Ltd.	CCRI,Multan	i.Dr. Zahid Mahmood ii. Dr.Fiaz Ahmed iii.Dr.M.Idrees Khan iv.Dr.M.NaveedAfzal v.Ms.SabahatHussain vi.Dr.RabiaSaeed	**Total = 18** Farmers= 13 SAS = 05
20.04.2018	Regional Agricultural Economic Development Centre (RAEDC) Vehari	Vehari	Dr. Zahid Mahmood	**Total= 19** Master Trainee

23.04.2018	PCSI,Multan	CCRI,Multan	Dr.Zahid Mahmood	**Total = 16** Technical officers
07.05.2018	-do-	-do-	-do-	**Total = 12** Technical officers
04.06.2018	CCRI Multan	-do-	i. Dr.Zahid Mahmood ii. . Dr. RabiaSaeed	**Total = 20** Master Trainee Agri.ext.deptt. Punjab
June 22, 2018	CCRI,Multan	CCRI,Multan	Dr. RabiaSaeed, Head, Entomology Section	**Total = 18** Officials from Pest Warning & Quality Control of Pesticides (PWQC), Punjab
July 17-18,2018	CCRI,Multan & agri.extension KPK & Baluchistan	CCRI,Multan	Dr.Zahid Mahmood & all heads of sections	**Total = 10** Technical officials from KPK & Baluchistan
23.07.2018	CCRI,Multan	CCRI,Multan	i.Dr.Zahid Mahmood ii.Dr.Fiaz Ahmed iii.Dr.M.NaveedAfzal iv.Dr.M.Idress Khan v.Dr.RabiaSaeed vi.Ms.SabahatHussain	**Total=20** Field staff of pesticide, seed industry & NGOs
31.07.2018	CCRI,Multan	Peer JaggiMor,KotAddu	i.Dr.Zahid Mahmood ii. Dr.M.Idress Khan iii.Mr.Sajid Mahmood	**Total=50** Farmers
09.08.2018	PCSI,Multan	CCRI,Multan	i.Dr. Zahid Mahmood, ii.Dr.M.NaveedAfzal	**Total=15** Cotton Selectors
29.08.2018	FSC &RD and CCRI	CCRI,Multan	Dr. Zahid Mahmood	**Total =450** Seed dealers
-do-	CCRI & PCSI ,Multan	PCSI ,Multan	Mr. Danish Iqbal	**Total =26** Cotton Selectors
05.09.2018	Food and Agricultural Organization (FAO) & CCRI Multan	CCRI,Multan	Dr. Zahid Mahmood	**Total =23** Master Trainee
10.10.2018	CCRI Multan and WWF-Pakistan	Khanewal	i.Mr. Muhammad Ilays Sarwar ii. Mr. Danish Iqbal	**Total =93** Farmers
October 12-13,2018	CCRI Multan	CCRI Multan	Dr. Zahid Mahmood	**Total =18** Farmers
06.11.2018	Agri.Ext.deptt.Bahawalpur& WWF-Pakistan	CCRI,Multan	Dr.Zahid Mahmood	**Total =60** Field Assistant
15.11.2018	CCRI,Multan	CCRI,Multan	Dr.Zahid Mahmood	**Total =10** Farmers, BastiMalook

10.12.2018	WWF-Pakistan, Nara Canal, District Khairpurmirs, Sindh	CCRI, Multan	Dr.Zahid Mahmood	**Total =24** Master Trainee
22.12.2018	Regional Agricultural Economic Development Center (RAEDC)	Vehari	Dr.Zahid Mahmood	**Total =22** Master Trainee
24.12.2018	WWF-Pakistan, Nara Canal, District Khairpurmirs, Sindh	CCRI ,Multan	Dr.Zahid Mahmood	**Total =22** Farmers
February 12-13,2019	CCRI,Multan & agri.extension KPK & Baluchistan	CCRI,Multan	Dr. Zahid Mahmood & all heads of sections	**Total = 13** Master Trainees KPK & Baluchistan
14.02.2019	PCSI,Multan	CCRI,Multan	Dr. Zahid Mahmood	**Total = 19** Cotton Selectors

7.1.2 Farmers Field Day Program

CCRI Multan organized Farmers' Field Day on October 16, 2018. Around 300 cotton farmers participated in the program. Dr. Zahid Mahmood, Director CCRI Multan briefed the visiting farmers about the cotton research and development activities carried out by the Institute. Later, the farmers were visited different field experimental fields for observing the field performance of advanced cotton lines developed at the Institute. The advance lines included CIM-303, CIM-632, Cyto-510, Cyto-511, Cyto-515, CIM-678, CIM-789, CIM-343, CIM-663, and CIM-602. Moreover, the fields of big boll size, long staple, tolerant to CLCuV, heat & water stress tolerant lines and natural colored cotton fields were also visited. Farmers showed enthusiasm and greater interest in cotton varieties developed at the Institute and appreciated the role of cotton scientists for evolution of high yielding varieties.

7.1.3 TV Programs

The following TV programs were conducted during the season:

Date	TV Channel	Topic	Resource Person	Remarks/Timing
07.05.2018	Dunya/Sach, Multan	Cotton Crop in Pakistan	Dr.Khalid Abdullah	05-mintutes
-do-	-do-	Role of CCRI in Cotton Production Technology	Dr.Zahid Mahmood	07-mintutes
-do-	-do-	Importance of Seminar for farmers	Dr.Fiaz Ahmed	02-mintutes
27.06.2018	Rohi,Multan	"Strategy to enhance cotton production in the country"	Dr.Khalid Abdullah	03-mintutes
-do-	-do-	"Pink Bollworm Management "	Dr.Zahid Mahmood	02-mintutes
10.08.2018	Channel-24,Multan	"Significant decisions taking in CCMG meeting "	Dr.Khalid Abdullah	03-mintutes
16.10.2018	PTV-Multan	"Cotton varietal development program carried out by the Institute"	Dr.Zahid Mahmood	5-minutes recorded
21.10.2018	Rohi-Multan	"Cotton research	-do-	7-minutes recorded

TRAINING PROGRAM FOR WWF-CONTRACTED FARMERS FROM SINDH

A group of small farmers from District Khairpurmirs, Sindh visited CCRI Multan on December 10th and 24th, 2018. The group was supervised under the WWF-Pakistan' 3-year project "Indus Ecoregion Community Livelihood Project (IECLP)". The exposure visit aimed to provide cross learning of farming practices to the small farmers for its replication at the ground level.

		and development activities of the Institute"		
13.11.2018	Rohi-Multan	"Cotton varietal development program carried out by CCRI"	Dr.Zahid Mahmood	3-minutes recorded
18.11.2018	Rohi-Multan	"Getting commercial license regarding Bt.CIM-632"	-do-	2-minutes recorded
20.11.2018	Express Multan	"Role of CCRI in PARB projects"	-do-	3-minutes recorded
19.01.2019	Aap News ,Multan	Impact of removal of import duty on cotton"	-do-	5-minutes recorded

7.1.4 TV/Press Coverage

The section arranged media coverage for various events during the season:

Date	Media Coverage
March20-22, 2018	Agriculture Research Sub-Committee (ARSC) Meeting by PTV Multan
27.06.2018	3rd National Seminar on "Pink Bollworm Management
06.07.2018	3rd Meeting of the Cotton Crop Management Group (CCMG)
10.08.2018	4th Meeting of the Cotton Crop Management Group (CCMG)
29.08.2018	Training Program for seed dealers
24.09.2018	5th Meeting of the Cotton Crop Management Group (CCMG
16.10.2018	Farmers Field Day Program
21.10.2018	Cotton Travelling Seminar
20.11.2018	Meeting of Punjab Agricultural Research Board (PARB)

7.1.5 Preparation of Video Clips

Following video clips were prepared for farmer's advice/information during the season:

Date	Topic
03.05.2018	African Delegation
09.05.2018	Recommendations for cotton sowing
18.05.2018	Seed delinting
21.05.2018	Cotton in Hydroponics at CCRI
22.05.2018	سی سی آر آئی ملتان میں کپاس پر تجربات بذریعہ آبی کاشت:ڈاکٹر فیاض احمد
23.05.2018	گندم کے بعد کپاس کی بجائی کے لیے زمین کی تیاری:ڈاکٹر محمد نوید افضل
24.05.2018	بوائی سے پہلے کپاس کے بیج کی ٹریٹمنٹ:ڈاکٹر فیاض احمد
01.06.2018	Best germination of Cotton 2018 at CCRI,Multan
12.06.2018	اپریل-مئی کاشتہ کپاس پر سبز تیلے کا حملہ اور اس کا کیمیائی کنٹرول:ڈاکٹر رابعہ سعید
09.08.2018	Naturally Colored Cotton Technology at CCRI ,Multan: قدرتی رنگدار کپاس
02.08.2018	Farmers Field Day Program at KotAddu on July 31,2018
03.09.2018	Boom Spray application at CCRI ,Multan
24.09.2018	Interview: Malik NaumanLangrial, Minister for Agriculture Punjab
16.10.2018	The upcoming cotton varieties of CCRI Multan
16.10.2018	Advanced Cotton lines developed at CCRI Multan

22.10.2018	Mini cotton picking machine demo at CCRI,Multan
07-11-2018	Brief Intro About BTCIM-789
06-11-2018	Demonstration of Mechanical Picking
02-11-2018	Screening of Cotton varieties
02-11-2018	Cotton Picking
30-10-2018	Candidate varieties of CCRI
19.12.2018	Naturally Colored Cotton Information
17.12.2018	What is GDP of a country
07.12.2018	Off-season Management of Pink bollworm
06.12.2018	Ending Cotton Crop Season BT-CIM-678
28.11.2018	ملتان میں قدرتی رنگدار کپاس کی پیداواری ٹیکنالوجی
27.11.2018	Meteorological observatory at CCRI Multan
22.11.2018	Recommendations for preserving upcoming cotton crop
21.11.2018	Meeting &Vist of PARB members at CCRI-Multan
13.01.2019	19-point Cotton Policy 2019 by Federal Minister MNFSR
18.01.2019	Importance of Laser Land Leveling for better yield
25.01.2019	Cotton sticks should be cut till 31st January, 2019
20.02.2019	CCRI Cotton Varieties & their production technology
21.02.2019	Soil Fertility & Health:Dr.Fiaz Ahmed

7.1.6 Radio Programs

The following Radio programs were conducted during the season:

Date	Radio	Topic	Resource Person	Remarks
24.04.2018	Radio Pakistan, Multan	Talk on “Agronomic practices for better cotton yield”	Dr. M. Naveed Afzal	Recorded 5-minutes
-do	-do-	Talk on “Cotton disease & their managment”	Ms. Sabahat Hussain	Recorded & on air 5-minutes
-do-	-do	Talk on “Growth seed rate before cotton cultivation”	Mr. Sajid Mahmood	Recorded & on air 3-minutes
12.07.2018	Radio Pakistan, Multan	Talk on “Insect pest management”	Dr. Zahid Mahmood	Recorded 03-mintutes
-do-	-do-	Interview on “Pest scouting and weed management”	Dr. Zahid Mahmood	Recorded 04-mintutes
13.10.2018	-do-	Discussion on “Current cotton crop situation and clean cotton picking”	i. Dr. Zahid Mahmood ii. Dr. M. Naveed Afzal	Live

7.1.7 Press Releases

Fifty Three (53) press releases throughout the season were sent to the press time to time for publication.

7.1.8 Articles

Three (03) Urdu articles were sent to the press for the guidance of cotton growers during the season.

7.1.9 Press Report

A press report regarding “Visit of Media Personals” at CCRI, Multan was sent to the press for publication during the season.

7.1.10 Tele-Cotton SMS Service

Following activities regarding Tele-Cotton SMS Service were conducted during the season:

a.Thirty (30) Tele-Cotton SMS were sent to more than 18,000 cotton growers, extension workers and other stakeholders regarding better crop management during the season.

b. Almost ten thousand (10,000) clients of Tele-Cotton were registered in data – base during the season and total registration is up to 18000.

7.1.11 Posts for Social Media

No. of posts regarding "Recommendations for Better Cotton Production Technology" were prepared and uploaded on official FB Page of the Institute during the season.

7.1.12 Preparation of Leaflet

The section composed & got printed the following leaflet during the season:

Leaflet	Nos.
کپاس کی گلابی سنڈی اور اس کا طریقہ انسداد	5000
کپاس کی گلابی سنڈی کا تدارک بذریعہ پی بی روپس	5000
Bt.CIM-632	2000
Bt.Cyto-177	2000
CIM-610	2000

7.1.13 Distribution of Printed Material

The following leaflets/booklets/handouts were distributed among growers, extension workers, agri. students of different colleges/universities etc. & field officers of Agri. Extension (Punjab) for their information and guidance during the season:

- Recommendations of Cotton Variety CIM-496
- Recommendations of Cotton Variety CIM-534
- Recommendations of Cotton Variety CIM-573
- Recommendations of Cotton Variety CIM-608
- Recommendations of Cotton Variety CIM-620
- Recommendations of Cotton Variety CIM-610
- Recommendations of Cotton Variety Cyto-124
- Recommendations of Cotton Variety Cyto-179
- Recommendations of Cotton Variety Bt.Cyto-177
- Recommendations of Cotton Variety Bt.CIM-598
- Recommendations of Cotton Variety Bt.CIM-599
- Recommendations of Cotton Variety Bt.CIM-602
- Recommendations of Cotton Variety Bt.CIM-632
- Recommendations for better seed germination
- *Kapsa Ki KashtAurNighehdasht*
- *Kapas K BeejKaUgaaouAurBehtarSifarshat*
- *Kapaasmein Potash kiAhmiyat*
- *Kaps Ki Mealy Bug AurOosKaInsdaad*
- *Kapaas Ki PattaMarorBemariSyBachaou Ki Hikmat-E-Amli*
- *KapaaskiMeleybug*
- کپاس کی گلابی سنڈی اور اس کا طریقہ انسداد
- کپاس کی گلابی سنڈی کا تدارک بذریعہ پی بی روپس

7.1.14 Demonstration of Mechanical Picking

Date	Participants	Briefed by
23.10.2018	Media personals of national newspapers ,Radio & TV	Dr. Zahid Mahmood, Director CCRI Multan
21.12.2018	Mr. Khalid Khokhar, President, Pakistan KissanIttehad and Mr. AsifMajeed, President, Evyol Group and Farmers delegation	-do-

7.1.15 Agricultural Exhibition

The section participated in following agricultural exhibitions during the season:

Date & Venue	Organized by	Title	Participation
30th March to 1st April ,2018 B.Z.U	Dunya TV, Lahore & B.Z.U Multan	"DunyaKissan Dost Mela - Agricultural Expo & Conference 2018"	Various dignitaries No. of farmers Students Others
06.04.2018 QilaQuhnaQasimBaugh,Multan	Nawa-e-Waqt Group	Kissan Mela-2018	-do-

7.2 Meetings

7.2.1 Agriculture Research Sub-Committee (ARSC)

Three days consecutive meeting of Agriculture Research Sub-Committee (ARSC) of Pakistan Central Cotton Committee (PCCC) was held at Central Cotton Research Institute (CCRI), Multan on March 20-22, 2018 under the chairmanship of Dr. Khalid, Abdullah, Vice President (PCCC)/Cotton Commissioner, MinTex. The agenda of the meeting was the consideration of Annual Summary Progress Report for the year 2017-18 and the approval of Annual Program of Research Work for the year 2018-19. The meeting was attended by all members of the subcommittee PCCC offices, other public stakeholders, private seed sector and progressive farmers. The section provided all type of technical facilities to organize the meeting.

7.2.2 Cotton Crop Management Group (CCMG)

Following Five (05) Cotton Crop Management Group (CCMG) meetings were held at Central Cotton Research Institute, Multan/other venues during the season:

Date/Venue	Chaired by/Special guests
04.04.2018	Mr. WasifKhurshid, Secretary Agriculture Punjab
12.05.2018 CCRI,Multan	i. Ms. Beenish Fatima Sahi Additional Secretary (Task Force) Punjab ii. Syed Fakhre Imam, Ex Speaker National Assembly iii. Dr. Khalid Abdullah, Cotton Commissioner, MNFSR, Islamabad;
06.07.2018 CCRI,Multan	i. SardarTanveerIlyas Khan, Minister for Agriculture, Punjab. ii.Mr. WasifKhurshid, Secretary Agriculture Punjab iii. MsBenish Fatima, Additional Secretary (Task Force iv. Dr. Khalid Abdullah, Cotton Commissioner, MNFSR, Islamabad
10.08.2018 CCRI,Multan	i.Mr. WasifKhurshid, Secretary Agriculture Punjab ii.MsBenish Fatima, Additional Secretary (Task Force) iii. Dr. Khalid Abdullah, Cotton Commissioner, MNFSR, Islamabad
24.09.2018 CCRI,Multan	i.MalikNauman Ahmad Langrial, Minister for Agriculture, Punjab ii.Dr. Khalid Abdullah, Cotton Commissioner, MNFSR, Islamabad

Meetings were attended by all the stakeholders of cotton economy including Vice Chancellor, MNSUA, Multan, Director Generals (DGs) Extension, PW&QC, Research, information and agri scientists, district officers' agriculture extension from Multan, Sahiwal, Bahawalpur and DG Khan Divisions, and senior officials of water management and energy, chief engineers of irrigation department,Punjab, representative of MEPCO, Multan and progressive growers, pesticides & fertilizers' companies' representatives were also there to share their opinions with the participants on different issues related to cotton. The section provided technical facilities to assist the meeting.

7.2.3 Cotton Crop Assessment Committee (CCAC)

Following Two (02) Cotton Crop Assessment Committee (CCAC) meetings were held at Islamabad during the season:

VISIT OF COTTON CLASSER FROM PCSI

A group of 15 cotton classers led by Mian Nasir Ali, Officer Incharge, Pakistan Cotton Standards Institute (PCSI) Regional Office, Multan visited CCRI Multan on August 9, 2018. Dr. Zahid Mahmood, Director CCRI Multan gave briefing about cotton research and development activities carried out by the Institute.

VISIT OF STUDENTS

Students of 7th Semester, B.Sc. (Hons.) Agriculture, Plant Breeding & Genetics, Faculty of Agricultural Sciences & Technology (FAST), Bahauddin Zakariya University Multan, led by Dr. Asif Saleem, Assistant Professor, Plant Breeding & Genetics Department visited CCRI Multan on 18th September, 2018. Ms Farzana Ashraf briefed about cotton research and development activities carried out by the Institute.

Date	Chaired by
12.09.2018	Dr. Muhammad HashimPopalzai, Federal Secretary, Ministry of National Food Security & Research, Islamabad
02.01.2019	-do-

The meeting was attended by representatives of Provincial Governments, All Pakistan Textile Mills Association, Pakistan Cotton Ginners Association, Trading Corporation of Pakistan and Progressive Cotton Growers. Dr. Zahid Mahmood, Director CCRI Multan attended both meetings.

7.2.4 Pakistan and Uzbekistan Cooperation in Agriculture Development

Meeting regarding “Pakistan and Uzbekistan Cooperation in Agriculture Development” was held at Ministry of National Food Security & Research, Islamabad on April 19, 2018. Uzbekistan Ambassador to Pakistan Mr. Furkat A Sidikov along with his delegation, Dr. Yusuf Zafar, Chairman, PARC, Islamabad; Dr. Zahid Mahmood, Director CCRI Multan and other officials attended the meeting. The areas of mutual interests including agriculture, agro-machinery manufacturing, food processing, dry fruits, fresh fruits, cotton, milk and its by-products and leather were discussed in the meeting.

7.2.5 Agricultural Policy Institute (API)

Annual meeting of the Agricultural Policy Institute (API) was held at Islamabad on May 15, 2018 chaired by Dr. Khalid Abdullah, Cotton Commissioner, Ministry of National Food Security & Research. Dr. Zahid Mahmood, Director CCRI Multan; cotton growers, experts, researchers, planners and representatives from agencies involved in production and marketing of cotton attended the meeting. The meeting deliberated the issues relating to the production, marketing and prices of cotton in connection with formulating the proposals for Cotton Price Policy Analysis 2018-19.

7.2.6 Senate Standing Committee Meeting on National Food Security and Research

The Senate Standing Committee on National Food Security and Research was held on October 9,2018 at Islamabad under the chairmanship of Senator Syed MuzaffarHussain Shah. The meeting was attended by Senator Muhmmad Ali Jamot, Senator ImamuddinShouqeen and senior officers from the Ministry for National Food Security and Research, IRSA, PARC and Central Cotton Research Institute Multan. The Committee was briefed by the Dr.Khalid Abdullah, Vice President, Pakistan Central Cotton Committee on expected shortfall in the production of cotton for Kharif season in 2018.

Dr. Zahid Mahmood, Director CCRI Multan apprised about the measures taken by the Institute in cotton productivity enhancement programs i.e., evolution of high yielding cotton varieties, organizing training programs for the field staff of Agriculture Department, private pesticide & seed association especially for the management of Pink bollworm and Cotton Whitefly.

7.2.7 Activities & Achievements of PCCC

Meeting regarding "Activities & Achievements of Pakistan Central Cotton Committee (PCCC)" was held under the chairmanship of Sahibzada Muhammad Mehboob Sultan, Federal Minister; and co-chaired by Dr. Muhammad HashimPopalzai, Federal Secretary, Ministry of National Food Security & Research, Islamabad on November 08, 2018.Dr. Khalid Abdullah, Vice President, PCCC gave a detailed briefing about the activities & achievements of the PCCC over the past decade and bottlenecks in carrying out cotton research activities. Dr. Muhammad Ali Talpur, Economic Consultant, MNFSR, Dr. Zahid Mahmood, Director CCRI Multan; Mr. ZakirullahKhalidi, Mr. Zulfiqar Ali, PCCC attended the meeting.

7.2.8 Strengthening of Seed Supply System in Pakistan

Second Roundtable Consultation on Development of Project on “Strengthening of Seed Supply System in Pakistan” was held at FAO Office, NARC Premises, Islamabad on 29th November 2018. Dr. Shakeel Ahmad Khan, Seed Sector Specialist, FAO gave a briefing about the strengthening of the seed sector in Pakistan. The meeting deliberated on the formalization of Foundation Seed Cell, supporting Fruit Plant Certification, Distinctness, Uniformity, Stability (DUS) Testing, and Seed Technology Training.Dr. Zahid Mahmood, Director CCRI Multan attended the meeting and deliberated upon the need for the

establishment of Foundation Seed Cell for the cotton crop and assistance required from the FAO in this regard.

7.2.9 Punjab Seed Council

The 50th meeting of the Punjab Seed Council was held at Lahore on May 09, 2018 under the chairmanship of Mr. Muhammad NaeemAkhtarBhabha, Minister for Agriculture, Government of the Punjab, Lahore. Planners, agricultural researchers and crop breeders attended the meeting. Cases for approval of crop varieties of cotton, maize, rice, mungbean, oilseed, citrus, and dry peas were presented. Approval of two cotton varieties of CCRI Multan; Bt.CIM-632 (Bt) and CIM-610 (conventional) was also given for commercial cultivation in the Punjab province. Dr. Zahid Mahmood, Director CCRI Multan attended the meeting and briefed the house about salient features of these two varieties.

7.2.10 Sindh Seed Corporation

Meeting of the Experts Sub-Committee of the Sindh Seed Corporation was held at the Directorate of Agricultural Research, Tandojam, Sindh on November 11, 2018 under the chairmanship of Mr. Noor Muhammad Baluch, Director General Agriculture (Research), Sindh. Cases of cotton varieties from various public and private sector institutions were presented.Dr. Muhammad Idrees Khan, Head, Plant Breeding & Genetics, CCRI Multan presented cases of Bt.CIM-602 and Bt.CIM-616 from CCRI, Multan.Dr. Zahid Mahmood, Director CCRI Multan presented cases of GH-Baghdadi, GH-Deebal, GH-Mubarak, GH-142, GH-Hammad from CRS, Ghotki.

7.2.11 77th Expert Sub-Committee

77th Expert Sub-Committee Meeting of the Punjab was held at Ayub Agricultural Research Center, Faisalabad on March 15, 2018 under the chairmanship of Dr.Abid Mahmood, Director General Research, Punjab. Two cotton varieties of CCRI Multan; Bt.CIM-632 and CIM-610 (conventional) were recommended to Punjab Seed Council for the approval of general cultivation in Punjab. Dr. Zahid Mahmood, Director CCRI Multan and Dr. Muhammad Idrees Khan Peer, Head Plant Breeding & Genetics Section attended the meeting with other participants.

7.2.12 Crop breeders and agricultural experts

A meeting of the crop breeders and agricultural experts was held at Punjab Seed Corporation Headquarter, Lahore on 17th September 2018 under the chairmanship of Mr. WaheedAkhtar Ansari, Managing Director, Punjab Seed Corporation. The meeting was held for fixation of procurement targets for Kharif and Rabi Crops by the Punjab Seed Corporation during 2018-19. Dr. Zahid Mahmood, Director CCRI Multan attended the meeting with other attendees. Four cotton varieties of CCRI Multan i.e., CIM-632, CIM-610, CIM-620 and Cyto-124 were included for procurement during 2018-19.

7.2.13 Cotton Research & Development Board of Punjab

A meeting of the Cotton Research & Development Board of Punjab held the Muhammad Nawaz Shareef University of Agriculture, Multan on December 24,2018 under the chairmanship of Mr. SohailMehmoodHarral, Chairman, Cotton Research & Development Board, Multan. The meeting deliberated upon cotton research and development activities during the year 2018 and measures to be adopted in 2019 crop season in the Punjab province. Dr. Zahid Mahmood, Director CCRI Multan attended the meeting and apprised the house on the collaborative efforts for the development of Cotton Production Plan, training programs for field staff of Agriculture Extension, Pest Warning Departments, private pesticide/seed industry, NGOs and especially the farmers conducted by the Institute during the period. He further apprised that such collaborative programs must also be continued during the coming season for the betterment of cotton crop in the province.

7.2.14 Punjab Agricultural Research Board (PARB)

A meeting of the Punjab Agricultural Research Board (PARB) funded projects for the “Management of Cotton Whitefly and Pink bollworm” was held at CCRI Multan on November 20, 2018 under the chairmanship of Dr. Zahid Mahmood, Director CCRI Multan. Prof. Dr. Muhammad Jalal Arif, Chairman, Department of Entomology, University of Agriculture, Faisalabad / Project Manager, briefed about the activities carried out during the period for the management of cotton whitefly and pink bollworm. The collaborating partners from different institutions also attended the meeting and presented the progress of work done so far.

7.2.15 Cotton Production Plan 2019-20

Miss Benish Fatima, Additional Secretary Task Force, Agriculture Department, Punjab chaired the meeting about the finalization of Cotton Production Technology Plan 2019-20 at AARI, Faisalabad on 16-01-19. DG Research (Punjab), Directors CCRI Multan, CRI Multan, RARI, Director Coordination Punjab, Academicians, Scientists of Basic and Adaptive Research Punjab, Extention, Pest Warning, PCPA, Seed corporations, state dept. representatives attended the meeting and gave their valuable suggestion to improve the cotton Production Technology for the cotton crop season 2019-20.Dr. Zahid Mahmood, Director CCRI Multan attended the meeting and suggested measures to be adopted for the cotton productivity enhancement during the crop season. He also suggested that collaborative programs for cotton farmers training and management of Pink bollworm & cotton whitefly campaigns must also be continued during the current season for cotton productivity enhancement in the province.

7.2.16 Pak-US ICARDA

A special review and planning meeting of "Pak US ICARDA Cotton Project" was convened at ICARDA Pakistan Office, NARC Islamabad on September 4, 2018 under the chairmanship of Dr Jodi Schefflor and Dr Lloyd Garcia, Plant Health Adviser, USAID, US Embassy Islamabad. Dr Muhammad Idrees Khan, Head, Plant Breeding & Genetics attended the meeting with other participants and briefed about the project activities carried out at CCRI Multan.

7.3 Seminars

a.The following national seminars were conducted during the season:

Date/Venue	Title	Organized by	Participants
March 19,2018 Vehari	Better Cotton Initiative"	Regional Agricultural Economic Development Center (RAEDC), Vehari	Dr. Zahid Mahmood, Director, CCRI Multan delivered the lecture on “Role of Cotton in Pakistan’s Economy, Cotton Varieties and their Features” to officials of Agriculture Extension Department, Punjab.About Fifteen participants attended the seminar.
March 30, 2018/Textile Engineering, B.Z.U ,Multan	"Importance of cotton fibre parameters with special reference to processing"	WWF-Pakistan	Mr. IlyasSarwar, Head, Fibre Technology Section gave the lecture on "Importance of cotton fibre parameters with special reference to processing" to the participants of the seminar .About 40 participants attended the seminar.
May7,2018 CCRI ,Multan	National seminar on "Cotton Production Technology"	CCRI, Multan	The seminar was chaired by Haji Sikandar Hayat Khan Bosan, Minister for National Food Security & Research, Government of Pakistan, Islamabad. Dr. Khalid Abdullah, Cotton Commissioner, Ministry of National Food Security & Research also co-chaired the seminar. The scientists of CCRI Multan delivered lecture on cotton production technology, agronomic practices for profitable cotton production, selection of cotton varieties, judicious use of fertilizer, insect pests and disease management. Around 250 agriculture researchers, academicians and farmers attended the seminar. Private seed/pesticide companies also displayed products at the stalls planted during the event.

Training program for the Technical Officers of PCSI

Training Program for Technical Officers of Pakistan Cotton Standards Institute (PCSI) was organized on 23.04.2018 and 07.05.2018, respectively. Lectures delivered about varietal development, cotton agronomy, insect pests and disease management, farmers training programs and clean picking measures. The group was led by Muhammad Nasir Ali, Incharge PCSI Regional Office, Multan. The participants also visited labs and fields of the Institute.

May 14,2018 Vehari	Seminar on " Optimizing Cotton Production 2018	Regional Agricultural Economic Development Centre (RAEDC) Vehari	Regional Agricultural Economic Development Centre (RAEDC) Vehari organized a cotton seminar "Optimizing Cotton Production 2018. Dr. Zahid Mahmood, Director CCRI Multan was the Chief Guest of the Seminar and presented talk on "Cotton Production Technology". Around 70 agriculture researchers, extension officials and farmers of the area attended the seminar.

b.Sarsabz Cotton Seminar

PCPA & Pakistan KissanIttehad organized “Sarsabz Cotton Seminar” in collaboration with CCRI ,Multan on 7th January 2019 at B.J.MarqueeMultan.Sahibzada Muhammad Mehboob Sultan, Federal Minister for Ministry of National Food Security &Research;,SyedFakhre Imam, Member National Assembly, Syed HussainJahaniaGardezi, Member Punjab Assembly, Mr. Khalid Mahmood Khokhar, Chairman Pakistan KissanIttehad, Mr. KhurramJavedMaqbool, Director Marketing and Sales at Fatima Group, Prof. Dr. Asif Ali, Vice Chancellor, MNSUA Multan; Dr. Khalid Abdullah, Cotton Commissioner, and Dr. Zahid Mahmood, Director CCRI Multan chaired the session. Mr. Jahangir Khan Tareen also participated as a Special Guest.

Talks on various aspects of cotton production & marketing were presented by Dr. Khalid Abdullah, Cotton Commissioner, Dr. Saghir Ahmad, Director Cotton Punjab; Mr. Baig from Fatima Group of Companies, and MsRabia Sultan, cotton grower from KotAddu.SahibzadaMehboob Sultan, Minister for National Food Security while addressing the gathering, stated that all efforts were made for achieving the target of 15 million bales of cotton production during the year 2019 through the measures proposed for area expansion, seed technology development, support measures and improved extension services. In this occasion 19-point cotton policy was also announced by the Sahibzada Muhammad Mehboob Sultan, Federal Minister for Ministry of National Food Security & Research, Islamabad.

c.Cotton Traveling Seminar

The scientists of traveling seminar visited the Institute on October21, 2018. The team was led by Mr. Muhammad Yasin, Cotton Botanist, Cotton Research Institute, Khan Pur. Dr.Khizar Hayat Bhatti,SO, Cytogenetics&Dr. ShehzadDyem , SO , Plant Breeding Section of the Institute participated in the seminar.Dr. Zahid Mahmood, director central cotton research institute delivered welcome address to the participants of Pakistan Central Cotton Committee at the Institute. He briefed the participants about performance of advanced lines developed by the Institute. The advanced lines included CIM-303, CIM-632, Cyto-510, Cyto-511, Cyto-515, CIM-678, CIM-789, CIM-343, CIM-663, and CIM-602 exhibiting excellent field performance.

7.4 MoU between CCRI & WWF-Pakistan

CCRI Multan entered into partnership with WWF Pakistan on May 22, 2018 at the institute. Dr. Zahid Mahmood, Director CCRI Multan and Mr. Asad Imran on behalf of Mr. ArifMakhdum, Director, Sustainable Agriculture & Food Program, WWF-Pakistan signed the agreement. Both the parties agreed to jointly undertake activities to develop and demonstrate sustainable practices to preserve natural attributes of cotton fiber at production and processing level. CCRI Multan will conduct trainings in collaboration with WWF-Pakistan on cotton production technology and fiber quality preservation techniques for cotton supply chain actors i.e. farmers, cotton pickers, intermediary market actors and ginners. Moreover, publication of resource material will also be printed and distributed among the trainees.

7.5 Participation in Workshop/Conference

Date	Workshop/Conference	Venue	Organized by	Participants
May 22-23, 2018	"International Workshop for Lab Establishment & Rearing Techniques of Pink Bollworm"	MNSUA, Multan	MNSUA, Multan	i.Dr. RabiaSaeed ii.Mr. Junaid Khan Daha iii. MrsShabanaWazir
August 7-8, 2018	Two-days consultative workshop “Land	Islamabad	Ministry of Climate Change,	Dr. Zahid Mahmood,

	Degradation Neutrality Target Setting Program for Pakistan"		Government of Pakistan, Islamabad	
September 5,2018	National Training Workshop on "Climate Modeling, Projections Generations and Data Analysis"	MNSUA-Multan	MNSUA-Multan	Mr. Muhammad Tariq
September 11-13,2018	Strategic Planning Workshop on "Eliminating child labour and forced labour in the cotton, textile and garment value chains: an integrated approach"	Islamabad	ILO in collaboration with the FAO and co-funded by the European Union	Dr.Zahid Mahmood
November 26-27,2018	2nd SINO-PAK International Conference on "Innovations in Cotton Breeding & Biotechnology"	PCCC,MNSUA & BZU ,Multan	MNSUA-Multan	Dr.Zahid Mahmood & all heads of sections with other scientific staff
December 17-18, 2018	Workshop on "Land Degradation Neutrality (LDN) Target Setting Program"	Islamabad	United Nations Convention to Combat Desertification (UNCCD)	Dr.Zahid Mahmood

7.6 Visitors

a)

Dignitaries/Delegation	Dated
2-member Australian delegation	22.02.2018
Mr. NaseemAbbassi, Deputy Secretary (PCCC), Ministry of Textile Industry	23.02.2018
15-member 25th Mid-Career Management Course, Lahore	14.03.2018
Dr. Iftikhar Ali, Deputy Chief Scientific / Deputy Director, Nuclear Institute for Agriculture and Biology (NIAB) and Dr. Noor AbidSaeed, Senior Scientist, Plant Protection Division, NIAB	29.03.2018
MrsNarjisAshfaq, CEO, Sangtani Women Rural Development Organization (SWRDO), RajanPur	19.04.2018
Mr. Serik Doman, Associate Professor, Grass Land Institute Xingjiang,China	30.04.2018
Six member delegation from C4 countries (Burkina Faso, Chad, Mali and Benin)	May 2-3,2018
Five member Technical Officers from Sangtani Women Rural Development Organization (SWRDO),NGO	08.05.2018
Technical team from ICARDA office, Islamabad	15.05.2018
Two members Chinese delegation	21.05.2018
Mr. Atiq-ur-RehmanQureshi, DGM Commercialization North, STEDEC	04.07.2018
Dr. ShahidMansoor, Director, NIBGE, Faisalabad	20.08.2018
5-memebers Chinese delegation	16.08.2018
Mr. Mustafa Diwan, Head of Marketing and Mr. Muhammad Ashraf, Head Technical Development,Syngenta, Pakistan	10.08.2018
3-member Greece delegation	07.09.2018
Maj. Gen. (R) Akbar SaeedAwan, Chairman, National Technology Council, Engr & Dr. AlamgirAkhtar Khan, Chairman, Department of Agriculture Engineering, MNSUA	17.09.2018
12-member 26th Mid-Career Management Course, Lahore	17.10.2018
18-member 26th Mid-Career Management Course, Islamabad	18.10.2018
Makhdoom Syed Ahmed AlamAnwer, former Chairman, National Assembly Standing Committee	01.10.2018
Dr. Khalid Abdullah, Vice President, PCCC	02.11.2018

13-member delegation of journalists from print and electronic media	23.10.2018
Ch. Gohar Ali, MakhdumRasheed, Ch. Abdul GhaffarArain, Progressive Growers	29.10.2018
Makhdoom Syed Ahmed AlamAnwer, Ex.MNA	14.11.2018
5-member delegation from seed sector	23.11.2018
Prof. Dr. SergegShabala, Professor of Stress Physiology, University of Tasmania, Australia and Dr. Shou-Qing Ni, Associate Professor, Shandong University, China	27.11.2018
Mr. Ejaz Sheikh, Consultant, EMS R&D Solutions Ltd., England	28.11.2018
Mr. Abdul Rehman, Research Monitoring & Evaluation Officer, Punjab Agricultural Research Board (PARB), Lahore	28.11.2018
Mr. Nazeer Ahmad Khan Baloch, MPA (PP-228), Lodhran	01.12.2018
Ms Sana Naseer, Manager and RanaAhsan, Officer, National Bank of Pakistan	05.12.2018
4-member progressive farmers delegation ,RYK	05.12.2018
3-members Chinese delegation	06.12.2018
Mr. Ali Naeem, Chief Executive Officer, ArystaLifeScience Pakistan along with company delegation	07.12.2018
Mr. GhulamSiddique, Director, Agricultural Mechanization Research Institute (AMRI), Multan	20.12.2018
Mr. Asif Rasool, Deputy Director, FSCRD, Multan	20.12.2018
Mr. Khalid Khokhar, President, Pakistan KissanIttehad and Mr. AsifMajeed, President, Evyol Group	21.12.2018
Malik Muhammad Amir Dogar MNA (NA-155) Multan, Chief Whip, National Assembly of Pakistan,	22.12.2018
Dr. Muhammad HashimPopalzai, Federal Secretary, Ministry of National Food Security & Research, Islamabad	30.12.2018
Dr. Khalid Abdullah, VP PCCC/ Cotton Commissioner, MNFS&R	30.12.2018
MsRabia Sultan, progressive cotton farmers from KotAddu, Muzafargarh	08.01.2019
Dr. Muhammad JavaidTareen, Director General Agriculture (Research), and Mr. InamulHaq, Director General Agri (Extension) Quetta, Balochistan	17.01.2019
Syed Ali HaidarGillani, , Member of Punjab Assembly	21.01.2019
5-member SIA delegation (Sustainability, Innovation, Advocacy,Karachi)	29.01.2019
Dr. Muhammad Anjum Ali, Director General Agriculture Extension, Punjab and Dr. Zahoor Ahmad, former Director CCRI	06.02.2019
Mr. Muhammad Khan Daha, MNA	15.02.2019

b) Student Study Tour

Name of University/Institution	No. of Participants
BurewalaAgri.College, (B.Z.U Campus)	98
University of Agriculture, Faisalabad	376
University College of Agriculture, BZU, Multan	138
Muhammad Nawaz Sharif University of Agri. Multan(MNSUA)	35
Agriculture Training Institute, Karor, Layyah	100
Govt. College of Layyah	49
College of Agriculture, BZU, Bahadur Sub-Campus, Layyah	66

7.7 Face book Page CCRI, Multan

A page on Face book www.facebook.com/CCRIM.PK is being regularly updated by the Section to disseminate the research activities of the Institute on social media.

8 FIBRE TECHNOLOGY SECTION

Fibre Technology section was established in 1976. The prime objective of Fibre Technology section is to provide technical support to Plant Breeding & Cytogenetics sections in testing of fibre characteristics and spinning potential of newly developed cotton cultivars & strains and facilitates the other sections of the institute as well, to investigate the effect of different agricultural practices on fibre characteristics. The section also extended these facilities to the cotton breeders working in Central Cotton Research Institute Sakrand, Cotton Research Station Ghotki, Cotton Research Station D.I. Khan, Cotton Research Station Mirpur Khas, Cotton Research Station Lasbella, Cotton Research Station Sibbi and to other relevant public and private parties as well. Research activities were focused to study the effect of potassium fertilizer & water stress on quality characteristics of cotton fibre, response of cotton quality characteristics to magnesium application by fertigation and foliar methods and saw & roller ginning comparison for cotton fibre quality. The department also conducted the “Quality Survey” in the core cotton producing districts of Punjab to determine the overall cotton fibre quality of the region grown commercially through lint sample collection from the cotton ginning factories of the respective areas.

Moreover, the spinning industry of Punjab province was also visited to accumulate information regarding the utilization of cotton fibre with special reference of the cotton fibre traits and others fibres as well in industry along with imported cotton. The achievements are given as under:

8.1 Testing of Lint Samples

The lint samples received from various sections of the institute, research stations of PCCC, government research stations, research scholars of different universities were tested for different fibre characteristics. The section also provided technical support to Pakistan Institute of Cotton Research & Technology, Karachi for the lint samples collected by PICR&T during the Quality Survey of ginning factories from Punjab & Sindh were analyzed at Fibre Technology Section to publish a comprehensive report entitled “Quality Survey of Pakistan Cottons” which reflects a true picture of commercially grown cotton at different locations and this report is fruitful for cotton Breeders, Ginners, Spinners, exporters and all stakeholders of cotton.

The detail of the samples tested is given in Table 8.1.

Table 8.1 Number of Samples Tested for Various Fibre Characteristics

Source	Fibre Length (mm)	Micro-naire ($\mu g\ inch^{-1}$)	Fibre Strength ($g\ tex^{-1}$)	(Tppsi)	Color grade	Trash (%)	Total
Breeding, CCRIM	17224	17076	17076	861			52237
Cytogenetics, CCRIM	5245	5245	5245				15735
Agronomy, CCRIM	36	36	36		33		141
Fibre Technology, CCRIM	261	261	261	38	110		931
Plant Physiology, CCRIM	533	533	533				1599
CCRIM	511	511	511				1533
CCRI, Sakrand	825	825	825				2475
CRS, M.P. Khas	147	147	147				441
CRS, Sahiwal	242	242	242		24		750
CRS, Ghotki	856	856	856		36		2604
CRS, D.I.Khan	1550	1550	1550				4650
CRS, Lasbella	119	119	119				357
CEMB, Lahore	35	35	35				105
Spot Examination,	35	35	35				105
FSC & RD, Khanewal	93	93	93				279
Thatha Gurmani Farm	328	328	328				984
Yield competition, M. garh	3	3	3				9
Quality Survey (Sindh)	1063	1063	1063		1063	191	4443
Quality Survey (Punjab)	484	484	484		484	492	2428
Quality Survey (KPK)	36	36	36		36		144
(MNSUA+BZU)	73	73	73				219
Total	**29699**	**29551**	**29551**	**899**	**1786**	**683**	**92169**

8.2 Testing of Commercial Samples

The section has extended the testing services to facilitate private sector. The number of samples tested is given in Table 8.2

Table 8.2 Number of Samples Tested for Various Fibre Characteristics

Source	Fibre Length (mm)	Micro-naire (µg inch^{-1})	Fibre Strength (g tex^{-1})	Color grade	Trash (%)	Total
Private Sector	42	42	42	3	5	**134**

8.3 The Effect of Different Moisture Levels on Fibre Characteristics of Cotton

The objective of the experiment was to study the effect of different moisture levels on fibre characteristics of cotton. The control of the moisture content of cotton during testing is important as the hygroscopic nature of cotton allows for many fibre properties to vary in response to the ambient environment. The ASTM standard calls for a temperature of 20±2°C and 65±2% relative humidity for testing of cotton fibre. *Bt.* CIM-789 genotype was selected for this purpose. The genotype was ginned by saw and roller ginning. The 50 lint samples were given three moisture levels viz., 6%, 8.5% and 10.5% of each ginning type were prepared and tested for various fibre characteristics. The results are presented in Table 8.3.

The findings from different moisture levels are presented in table 8.3 revealed that there were differences between different moisture contents, for fibre length, fibre strength, uniformity index, degree of whiteness and degree of yellowness for each ginning type. The fibre length, uniformity, strength and degree of yellowness increased, degree of whiteness decreases with increase in moisture level for each ginning type. There is no effect of moisture level on micronaire value for each cotton type.

Table 8.3 Fibre characteristics as affected by different moisture levels.

Ginning Type	Saw Ginning			Roller Ginning		
Moisture Level	**6.0%**	**8.5%**	**10.5%**	**6.0%**	**8.5%**	**10.5%**
Fibre Length (mm)	25.2	25.9	26.3	25.6	26.3	26.5
Uniformity Index (%)	81.0	82.2	80.3	82.1	82.8	82.7
Micronaire Value	3.9	4.0	4.2	4.0	4.1	4.0
Strength (g/tex)	27.0	27.7	28.4	27.4	28.0	28.7
Degree of Whiteness (Rd)	67.9	68.4	68.0	66.7	66.1	66.1
Degree of Yellowness(+b)	9.2	8.9	11.2	9.8	8.9	10.6

8.4 To study the effect of Potassium fertilizer & water stress on quality characteristics of cotton fibre.

The objective of this study to evaluate the role of potassium fertilizer on fibre quality characteristics under no stress and water stress conditions. This experiment was conducted with the collaboration of Plant Physiology/Chemistry section. The layout of experiment was split-split block design with three replications. The sowing of cotton and application of potassium fertilizer was done by Plant Physiology/Chemistry section. Five genotypes were selected. The dose of potassium was 0 and 50 kg per hectare. Five plants of all varieties were tagged from each replication. Picking is done on maturity and ginned at miniature ginning machine. The samples were tested for fibre characteristics on High Volume Instrument (HVI-900A). The results obtained were presented in tables 8.4.

Table 8.4 Effect of potassium fertilizer and water stress on quality traits of cotton

Water stress levels (S)	K_2O levels kg/ha (K)	Cotton genotypes (V)	Fibre length (mm)	MIC	Strength (g/tex)	Lint (%)	Seed Index (%)
Stress (S1)	0 (K1)	Cyto-124 (V1)	29.3	4.6	31.4	36.0	6.9
		Bt. CIM-554 (V2)	25.4	4.5	27.0	38.0	7.2
		BH-212 (V3)	25.3	4.5	26.4	35.1	6.4
		BS-13 (V4)	24.6	5.1	25.5	37.4	7.9
		FH-142 (V5)	24.4	5.1	25.1	36.2	7.1
	50 (K2)	Cyto-124 (V1)	30.1	4.4	32.8	37.5	6.4
		Bt. CIM-554 (V2)	26.1	5.1	27.1	38.3	7.0
		BH-212 (V3)	25.5	4.4	26.5	36.3	7.3
		BS-13 (V4)	25.0	5.0	26.0	36.8	7.7
		FH-142 (V5)	24.4	4.8	25.1	36.0	7.0
No Stress (S2)	0 (K1)	Cyto-124 (V1)	28.8	4.4	28.4	39.2	6.4
		Bt. CIM-554 (V2)	24.9	4.7	26.0	37.3	6.9
		BH-212 (V3)	25.1	4.6	26.1	35.5	6.9
		BS-13 (V4)	24.6	5.3	25.4	39.8	7.3
		FH-142 (V5)	24.8	5.2	25.8	36.8	7.5
	50 (K2)	Cyto-124 (V1)	28.4	4.6	29.9	38.1	7.2
		Bt. CIM-554 (V2)	26.5	4.7	27.5	39.6	6.9
		BH-212 (V3)	23.9	5.2	25.0	36.7	7.4
		BS-13 (V4)	24.2	5.0	25.5	39.5	7.1
		FH-142 (V5)	24.3	5.3	25.1	36.6	6.5

Sub effects

Water Stress Levels (S)	Fibre length (mm)	MIC	Strength (g/tex)	Lint (%)	Seed Index (%)
S1	26.0	4.7	27.3	36.7	7.1
S2	25.5	4.9	26.4	37.9	7.0

K_2O levels kg/ha (K)	Fibre length (mm)	MIC	Strength (g/tex)	Lint (%)	Seed Index (%)
K1	25.7	4.8	28.2	37.1	7.0
K2	25.8	4.8	25.5	37.5	7.1

Cotton genotypes (V)	Fibre length (mm)	MIC	Strength (g/tex)	Lint (%)	Seed Index (%)
V1	29.1	4.5	27.8	37.7	6.7
V2	25.7	4.7	28.4	38.3	7.0
V3	24.9	4.7	26.1	35.9	7.0
V4	24.6	5.1	26.3	38.4	7.5
V5	24.5	5.1	25.7	36.4	7.0

CD 5%	Fibre length (mm)	MIC	Strength (g/tex)	Lint (%)	Seed Index (%)
S	**0.13**	NS	**0.38**	NS	NS
K	NS	NS	0.24	NS	NS
V	**1.16**	NS	**1.14**	NS	NS
S x K	NS	NS	NS	NS	NS
S x V	NS	NS	NS	NS	NS
K x V	NS	NS	**1.62**	NS	NS
S x K x V	NS	NS	NS	NS	NS

The data presented in table 8.4 indicated the significant effects of water stress levels and varieties for fibre length and strength whereas potassium fertilizer has significant effect on strength. Micronaire, lint percentage and seed index did not differ significantly for water stress levels, potassium fertilizer and cotton genotypes.

8.5 Response of cotton quality characteristics to magnesium (mg) application by fertigation and foliar methods.

To explore the role of magnesium applied by different methods on quality characteristics of *Bt.* CIM-434 and CIM-610, Non-Bt. variety. This experiment was conducted with the collaboration of Plant Physiology/Chemistry section. The layout of experiment was randomized complete block design with three replications. The sowing and application of magnesium by fertigation and foliar methods was done by Plant Physiology/Chemistry section. The dose of

magnesium in fertigation method was 10 and 20 kg per hectare and in foliar method was 3 and 6 kg per hectare and a control. Five plants of both varieties were tagged from control and each magnesium application for each replication. Picking is done on maturity and ginned at miniature ginning machine. The samples were tested for fibre characteristics on High Volume Instrument (HVI-900A). The results obtained were presented in tables 8.5 and 8.6.

Table 8.5 Fibre characteristics of *Bt.* CIM-343 as affected by different Mg dose levels

Application	Magnesium Dose (Kg/ha)	Fibre Length (mm)	Uni. Index (%)	MIC	Strength (g/tex)	Elongation (%)	Seed Index (%)
Control	0	25.78	82.42	5.07	26.08	5.00	7.37
Soil	10	25.67	82.13	4.87	25.70	5.03	7.23
	20	26.07	84.37	5.17	25.90	5.30	7.75
Foliar	3.0	26.90	81.77	5.10	26.67	5.20	7.77
	6.0	25.80	82.03	5.27	24.97	5.37	7.55
CD (5%)		**0.78**	**2.70**	**0.43**	**1.86**	**0.52**	**0.77**

Table 8.6 Fibre characteristics of CIM-610 as affected by different Mg dose levels

Application	Magnesium Dose (Kg/ha)	Fibre Length (mm)	Uni. Index (%)	MIC	Strength (g/tex)	Elongation (%)	Seed Index (%)
Control	0	27.00	84.15	5.02	26.45	5.62	7.73
Soil	10	27.23	83.30	4.97	26.63	5.40	7.42
	20	27.23	83.63	4.63	26.77	5.40	7.32
Foliar	3.0	27.37	83.37	4.63	28.03	5.60	7.31
	6.0	27.57	84.30	5.03	27.63	5.73	7.53
CD (5%)		**1.59**	**2.19**	**1.06**	**2.50**	**0.79**	**0.78**

The effect of mg on fibre length by fertigation method was non-significant on both varieties but the effect is significant on *Bt.* variety by foliar method at dose of mg is 3 kg per hectare. The maximum fibre length is obtained by foliar method at dose of mg, 3 kg per hectare is 26.90mm of Bt. CIM-343. In variety CIM-610 the fibre length of control is 27.00mm and maximum fibre length at mg dose of 6 kg per hectare by foliar method is 27.57mm. Uniformity index (UI) was not influenced significantly by the mg application. The maximum UI was obtained of *Bt.* CIM-343 is 84.37% at mg dose of 20 kg per hectare by fertigation method and the minimum 81.77% was obtained at foliar method of mg, 3 kg per hectare. The maximum UI was of CIM-610 is 84.30% by foliar method at mg dose of 6 kg per hectare and minimum value 83.30% was found by fertigation method at mg dose of 10 kg per hectare. There is no significant difference for micronaire for both varieties. Maximum micronaire 5.27 was obtained of Bt. CIM-343 by foliar method at mg dose level of 6 kg per hectare and the minimum micronaire 4.87 was by fertigation method at mg dose of 10 kg per hectare. Maximum micronaire 5.03 was noted of CIM-610 by foliar method at mg dose of 6 kg per hectare and the minimum value of 4,63 was noted also by foliar method at mg dose of 3 kg per hectare. The effect of mg by foliar and fertigation method on both varieties were non-significant for strength and seed index. Strength is slightly increased from control for both varieties by foliar method.

8.6 Quality Survey of Lint Samples from Ginning Factories in Punjab Province

A quality survey was conducted to examine the lint quality of ginning factories during the cotton season 2018-19. The samples were collected by this section and all stations of PCCC from cotton growing area of Punjab and Sindh province. The quality of lint in different cities during the crop season 2017-18 is given as under.

MOU ON COTTON PRODUCTION TECHNOLOGY BETWEEN WWF-CCRIM

CCRI Multan entered into partnership with WWF Pakistan today the 22nd May 2018. Dr. Zahid Mahmood, Director CCRI Multan and Mr. Asad Imran on behalf of Mr. Arif Makhdum, Director, Sustainable Agriculture & Food Programme, WWF-Pakistan signed the agreement. Both the parties agreed to jointly undertake activities to develop and demonstrate sustainable practices to preserve natural attributes of cotton fiber at production and processing level. CCRI Multan will conduct trainings in collaboration with WWF-Pakistan on cotton production technology and fiber quality preservation techniques for cotton supply chain actors i.e. farmers, cotton pickers, intermediary market actors and ginners. Moreover, publication of resource material will also be printed and distributed among the trainees.

Table 8.7 Quality Survey for lint quality of various cities in Punjab province.

District	City		Fibre Length (mm)	Uni. Index (%)	MIC	Strength (g/tex)	SFI (%)	Rd	+b
Khanewal	**Khanewal**	Max.	27.7	84.9	4.9	28.7	12.5	70.4	10.9
	Kabeerwala	Min.	24.9	79.9	4.2	24.8	5.4	62.6	8.4
	Mianchannu	**Avg.**	**26.1**	**82.2**	**4.6**	**27.1**	**9.1**	**67.2**	**9.7**
Sahiwal	**Sahiwal**	Max.	27.1	86.3	5.3	29.6	15.5	71.7	11.5
	Chichawatni	Min.	23.5	78.0	3.9	23.0	3.6	59.8	9.1
		Avg.	**25.8**	**81.6**	**4.5**	**26.8**	**9.9**	**65.1**	**10.3**
Jhang	**Jhang**	Max.	26.7	84.6	5.1	28.9	12.9	69.5	9.4
		Min.	25.5	79.3	4.3	25.0	5.9	63.6	8.5
		Avg.	**26.3**	**82.0**	**4.7**	**27.1**	**9.2**	**66.5**	**9.1**
Toba Tek Singh	**Toba Tek Singh**	Max.	26.7	84.4	4.9	28.7	12.6	68.5	9.9
		Min.	24.8	79.6	4.4	26.0	6.0	64.0	9.2
		Avg.	**25.9**	**81.8**	**4.5**	**27.1**	**9.6**	**66.4**	**9.6**
Okara	**Okara**	Max.	26.3	83.0	5.0	27.8	11.2	68.5	9.9
		Min.	25.7	80.6	4.5	26.3	8.2	64.9	9.4
		Avg.	**25.9**	**81.8**	**4.7**	**27.2**	**9.7**	**66.3**	**9.6**
Pakpatan	**Pakpatan**	Max.	27.3	84.3	5.1	28.8	10.1	70.8	10.1
	Arifwala	Min.	25.3	81.7	4.0	24.3	6.1	64.6	8.7
		Avg.	**26.5**	**82.9**	**4.8**	**27.0**	**8.0**	**67.3**	**9.5**
Faisal abad	**Faisalabad**	Max.	26.5	82.4	4.6	28.2	12.0	67.4	10.3
		Min.	25.1	80.2	4.0	26.0	8.9	64.1	9.1
		Avg.	**25.6**	**81.3**	**4.3**	**27.0**	**10.4**	**66.1**	**9.5**
Bahawal pur	**Bahawalpur**	Max.	29.3	86.3	5.3	28.9	12.9	73.2	10.1
	Hasilpur	Min.	24.4	79.4	4.3	23.3	3.9	63.1	8.1
	Lodhran	**Avg.**	**26.1**	**82.4**	**4.8**	**26.4**	**8.8**	**67.9**	**9.2**
Bahwal nagar	**Fortabbas**	Max.	27.0	83.3	5.1	27.8	12.1	70.6	9.5
	Chishtian	Min.	24.4	80.0	4.3	24.0	7.3	65.8	6.1
		Avg.	**26.0**	**81.9**	**4.6**	**26.4**	**9.5**	**67.8**	**8.9**
Multan	**Shujabad**	Max.	27.8	84.6	4.9	29.5	11.8	69.8	9.9
	Jalalpur	Min.	25.5	80.2	4.2	26.0	5.7	61.7	7.9
		Avg.	**26.5**	**82.4**	**4.5**	**27.7**	**8.7**	**66.7**	**9.0**
Muzaffa rgarh	**Muzaffargarh**	Max.	27.9	84.1	4.8	29.8	10.9	76.6	10.6
		Min.	25.7	80.6	3.9	26.5	6.2	63.0	9.0
		Avg.	**26.8**	**82.4**	**4.2**	**28.0**	**8.4**	**69.4**	**9.5**
D.G. Khan	**D.G. Khan**	Max.	28.3	84.2	4.8	29.2	10.3	77.9	10.2
		Min.	25.6	81.0	3.7	24.5	5.8	65.8	8.2
		Avg.	**26.9**	**82.4**	**4.2**	**27.7**	**8.4**	**72.0**	**9.2**
Rajanpur	**Rajanpur**	Max.	27.8	86.0	5.9	28.9	12.7	77.4	10.0
	Jampur	Min.	24.7	79.5	3.8	23.8	4.0	64.6	8.2
		Avg.	**26.5**	**82.5**	**4.4**	**27.1**	**8.4**	**68.7**	**9.2**
Vehari	**Vehari**	Max.	27.8	84.7	4.9	29.2	12.7	71.8	10.6
	Booray wala	Min.	24.9	79.3	3.4	24.6	5.8	59.7	9.0
		Avg.	**26.1**	**81.9**	**4.2**	**27.0**	**9.4**	**64.8**	**9.8**
Mianwali	**Essa Khel**	Max.	27.8	85.7	5.1	28.7	10.9	69.4	9.8
	Wan Bachran	Min.	25.1	80.6	4.4	26.1	3.9	64.3	8.9
	Piplan	**Avg.**	**26.5**	**82.9**	**4.8**	**27.4**	**8.0**	**67.0**	**9.3**
	Hafizwala								
Bhakkar	**Saray Mohajir**	Max.	27.6	83.8	5.0	28.6	10.2	70.7	10.1
	Kalour Kot	Min.	26.5	82.7	4.6	27.5	8.3	68.3	9.7
		Avg.	**25.9**	**81.2**	**4.3**	**26.5**	**6.3**	**66.6**	**9.1**

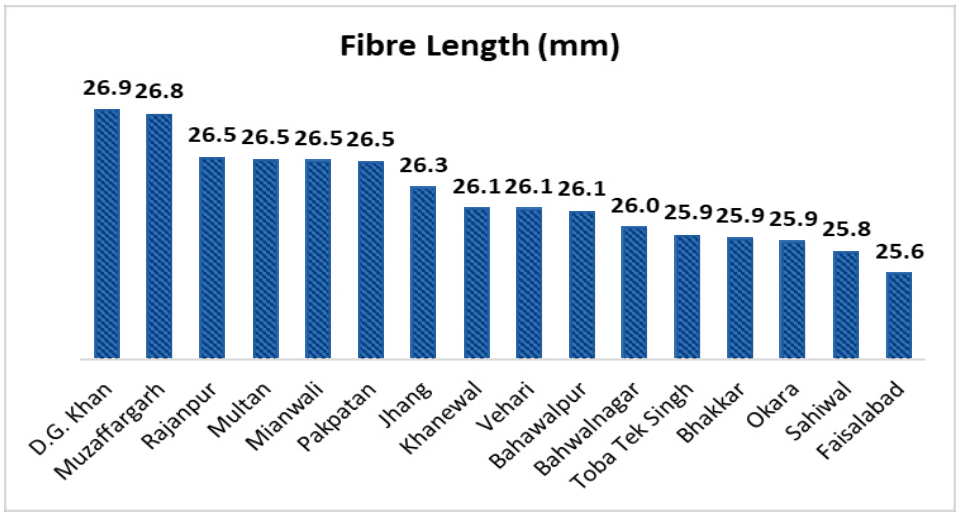


Fig 8.1 Fibre length for various districts of Punjab province

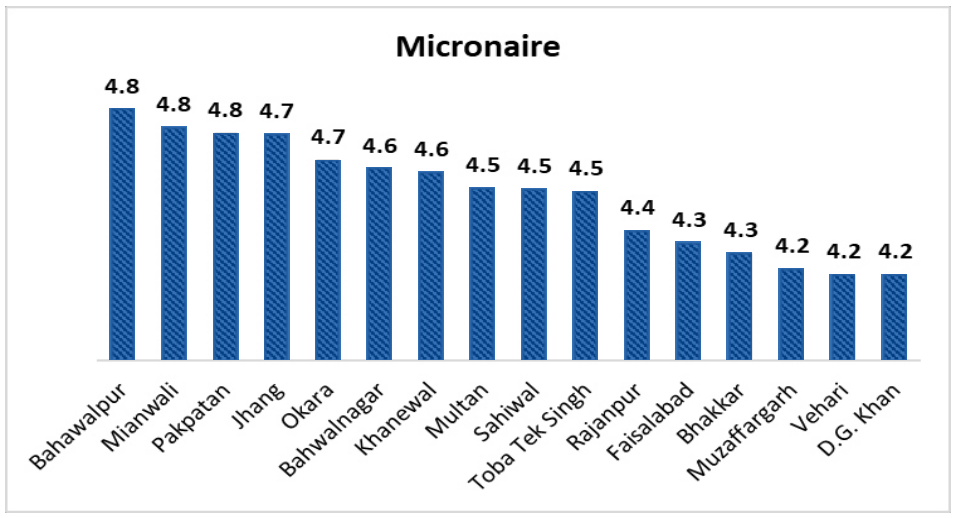


Fig 8.2 Micronaire for various districts of Punjab province

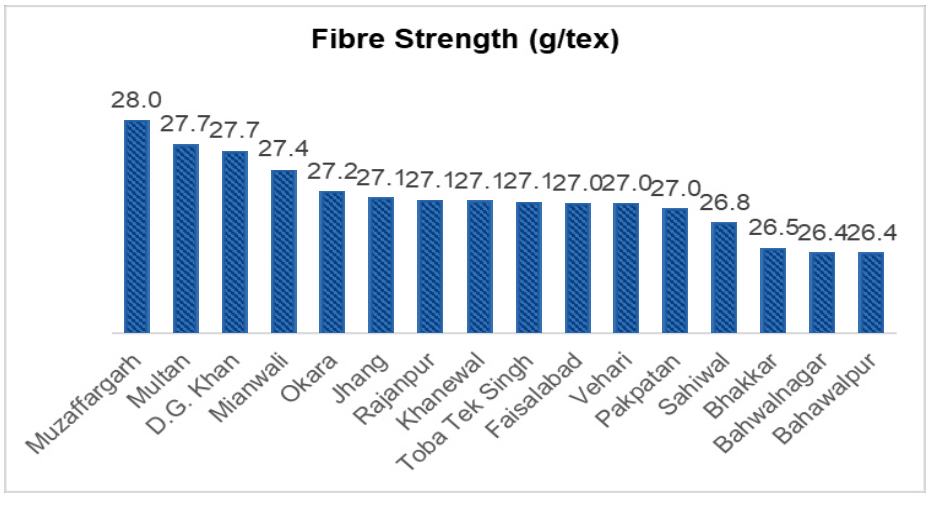


Fig 8.3 Fibre strength for various districts of Punjab province

Table 8.8 Quality Survey for lint quality of various cities in Sindh province.

District	City		Fibre Length (mm)	Uni. Index (%)	MIC	Strength (g/tex)	SFI (%)	Rd	+b
Mirpur Khas	Mirpur Khas	Max.	27.8	84.0	4.2	28.2	14.8	70.3	10.2
		Min.	24.4	78.2	3.3	25.2	6.9	61.8	9.4
		Avg.	**26.1**	**82.1**	**3.8**	**26.8**	**9.2**	**67.2**	**9.8**
Sukkur	Rohri Saleh Pat Arore	Max.	29.3	85.5	5.0	30.9	10.7	76.4	10.0
		Min.	27.0	80.4	4.2	26.7	3.5	64.3	7.6
		Avg.	**28.0**	**83.3**	**4.5**	**28.9**	**6.7**	**69.9**	**9.0**
Ghotki	Ghotki Mirpur Mathelo Deherki	Max.	30.3	86.2	4.9	30.4	8.9	73.2	9.7
		Min.	27.6	81.6	4.3	26.8	3.5	66.4	7.8
		Avg.	**28.6**	**83.8**	**4.7**	**28.7**	**5.9**	**71.0**	**8.7**
Nawabshah		Max.	28.1	84.0	5.0	28.9	13.2	72.7	10.1
		Min.	24.3	79.2	4.0	25.1	6.5	65.3	8.6
		Avg.	**26.1**	**81.4**	**4.5**	**27.0**	**10.0**	**68.4**	**9.2**
Noshero Feroz	Neshero Feroz Kumb	Max.	27.9	84.4	5.1	28.6	11.8	70.7	10.0
		Min.	25.5	80.1	4.5	26.1	5.6	65.3	8.4
		Avg.	**26.4**	**82.1**	**4.7**	**27.3**	**9.0**	**67.7**	**9.0**
Khairpur	Khairpur Mundo Dero Sui Gas Rasoolabad Karoondi Hingorja Chowdagi Banglo Gadeji Satharja Gambat	Max.	28.9	85.0	5.0	30.7	11.3	72.0	10.3
		Min.	26.0	80.4	4.2	26.0	4.4	64.1	8.6
		Avg.	**27.1**	**82.5**	**4.6**	**27.7**	**8.2**	**67.9**	**9.4**

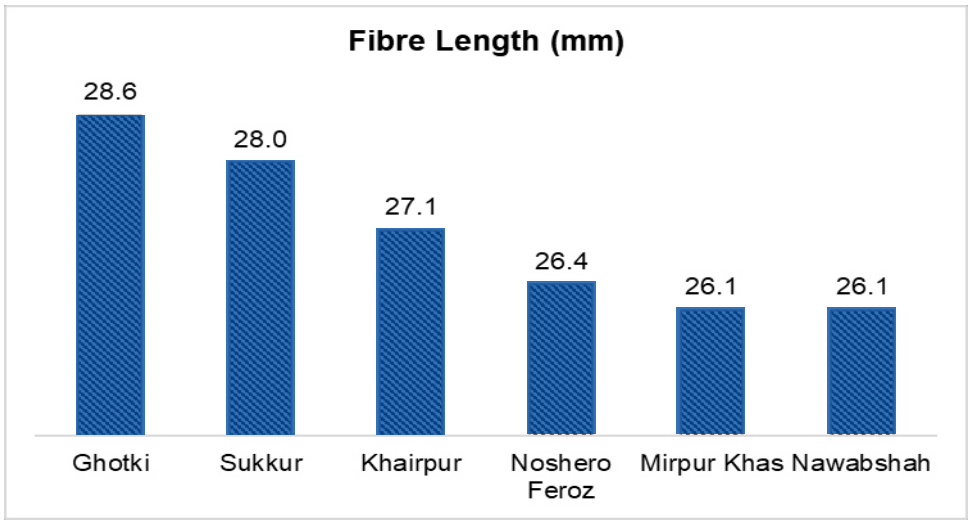


Fig 8.4 Fibre length for various districts of Sindh province

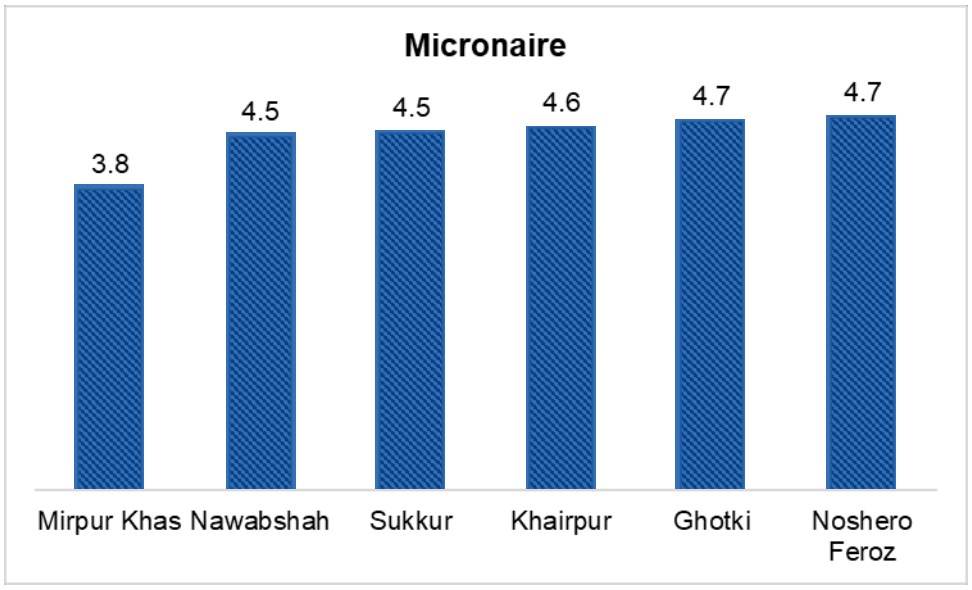


Fig 8.5 Micronaire for various districts of Sindh province

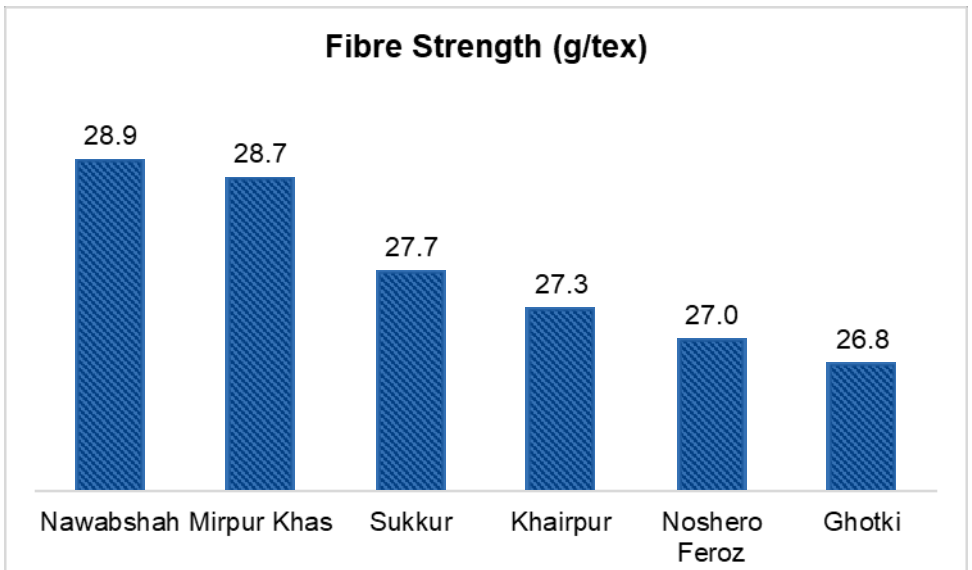


Fig 8.6 Fibre Strength for various districts of Sindh province

8.7 Saw and Roller Ginning Comparison for Cotton Fibre Quality

The Experiment was design to investigate the effect of Roller & Saw ginning on cotton fibre quality. Genotype 789 was selected and seed cotton was obtained from the field of agronomy section. 50 samples were selected for saw ginning and 50 for roller ginning. The ginning was done at laboratory scale machine. After ginning the samples were conditioned for testing. The fibre testing was done at High Volume Instrument (HVI-900A). Seed index was calculated by counting 100 seed per sample. The results of ginning comparison are shown in table 8.9.

There are significant differences for fibre length, uniformity, short fibre index, elongation, degree of reflectance, degree of yellowness and seed index. Fibre length, uniformity, short fibre index and seed index of roller ginned cotton are better than saw ginned cotton while saw ginned cotton gave good colour values.

Table 8.9 Comparison of saw and roller ginning

Ginning Type	Fibre length (mm)	Uniformity Index (%)	MIC	Strength (g/tex)	Short Fibre Index (%)	Elongation (%)	Rd	+b	Seed Index (%)
Saw Gin	25.3 B	82.8 A	4.0 A	26.8 A	8.7 A	5.6 A	67.3 A	8.98 B	6.57 A
Roller Gin	25.7 A	83.7 B	4.0 A	26.6 A	7.2 B	5.1 B	64.6 B	9.20 A	6.36 B
Difference (Roller-Saw)	**0.32**	**0.90**	**0.00**	**-0.22**	**-1.51**	**-0.51**	**-2.67**	**0.26**	**-0.21**

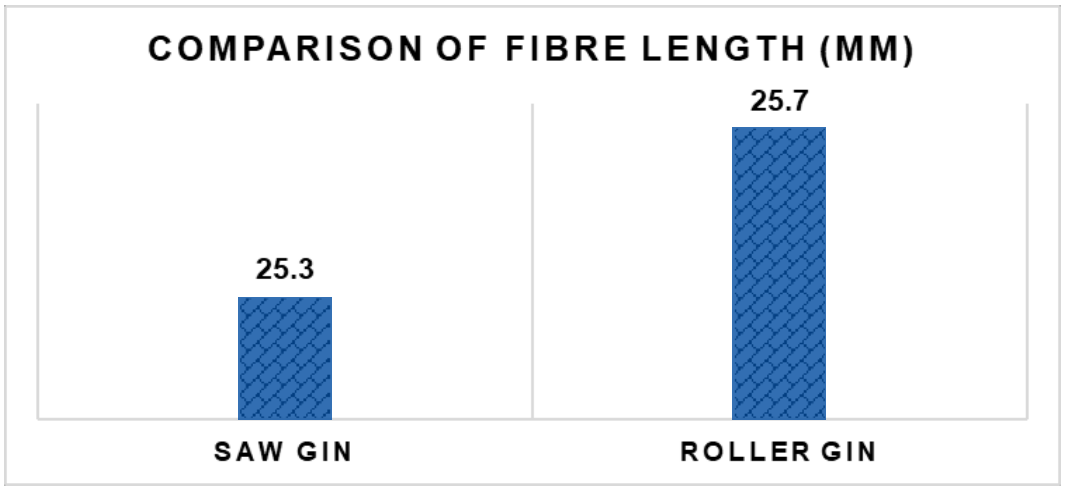


Fig 8.7 Fibre length comparison for saw and roller ginning

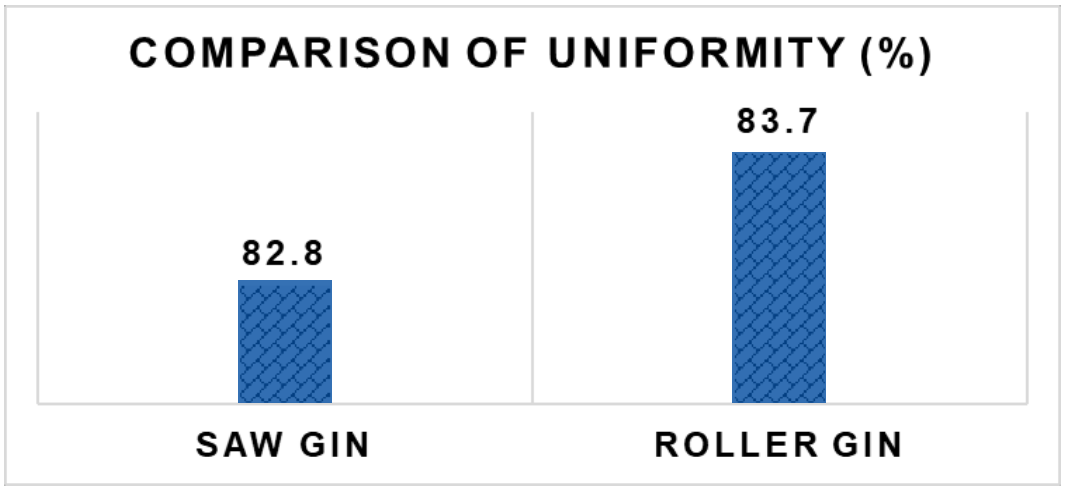


Fig 8.8 Uniformity Index comparison for saw and roller ginning

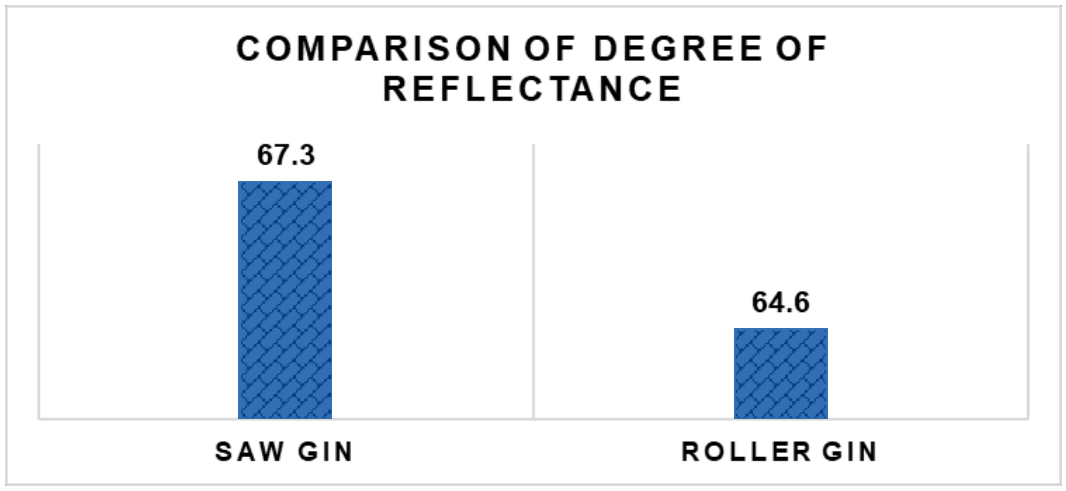


Fig 8.9 Degree of Reflectance comparison for saw and roller ginning

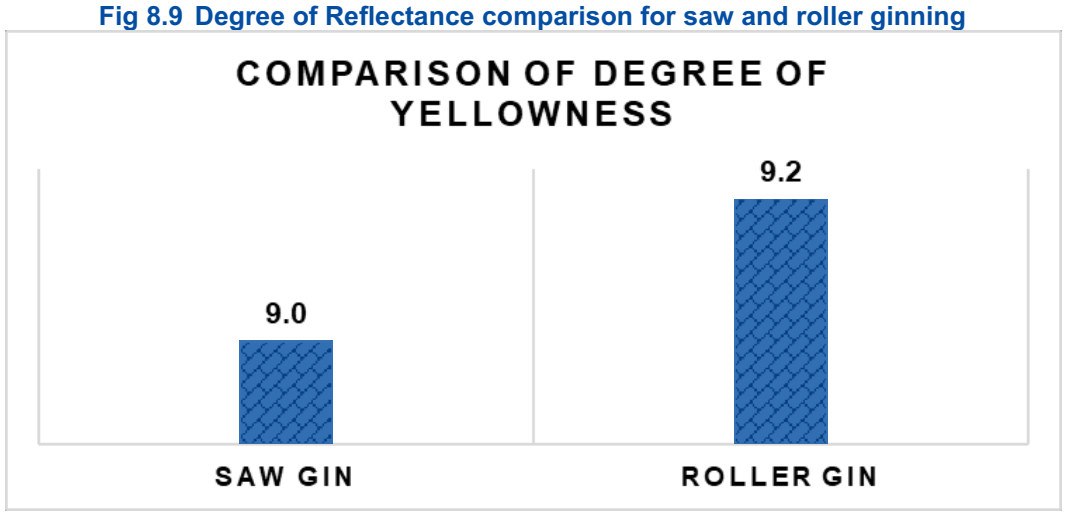


Fig 8.10 Degree of Yellowness comparison for saw and roller ginning

8.8 ICA-Bremen Cotton Round Test Program

The Fibre Technology Section participated in the ICA-Bremen Cotton Round Test Program under Faser Institute, Germany to keep the fibre testing equipment in calibrated form. Three lint samples were received during the year 2018. The lint samples were tested for different fibre characteristics. The results were submitted to the Faser Institute, Germany and fibre analysis met with other testing laboratories in the world.

The results of the Institute's Laboratory and the average results of the other participating laboratories are presented in Table 8.8.

Table 8.10 ICA-Bremen Cotton Round Test Program with Faser Institute, Germany

Date of Test	Sample No.	Name of Test	Results of CCRI, Multan (1)	Avg. results Of all Labs (2)	Difference (1-2)
02.04.18	**2018/1**	**Conventional Instruments**			
		Micronaire	4.05	4.10	-0.05
		Pressley Index (0")	9.93	9.50	0.43
		G / tex (1/8")	30.9	29.35	1.55
		Elongation (%)	5.40	6.40	-1.00
		HVI-900A			
		U.H.M.L. (mm)	35.0	35.0	0.00
		Uniformity Index (%)	87.7	85.9	1.80
		Micronaire	3.94	4.10	-0.16
		G/tex (1/8")	35.4	37.8	-2.40
		Elongation (%)	5.60	6.70	-1.10
		Rd (Reflectance)	69.7	69.8	-0.10
		+b (Yellowness)	13.5	13.4	0.10
15.11.18	**2018/2**	**Conventional Instruments**			
		Micronaire	3.63	3.77	-0.14
		Pressley Index (0")	7.43	7.40	0.03
		G / tex (1/8")	21.4	22.0	-0.60
		Elongation (%)	6.20	6.20	0.00
		HVI-900A			
		U.H.M.L. (mm)	29.2	28.75	0.45
		Uniformity Index (%)	82.5	81.6	0.90
		Micronaire	3.70	3.80	-0.10
		G/tex (1/8")	30.3	29.7	0.60
		Elongation (%)	5.60	6.60	-1.00
		Rd (Reflectance)	72.8	75.2	-2.40
		+b (Yellowness)	9.90	8.90	1.00
14.11.17	**2017/3**	**Conventional Instruments**			
		Micronaire	3.70	Awaiting	
		Pressley Index (0")	8.10	Results from	
		G / tex (1/8")	22.8	concerned	
		Elongation (%)	7.00		
		HVI-900A			
		U.H.M.L. (mm)	28.3		
		Uniformity Index (%)	80.8		
		Micronaire	3.75		
		G/tex (1/8")	29.5		
		Elongation (%)	6.50		
		Rd (Reflectance)	75.1		
		+b (Yellowness)	12.3		

8.9 Survey of Spinning Industry of Pakistan

Survey of spinning industry was conducted to collect data regarding the utilization of cotton fibre with special reference of the cotton fibre traits and others fibers as well in industry and to focus the economics comparatives. Seven spinning units were visited in the Punjab to ascertain the cotton fibre and yarn quality being consumed by the spinning industry. The data collected are presented in Table 8.10.

Table 8.11 Survey of Spinning Industry

Mill #	No. of Spindles	Production Capacity (100 lb bags /day)	Consumption of Pak Cotton (160 kg bale)	Consumption of Imported Cotton (220 kg bale)	Fibre used	Avg. Count	Counts Spun from Pak Cotton	Counts Spun from Imported Cotton
01	225,000	220	380,000	90,000	Cotton, Viscose, Polyester	16s	4s to 30s	80s, 120s
02	100,000	800	105,000	45,000	Cotton, Viscose Lycra	40s	8s to 30s	30s to 100s
03	75,000	700	200,700	36,500	Cotton, Viscose, Polyester, Acrylic	24s	10s to 52s	40s to 60s
04	72,000	375	365,000	-	Cotton, Viscose	40s	52s	52s to 60s
05	40,000	770	-	-	Cotton, Polyester, Viscose, Bamboo	26s	10s to 40s	-
06	25,104	1500	60,000	-	Cotton	14s	10s to 20s	-
07	20,280	275	10,000	-	Cotton, Polyester, Viscose	40s	40s	-

Moreover, comparative study was also made with regard to yarn spun and fibre quality from local viz-a-viz imported cotton. The Pakistani cotton easily fulfil the requirement for spinning of medium to fine counts. On overall average basis, there was significant difference of fibre quality of local vs imported cotton being consumed for the spinning of extra fine counts yarn. The comparative fibre analysis for cotton from different regions is presented in Table 8.11.

Table 8.12 Comparison of Fibre Traits of Pakistani vs Imported Cotton

Country	Rate (Cents/lb)	Fibre Length (mm)	Strength (g/tex)	Micronaire	Moisture (%)	Trash (%)
Pakistan	70-80	27.3	29.0	4.4	8.9	8.1
American Pima	155	36.0	41.0	4.2	-	2.0
Giza	125	33.0	46.0	4.2	-	4.0
Indian (DCH)	110	35.5	48.6	4.2	5.1	3.7
Indian (Shankar 6)	-	30.8	31.2	4.0	8.0	4.0
Indian	-	27.7	29.0	4.9	7.5	4.5
Afghani	-	27.2	31.0	4.4	6.5	3.5

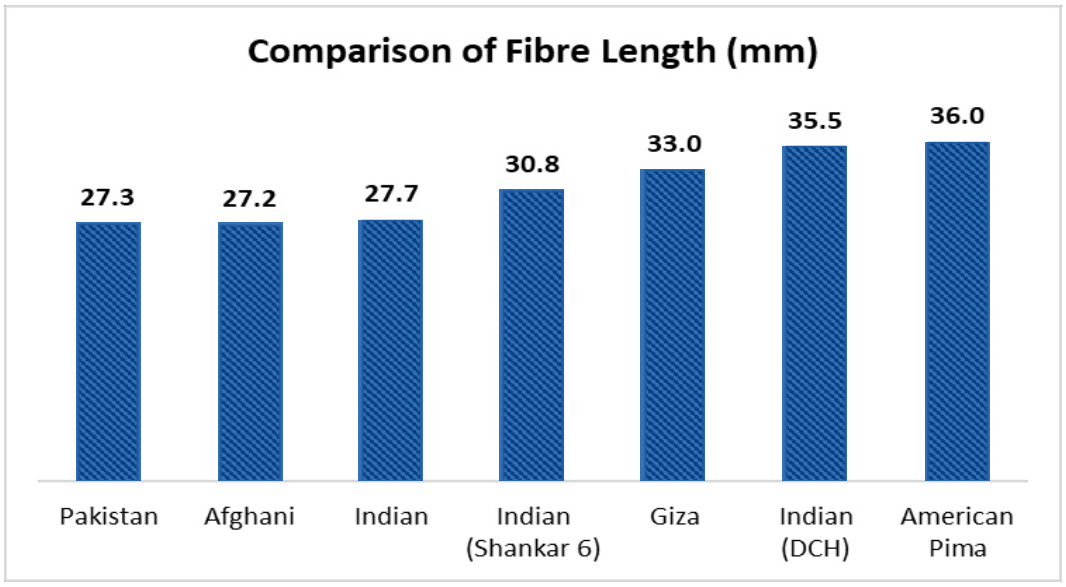


Fig. 8.11 Fibre length comparison for Pakistani and Imported cotton

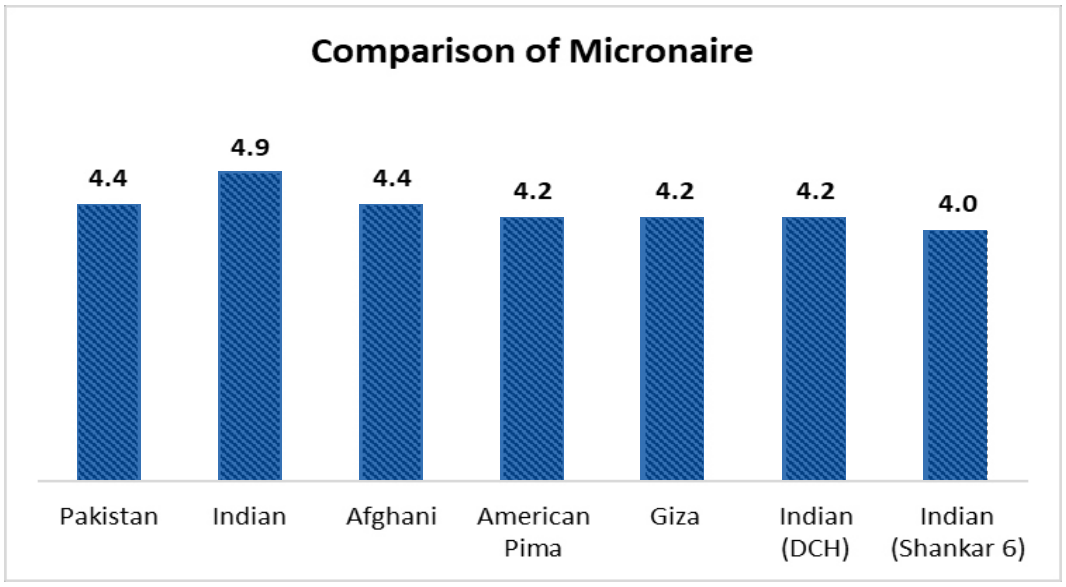


Fig. 8.12 Micronaire comparison for Pakistani and Imported cotton

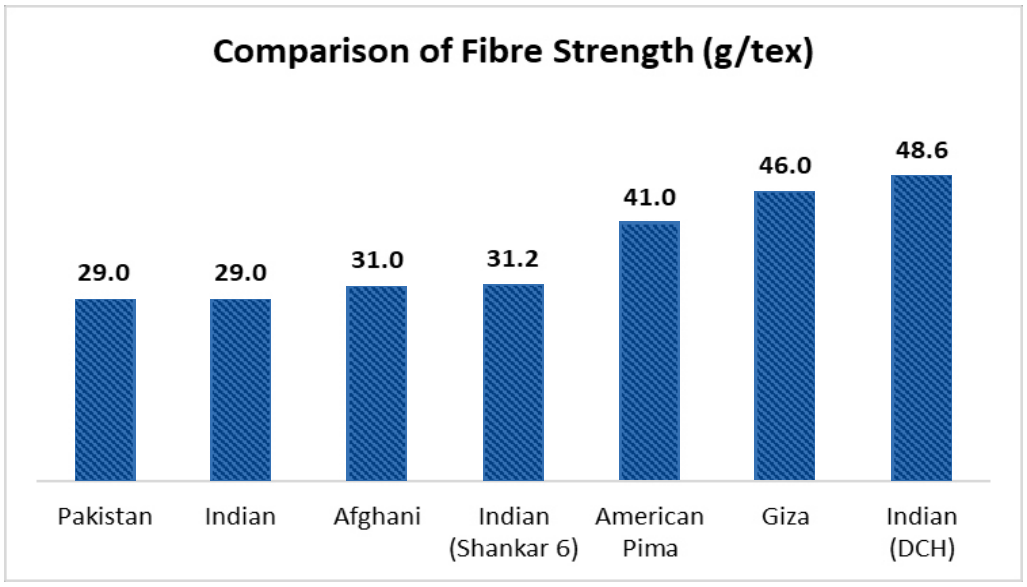


Fig. 8.13 Fibre strength comparison for Pakistani and Imported cotton

8.10 Delivered lecture at Pakistan Cotton Standards Institute (PCSI) to participants of 2nd Cotton Selectors Training Course 2018' on the topic of "The Role of Cotton Fibre Parameters in Processing & End Product" by Scientific Officer of Fibre Technology section Danish Iqbal.

"SARSABZ O SHADAB PAKISTAN" CAMPAIGN

9. STATISTICS

The main responsibility of this section is to design, layout of experiments and perform analysis of research data provided by all sections of the institute. These facilities are also provided to Directorate of Research PCCC, and other stations of Pakistan Central Cotton Committee. The data of National Coordinated Varietal Trial is statistically analyzed. The rates of cotton commodities are documented daily.

9.1 Statistical Analysis

199 set of experimental data were analyzed by Statistics Section during 2018-19 in which four data sets of Breeding & Genetics, five Cytogenetics. Sixteen Entomology, fourteen Fibre Technology sections of the institute and 140 data sets of National Coordinated Varietal Trail conducted by Directorate of Research, Pakistan Central Cotton Committee, Multan presented in Table 9.1.

Table 9.1 Detail of Statistical Analyses.

Sections	RCBD	Split	Split-Split	F-Pool	Regression	Total
Agronomy	---	---	---	---	---	**---**
Physiology	---	---	---	---	---	**---**
Breeding	4	---	---	12	---	**16**
Cytogenetics	5	---	---	---	---	**5**
Pathology	---	---	---	---	---	**---**
Entomology	16	---	---	---	---	**16**
Fiber	14	---	8	---	---	**22**
NCVT	140	---	---	---	---	**140**
Total	**179**	**---**	**8**	**12**	**---**	**199**

In NCVT 2018 field trials total 111 lines were tested for yield at fourteen different locations throughout Pakistan. Set A contained nine Non-Bt. strains with two standards. Set B contained twenty-five new Bt. strains with two standards. Set C contained twenty-eight new Bt. strains with two standards. Set D contained twenty-five new Bt. strains with two standards. While Set E contained twenty-four new Bt. Strains with two standards. In total One hundred and eight new Bt. strains were tested.

9.2 Prices of seed cotton and its Components

Daily Spot Rates of Cotton (lint) were documented. The average weekly price for Base Grade cotton per 40 kg for the four cotton seasons i.e. 2015-16, 2016-17, 2017-18 and 2018-19 exclusive of upcountry charges are shown in Fig 9.1.

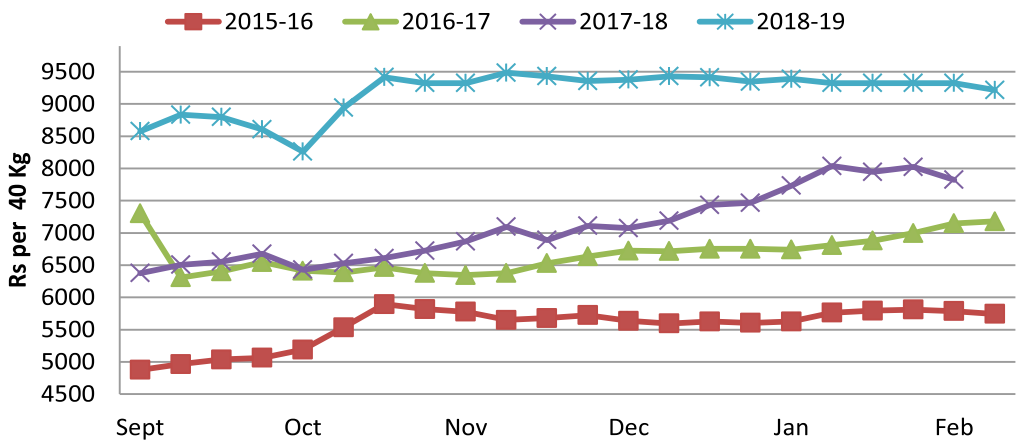


Figure 9.1: Weekly Average Spot Rates of Lint announced by Karachi Cotton Association during Cotton Seasons 2015-16, 2016-17, 2017-18 and 2018-19.

The data presented in figure 9.1 showed the fluctuation of rate during the season of last four years. In year 2018-19 rates were comparatively higher than previous years. In year 2017-18 the average price was at 7100/40 kg with the minimum value 6376 per 40 kg in the month of September 2017 and

maximum of 8037 per 40 kg in January 2018 while in 2018-19 the average price was at 9173 per 40 kg with the minimum value 8260 per 40 kg in October 2018 and maximum value 9485 per 40 kg in November 2018.

Rates of seed cotton, Cottonseed, Cottonseed Cake, Cottonseed Oil and Cotton Lint were collected from Market Committee Multan. The Prices are provided for Rs per 40kg, temporal trend of rates for four years on weekly basis is illustrated in Fig. 9.2. to 9.6.

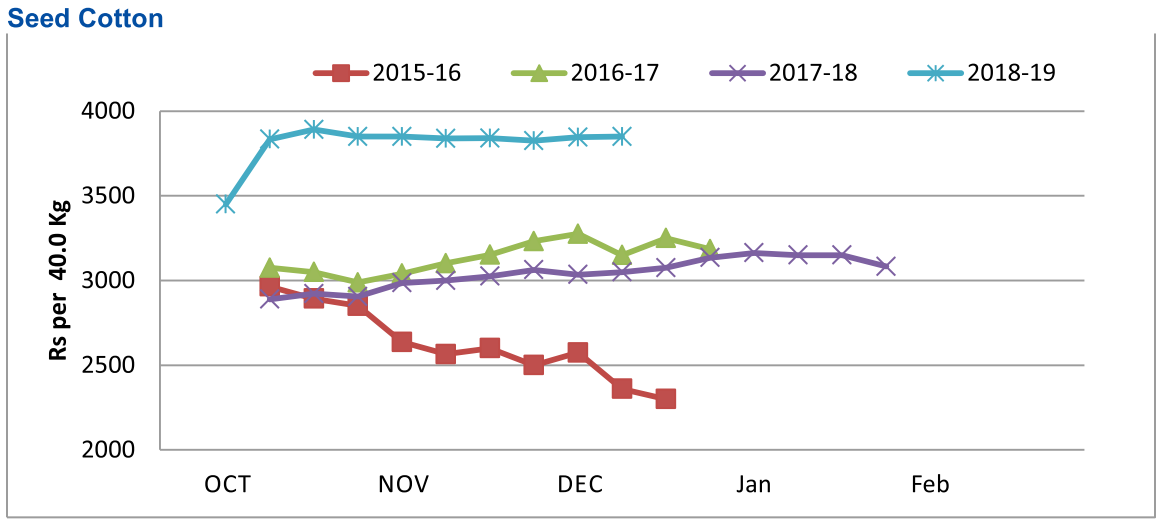


Figure 9.2: Weekly Average Rates (Rs /40Kg.) of Seed cotton of Multan Market during 2015-16, 2016-17, 2017-18 and 2018-19.

The seed cotton rates are presented in figure 9.2 showed that the rates of 2018-19 are much higher than that of previous years. In 2017-18 the average seed cotton rates of Multan market were at 3042 per 40 kg with minimum of 2889 per 40 kg and maximum 3163 per 40 kg while in 2018-19 the average rate was 3807 per 40 kg with maximum rate was 3891 per 40 kg and minimum rate was 3450 per 40 kg. The percent increase of year 2018-19 average price from 2015-16 is 31.0%, from 2016-17 is 17.6% and from 2017-18 is 20.1%.

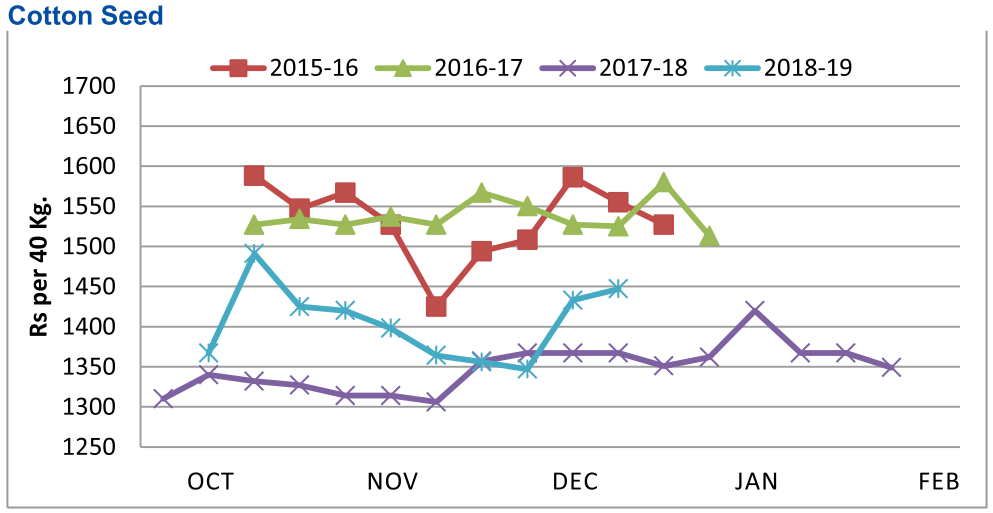


Figure 9.3: Weekly Average Rates (Rs /40Kg.) of Cottonseed of Multan Market during 2015-16, 2016-17, 2017-18 and 2018-19.

The cottonseed rates were lower from 2015-16 and 2016-17 and higher than 2017-18. The maximum value 1491 was in October 2018 while minimum price in December 2018. Price comparison from last year revealed that average price 1348 per 40 kg was attained in 2017-18 with minimum price of

1306 per 40 kg and maximum price of 1420 per 40 kg in January 2018 while the average price 1405 per 40 kg was obtained in 2018-19 with maximum price was 1491 per 40 kg and minimum price was 1347 per 40 kg.

Cottonseed Cake

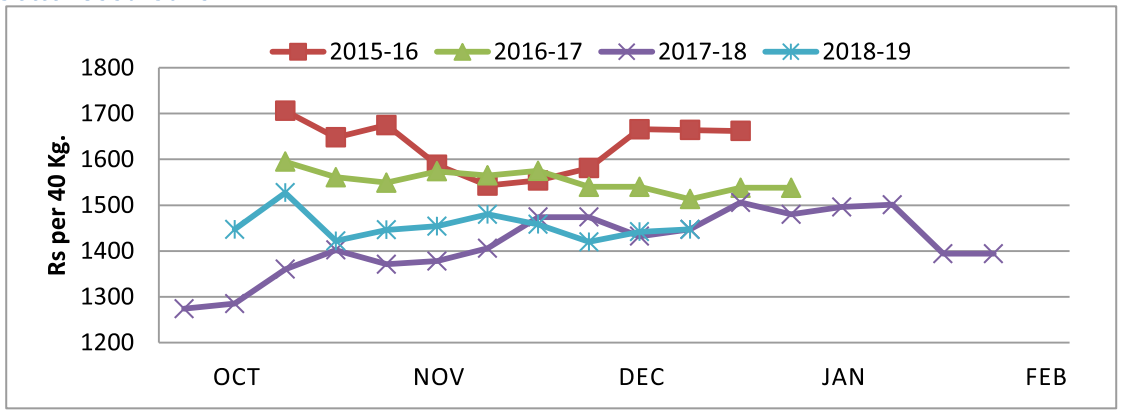


Figure 9.4: Weekly Average Rates (Rs /40Kg.) of Cottonseed Cake of Multan Market during 2015-16, 2016-17, 2017-18 and 2018-19.

Cottonseed cake rates of year 2018-19 were little bit higher than year 2017-18 while lower from 2015-16 and 2016-17. Average rate of 2017-18 was 4229 per 40 kg with maximum 4448 per 40 kg and minimum 4118 per 40 kg while in 2018-19 the average rate was 4236 per 40 kg with maximum 4506 per 40 kg and minimum 4158 per 40 kg.

Cottonseed Oil

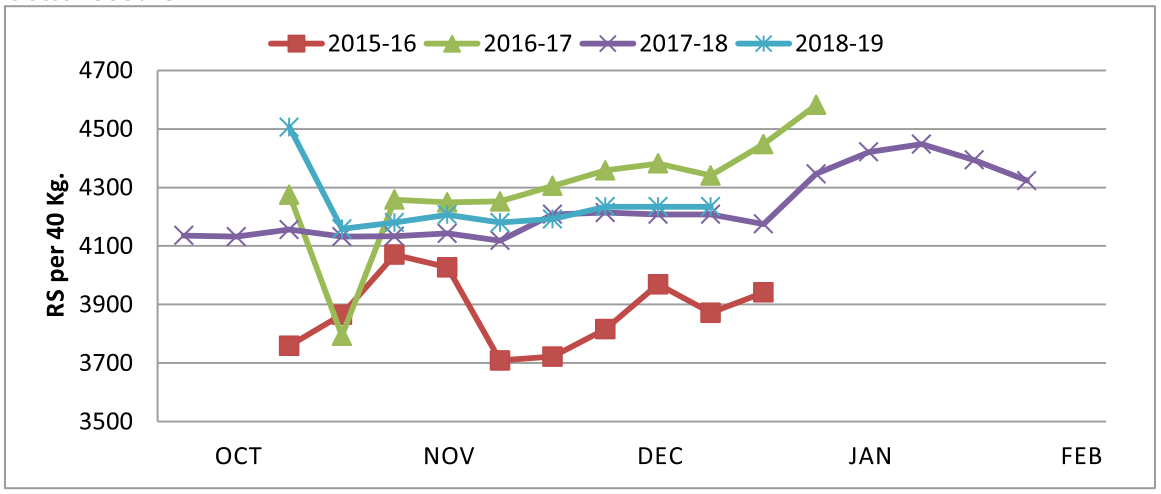


Figure 9.5: Weekly Average Rates (Rs/40 Kg) of Cottonseed Oil of Multan Market during 2015-16, 2016-17, 2017-18 and 2018-19.

Cottonseed oil rates of year 2018-19 were higher than years 2015-16 and 2017-18 while lower from 2016-17. Average rate of 2017-18 was 4229 per 40 kg with maximum 4448 per 40 kg and minimum 4118 per 40 kg while in 2018-19 the average rate was 4236 per 40 kg with maximum 4506 per 40 kg and minimum 4158 per 40 kg.

Cotton Lint

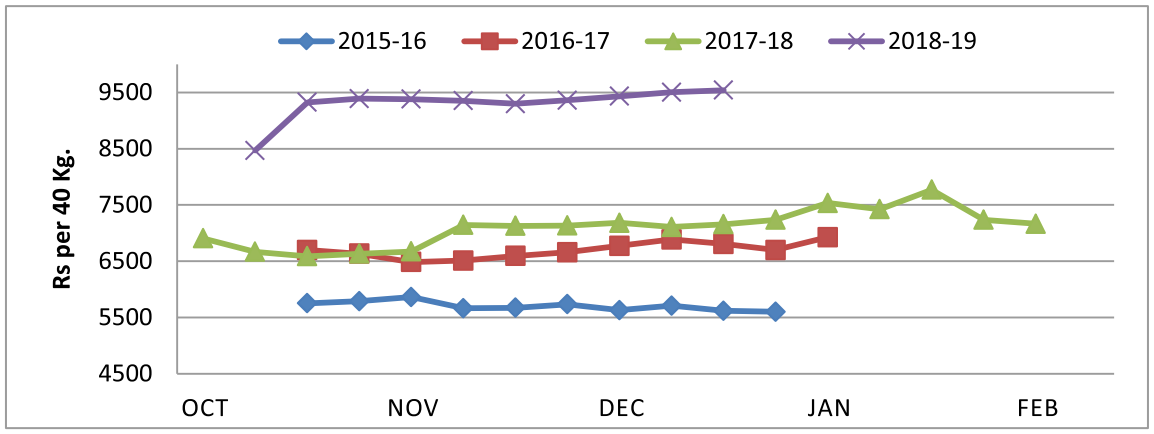


Figure 9.6: Weekly Average Rates (Rs /40Kg.) of Cotton Lint of Multan Market during 2015-16, 2016-17, 2017-18 and 2018-19.

The cotton lint rates were higher from previous years. The maximum rate was 9541 per 40 kg in January 2019 while minimum rate in October 2018. Price comparison from last year revealed that average price 7099 per 40 kg was attained in 2017-18 with minimum price of 6589 per 40 kg and maximum price of 7772 per 40 kg while the average price 9305 per 40 kg was obtained in 2018-19 with maximum price was 9541 per 40 kg and minimum price was 8469 per 40 kg.

INDEPENDENCE DAY CELEBRATION AT CCRI MULTAN

VII. RECOMMENDATIONS

Unlike other countries, cotton crop in Pakistan faces a number of challenges such as weather adversaries including higher (day & night) temperatures, irregular rainfall pattern, shortage canal irrigation water supplies, availability of water at sowing time and peak demand period, non-judicial use of crop inputs (irrigation, fertilizer, pesticide etc.), deteriorating soil health (salts, fertility problems) rising cost of inputs resulting in un-economical crop yields, insect-pest complex (whitefly, jassid, thrips, Bollworms, dusky & red cotton bugs etc), diseases (CLCUD, stem & twig blight) and fluctuating produce prices. In addition, the *Bt* cotton has now become vulnerable to Pink Bollworm infestation which not only increases the cost of production through additional use of pesticides but also limits crop yield. To ensure sustainable crop productivity along with economic returns for the farmers, concerted efforts need to be carried out at all levels involving the cotton sector stakeholders through public and private partnership approach. Based on the research work conducted by the scientists of the Institute, all the way through, following recommendations are made to dilute cotton production problems and getting maximum yield from the available resources.

SOIL SELECTION AND ITS PREPARATION

- Select best piece of land available for cotton cultivation.
- Farm machinery be optimized and be in ready condition for efficient and timely operations.
- Where plant growth is restricted and downward penetration of water in the soil is slow, crosswise chiseling/ripping or deep ploughing should be done.

IMPROVEMENT OF SOIL HEALTH

- Improvement and maintenance of soil physical condition ensures better soil productivity. Therefore, green manuring/farm yard manures should be incorporated one month before sowing to improve the physical condition of the soil. Among green manure crops, berseem is the best choice.
- After the use of combine harvester, tradition of burning wheat straw is not beneficial. It must be incorporated into the soil which improves the physical properties and organic matter content of soil.
- Disc harrow rather than rotavator should be used for wheat straw incorporation and it must be followed by irrigation along with ½ bag of Urea to accelerate the decomposition process and to avoid white ant problem.
- Cure and preserve the farmyard manure properly in pits. Donot keep in heaps in the open sky.
- Reclamation of saline-sodic soils is accomplished by incorporating recommended quantity of gypsum into the soil followed by 2-3 heavy irrigations. This should be followed by green manuring to restore soil fertility.
- Chiseling after 2-3 years should be practiced in order to break the hard and plough pan to improve root growth and soil health.

PLANTING

- In problem soils (saline, clayey and lands with salt patches of varying sizes) planting on bed-furrow is better than drill planting.
- Bed-furrow planting ensures better plant population. It saves 30% irrigation water over conventional planting (flat cultivation). It protects the crop from the damages of heavy rains. Apply second irrigation 3-4 days after sowing on bed-furrow to ensure better seedling emergence and growth. Afterwards, apply irrigation 8-10 days interval. Weeds are the major problems in bed-furrow planting, therefore, use integrated weed management (IWM) to control weeds.
- To sustain the good physical soil conditions, always cultivate the fields in '*wattar*' condition (workable condition) and never cultivate in dry condition.
- Laser level the fields properly for uniform and economized application of fertilizer and irrigation water.
- Apply single '*rouni*' on well-leveled fields for flat (conventional) planting due to scarcity of canal water.
- Planting the cotton at proper time, late planting should be avoided to minimize the yield losses and virus infestation.

Recommendation of cotton varieties for general cultivation

- Recommendation of *Bt*. & Non *Bt* cotton varieties for general cultivation in core and non-core cotton areas of the Punjab

Bt Varieties	Non-Bt Varieties
Bt. CIM-632, *Bt*.CIM-598, *Bt*.CIM-599, *Bt*.CIM-602, *Bt*. Cyto-177, *Bt*. Cyto-178, *Bt*.CIM-600, *Bt*.cyto-179, IR-3701, IR-1524, IR-NIAB-824, FH-118, FH-142, MNH-886, VH-259, IUB-222, BH-178, IUB-2013 Tarzan-1, Tarzan-2, Sitara-008, Sitara-11M, A-555, Saiban-201.	CIM-610, CIM-620, Cyto-124, CIM-496, CIM-506, CIM-554, CIM-573, NIAB-777, NIAB-Kiran, NIAB-112, FH-942, MNH-786, CRSM-38, SLH-317, BH-187, NIBGE-115, NIAB-852, NIAB-846, GS-1.

- Always purchase 10% more cotton seed than required for re-planting in case of any damage to planting or lower germination.
- Always plant 10-20% area with Non-Bt along with Bt varieties, as refuge crop, to avoid development of resistance in insects.
- Always use delinted seed. One litre concentrated commercial sulphuric acid is sufficient for delinting 10 kg fuzzy cotton seed. Wash thoroughly and dry the seed under the sunlight. Always store cotton seed in gunny bags or cotton cloth bags in such a way that air could pass across the bags from bottom to top. Avoid the storage cotton seed in plastic bags.
- Check seed germination before planting. Use delinted seed @ 6-8 kg/acre with 75 percent germination for flat planting. Adjust seed rate according to germination percentage.
- Ensure that seed drill is in perfect condition and will drop the seed uniformly at appropriate depth for perfect emergence of cotton seedlings.
- Optimum sowing time for Southern Punjab is from 1st April to 31st May. The yield decreases drastically in June planting. Planting up to May 15th should be preferred. It gives better yield than late planting.
- Ensure 23,000-25,000 plants per acre for obtaining profitable yield.

THINNING

- Thinning should be completed after dry hoeing and before first irrigation in flat planting (conventional) by allowing 9-12" plant to plant distance within the lines to obtain 17000-23000 plants per acre. On bed-furrow planting, thinning should be completed when plants are 10cm (4") in height. Remove weak or virus affected plants.
- A uniform early good crop stand ensures profitable cotton production.

WEED CONTROL

- The first 40-70 days after sowing are crucial and growth of weeds is faster than cotton plant, therefore, all possible measures should be adopted to control weeds.
- Use of pre-emergence herbicides save the crop from early weed infestation when the crop does not permit mechanical hoeing operations.
- S-Metalacholar 960 EC and Acetachlor 50EC should not be incorporated in the soil at sowing time. They cause mortality of cotton seedlings during germination. These herbicides are used on bed-furrow planting as surface application within 24 hours of sowing/irrigation on moist soil.
- Pendimathelin 330 EC can be used as pre-emergence herbicide in flat planting at seed bed preparation by incorporating into soil at 5 cm depth.
- Pendimathelin 330 EC can be used in bed-furrow planting in dry condition before sowing.
- Glyphosate 490 G/L @ 4.7 lit ha^{-1} can be used as post-emergence weedicide provided the cotton plants are protected with shield.
- Grasses especially “*Swanki*” and “*Madhana*” at 3 to 4 leaf stage can be controlled by spraying Haloxifop @ 400ml/ac as post-emergence without protecting the cotton plants. Haloxifop can be used

RETIREMENTS

Mr. Muhammad Amin Tubewell Operator
09.06.2018

Mr. Qaswar Hussain, Driver
09.06.2018

Syed Zameer Abbas, Lab Technician
11.11.2018

Mr. Abdus Sattar, Lab, Asst. 04.01.2019
Mr. M. Saddiqu, Lab Attd. 14.02.2019

more than one time at any growth stage of cotton plant. No phyto-toxicity was observed on crop by the spray of said herbicide.

- In flat planting, interculturing is very effective for weed eradication at early stage. After every shower of rain, and irrigation when the fields attain '*wattar*' conditions (workable condition) hoeing should be done and this practice should be continued as long as the crop permits. After every interculturing, weeds which could not be eradicated by interculturing must be removed manually and the crop should be earthed up during the last interculturing operation

IRRIGATION

- For flat (conventional) planting, apply first irrigation 30-40 days after sowing keeping in view the variety, soil type, crop and weather conditions. Subsequent irrigation should be applied at 12-15 days interval. There should be no water stress to the crop from 1st August to end of September. Apply that quantity of irrigation water which should be absorbed by the soil within 24 hours. Water standing in field after 24 hours results fruit shedding. Be sure that white flower should not appear at the top of the plant which is an indication of water stress to the crop especially before the month of September.
- In bed-furrow planting, after the irrigation for germination, subsequent irrigations should be given at 8-10 days interval.
- Last irrigation must be applied in mid of October to avoid delay in crop maturity and late season pest attack.
- In case of excessive vegetative growth, mepiquat chloride @ 400 ml per acre in 3-4 split doses (if needed) during the months of July and August may be used to regulate the plant growth and enhance fruit bearing.

FERTILIZER

- Fertilizers should be used on the basis of soil test reports. For the soils showing available phosphorus less than 10 ppm, use 100-150 kg P_2O_5 per hectare at the time of planting or after thinning. If possible, mixing of phosphate fertilizer with farmyard manure in 1:2 ratio improves its efficiency. Use 50 kg K_2O per hectare at planting, to soils showing available potassium less than 125 mg kg^{-1} soil.
- Cotton-wheat is the major cropping pattern in the cotton area. Farmers should also use recommended levels of phosphorus and potassium fertilizers for wheat crop.
- In normal season planting, 150-200 kg N per hectare should be applied in split doses and fertilizer application should be completed by the time the crop makes canopy or by mid-August. Excessive use of nitrogen does not improve the yield but attracts the pests, delays the crop maturity and adds up cost of production.
- To improve the efficiency of nitrogen, phosphorus and potassium fertilizers, these may be applied in split doses. Band placement or fertigation of phosphorus in splits is more efficient than the broadcast at time of sowing.
- The crop showing deficiency of nitrogen late in the season can be sprayed in morning/evening with 3% urea solution (3 kg urea per 100 litre water) but it should not be mixed in the insecticide spray.
- Fertigation (fertilizer solution dripping into irrigation water) of nitrogenous fertilizer is also a useful method to apply nitrogen during the cropping season but its efficacy is more in leveled fields.
- The adverse effects of water shortage in cotton crop may be minimized by the application of phosphorus and potassium fertilizers.
- Gypsum as a source of sulphur may be added @ 50-100 kg per hectare in light textured and saline-sodic soils to correct sulphur deficiency syndrome.
- Three-four foliar sprays of boron and zinc @ 0.05% solution [(250g zinc sulphate with 21% Zn, 300g boric acid)/ per 100 litre water] should be done to improve fruiting.
- Mixing of 2% urea in the spray tank along with B and Zn nutrients enhances the efficacy of foliar spray.
- Potassium application through foliar sprays of 2% KNO_3 or K_2SO_4 (soluble potash) solution improves yield over non-sprayed crop and minimizes the adverse effects of biotic and abiotic stresses.

- Half of the recommended dose of NPK fertilizers i.e. 75N+25P_2O_5+25K_2O kg ha^{-1} is as effective as recommended dose (150N+50P_2O_5+50K_2O kg ha^{-1}) when applied in conjunction with poultry broiler litter.
- Seed priming and subsequent foliar sprays of amino acid proline @ 0.1% increases cotton health and production. The efficiency of proline is further increased by addition of B & Zn in foliar sprays.

FRUIT SHEDDING

- Fruit shedding results either due to natural adversaries like high temperature coupled with high relative humidity, cloudiness, and intermittent rains or due to insufficient nutrition, excessive or shortage of water and pest attack.
- Take care of nutritional deficiency, irrigation, pests and don't worry about natural shedding.

PLANT PROTECTION

- Keeping in view the losing efficacy of *Bt* cotton against pink bollworm, farmers are advised to plant cotton not before the 1st April.
- Always use seed delinted with sulphuric acid to avoid carryover of pink bollworm residing in double seed
- Seed treatment with insecticide ensures better crop growth and saves it from sucking pests at early stage.
- The first spray should be delayed as long as crop tolerates pests so that predators and parasites could play their role to suppress the pest population.
- Pyrethroids or their combinations should be avoided at early stage of the crop.
  Pesticides application should be on the pest scouting basis at the following economic threshold levels (ETL).
- Insect growth regulators (IGRs) are most effective against whitefly at immature stages (whitefly nymphs).
- Leftover bolls are the main source of pink bollworm for the next cotton crop. Therefore, the cotton field should be grazed after picking to reduce the number of left over bolls. It is better if the cotton sticks are shredded and incorporated into the soil which will improve the physical condition of the soil.
- In case the cotton sticks are to be kept for fuel purpose, these should be kept in bundles and top portion should be directed towards sun and should be used by mid-February.
- Spray machines must be perfectly in order and properly calibrated. Use hollow cone nozzles with uniform flow rate, fine mist and keep the nozzle at 1.5 to 2 feet height from the plant canopy to ensure better coverage of the crop.
- Use right dose of right insecticide at appropriate time with clean water for better results. Spray in the morning or late in the afternoon. Do not spray when rain is expected. If the rain has affected spray application, it should be repeated. Pest scouting should also be done after 3-4 days of spray to assess efficacy of the pesticide.

Economic Threshold Levels of Different Pests

Name of insects	Economic threshold levels
Jassid	1-2 adults/nymphs per leaf
Whitefly	5 adults/nymphs or both per leaf
Thrips	8-10 adults/nymphs per leaf
Spotted bollworm	3 larvae/25 plants
Pink bollworm	5 % bolls damage
American bollworm	5 brown eggs or 3 larvae or collectively 5/25 plants
Armyworm	Localized chemical treatment

CONTROL OF DISEASES

- The seed should be treated with fungicides for seed rot and seedling diseases during early planting.
- Previous year's cotton stubs should be removed from the fields. The reason being that new sprout from diseased stubs is the source of Cotton Leaf Curl Virus (CLCuD) transmission to the newly planted crop.
- Always plant more than one virus resistant/tolerant variety to create genetic barrier.
- Use healthy and delinted seed.
- Avoid the late planting of cotton to minimize the CLCuD incidence.
- The seed should also be treated with systemic insecticide to protect the crop against whitefly which is the vector of CLCuV.
- Whitefly is the vector of CLCuD. It should be managed and controlled at economic threshold level.
- Reduce the whitefly population during mid-June to end-August and other pests to manage CLCuD.
- The diseased and weak seedlings should be removed at thinning stage and buried.
- Weeds in and around cotton fields, water channels and field bunds should be eradicated. Reduce the whitefly population during mid-June to end of August and other pests to manage CLCuD.
- Judicious use of fertilizer and irrigation helps in the management of CLCuD.
- Application of fertilizer and irrigation should be given in accordance with recommendations. Excessive use of these inputs increases the incidence of boll rot of cotton.

PICKING & STORAGE

- Seed cotton on the plant is a precious silver fiber. Maintaining its quality during picking, storing and transportation from field or store to the ginning factories is helpful to get quality price.
- Start picking when 60-70% bolls are opened. Avoid picking under adverse weather conditions when the sky is cloudy or rain is expected. After rain, pick seed cotton when it is dry.
- Do not start picking early in the morning when there is dew on the crop. Let the dew dry and then start picking.
- Start picking from the bottom to the top. Pick fully opened and fluffy bolls. Seed cotton should be free from weeds and crop trash.
- Use cotton cloth bags for transportation. Do not use plastic or gunny bags.
- Do not place cotton on moist soils in the field.
- Store the seed cotton in ventilated stores in heaps of pyramid shape for proper aeration. The floor of the store should be of concrete and dry.
- Moisture content in the seed cotton should be less than 12% otherwise the seed cotton will heat up subsequently deterioration the quality of lint cotton seeds.

VIII. PUBLICATIONS

a) International

1. Adem Bardak, Khezir Hayat, Zahid Mahmood, Mehboob-ur-Rahman, Muhammad Atif Iqbal, Halil Tekerek. 2017. Genetic Mapping of cotton (Accepted for publication). Intech Publishers for Book entitled as “Cotton” edited by Dr. Mehboob-ur-Rahman & Dr. Yusuf Zaffer. ISBN 978-953-51-5817-2. 2.
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c) Proceeding of International Conference

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2. Asia Perveen, Fiaz Ahmad, Noor Muhammad and Zahid Mehmood. 2018. An assessment of morphological and physiological indicators of thermotolerance in field grown cotton, p27. In proceedings of international conference on Climate Smart Agriculture: The way of farming for 21st Century" held at MNSUA from 8-9 October, 2018.
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4. Muhammad Naeem Akhtar, Tanveer-ul-Haq, Fiaz Ahmad, Wazir Ahmed, Abdul Ghaffar and Muhammad Imran. 2018. Exploring genotypic variation in cotton (Gossypium hirsutum L.) for K use efficiency in

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6. Noor Muhammad, Fiaz Ahmad Ali Raza Khan, Khurram Shahzad, Naeem Akhtar, Asia Parveen and Imran Haider Shamsi. 2018. Does there exist a natural detoxification mechanism between aluminum and manganese in acidic soils?, p47. In proceedings, 1st International Conference on “Soil and Crop Health in Changing Climate” held at MNSUA, from 28-29 November, 2018.

d) Training

i) Mr. Muhammad Tariq, Scientific Officer, Agronomy Section attended two-days training program on “Climate Modeling, Projections Generation and Data Analysis” held at MNSUA, Multan from September 5-6, 2018.

TRAVELING SEMINAR 2018

Participants of the PCCC Cotton Traveling Seminar 2018 visited CCRI Multan on October 21, 2018.

Annexure-I

Comparative Monthly Meteorological Data Recorded at CCRI, Multan during 2017 and 2018

Month	Air Temperature (°C)				Relative Humidity				Average Wind Speed (Km h^{-1})		Rainfall (mm)		Evapo-transpiration (cm day)		Soil Temperature (°C)	
	Minimum		Maximum		Minimum		Maximum								0 cm	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
January	8.5	7.6	17.0	19.7	60	73	98	93	6.7	3.2	11.7	0.0	0.16	0.29	12.4	9.3
February	11.1	12.2	21.8	22.8	62	65	91	86	3.4	4.9	11.0	6.8	0.31	0.39	15.4	13.7
March	16.6	16.7	26.9	30.3	58	63	79	79	4.3	5.0	0.0	0.0	0.51	0.58	21.2	21.0
April	22.8	22.8	37.2	36.1	51	47	56	67	5.5	6.6	5.7	3.0	0.98	0.97	28.5	27.2
May	28.3	27.8	39.7	38.6	57	41	69	64	6.7	6.6	0.1	4.0	1.12	1.10	32.6	31.6
June	28.7	30.3	37.5	38.9	69	52	80	78	7.5	7.2	45.6	2.0	1.09	1.09	33.2	34.6
July	30.0	29.8	37.3	36.6	67	59	79	84	7.2	6.7	4.9	9.0	1.15	0.99	35.3	34.5
August	28.4	28.9	35.2	35.9	60	68	85	83	7.7	6.3	30.0	2.0	0.99	0.97	34.9	34.1
September	25.8	24.8	35.4	34.9	65	66	89	88	4.3	4.9	10.0	0.0	0.77	0.88	30.3	31.5
October	20.3	16.8	33.7	29.3	66	66	89	84	2.4	2.9	0.0	0.0	0.80	0.64	25.4	24.0
November	13.8	9.6	22.2	28.2	70	70	93	94	2.7	2.3	4.2	0.0	0.20	0.42	16.3	17.2
December	8.9	7.3	20.4	21.2	59	72	91	99	2.1	2.8	16.0	0.0	0.22	0.26	10.1	11.0

Annexure-II

List of Officers at Central Cotton Research Institute, Multan (2018-19)

Discipline/ Designation	Incumbent	Qualification	Effective Date
DIRECTORATE			
Director	Dr. Zahid Mahmood	M.Sc. (Hons.) Agri., Ph.D	01.02.17
Farm Officer	Mr. Muhammad Azam Mian	M.Sc. (Hons.) Agri.	17.03.10
Administrative Officer	Mr. Zakirullah Khalidi	B.A.	20.05.14
Accountant	Mr. Nazir Ahmad[1]	B. Com.	11.12.00
APS	Mr. Zahid Khan	B.Com., M.A. (Economics)	02.02.14
Superintendent	Tahir Abbas Shamsi	B.A.	21.04.16
Superintendent	Nazar Abbas	B.A.	21.04.16
AGRONOMY			
SSO	Dr. Muhammad Naveed Afzal	M.Sc. (Hons.) Agri., Ph.D.	20.05.14
SO	Dr. Muhammad Ahmad	M.Sc. (Hons.) Agri., Ph.D.	05.05.16
SO	Mr. Muhammad Tariq	M.Sc. (Hons.) Agri.	29.05.14
BREEDING AND GENETICS			
SSO	Dr. Muhammad Idrees Khan	M.Sc.(Hons). Agri., Ph.D	20.05.14
SO	Mr. Muhammad Akbar	M.Sc. (Hons.) Agri.	17.03.10
SO	Mr. Khadim Hussain	M.Sc. (Hons.) Agri.	17.03.10
SO	Hafiz Abdul Haq	M.Sc. (Hons.) Agri.	14.05.14
SO	Mr. Saeed Muhammad	M.Sc. (Hons.) Agri.	16.05.14
SO	Dr. Fazal-i-Dayam Shehzad	M.Sc. (Hons.) Agri., Ph.D	15.05.14
CYTOGENETICS			
SO	Mrs. Farzana Ashraf	M.Sc. (Hons.) Agri.	22.03.10
SO	Dr. Khezir Hayat	M.Sc. (Hons.) Agri., Ph.D.	22.03.10
SO	Hafiz Muhammad Imran	M.Sc. (Hons.) Agri.	16.05.14
SO	Mrs. Rashida Aslam	M.Sc. (Hons.) Agri.	15.05.14

[1] On ex-Pakistan leave from 20.01.16

Discipline/ Designation	Incumbent	Qualification	Effective Date
ENTOMOLOGY			
SO	Dr. Rabia Saeed	M.Sc. (Hons.) Agri., Ph.D.	17.03.10
SO	Syed Ishfaq Ali Shah[2]	M.Sc. (Hons.) Agri.	22.03.10
SO	Mrs. Shabana Wazir	M.Sc. (Hons.) Agri.	14.05.14
SO	Mr. Junaid Ali Khan	M.Sc. (Hons.) Agri.	21.12.17
PLANT PATHOLOGY			
SSO	Mrs. Sabahat Hussain	M.Sc. (Hons.) Agri.	20.05.14
PLANT PHYSIOLOGY / CHEMISTRY			
SSO	Dr. Fiaz Ahmad	M.Sc. (Hons.) Agri. Ph.D. (UK)	20.05.14
SO	Mrs. Asia Parveen	M. Phil (Biochemistry).	18.03.10
SO	Mr. Noor Muhammad	M.Sc. (Hons.) Agri.	15.05.14
FIBRE TECHNOLOGY			
SO	Mr. Muhammad Ilyas Sarwar	M.Sc. Fibre Technology	14.05.14
SO	Mr. Danish Iqbal	M.Sc. Fibre Technology	19.05.14
TRANSFER OF TECHNOLOGY			
SO	Mr. Sajid Mahmood	M.A. (Mass Comm.)	11.12.06
Network Administrator	Mr. Muhammad Naveed Arshad	MS (Computer Science)	11.08.14
STATISTICS			
SO (Marketing)	Mr. Mubashir Islam Gill	M.B.A.	08.12.06

[2] Study Leave from 01.09.15

SSO : Senior Scientific Officer **SO :** Scientific Officer **APS:** Assistant Private Secretary

VISITOR'S BOOK

CENTRAL COTTON RESEARCH INSTITUTE, MULTAN.

Name	Address	Remarks if any
AZFAR MANZOOR	NIMS, LAHORE	It was a wonderful visit, a great learning experience for the participants and institute is doing an excellent work in the area.
Lubna Said Ghias PAS. Lubna:	NIMS, Islamabad. 26th MCMC.	Quite an enriching experience. We were exposed to extensive research work and endeavours undertaken by CCRI, Multan. It not only acquainted us with the issues in cotton production but also enlightened us about the potential of the sector. Being future policy makers, we have developed an insight into the issues and would surely incorporate the pro-agriculture & pro-farmer policies, ~~be~~ in future, with special focus on the input of R&D institutes.
	Dr. Faheem Jahangir Khan. DS, NIMS. Islamabad. 18/Oct/18	

VISITOR'S BOOK

CENTRAL COTTON RESEARCH INSTITUTE, MULTAN.

Name	Address	Remarks if any
DR. Hashmi Popalzai	Secretary M/O NFS&R	Excellent visit to see the Institute conducting research. Need to improve the dissemination of the Research. 30/12/18

March 01, 2019
Mr. Bilal Israel Khan (khan.mrbilal@gmail.com)

Today I and my son, Ibrahim Bilal Khan, visited with Dr. Zahid Mehmood at CCRI, and it was one of the best couple of hours I have ever spent in a Pakistani research institute. Of course CCRI has been here for ages, and I have been here countless times, and coming since innumerable years.. So obviously the main difference this time was entirely due to the company of Dr. Zahid. Even though the good Doctor has been around on the cotton scene for dozens of years, this was the first time I really got the opportunity to see his work, and get a glimpse into his commitment to duty, his passion for relevant research, enthusiasm to see progress in the production of cotton in the country, and carrying out endeavors beyond the call of Duty and expected requirement.

I saw how he is doing pioneering work in the introduction of not merely mechanical picking, but at the same time developing varieties suitable for mechanical harvesting. Good quality, high yielding cultivars are the burning need of the sector at present, and in this department Dr. Sb is also doing commendable work.

It was also nothing less than fascinating to see his research activities in the field of resistance management of various cotton pests. For the first time in my life I saw today, under the microscope, eggs of the pink boll worm, and also the newly hatched larvae. Those larvae are about the smallest insect that may be visible to the naked eye! And these worms enter the cotton bolls almost immediately after emerging from the eggs, after which they naturally become protected from, and impervious to every known insecticide.

Also, I have been dealing with the cotton mealy bug ever since its first appearance, but saw for the first time the great difference in size and shape of the males and females. Also saw work being carried out on all the other major pests. On another note it should be mentioned that without official help he has also managed to construct a beautiful, large masjid for the institute, which I am sure will be pleasing to Allah (Subhanhu wa Ta'ala), and be instrumental in blessing his efforts with barkat and good fortune. With our unfortunate national psyche of professional jealousy, laziness and an element of dishonesty, a director needs lots of help from Allah Ta'ala to succeed effectively in advancement of good works. My prayers go out for Dr. Zahid Mehmood, that may Allah always guide him on the Right Path, and award him excellent success in all projects which he undertakes. Aameen. Inn Shaa Allah.

I am very much obliged to him for sparing so much of his precious time to educate me on the various aspects of the efforts he is making for the successful reincarnation of cotton in Pakistan.

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